Net view map for the active management of markers on Mobile devices

FINAL DEGREE REPORT

Author: Jaume López Gasset
Director: Hermini Corton Gruñeiro
Professor: Xavier Martorell Bofill
Speciality: Software Engineering
Date: 19th October 2015
Content index

1. Introduction and state of the art ................................................................. 9
   1.1 Problem formulation ........................................................................... 9
   1.2 State of the art .................................................................................. 9
      1.2.1 Context ...................................................................................... 10
      1.2.2 Stakeholders ............................................................................. 14
      1.2.3 Market study ............................................................................ 15
      1.2.4 Conclusions ............................................................................. 18

2. Project extension ...................................................................................... 19
   2.1 Phases of the project .......................................................................... 19
   2.2 Possible problems ............................................................................. ¡Error! Marcador no definido.
   2.3 Methodology and rigour ..................................................................... 21
      2.3.1 Working methodology ................................................................ 21
      2.3.2 Monitoring tools ......................................................................... 21
      2.3.3 Checking method ......................................................................... 21

3. Working plan ......................................................................................... 22
   3.1 Tasks description ................................................................................ 22
   3.2 Specification of the tasks .................................................................... 22
      3.2.1 Project plan ................................................................................ 22
      3.2.2 Information research ................................................................. 22
      3.2.3 Analysis and design .................................................................... 23
      3.2.4 Building phase 1: Implement of Android app .............................. 23
      3.2.5 Building phase 2: Implementation of the alert server ................. 24
      3.2.6 Building phase 3: Configuration of Google server ....................... 24
      3.2.7 Checking ...................................................................................... 24
      3.2.8 Finishing the written project ....................................................... 25
      3.2.9 Preparing the TFG defence ......................................................... 25
   3.3 Project plan ........................................................................................ 25
      3.3.1 Timing ......................................................................................... 26
      3.3.2 Changes related to initial plan ..................................................... 26

4. Economical management ........................................................................ 29
   4.1 Identification and costs estimations ................................................... 29
1. Net view map for the active management of markers on Mobile devices (Android)

2. Management control

3. Sostenibility and social agreement

4. Technological study and decision-making

5. Map

6. Geolocation alerts

7. Requisits model

8. Functional requisits – Use cases

9. Non-functional requirements

10. Appearance requirements

11. Style requirements

12. Easy using requirements

13. Learning requirements

14. Comprehension or courtesy requirements

15. Reliability and availability requirements

16. Capacity requisits

17. Productivity requirements
7.2.10 Physic environment that has been planned ...................................................... 48
7.2.11 Support requirements ....................................................................................... 48
7.2.12 Adaptability requirements ............................................................................... 49
7.2.13 Acce requires.................................................................................................... 49
8. Conceptual model ................................................................................................. 50
8.1 Classes diagram .................................................................................................... 51
8.2 Primary key restrictions ....................................................................................... 52
8.3 Other restrictions ................................................................................................. 52
9. Use case models .................................................................................................... 53
9.1 Use case 1: Viewing and navigate on the map ....................................................... 53
9.2 Use case 2: See basic information of an element ................................................... 53
9.3 Use case 3: Search the alert ................................................................................ 54
9.4 Use case 4: Consulting an alert .......................................................................... 54
9.5 Use case 5: Alert management ........................................................................... 55
9.6 Use case 6: Search for a marker ........................................................................ 56
9.7 Use case 7: Consult a marker ............................................................................ 57
9.8 Use case 8: Manage the marker ......................................................................... 57
9.9 Use case 9: Manage alert subscriptions ............................................................... 59
9.10 Use case 10: Manage preferences ..................................................................... 59
9.11 Use case 11: Filter the layer viewing of the map ................................................ 60
9.12 Use case 12: Select a base map to be shown ..................................................... 60
10. Logic model ........................................................................................................... 61
10.1 Pattern model ..................................................................................................... 61
10.1.1 Use case 1: Viewing and navigate on the map ............................................... 62
10.1.2 Use case 2: See the basic information of a graphical element ...................... 63
10.1.3 Use case 3: Search the alert .......................................................................... 65
10.1.4 Use case 4: Consulting an alert .................................................................... 65
10.1.5 Use case 5: Manage an alert ........................................................................ 66
10.1.6 Use case 6: Search a marker ........................................................................ 71
10.1.7 Use case 7: Consult a marker ....................................................................... 71
10.1.8 Use case 8: Manage the marker ................................................................. 72
10.1.9 Use case 9: Manage the subscribed alerts .................................................... 75
10.1.10 Use case 10: Manage preferences ................................................................. 77
10.1.11 Use case 11: Screen the layer viewing of the map ........................................ 80
10.1.12 Use case 12: Select the base map to show .................................................. 81
10.2 Design patterns ................................................................. 81
  10.2.1 MVC-MVP ................................................................. 82
  10.2.2 ViewHolder ................................................................. 82
  10.2.3 Factory ................................................................. 82
  10.2.3 Adapter ................................................................. 82
  10.2.4 Builder ................................................................. 82
  10.2.5 Singleton ................................................................. 82
11. Deployment model ................................................................. 83
12. Presentation model ................................................................. 84
  12.1 Principal screen ................................................................. 84
  12.2 Interaction with the elements of the map ........................................ 85
  12.3 Creating alerts – by radius (circle) ........................................ 86
  12.4 Browser ................................................................. 87
13. Implementation model ................................................................. 88
  13.1 Introduction ................................................................. 88
  13.2 Graphic interface ................................................................. 88
    13.2.1 Principal screen ................................................................. 88
    13.2.2 Interaction of the elements of the map ........................................ 89
    13.2.3 Available options ................................................................. 91
    13.2.4 Alerts creation ................................................................. 91
    13.2.5 Subscriptions ................................................................. 94
    13.2.6 Browser ................................................................. 95
    13.2.7 Manage the layers ................................................................. 96
    13.2.8 Preferences ................................................................. 96
  13.3 Parts of the system ................................................................. 97
    13.3.1 Programming environment ................................................ 97
    13.3.2 Programming language ................................................ 97
    13.3.3 Principal library ................................................................. 97
    13.3.3 External libraries ................................................................. 98
  13.4 Internal functioning ................................................................. 98
14. Tests ................................................................................ 100
15. Conclusions........................................................................ 103
  15.1 Objective resolution ................................................................. 103
  15.2 Changes on the planning ................................................................. 103
  15.3 Budget changes ......................................................................... 103
15.4 Future improvements ................................................................. 104
15.5 Personal opinions .................................................................. 104
Annex 1 – Initial Gantt diagram .......................................................... 106
Annex 2 – Gantt diagram with the first planning changes ..................... 107
Annex 3 – Gantt diagram with the last planning changes ..................... 108
References .................................................................................... 109

Pictures Index
1. Devices connected to Internet around the world .................................. 9
2. Graphic definition of geographical information system ..................... 10
3. Geographical coordinating system .................................................. 11
4. Geographical projections ................................................................ 12
5. UTM Zones .................................................................................. 13
6. Google Now ................................................................................ 15
7. Foursquare App .......................................................................... 16
8. Map with the Collector for ArcGis app datum ................................... 17
9. GeoChase App ............................................................................ 18
10. System structure ........................................................................ 20
11. App to manage the amount of hours related to this project .............. 34
12. Google Maps ............................................................................. 36
13. ArcGis Runtime SDK for Android ................................................ 37
14. OpenLayers ............................................................................... 38
15. Android Geofences ..................................................................... 39
16. GeoTrigger ESRI ....................................................................... 39
17. GeoFire .................................................................................... 40
18. Class Model ............................................................................... 52
19. Sequence diagram of the Use case 1 – view map .............................. 63
20. Sequence diagram of the Use case 1 – navigate map ....................... 64
21. Sequence diagram of the Use case 2- get information of the selected alert ........................ 64
22. Sequence diagram of the Use case 2- get information of the selected marker ........................ 65
23. Sequence diagram of the Use case 3 – search an alert ................... 65
24. Sequence diagram of the Use case 4 – consult an alert .................... 66
25. Sequence diagram of the Use case 5 – create an alert ..................... 67
26. Sequence diagram of the Use case 5 – create an alert ..................... 67
27. Sequence diagram of the Use case 5 – modify an alert ................... 69
28. Sequence diagram of the Use case 5 – modify an alert 2 .................. 70
29. Sequence diagram of the Use case 5 – remove an alert ................... 71
30. Sequence diagram of the Use case 5 – remove an alert 2 .................. 71
31. Sequence diagram of the Use case 6 – search a marker .................. 72
Net view map for the active management of markers on Mobile devices (Android)

32. Sequence diagram of the Use case 7 – consult a marker ................................................................. 72
33. Sequence diagram of the Use case 8 – create a marker ................................................................. 73
34. Sequence diagram of the Use case 8 – create a marker 2 ............................................................ 73
35. Sequence diagram of the Use case 8 – modify the marker ............................................................ 74
36. Sequence diagram of the Use case 8 – modify the marker 2 .......................................................... 74
37. Sequence diagram of the Use case 8 – remove a marker ............................................................... 75
38. Sequence diagram of the Use case 9 – Subscribe an alert ............................................................. 76
39. Sequence diagram of the Use case 9 – remove an alert subscription ............................................... 77
40. Sequence diagram of the Use case 9 – change the category of the label ......................................... 77
41. Sequence diagram of the Use case 10 – activate notifications ...................................................... 78
42. Sequence diagram of the Use case 10 – deactivate notifications .................................................. 78
43. Sequence diagram of the Use case 10 – activate the map rotation .................................................. 78
44. Sequence diagram of the Use case 10 – deactivate the map rotation ............................................. 79
45. Sequence diagram of the Use case 10 – activate scroll infinite map ............................................... 79
46. Sequence diagram of the Use case 10 – deactivate scroll infinite map .......................................... 80
47. Sequence diagram of the Use case 10 – activate tracking sequence .............................................. 80
48. Sequence diagram of the Use case 10 – deactivate tracking ......................................................... 80
49. Sequence diagram of the Use case 10 – change the following profile ........................................... 81
50. Sequence diagram of the Use case 11 – activate layer visibility ....................................................... 81
51. Sequence diagram of the Use case 11 – deactivate the layer view .................................................. 82
52. Sequence diagram of the Use case 12 – change the base map ....................................................... 82
53. Deployment model .......................................................................................................................... 84
54. Model presentation – Principal screen ............................................................................................ 85
55. Model presentation – Interaction map 1 ........................................................................................... 86
56. Model presentation – Interaction map 2 ........................................................................................... 86
57. Presentation model – creating alerts ................................................................................................. 87
58. Presentation model – creating alerts 2 ............................................................................................. 87
59. Presentation model – browser .......................................................................................................... 88
60. Implementation model – principal screen .......................................................................................... 90
61. Implementation model – get alert information .................................................................................. 90
62. Implementation model – select an alert ............................................................................................. 91
63. Implementation model – select an alert 2 ......................................................................................... 91
64. Implementation model – Available options ..................................................................................... 92
65. Implementation model – geometrical selection ................................................................................. 93
66. Implementation models – draw an alert ............................................................................................ 93
67. Implementation model – draw an alert with accuracy ......................................................................... 94
68. Implementation model – alert creating form ..................................................................................... 94
69. Implementation model – Subscription’s screen .................................................................................. 95
70. Implementation model – alert browser ............................................................................................. 96
71. Implementation model – Markers' browser ......................................................................................... 96
Tables Index

1. Implementation model – manage the layers ................................................................. 97
2. Implementation model – Preferences screen ............................................................... 97

1. Amount of hours .......................................................................................................... 26
2. Hardware resources of the project ............................................................................... 28
3. Software resources of the project ............................................................................... 28
4. Human resources salaries ......................................................................................... 30
5. Human resources costs of the project ........................................................................ 30
6. Hardware costs of the project ..................................................................................... 31
7. Software costs of the project ....................................................................................... 31
8. General costs ............................................................................................................... 32
9. Final budget ................................................................................................................ 33
10. Hardware costs of the projects with the last changes ................................................. 33
11. Total budget with the last changes ............................................................................. 33
12. First line of the sustainability matrix of this TFG ....................................................... 35
13. Uses cases .................................................................................................................. 42
14. Appearance requirements .......................................................................................... 43
15. Style requirement 1 .................................................................................................... 44
16. Style requirement 2 .................................................................................................... 44
17. Easy using requirements ........................................................................................... 45
18. Learning requirements ............................................................................................... 45
19. Comprehension or courtesy requirements .................................................................. 46
20. Reliability and availability requirements 1 ................................................................ 46
21. Reliability and availability requirements 2 ................................................................ 47
22. Capacity requirements ............................................................................................... 47
23. Productivity requirements .......................................................................................... 48
24. Physic environment requirements .............................................................................. 49
25. Support requirements ............................................................................................... 49
26. Adaptability requirements .......................................................................................... 50
27. Acces requirements .................................................................................................... 50
28. Primary key restrictions ............................................................................................. 53
29. Results of the test about the notifications that have arrived ....................................... 101
1. Introduction and state of the art

1.1 Problem formulation

During the last years, the world related with technologies has changed according to people and business necessities. New mobile devices like mobile telephones, tablets, intelligent watches... have helped to develop technologies related to communication.

Another fact to bear in mind related to the technological evolution is that, nowadays, Internet has become an important tool. There are more than 10.000 million of different kind of devices connected to it. Users use Internet to achieve different targets like searching for information, to keep in contact with other users, to buy different kind of stuff...

Thanks to the big expansion that has appeared as a consequence of mobile devices, lots of different apps have appeared to give useful solutions to the users, taking advantage of the net connection. Nowadays, the tendency is to create solutions to make user’s life easier, to provide automatic tools to minimize the interaction with the device, the main point of this is to make sure that the user feels comfortable and safe.

Thinking about all this elements, the next step related to devices evolution are apps aware of the context, that is to say apps that provide information to the user related to where they are.

Many enterprises need a mobile app to manage markers represented on a map, but they need that app to be aware with the context, saying useful information when they get into a specific zone by shooting an alarm when the device changes its position. And they also need that device to be able to process the information and to communicate that information through automatized and personalized notifications.

These ideas are also applicable to the common user, an example could be a mother that wants to know when his child has arrived home, or another uses related to local...
promotions, information related to places and tourism and information related to traffic. This idea could also be applied to not mobile devices like domotics, to turn on, turn off or to configure different home elements. An example could be that the lights of a house could turn off when there is anyone inside, or to turn on the heater before arriving home, everything thinking about what the user needs.

All this statements are the reasons for the main objective of this project. The main target is to offer a mobile app to visualize and to manage markers actively, to manage different kind of alarms taking care of the context in which these are required and to personalize all this points taking care of user’s necessities.

1.2  State of the art

1.2.1 Context

As we have seen during last sections, the creation of this project is based on a concrete informatics system, the Geographical Information System (GIS). During this project this terminology is used, and that is the reason why it is important to define this term and some of the concepts related to it. Moreover, this project will be done using a technology and some elements that will also be contextualized to help the reading comprehension when reading this work.

Some of these concepts are listed here:

- **GIS**

  The acronym GIS is referred to a geographical information system. GIS is defined as a group of tools that integrates and relates different components (Picture 2) to manage, analyze and visualize geographical knowledge.

A GIS system is able to integrate, to accumulate, to edit, to analyze, to share and to display geographically referenced. That is to say, that users can use a GIS system as a tool to
search information, to analyze special information, to edit the datum, to draw maps and to represent the results of all of these operations.

The GIS system works as a database with the geographical information, and it is connected through and identifier with the graphics of a map. Thanks to this, a GIS system can do complex tasks quick and efficiently like the geolocalisation or generating routes do.

- **GEODATABASE**

  A Geodatabase makes reference to a concrete system of database management (SGBD) that allows to keep and manipulate physically the geographical information. The geographical datum that can be represented are points, lines or polygons.

  But a Geodatabase is not only to manage geographical information, is also for special information. Apart from catching geographical information from the elements, special information can be consulted, and it is possible to calculate the distance between two elements, the intersection among different elements...

- **COORDINATE SYSTEM**

  A main point related to a GIS system that is important to know is which coordinates system must be used to represent a map. Even that is a large topic, the most important thing referred to our project is to know that a coordination system is basically a way of representing the Earth on a map. Two different kinds of coordination systems exist:

  A. **Geographical**

      Geographical system is a tridimensional Cartesian system, in which latitude and length of a point are represented through angles that have been measured from the center of the Earth to the point located on the surface. It is used to represent the whole Earth because this system is able to locate any point through its latitude and its length.

      ![Image of Geographical Coordinating System](image.png)

      Picture 3. Geographical coordinating system

  B. **Projected**

      The other coordinates system is the projected coordinates. This is a system that differs to the last one because it is represented through distances, specifically in meters. This representation of the points uses a Cartesian coordinates system (x,y) that is mathematically calculated taking the information from geographical
coordinates and establishes an ordered relation between the points of the curve surface of the Earth and the points of a plain surface like a plan.

To achieve all of this, a meridian and a parallel net are used. This method can be distorted and that is the reason why 3 different kind of projected coordinates exist. Each one represents different Earth zones:

1. **Cylindrical projection**

   This projection projects all the Earth on a cylindrical surface. This projection has some inconvenient because it distorts zones in which there is a high latitude. It is impossible to appreciate the Polar Regions on a real form. This is the projection that will be used on this project, usually is the most used.

2. **Conic projection**

   This projection projects the surface elements on a conic tangent line surface, putting its vertex on the shaft that joins together the two poles. The result after applying this kind of projection is a semicircular map, as we can see on picture 4.

3. **Polar projection**

   This projection projects a portion of the Earth on a flat tangent to the Earth at a concrete point. This system gives a vision of the Earth from a lower or a higher point. This kind of projection is usually used to create maps related to the polar regions of the Earth.

*Picture 4. Geographical projections*

- **UTM**

   **UTM** is a coordinates system based on the cylindrical projection, the difference is that the tangent line is not done related to the equator, the tangent line has been done related to a meridian. With this method we only have little distorts because there is a point at the limit of
the zone that is projected on different coordinates that are specific of each UTM zone, this are called *time zones*.

The Earth planet is dived into 60 *time zones* that measure 6 grades of length, in 20 zones of 8 latitude grades defined by letters. Each grid UTM is defined through the *time zone* number and the letter on the zone, for example Catalonia is in the zone 31T.

**Picture 5. UTM Zones**

- **DATUM**

  The DATUM is the reference system, this defines an origin and a situation of a correct coordinates system for a concrete Earth zone, and this is not able to all the Earth surface. Nowadays, in Europe is used the *European Terrestrial Reference System 1989* (ETRS89). In Spain we should use this, but lots of our cartography has been created with the last reference system, the *European Datum 1950* (ED50). Finally, it is also important to emphasize the *World Geodetic System 1984* (WGS84) used to locate any point of the Earth.

- **WMS**

  WMS \[^{10}\] (*Web Map Service*), is a service that creates datum maps referenced on a dynamic form from geographical information. This Web Map Service defines a map as a representation of the geographical information through an image file that can be seen at a computer screen.

- **GEOCODE**

  The geocode is the process to transform a description into a position, like an address or a concrete place located on the Earth surface. This coordinates that the geocode produces can be later used to locate the map point with a geographical information system.
1.2.2 Stakeholders

An important point to understand the project context is to know the stakeholders. Stakeholders are people that are going to use the product and are also people who are going to take profit of the results. In this project, the main stakeholders are:

1) Developer

The main objective of this project is to present it as a TFG (Treball de final de Grau). This TFG is a compulsory subject included in the Computer Engineering Degree. This is an exceptional case because the developers of a project are not usually included because they do not receive a derivative benefit apart from the earning and the personal satisfaction.

2) Potential clients

Clients are the main key to build this system, because they are the people that are going to use this app and, for this reason, this project has been thought, designed and build to achieve the maximum number of clients of the GIS sector. This project has been thought as an adaptable structure to achieve different objectives, we have two possible clients.

- Enterprises

Telespazio Ibérica is going to develop that system and will be in charge to find clients. This clients will be enterprises interested in take profit of this system that can be adapted to the client necessities. Not only the enterprise is going to take profit of this system, as a domino effect the staff will also have benefits when using the app, by receiving automatically datum from the switchboard...

- Users

The users of this mobile devices could get into this app and have benefits of it. In this situation, a collateral benefit could also appear depending on how they use the system. For example, if it is used to know if a child has arrived to school, the mother and his child would be benefited of the system.

3) Telespazio Ibérica

Telespazio Ibérica is the enterprise in which this project will be done, this enterprise is collaborating with lots of resources that are necessary to work on it. This collaboration means that this enterprise owns part of the intellectual property of this TFG, and, as a result of the system that has been created. By selling this product Telespazio Ibérica will take profit by earning money after selling that product to possible clients.

Moreover, it is possible to increase benefits if new clients appear with different necessities that involve a modification of the original product and, as a consequence, the creation of new projects.

4) Author of the project

The author of this project will also be benefitted, because a part from the interest on that topic (GIS system on mobile devices), he will also be rewarded on his marks because of the work that has been done during this project.
1.2.3 Market study

Before starting to build our system, it is important to make a research about studies that have been done before related to this topic to get important information to start our project. With all this information we can verify if our project will really provide something more relevant. And we will discover if it is possible to use technology that has been already created or if it is necessary to design the project from the beginning.

We are going to show the most important apps related to geolocation bearing in mind our context. We will also study about which tools have been used to create them, taking care the 3 main elements that will be the base of our project: the viewer map, the geographical alarms and the notifications sent to the mobile device.

1) **Google Now**

*Google Now* was one of the first apps that appeared to offer information taking care of the context. It is a very important app that is included in the *Android* system.

*Google Now* can offer different kinds of information, for example this app can tell the user where the nearest public transport is. This app can also tell the user important information related to his work itinerary. This app functions automatically and even we can choose which information we can get from it, it is not possible to use it in our project.

About this app, we think that the API used to see the map and to show the information could be useful. After continuing our research related to the other two elements used in our project, we have found that *Android* suggests two different solutions:

-
Google Cloud Messaging (GCM)\(^{[13]}\)

It is a service that allows the app to send data from our server to an Android device.

- **Geofence**

  It is normally used to create alarms by zones\(^{[14]}\).

After reading all this information, we can verify the limitations of the solution that has been studied in relation to what we want to achieve through this project. We have discovered different tools that can be really useful on the project.

2) **Foursquare**

This app is like a free time guide that has been geolocated. Foursquare shows us which interesting places we have near. This app only shares our location when we decide it, it is not permanently sending information to our mobile device, which is the main difference with Google Now.

![Foursquare App](image)

Other characteristics of this app are that this app allows the user to interact with other users that are connected. The app also allows the user to see which interesting places our friends have said that are good, register new interesting places...

In this case, this app do not give us more relevant information for our project. This app uses the maps service of Google and its markers to mark interesting points and places.

3) **Collector for ArcGis**

This Android application that has been created by ESRI, it is used to achieve datum immediately without needing to be developed.
The main characteristics are to create and share a map, to catch datum in a point shape, lines or area organization, to search places and to get addresses (geocoding), etc. This app has some peculiarities to bear in mind, for example, this app can work without connection with some of its functions limited, or with small restrictions (in order to do this you must subscribe to ArcGIS Online\(^1\)).

The main reason to get that subscriptions is because ESRI forces, through this solution, to keep the maps that have been created in the company servers and makes the user pay for their service.

If we contemplate what we can use in our project we will discover that only one of this elements has been implemented, the maps visor with markers. To see if we can take advantage of this we have done a little investigation on it. After this, we have discovered that this app uses a development tool called ArcGIS Runtime SDK for Android.

This API has been basically thought to visualize maps on it and to manage markers showed as points, lines or polygons. This solution could be really useful for our project.

4) **GeoChase**

This is another product created by ESRI and pursues the target of offering, through push notifications, the best places to visit in Palm Springs. It looks like a very simple app with few content, but this is because the main objective of this app is to show a brew demonstration of the system that implements this app to send the notifications. It is called Geotrigger Service.

\(^1\) It is a collaborating platform based on the cloud that allows the user manage, create and share maps and datum.\(^{[17]}\)
This service comes from an SDK that can be used to manage this alarms from a mobile device and, for this reason, is another option to bear in mind during our project. Moreover, this app uses a tool that we have thought it was useful in another app, we can see the map with its elements on it.

1.2.4 Conclusions

After having seen some of the solutions related to this topic that already exist, we could find some tools that we could use to create our system. On one hand, we have found free software tools like Google and, on the other hand, another tools with subscriptions like ESRI enterprise has done.

Finally, with all this datum a more exhaustive study is going to be done in our next task. We will work on pros and against of all this tools, we are going to see where are their limits (for example, Geofence of Google enterprise is limited to 100 alarm zones for one device) and we also will see which one fits better with our system. We can guarantee that we will use some of this tools as a reference and we are not going to create new ones.
2. Project extension

2.1 Phases of the project

Our project focus is to use it for business and for standard users. The development of this mobile app will use as a base the Android platform, because this system is the most used by staff and by standard users. We are going to reject to do it through different platforms like iOS or Windows Phone.

In order to do this project different stages will be required:

- Firstly, a research will be done to find the software solutions that could be integrated satisfactorily on this project to achieve the main objective and to find tools to make easier the creation of the map visor and the alarms geolocated. When we finally get all the information we will decide, by thinking the pros and the cons, about all of them to choose which ones can be used on this project.

- Secondly, an Android app (Picture 10) will be created taking advantage of the permanent Internet connection and the GPS position, that will allow us to see on the map where we are and, as a consequence, to get different notifications depending on where we are. The app will have the following characteristics:

  - The user will have the possibility to choose which notification he wants to receive, for this reason an interface with parameters that will be the responsible of the different alerts. The system will do it through some labels to which the user wants to be subscribed, in case of getting into or going away from a concrete zone, and another ones that will be optional to choose when the user wants to receive these notifications.

  - Moreover, options related to the markers management will be added and the possibility of including a routing system (within which the user will have the possibility to create a way in which some geolocated alarms could be activated depending on where we go).

- After all this, a server (Picture 10) that communicates with the app must be included to keep all the information related to alerts and to process the checking every time the device moves. If the device is at a place with specific conditions the alert will be sent as a notification. Even more, the necessary elements will be configured to use the Android notification service that is in a Google server. (Picture 10)

- (Optional) The client could use his own server to work on with the datum that has been send after activating an alert. (Figure 10)
Finally, an assessment will be done to make sure that the system is working properly, firstly using simulated positions and, at the end, at a real environment.

2.2 Possible problems

While this project is about to be created we will have to bear in mind some obstacles that could appear:

- The main obstacle will be the fact related to using new technology. As a consequence, new knowledge related to it will be required to apply this knowledge properly. To this knowledge we have to include all the information relate to a GIS system and to coordinates, layers projections, etc.

Furthermore, another problem that can appear is to have few information related to that topic. Finally, in case of using any SDK that allows to make easier the integration of the alarm system, if they exist. This project depends on a development software that is from another company, which could be a problem because unexpected bugs could appear and not be solved. And also new updates could appear in a short time, that could involve and analysis to discover if it is necessary to include a possible new version of the product, verify how this could affect to the project and a review of the correct function of the different parts of the system that had already been done.

- Another of the most important obstacles to make this project is the short time that we have. This is basically the main motive to plan efficiently and being very realistic on how to create the system in 4 months by using a working methodology adapted to this characteristics. And with a little bit of flexibility to face possible unexpected problems and changes during the creation of this project.
Another possible obstacle could be using some license when using an existent SDK that could imply to pay some money that would must be included in the costs section.

It is important to emphasize that even the other obstacles do not imply costs like paying for a license or renting a server with more space than it was previously thought, it always implies more costs that must be added to the costs section as we will see later.

2.3 Methodology and rigor

2.3.1 Working methodology

To do this project a development methodology based on Scrum-agile will be followed. It is a system that wants to be used by particular users and also used by enterprises. This project must adapt to the changes that the customer could need, for this reason this is the best methodology we could use. In this case, there are no real clients, so the customer paper will be played by the director and the professor of this project.

Another important key point is that this methodology allows the communication to be constant through periodical meetings in which the tasks to be done will be planned, identified and done. The daily meetings with the director of the project will last 15 minutes and will be used to talk about how the project is going, to talk about what was been done the day before, to talk about what is going to be talked about on the next meeting and to see if any problem have appeared. A feedback with the professor of this project will be done by email weekly or biweekly.

2.3.2 Monitoring tools

The first tool that has been elected to do this project is Git, which is used to control de code versions, it is a system that registers the changes that have been done. The second tool that will be used is Bitbucket that is a lodging web service used for projects that use the system Git. Git allows the monitoring control for all the people involved in the project through issue tracker, is a flexible system that allows to manage tasks.

The main reason to use Bitbucket instead of the other choice GitHub is that the first one allows us to have free private repositories and adds more security, because this repositories cannot be seen even in the user profile.

2.3.3 Checking method

Thanks to the following tools and to the work methodology that we have chosen to do this project, a validation of the tasks will be done regularly. Using the Scrum method during the daily meetings with the director of the project, observing the evolution of the sprints and the tasks that are finished waiting for the approval we can guarantee a correct validation of the issues. The director will be the one who will decide which issues are finished, which ones must be done again and which new issues must be created to continue with this project.

The daily meetings with the professor of this project will be used to see the evolution from a global view and to warn about possible digressions to achieve a successful project.
3. Working plan

3.1 Tasks description

In order to do a good project it is essential a good plan of the different tasks. The plan must include, as specific as possible, which tasks are going to be done and the time that is required to do them properly, taking care about the risks and the possible diverts.

This project has been planned to be done in a short time, a four-month period because that is the time required for this subject. The project was initiated the 16th February 2015 and is going to be finished and exposed by the speaker the 2nd July 2015. For this reasons it is really important to adapt properly the time to each task.

Bearing all of this in mind the project has been planned into 4 stages:

- The first stage, the initial phase is to plan the whole project.
- The second stage is to make a research of information, analyze it and make the design of the system.
- During the third stage we will work on software development doing tests when it is required.
- And during the last stage, the document will be finished and exposed through a speech by the author of this project.

As the methodology being used will be Scrum-Agile, the tasks will be Sprints, but during this document we refer to them as tasks. And now we are going to detail all the tasks that are included into this 4 stages.

3.2 Specification of the tasks

3.2.1 Project plan

The first stage, without any doubt is the base in which we are going to create our system. This means that is a very important task, because this task is the one that decides the main objectives of this project, the time that is going to be required to do it, the costs, the impact that our system can carry out related to the environment... Any impediment that could appear will affect directly to the project success during the time that has been expected.

This plan will include 7 delivery schedules that form the initial GEP phase. The time required for this task is about 80 hours that will be done during a month. It is important to know that each delivery depends on having finished properly the last one.

3.2.2 Information research

The target of this stage is to search information. It is necessary to achieve knowledge related to the GIS system, knowledge about concepts related to coordinating systems that must be used, knowledge about projections...

It is also needed to search information about the different systems or APIs that can be used to represent maps on a mobile device. Then, it will be necessary to create a report...
writing about pros and against of it. And, finally, making decisions about which of these would be the best for our system. The same happens with GeoEvents, a research must be done to see which tools exist nowadays at the market, analyze them and choose the best option.

Despite the fact that this phase is not dependent of another stage, it is going to be started after finishing the first stage, because the initial phase will require lots of hours. The time for the information research will be less than 30 hours and it will last a week. If it was necessary more information would be searched during next stages, but the target is to get all the information during this stage.

3.2.3 Analysis and design

During this stage is when the information researched during the first stage will be applied and, taking care of the tools that have already been chosen, an analysis will be done and also the system will be designed. This second stage is dependent on the first one because we need the information that we get on it.

With all this information the datum model, the domain model and the presentation model will be defined. That is to say that diagrams of classes will be created, the use cases with all of their functionalities, the way in which servers will communicate with the app, the interface of the app...

This part of the project is really important, for this reason it is necessary to invest large time on it to avoid having to design again any part of the project, because this will make us dedicating more hours to that part by redesigning and applying again the new part. 120 hours will be dedicated to that stage that will last a month.

3.2.4 Building phase 1: Implement of Android app

After having finished the Sprint with the analysis and the design of our system, it is time to start the applying phase. For all of the applying interactions it is necessary having finished previously the last task. This part depends on the analysis and design stage.

In order to implement the Android application four targets will be achieved:

- The first one will be to create the visor map to represent the markers with its information and the geographical zones with its alerts.
- The next one will be to manage the punctual elements and staff related with that (the creation of a local or remote base with the information of the elements and the creation, edition and removing of the elements through an interface that will also be created).
- The same will be done with the last two targets, the management of the events and the routing.

These goals related to interaction, will be achieved through a method with 3 phases dependent on the others. These phases are: application, exhaustive tests about the application and, finally, the detection of problems and reanalyze and design them again if it was necessary.
To achieve this Sprint 3 weeks will be approximately required, an amount of almost 100 hours. It is also important to say that this Sprint is not dependent to other iterations, it would be possible to overlap them. But, as there is only one developer, an order will be followed and the next phase is not going to be started until having finished the actual. If that is not the case we will have to think about an increase of weeks to end this phase.

3.2.5 Building phase 2: Implementation of the alert server

This phase, dedicated to implement alerts, will be done following a temporal order because there are not enough software developers (even this could be done after each analysis and designing phase as we have said before). The targets would be the ones that have been described before during the implementation, the tests and reanalysis and with the design if it was necessary. 60 hours will be required during two weeks.

During this phase, the target is to prepare a server to keep the geographical zones where we want to control the geolocation events, with all the corresponding information. This information will be the geometry, an identifier, some labels to represent the different categories to which the user can subscribe, the kind of action (mobile notification or a callback from a client’s server), the trigger condition and some extra elements to limit the alerts after a concrete total number or to limit them depending on timetables.

The system will be managed to receive requests to register alerts or to verify if a device has changed its position. The system will also have to manage the answers that the server gives when a device changes its position and this action activates an alert. To activate an alert the device must be into a geographical zone with alerts, the user must be subscribed to any label with an alert that accomplishes the condition (getting in or out) and that do not accomplish any of the imposed limitations. This answer will be according to the action that had been configured to the alert, this answer could be to send a notification to the mobile device, to send an answer to a client’s server to work with datum, or both actions together.

3.2.6 Building phase 3: Configuration of Google server

The last phase of creation is the responsible of setting up the last element of the system, the Google server that will be necessary to receive the notifications at the mobile device. As it is explain on picture 10, two other elements will be set up to communicate with the system. Some tools will be searched or created to test the app during the next phase.

This phase will be the shortest of the three. 30 hours will be required to do it and they will be done in approximately one week. As in the last two iterations, only the analysis and the designing part are dependent on the other parts; but following the same logic pattern this part will be done after the second phase of construction when the three targets had been achieved. Even the order of the three iterations is the one that has been explained, it would be possible to change the order among them.

3.2.7 Checking
After having finished the three iterations and the implementations on the software system, the general tests will start, is for that reason that there is a dependency on the three previous phases. Following the order that has been established it will start after the third phase of construction.

To do this tests, a test plan will be created to check if the whole system works properly. This test plan will be done twice, the first time will be done using simulated positions with the tool that has been created or classified from the third phase of construction, and the second time, with real positions, following the plan defined on the test plan.

After having done the two tests, a report will be created to show the results and the possible mistakes that could have appeared. If that is the case a new iteration will be done. This iteration will be done reanalyzing and designing again, applying this modifications, doing punctual tests and, finally, doing general tests until the whole system works correctly.

This phase can be very variable, so the estimation of the time are 40 hours on a week in which possible errors could be fine during 4 times.

### 3.2.8 Finishing the written project

After having finished all the testing part, we can say that all the software part has been finished. Is at this moment, when the final report will be written, in that part, the delivery 7 the correct order of the sections, the corrections of the GEP teacher and all the information that has appeared during the project will be included on it. Finally, a review of the whole report will be done.

This phase has a dependency on the tests done before, because it is necessary having finished the whole software system to finish the report. 20 hours done in three days will be required for this part.

### 3.2.9 Preparing the TFG defense

Finally, the last part of this report would be preparing the defense of the TFG in front of a tribunal, this phase depend on having finished the last phase and its documentation. To prepare this part 30 hours in four days will be required. This part will be done in two different parts. During the first one a Power Point with the support slides will be created to help during the oral presentation, and the second would be the preparation, creating a script and doing rehearsals pretending the real oral exposition.

### 3.3 Project plan

At the annex 1 we can see the initial Gantt diagram, in which only the general tasks appear, because in the previous section we have explained more detailed the subtasks that appear on it. Showing the Gantt diagram with the tasks on it we can see perfectly the initial planning.
3.3.1 Timing

Even that we can see on the Gantt diagram the amount of hours for each part of the project, we can also see these information and the total amount of hours dedicated to this project on the following chart:

<table>
<thead>
<tr>
<th>Project plan</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information research</td>
<td>30</td>
</tr>
<tr>
<td>Analysis and design</td>
<td>120</td>
</tr>
<tr>
<td>Implementation of Android application</td>
<td>100</td>
</tr>
<tr>
<td>Implementation of the alerts server</td>
<td>60</td>
</tr>
<tr>
<td>Configuration of Google server and connectivity</td>
<td>30</td>
</tr>
<tr>
<td>General testing</td>
<td>40</td>
</tr>
<tr>
<td>Finishing the report</td>
<td>20</td>
</tr>
<tr>
<td>Preparing the defence of the TFG</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>510 hours</strong></td>
</tr>
</tbody>
</table>

Table 1. Amount of hours

3.3.2 Changes related to initial plan

Firstly, during the research phase, a change appeared respect to the initial planning. This change was due to the deeply research process about the existent technologies. It basically, affects to the distribution order of the phases.

A research of information was done to help on creating the app:

- Include a map into the Android app that allows us to show geometry.
- Include a geographical alerts system
- A local or remote server to manage the information: alerts and markers.

In order to achieve this phase, we had to put emphasis on doing a deep research. It was required not only to search information and contrasting the alternatives, but also an implementation process in which real tests were done.

For this reason it was necessary to complete the configuring phases: of the Google server and the connectivity, the implementation of the alert server before the analysis and design phase, changing the order explained on the initial planning, but in none of the cases delaying the deadline stablished to finish the project, as we can see on the Annex 2.

Secondly, another unexpected change has appeared and has had a big repercussion on the project and has postponed the deadline until the 19th October. The reason of this change was the delay because of having changed the working contract (40 hours per week instead of 20). As a consequence, it was not possible to dedicate more hours during work-time. This second change is showed on the Annex 3.

In none of this two cases the planning changes, respect the initial plan, have changed the total or the partial amount of hours dedicated to each of the project phases.
3.4 Project resources

In this part we can see the resources that have been used during this project. On one hand, we have the human resources, like the headmaster of the project, the analyzer, the designer, the architect and the responsible of the tests.

On the other hand we can find the material resources that have been used, like we can see on the following tables:

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Usefulness</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP EliteDesk 800 G1, Windows 7 64 bits</td>
<td>Machine for developing the project</td>
</tr>
<tr>
<td>LG G Pad 8.3” with Android Kitkat 4.4.2</td>
<td>Tablet to do the trials</td>
</tr>
<tr>
<td>LG G3 5.5” with Android Lollipop 5.0</td>
<td>Mobile to do the real testings</td>
</tr>
<tr>
<td>Server to be determined</td>
<td>To storage the alerts</td>
</tr>
<tr>
<td>Google server cloud messaging</td>
<td>To process the push notifications</td>
</tr>
</tbody>
</table>

*Tables 2. Hardware resources of the project*

<table>
<thead>
<tr>
<th>Software</th>
<th>Usefulness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eclipse Luna + SDK Google</td>
<td>Device for the Android development</td>
</tr>
<tr>
<td>Microsoft Office</td>
<td><em>Office Suite</em> to generate the memory</td>
</tr>
<tr>
<td>Git</td>
<td>Code versions control</td>
</tr>
<tr>
<td>Bitbucket</td>
<td>Service to keep the code and manage the tasks</td>
</tr>
<tr>
<td>Gmail</td>
<td>Mail service to keep in contact with the team</td>
</tr>
<tr>
<td>VPN + desk remote connection</td>
<td>To get connected to the development PC</td>
</tr>
</tbody>
</table>

*Tables 3. Software resources of the project*
3.5 Taking into account alternatives and the action plan

The greatest advantage about using an agile methodology like Scrum-Agile is that the defined plan has a big scope for action if there were some possible digressions. This means, for example, that in the three applications iterations case, they could be combined or alternated in case of necessity to avoid derivative problems like the delay of a server for the alerts, or in case the server freezes, etc. Moreover, there is an auxiliary machine with similar characteristics just in case the machine that we have breaks down.

Even that in all the planned phases had a time allowed for the possible unexpected digressions, including the test phases in which the reanalysis and the design will be done when it is necessary, there is an extra week that has been not taken into account for the plan project and will be like a reserve just in case it is necessary. All the things that have been said and the meeting with the speaker of this project (in which the plan could be readjusted according to the progress) claim that the project will be finished according to the plan that has been established.

It is not much possible but, in case we could not use a server of the company, we will have to purchase an online server, for this reason we have to take into account the cost that it could represent. It is also appreciated with a big percentage the option of finally using an existent technology for the map and the alerts part and that could imply to pay for some licenses, so that is an extra cost that will be counted on the next section.
4. Economical management

4.1 Identification and costs estimations

After having planned detailed the timing, as we have seen in the previous section, the next section must include the whole TFG project. There is a suggestion about the budget that will be necessary for its execution.

The budget must take into account the costs of all the resources that appear on our project. These resources are the human resources associated to the activities, the technological resources that have been used (the physical and the digital ones) and another resources like the general costs like the power costs or the costs related to internet.

It is important to take into account that this project have required an amount of 510 hours in four months and a half, and, for this reason, the costs will be calculated taking into account this datum.

4.1.1 Human resources

Firstly, it is necessary to search which is the price per hour of the people that has collaborated during this project. The chart 4 shows the price per hour that nowadays is used at the enterprise where this project will be developed.

<table>
<thead>
<tr>
<th>Human resources</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headmaster of the project(C)</td>
<td>42 €/h</td>
</tr>
<tr>
<td>Analyst (A)</td>
<td>34 €/h</td>
</tr>
<tr>
<td>Designer (D)</td>
<td>34 €/h</td>
</tr>
<tr>
<td>Programmer (P)</td>
<td>29 €/h</td>
</tr>
<tr>
<td>Tester (T)</td>
<td>24 €/h</td>
</tr>
</tbody>
</table>

Table 4. Human resources salaries

Secondly, the cost of each activity will be calculated taking into account which resource is implied and which is the cost that it has and the hours that have been required to it. Finally, we will get the sum of the total cost related to human resources.

<table>
<thead>
<tr>
<th>Tasca</th>
<th>Hours</th>
<th>Resources</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project planning (GEP)</td>
<td>80</td>
<td>C</td>
<td>3360 €</td>
</tr>
<tr>
<td>Searching information</td>
<td>30</td>
<td>C</td>
<td>160 €</td>
</tr>
<tr>
<td>Analysis and design</td>
<td>120</td>
<td>A, D</td>
<td>4080 €</td>
</tr>
<tr>
<td>Implementation of the Android app</td>
<td>100</td>
<td>P</td>
<td>2660 €</td>
</tr>
<tr>
<td>Implementation of the alert server</td>
<td>60</td>
<td>P</td>
<td>1740 €</td>
</tr>
<tr>
<td>Configure the google server and the connectivity</td>
<td>30</td>
<td>P</td>
<td>870 €</td>
</tr>
<tr>
<td>General tests</td>
<td>40</td>
<td>T</td>
<td>960 €</td>
</tr>
<tr>
<td>Finishing the report</td>
<td>20</td>
<td>C</td>
<td>840 €</td>
</tr>
<tr>
<td>Preparing the TFG defence</td>
<td>30</td>
<td>C</td>
<td>1260 €</td>
</tr>
</tbody>
</table>

Total cost of human Resources 15930 €

Table 5. Human resources costs of the project
4.1.2 Technological resources

Apart from the human resources that are implied on this project, it is also necessary to include the costs related to the technological resources. Every hardware and software that has been used during this project has an amortization cost that must be calculated, because only a little part of it must be included into our project.

- **Hardware**

  To calculate the proportional part of the costs he must know how many real hours the hardware has been used. The real hours are the result of multiplying the working days (253) by the diary working hours (8) and the years of shelf life that the tax office allows to use a hardware (3-4). After all this, we only need to multiply the cost of the product by the hours that this project has required divided into the real hours that have been previously calculated.

<table>
<thead>
<tr>
<th>Hardware resources</th>
<th>Cost</th>
<th>Life cycle</th>
<th>Amortization costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HP EliteDesk 800 G1</strong></td>
<td>800 €</td>
<td>4</td>
<td>53.5 €</td>
</tr>
<tr>
<td><strong>LG G Pad 8.3” with Android Kitkat 4.4.2</strong></td>
<td>290 €</td>
<td>3</td>
<td>25.79 €</td>
</tr>
<tr>
<td><strong>LG G3 5.5” with Android Lollypop 5.0</strong></td>
<td>399 €</td>
<td>4</td>
<td>26.68 €</td>
</tr>
<tr>
<td>Alerts server</td>
<td>399 €</td>
<td>3</td>
<td>35.48 €</td>
</tr>
<tr>
<td>Google server cloud messaging</td>
<td>Free</td>
<td>3</td>
<td>0.00 €</td>
</tr>
<tr>
<td><strong>total hardware cost</strong></td>
<td></td>
<td></td>
<td>141.30 €</td>
</tr>
</tbody>
</table>

*Table 6. Hardware costs of the project*

- **Software**

  The software cost is calculated in the same way as it has been done with the hardware. The only difference is that the tax office only allows the amortization of it for 2 or 3 years, because it is thought that this becomes obsolete faster. If it was a free software there would be no costs.

<table>
<thead>
<tr>
<th>Software resources</th>
<th>Cost</th>
<th>Life cycle</th>
<th>Amortization costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Windows 7 SP1 - 64 bits</strong></td>
<td>175,00 €</td>
<td>3</td>
<td>15.56 €</td>
</tr>
<tr>
<td><strong>Eclipse Luna + SDK Google</strong></td>
<td>Free</td>
<td>2</td>
<td>0.00 €</td>
</tr>
<tr>
<td><strong>Microsoft Office</strong></td>
<td>539,00 €</td>
<td>2</td>
<td>71.90 €</td>
</tr>
<tr>
<td><strong>Git</strong></td>
<td>Free</td>
<td>3</td>
<td>0.00 €</td>
</tr>
<tr>
<td><strong>Bitbucket</strong></td>
<td>Free</td>
<td>2</td>
<td>0.00 €</td>
</tr>
<tr>
<td><strong>Gmail</strong></td>
<td>Free</td>
<td>2</td>
<td>0.00 €</td>
</tr>
<tr>
<td><strong>VPN + desk remote connection</strong></td>
<td>Free</td>
<td>3</td>
<td>0.00 €</td>
</tr>
<tr>
<td><strong>total software cost</strong></td>
<td></td>
<td></td>
<td>87.46 €</td>
</tr>
</tbody>
</table>

*Table 7. Software costs of the project*
4.1.3 General costs

As we have done in the last sections, the amortization cost would be also calculated, but this time we will do it with the annual costs. After this, we will divide that number by the annual real hours and we will get the real costs related to general costs.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Rate</th>
<th>Annual price</th>
<th>Consum</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric consume</td>
<td>0.149 €/kWh</td>
<td>72.22 €</td>
<td>4 months and a half</td>
<td>27.09 €</td>
</tr>
<tr>
<td>Internet access (ADSL)</td>
<td>39.81 €/month</td>
<td>477.72 €</td>
<td>4 months and a half</td>
<td>179.15 €</td>
</tr>
<tr>
<td>Internet access (4G)</td>
<td>10.00 €/month</td>
<td>120.00 €</td>
<td>4 months and a half</td>
<td>45.00 €</td>
</tr>
<tr>
<td>Movements</td>
<td>5.00 €/des</td>
<td>-</td>
<td>10 movements</td>
<td>50.00 €</td>
</tr>
<tr>
<td>Printing</td>
<td>0.03 €/full</td>
<td>-</td>
<td>100 paper sheets</td>
<td>3.00 €</td>
</tr>
</tbody>
</table>

**Total cost**

304.24 €

*Table 8. General costs*

4.1.4 Unexpected problems

Another point to take into account into the total budget are the costs related to the unexpected problems that could appear. In this project these three have been contemplated:

- **Delay of the project**

  As it was exposed in the last delivery, a scope for action of a week was added to the plan to make sure that the plan could be finished when it was thought. It is expected that this week will be used to solve the development difficulties, for this reason the costs will be for the extra hours inverted by the programmer. The risk of this is about a 30% because of the programmer experience in that field. If we take into account all of this parameters the final cost will be of 174€.

  Furthermore, there is a possibility to imply an apprentice during a week to support at the development tasks related to the Android application if it is necessary (the cost will be of 8€ per hour). If we add the apprentice costs, the amortization costs of the machines that he will use and the general costs that could appear, we get an extra cost of 51€ that, added to the last ones, will be 220€.

- **License needed**

  Another point to take into account is the possibility that a license would be required when using a tool that already exists to develop the alerts. One of the options will be using a tool that has been developed by ESRI that works though credits. The basic license offers the quantity of 50 credits that are equal to 300 monthly alerts. But there is a 60% risk of using a thousand alerts in a month, mainly during the test phase. For this reason, the cost of this unexpected problem will be the price of that license (200 credits that allow 1200 monthly alerts multiplied by the risk: 10.74€).
4.1.5 Contingency

With the aim to protect the project of possible risks that have not being identified during the planning of the project, a 20% has been added to the total costs. The total costs are the result of adding the costs specified during the last sections.

4.1.6 Total budget

Finally, we get the final budget:

<table>
<thead>
<tr>
<th>Resources</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human resources</td>
<td>15930.00 €</td>
</tr>
<tr>
<td>Technological resources - Hardware</td>
<td>141.30 €</td>
</tr>
<tr>
<td>Technological resources - Software</td>
<td>87.46 €</td>
</tr>
<tr>
<td>General costs</td>
<td>304.24 €</td>
</tr>
<tr>
<td>Unexpected problems</td>
<td>220.00 €</td>
</tr>
<tr>
<td>Contingencies</td>
<td>3336.60 €</td>
</tr>
</tbody>
</table>

| Total cost                     | 20019.60 € |

Table 9. Final budget

4.1.7 Changes related to the initial budget

As we have said, there is a change that has been caused by having chosen an existent technology that we will explain at the study and making decisions section. The changes that have been done during the planning of this phase do not affect to the death line stablished at the beginning and they are also not going to affect to the costs.

As we will see, we are going to use a service proportioned by ESRI for our geographical alerts and, for this reason, the alert server that we put in our costs budget will be free. For this reason we are going to save 35.84 €.

<table>
<thead>
<tr>
<th>Hardware resource</th>
<th>Cost</th>
<th>Life cycle</th>
<th>Amortization costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP EliteDesk 800 G1</td>
<td>800 €</td>
<td>4</td>
<td>53.5 €</td>
</tr>
<tr>
<td>LG G Pad 8.3” with Android Kitkat 4.4.2</td>
<td>290 €</td>
<td>3</td>
<td>25.79 €</td>
</tr>
<tr>
<td>LG G3 5.5” with Android Lollypop 5.0</td>
<td>399 €</td>
<td>4</td>
<td>26.68 €</td>
</tr>
<tr>
<td>Alert server</td>
<td>Free</td>
<td>3</td>
<td>0.00 €</td>
</tr>
<tr>
<td>Google server cloud messaging</td>
<td>Free</td>
<td>3</td>
<td>0.00 €</td>
</tr>
</tbody>
</table>

| total hardware cost                       | 105.82 € |

Table 10. Hardware costs of the projects with the last changes

Finally, if we apply the changes of the total costs related to Hardware resources, the final cost of the project will be 19984.12 €.
4.2 Management control

To guarantee that the project is going to achieve the targets following the timing that has been planned, we will use a control tool that the enterprise already has that is called Conthora. This tool is really useful to count the human resources’ hours dedicated to the project. In this program you have to introduce the hours that you have work on the module that belongs to the project, as we can see on picture 11. With Conthora we can know exactly how many hours has dedicate each person to this project.

A weekly re-counting will be done to create a report with the datum that have been obtained. That measure is going to be done to see if the project is following the plan or if some disrupts have appeared and a new readjustment of the plan must be done. This process will also be done at the end of all the phases of this project.

Finally, after finishing the project, a re-count of all the total real costs will be done and another report will also be done comparing the real datum with the ones that were planned at the beginning.
5. Sustainability and social agreement

A project has to take into account the three dimensions of the sustainability on its planning: economic, social and environmental. For this process it is required to check if the project fulfills the criteria answering to some questions.

<table>
<thead>
<tr>
<th>Planification</th>
<th>Echonomical</th>
<th>Social</th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>9</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 12. First line of the sustainability matrix of this TFG

5.1 Economical

In this delivery we could see how an assessment of the costs has been done including all the elements to bear in mind: direct costs of the activity, indirect costs, amortizations, possibilities and unexpected problems.

The cost of the project would be viable because it is focused to a market where there is a lack of similar systems. It has been focused taking into account possible clients that the enterprise have that would be interested to apply this system. This project has also been done thinking about the real costs of this enterprise. Even that the execution of the project could be done in less time, more human resources would be required and, as a consequence, the total cost of this project could be very similar to the actual.

5.2 Social

In this dimension, the creation of the project means an improvement on the routine task control of some enterprises. On one hand, it is easier for the worker to automatize functions on his tablet, while he had to do it manually before. And, on the other hand, the responsible of validating the datum obtained with this tablet.

Referring to the personal use, the security, the comfort and the lifestyle could be improved. For example, activating automatically the home alarm when there is no one inside, or a mother could know when her child has arrived home. In contrast, a badly use could also appear, because it can be used to control someone; for this reason, the user has to be conscious that this app exists on its terminal and which alerts are activated at every moment.

5.3 Environmental

In general terms, the environmental impact, which appears as a consequence of the project development, has extra costs related to power, paper sheets to print and the electromagnetic waves that the mobile devices produce. We have also to take into account that this project has been done including the maximum of possible different uses, that is to say that this project could be used again to create new ones with different objects that would be more concrete depending on the client.
6. Technological study and decision-making

Before starting with the design of the software it is important to do a deep study process to include the map, a study about the alerts located geographically and a study about how to keep the datum.

On the next section we can see the decisions that have been made for each one:

6.1. Map

6.1.1 Google Maps

Google Maps is the maps service most used around the world, that includes into its services searching streets according to the position, routes, etc. With this API both, the alerts and the markers, can be shown with the information that comes from it.

The most important characteristics are:

- Deep interaction: zoom, scroll, rotation, vision angle.
- Lots of events integrated: click, large click, double click, etc.
- Integration of the elements related to interaction control: compass, location button, etc.
- Use the location API of Android to the location changes.
- To let drawing different geometric pictures, points, polygons and polylines.
- Easy personalization of the markers and other geometry.
- The possibility to include a street view.
- Diary applications of geographic codifying or limited routes.
6.1.2 ArcGis Runtime SDK for Android

This SDK is a service of the ESRI Company that almost offers the same options as the geocode, routes or what is the most important for us. This service offers the possibility to personalize the map with our datum: the markers and the alerts.

Other important characteristics are:

- High interaction: zoom, scroll and rotation.
- Some of the interacted events. For example when you click a popup can be opened.
- Without integrating the control elements interaction.
- Uses the Android’s API location for the location changes.
- Allows you to draw different geometries like points, polygons and polylines.
- Easy personalization of markers and other geometries.
- The possibility to work on it offline with all the services (it requires the properly license).
- The possibility to load element layers offline and online.

6.1.3 OpenLayers

The most important peculiarity of OpenLayers is that, even it supports the execution on mobile devices, the JavaScript has been done, and there is not a total integration with Android.
This means more difficulties when implementing all the functionalities that have been thought in this project, even API allows to show the datum and the information that is necessary.

This do not include a geographical codifying system, not includes a routes system and to implement it into our system it would be necessary to configure a server with a web service to do this functions (like the ones that Oracle offers and a server to keep the information of a map and able to create the tiles required like could be GeoServer).

6.1.4 Conclusions

Taking into account all this information, doing some tests and thinking on the pros and cons, we can conclude that ESRI will be the API that we are going to use when creating this system.

The option that was quickly discarded was the last one. The reason why, is even that the idea about being a free code API sounds good, it is not easy to apply it with Android because lots of time would be required, lots of resources would be needed and all this will be a negative impact in our initial planning of the project.

Between the two other options, even if the Google API gives us more options and functionalities, the tool that has been selected gives us the best integration with the geographical alerts tool and with the google maps solution. It is also important that everything we can achieve with this project could be perfectly done with any of this two solutions and, for this reason, choosing Google would not give us any significant benefit in relation to the ESRI solution.

Another important reason to our choice is that the enterprise that develops this TFG (Telespazio) is partner of this company and there is some interest on using this system. Moreover, ESRI has desktop tools to create layers that we will use to import them to our application, offline and online.
6.2. Geolocation alerts

In relation to the alarm system with geographical location, 3 big alternatives have been found to integrate it into our system:

6.2.1 Android’s API service

Android includes into his API a native class called geofences, which has been done to create geographical zones and to send notifications when one of the events is activated: getting into, getting out or staying into the same zone during a concrete period of time.

![Picture 15. Android Geofences]

The most important characteristics are:

- It is only allowed to create zones in a circle form if we know the radius.
- The length can be configured.
- The checking time of the location can be configured.
- It has a limit of 100 geodefence on each device/user.

6.2.2 ESRI Geotrigger service

![Picture 16. GeoTrigger ESRI]
ESRI enterprise offers an alert service for the geographical locations that allows sending notifications with more options to a mobile or to the client’s server. The configuration has only being created to detect when you get into or out of a zone, but it has more interesting characteristics:

- Includes a tags system to which users can subscribe.
- Personalized notifications: message, sign, sound, URL or extra datum.
- Options to limit the alerts.
- It allows to create geometry in a circle form like polygons.
- Includes a system of 3 different profiles related to configure the management of the battery.
- A service of datum in a ESRI server (this action need to be done online)
- 600 free alerts. Then the alerts will be 0.7 cents each one.

6.2.3 GeoFire

Geofire is a combination of open-source libraries that are basically used to control the fleets, as we can see on the picture. Only has a control when the position changes if this happens only into a concrete zone, but it has not any system of notifications.

6.1.4 Conclusions

With all the information that we have obtained from the research, after having done exhaustive tests, after having thought about pros and against (that we will see at the final document), the ESRI solution will be the chosen.

First of all, the Geofire option has been rejected because it is more limited to the fleet control and it does not fit properly to this project. Secondly, if we compare this system with the Google’s API, the geotrigger service contributes to the simplicity of the code and also give us more options to create alerts and to send notifications and also includes a system to manage the battery, so we can avoid to do this action manually. We can also create tools to create triggers and tools to realize tests of the alerts with fake positions.
Even that it has some negative characteristics like the cost of the alert when there are lots of them or because it is not a free code system, there is an interest on use it.

6.3. Storage

Taking into account the APIs that have been selected for the maps and for the geographical alerts, we can define which system we have to create to keep the datum.

Firstly, a remote server will be required, in which a checking will be done every time a device has a new location (that is to say, every time it moves at an established alert). Moreover, to do this checking, all the alerts must be kept in this server. ESRI is in charge of all this, for this reason, there is no cost related to setting up the server.

Despite all the datum related to these alerts that are in the server, we also have them with the aim to improve the efficacy when showing them on the app. All the alerts in local will be represented in only one layer. This layer will be composed by geometry formed by polygons. It is important to stress that this datum will be synchronized all the time, to avoid problems with datum that do not exist in one of these two places.

We will also have the datum from the markers that appear in the same layer (in which only geometry in a point form will appear). Moreover, all the information originated by this has to be saved. Finally, we will have a third temporal layer for the routes. As a result, this layer will have only polylines.

No more geometric datum will be kept in the app, but more extra layers could be added to show information. These layers will only be related to reading datum, so the information is not necessary to be kept.
7. Requirements model

7.1. Functional requirements – Use cases

One of the most important points to have into account in our system design are the system requirements. These requirements are the key to define the parameters that our system has to accomplish, taking into account the defined targets.

The functional requirements, the ones referred to the use cases, that have been defined by the creation of our system are the following:

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Priorities</th>
<th>Characteristics</th>
<th>Fulfillment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visualize and navigate on the map</td>
<td>High</td>
<td>The user can navigate on the map and see the graphical elements that have been added (markers and alerts).</td>
<td>Only the graphical elements that exist with its filters will be showed.</td>
</tr>
<tr>
<td>Filter the layer view of the map</td>
<td>Medium</td>
<td>It is possible to choose which layers will be showed on the map.</td>
<td></td>
</tr>
<tr>
<td>Visualize basic information of a graphic element</td>
<td>High</td>
<td>The user can interact with the graphic elements of the map to get the basic information that is related to it.</td>
<td>An alert must exist.</td>
</tr>
<tr>
<td>Consult an alert</td>
<td>High</td>
<td>The information about an alert on the map can be consulted.</td>
<td>An alert must exist.</td>
</tr>
<tr>
<td>Manage an alert</td>
<td>High</td>
<td>It is possible to create, modify and remove an alert.</td>
<td>An alert must exist.</td>
</tr>
<tr>
<td>Search for an alert</td>
<td>Medium</td>
<td>A browser will allow the user to search alerts.</td>
<td>An alert must exist.</td>
</tr>
<tr>
<td>Manage alert subscriptions</td>
<td>High</td>
<td>The user can add or remove tags for the alerts that want to have activated.</td>
<td>An alert must exist.</td>
</tr>
<tr>
<td>Consult a marker</td>
<td>High</td>
<td>It is possible to consult the information of an element of the map.</td>
<td>A marker must exist.</td>
</tr>
<tr>
<td>Manage a marker</td>
<td>High</td>
<td>It is possible to create, modify and remove markers.</td>
<td>A marker must exist.</td>
</tr>
<tr>
<td>Search a marker</td>
<td>Medium</td>
<td>A browser will allow the user to search markers.</td>
<td>A marker must exist.</td>
</tr>
<tr>
<td>Select a base map to be showed</td>
<td>Low</td>
<td>A baseMap could be chosen from a list of maps.</td>
<td>A BaseMap must exist.</td>
</tr>
<tr>
<td>Manage preferences</td>
<td>Medium</td>
<td>It will be possible to configure some parameters to activate or deactivate the notifications.</td>
<td></td>
</tr>
</tbody>
</table>

*Table 13. Use cases*
7.2 Non-functional requirements

During this analysis and designing phase, some non-functional requirements have been defined to compliment the functional requirements of the system. This requirements are really important, because if they are not defined properly, it could have bad consequences. In our system we have defined the following:

7.2.1 Appearance requirements

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>1</th>
<th>Kind of requirement</th>
<th>10a</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>The system is attractive and invites the user to use it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification:</td>
<td>We want many users for this app so it is important for the app to be attractive.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author:</td>
<td>User.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction judgement:</td>
<td>A survey will be done to a group of people and the 80% or more will say that the app is attractive.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Client satisfaction</td>
<td>4</td>
<td>Client dissatisfaction:</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependencies:</td>
<td>High</td>
<td>Conflicts:</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support:</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History:</td>
<td>22/04/2015 - definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 14. Appearance requirements
7.2.2 Style requirements

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>2</th>
<th>Kind of requirement</th>
<th>10b</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>The system seems reliable to the user.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification:</td>
<td>Users must feel comfortable and safe with the system to use it with no fear. It is important to create a confidence image.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author:</td>
<td>User.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction judgement:</td>
<td>A survey will be done to a group of people and at least the 95% will say that the system gives confidence to them.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Client satisfaction</td>
<td>3</td>
<td>Client dissatisfaction:</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependencies:</td>
<td>High</td>
<td>Conflicts:</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support:</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History:</td>
<td>22/04/2015 - definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 15. Style requirement 1

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>3</th>
<th>Kind of requirement</th>
<th>10b</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>The system has a simple and interesting design.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification:</td>
<td>Similar systems to our system exist, so, in order to compete with them, it is important for our system to have a simple design that could be used by any user and, at the same time, it must be interesting to make the users choose our system and not another one.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author:</td>
<td>User.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction judgement:</td>
<td>A survey will be done to a group of people and at least the 90% will say that the system is simple and the 70% will say that they would use this system better than other ones.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Client satisfaction</td>
<td>3</td>
<td>Client dissatisfaction:</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependencies:</td>
<td>High</td>
<td>Conflicts:</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support:</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History:</td>
<td>22/04/2015 - definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 16. Style requirement 2
### 7.2.3 Easy using requirements

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>4</th>
<th>Kind of requirement</th>
<th>11a</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>The system will be easy to use for the users.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification:</td>
<td>As the profile of the users will be different, the system must be easy to be used to spread it as much as possible to a big crowd of potential users.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author:</td>
<td>User.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction judgement:</td>
<td>The 90% of the users that have answered the survey say that the system is easy to be used.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Client satisfaction</td>
<td>3</td>
<td>Client dissatisfaction:</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependencies:</td>
<td>High</td>
<td>Conflicts:</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support:</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History:</td>
<td>22/04/2015 - definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 17. Easy using requirements

### 7.2.4 Learning requirements

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>5</th>
<th>Kind of requirement</th>
<th>11c</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>The portal must be easy to be used without having previous information.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification:</td>
<td>The users must use the system directly.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author:</td>
<td>User.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction judgement:</td>
<td>The system will be tested by a group of people. More than 95% people can not have had a problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Client satisfaction</td>
<td>2</td>
<td>Client dissatisfaction:</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependencies:</td>
<td>Medium</td>
<td>Conflicts:</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support:</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History:</td>
<td>22/04/2015 – definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 7.2.5 Comprehension or courtesy requirements

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>6</th>
<th>Kind of requirement</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td></td>
<td>The language must be clear, correct, brief and respectful.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification:</td>
<td></td>
<td>The users must feel that they are treated correctly and respectful by the system, moreover, they must understand the system contents without problems.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author:</td>
<td></td>
<td>User.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction judgement:</td>
<td></td>
<td>A survey will be done to a group of people and, at least, the 95% will say that the system has a clear, correct, brief and respectful language.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Client satisfaction</th>
<th>2</th>
<th>Client dissatisfaction:</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependencies:</td>
<td>Medium</td>
<td>Conflicts:</td>
<td>-</td>
</tr>
<tr>
<td>Support:</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>History:</td>
<td>22/04/2015 - definition</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 7.2.7 Reliability and availability requirements

<table>
<thead>
<tr>
<th>Requisit #</th>
<th>8</th>
<th>Kind of requirement</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td></td>
<td>The system must be available during most of the time.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification:</td>
<td></td>
<td>Users must be available to use the system every time they want it.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author:</td>
<td></td>
<td>User.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction judgement:</td>
<td></td>
<td>The system and the actions that require access to the alert server will be always available, at least 99.9% of the time.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Client satisfaction</th>
<th>4</th>
<th>Client dissatisfaction:</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependencies:</td>
<td>High</td>
<td>Conflicts:</td>
<td>-</td>
</tr>
<tr>
<td>Support:</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>History:</td>
<td>22/04/2015 – definition</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 20. Reliability and availability requirements 1

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>9</th>
<th>Kind of requirement</th>
<th>12d</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>The system must be reliable with the datum storage.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Justification:</strong></td>
<td>The system must keep the information that has been introduced.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Author:</strong></td>
<td>User.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Satisfaction judgement:</strong></td>
<td>The system will keep the datum safe by keeping them into the internal memory of the devices (it will be hidden for the user).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Client satisfaction</strong></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Client dissatisfaction:</strong></td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dependencies:</strong></td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Conflicts:</strong></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Support:</strong></td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>History:</strong></td>
<td>22/04/2015 - definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 7.2.8 Capacity requisits

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>10</th>
<th>Kind of requirement</th>
<th>12f</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>The system must be able to show 1000 elements on each screen simultaneously.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Justification:</strong></td>
<td>The system must be able to support a minimal value of the elements that are showed on the screen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Author:</strong></td>
<td>User.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Satisfaction judgement:</strong></td>
<td>The answering time of the system is normal (Requirement #7) when there are 1000 elements on each screen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Client satisfaction</strong></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Client dissatisfaction:</strong></td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dependencies:</strong></td>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Conflicts:</strong></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Support:</strong></td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>History:</strong></td>
<td>22/04/2015 - definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7.2.9 Productivity requirements

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>11</th>
<th>Kind of requirement</th>
<th>13c</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>The system requires a setting up manual into the device with an .apk file attached and it is necessary to give permission to it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification:</td>
<td>This Android App is not available into the Google Play, for this reason the user must install it manually, accepting the permissions. Moreover, the configuring option “origens desconeguts” of the app must be activated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author:</td>
<td>User.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction judgement:</td>
<td>Auto explanatory.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Client satisfaction</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Client dissatisfaction:</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependencies:</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conflicts:</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support:</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History:</td>
<td>22/04/2015 - definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 23. Productivity requirements*
7.2.10 Physic environment that has been planned

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>12</th>
<th>Kind of requirement</th>
<th>13a</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>The system will be implemented on mobile devices that include the Android system, on the versions 4.1 and 5.1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification:</td>
<td>Nowadays there is a big fragmentation among the Android devices, even that the 93.7% of the users have at least the 4.1 version.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author:</td>
<td>Promoter.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction judgement:</td>
<td>The system will be implemented on different versions of the Android system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Client satisfaction</td>
<td>1</td>
<td>Client dissatisfaction:</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependencies:</td>
<td>High</td>
<td>Conflicts:</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support:</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History:</td>
<td>22/04/2015 - definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 24. Physic environment requirements

7.2.11 Support requirements

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>13</th>
<th>Kind of requirement</th>
<th>14b</th>
<th>Event/BUC/PUC #</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>The system must have a using manual of the system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification:</td>
<td>The user must be able to consult everytime he want the manual to search how to use the system or to solve any doubt that he could have.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author:</td>
<td>User.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction judgement:</td>
<td>A manual to explain how the system function will be created to help the users.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Client satisfaction</td>
<td>3</td>
<td>Client dissatisfaction:</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependencies:</td>
<td>High</td>
<td>Conflicts:</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support:</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History:</td>
<td>22/04/2015 – definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 25. Support requirements
7.2.12 Adaptability requirements

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>Kind of requirement</th>
<th>Description:</th>
<th>Justification:</th>
<th>Author:</th>
<th>Satisfaction judgement:</th>
<th>Client satisfaction</th>
<th>Client dissatisfaction:</th>
<th>Dependencies:</th>
<th>Conflicts:</th>
<th>Support:</th>
<th>History:</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>14c</td>
<td>The website must be correctly seen at all the tablets, with their different sizes and resolutions.</td>
<td>The users could have different tablets and we have to make sure that the system could be used without problems on it.</td>
<td>User.</td>
<td>The system will be tested in almost 3 different tablets from different sizes and resolutions.</td>
<td>1</td>
<td>4</td>
<td>High</td>
<td>-</td>
<td>-</td>
<td>22/04/2015 - definition</td>
</tr>
</tbody>
</table>

Table 26. Adaptability requirements

7.2.13 Access requirements

<table>
<thead>
<tr>
<th>Requirement #</th>
<th>Kind of requirement</th>
<th>Description:</th>
<th>Justification:</th>
<th>Author:</th>
<th>Satisfaction judgement:</th>
<th>Client satisfaction</th>
<th>Client dissatisfaction:</th>
<th>Dependencies:</th>
<th>Conflicts:</th>
<th>Support:</th>
<th>History:</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>15a</td>
<td>It must be possible to use the app through an Internet connection.</td>
<td>Taking into account the system characteristics, a permanent Internet connection is required to let the system work properly.</td>
<td>User.</td>
<td>The system is used with an Internet connection (in the 100% of the cases).</td>
<td>3</td>
<td>5</td>
<td>High</td>
<td>-</td>
<td>-</td>
<td>22/04/2015 - definition</td>
</tr>
</tbody>
</table>

Table 27. Access requirements
8. Conceptual model

To create a frame of reference organized and clearly defined to represent the fundamental objects of the system and to see how these are related among them, it is necessary to create a conceptual model.

The conceptual model is composed by a class diagram and its restrictions, the primary key ones and the textual. On this following report we will see only the diagram, but showing only the objects without their attributes and methods, to see them clearly. The main objective is to show the structure of the design.
8.1. Classes diagram
8.2. Primary key restrictions

<table>
<thead>
<tr>
<th>Class</th>
<th>Primary key</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capa</td>
<td>id</td>
</tr>
<tr>
<td>MapaBase</td>
<td>id (Capa)</td>
</tr>
<tr>
<td>Gràfica</td>
<td>id (Capa)</td>
</tr>
<tr>
<td>Gràfic</td>
<td>id</td>
</tr>
<tr>
<td>Geometria</td>
<td>id</td>
</tr>
<tr>
<td>Punt</td>
<td>id (Geometria)</td>
</tr>
<tr>
<td>Polígon</td>
<td>id (Geometria)</td>
</tr>
<tr>
<td>Circular</td>
<td>id (Geometria)</td>
</tr>
<tr>
<td>NoCirular</td>
<td>id (Geometria)</td>
</tr>
<tr>
<td>Alerta</td>
<td>id</td>
</tr>
<tr>
<td>Etiqueta</td>
<td>id</td>
</tr>
<tr>
<td>Dispositiu</td>
<td>id</td>
</tr>
<tr>
<td>Subscripció</td>
<td>id (Dispositiu) – id (Etiqueta)</td>
</tr>
<tr>
<td>Localització</td>
<td>id</td>
</tr>
<tr>
<td>Notificació</td>
<td>id (Dispositiu) – id (Etiqueta) – data – id (Localització)</td>
</tr>
</tbody>
</table>

*Table 28. Primary key restrictions*

8.3. Other restrictions

- A notification arrives if the coordinates of the location intersect with an alert polygon that has a subscribed label, and if the activation model of the alert coincides.
- A notification cannot arrive if the user has exceed the maximum of the alerts related to it.
- A notification cannot arrive if the creation date, respect the last notification received, is less than the time value that this kind of alert has been assigned.
- A notification cannot arrive if the device has not been activated to receive the notifications.
- A notification cannot arrive if the device has not activated the tracking.
9. Use Case Model

After having defined the functional requirements, it is necessary to create their model for the client. The client will see the basic functioning of all of them, without talking about concepts related to a graphic interface.

As we have done in other sections, taking into account that we have a big number of Use cases, we are only going to show some of them.

9.1 Use case 1: Viewing and navigate on the map

**Primary actor:** User

**Precondition:** None.

**Trigger:** The user wants to consult the datum related to an alert.

**Main Success Scenario:**

1. The user is on the main screen.
2. The system shows a map with the graphic elements that can be seen in the zone that is being visualized.
3. The user does a movement on the map.
4. The system shows the new zone with the graphic elements that can be seen in the new zone that is being visualized.

**Extensions:**

3a. The user makes a zoom change
   2a1. The system shows the new zone with the graphic elements that are visible in the new zone that has been visualized.

3b. The user do not do any action
   2a1. The use case finishes.

9.2 Use case 2: See basic information of an element

**Primary actor:** User

**Precondition:** An alert or marker must exist and must be seen on the map.

**Trigger:** The user wants to consult the basic information of an alert or of a marker.

**Main Success Scenario:**

1. The user makes a simple click on a map alert.
2. The system shows the basic information of the alert or the marker that has been selected.
3. The user clicks on any point on the map.
4. The system closes the window that has the information.

9.3 Use case 3: Search the alert

**Primary actor:** User

**Precondition:** None

**Trigger:** The user wants to search an alert.

**Main Success Scenario:**

1. The user selects the option on the alert browser that is at the principal menu.
2. The system shows a new screen with the alert browser and all the alerts of the system appear on it.
3. The user introduces some parameters to filter the search and communicates this action to the system.
4. The system search the alerts according to the parameters that have been indicated by the user and shows the new list with the alerts that the system has found.
5. The user repeats the 3 and 4 steps as much as he wish.

**Extensions:**

2a. The system finds no alerts.

2a1. The system says to the user that any alert has been found and the use case finishes.

4a. The system does not find any alert.

4a1. The system informs to the user that any coincidences have been found among the alerts and the information that has been introduced. The use case finishes.

9.4 Use case 4: Consulting an alert

**Primary actor:** User

**Precondition:** An alert must exist.

**Trigger:** The user wants to consult all the datum referred to an alert.

**Main Success Scenario:**

1. The user makes a research with the alert browser.
2. The system shows the alerts list according to the searching conditions that the user has chosen.
3. The user selects an alert from the list.
4. The system shows all the datum related to the selected alert and also where it is on the map.
5. The user repeats the steps 3 and 4 as much as he wishes.

9.5 Use case 5: Alert management

Primary actor: User.
Precondition: None.
Trigger: The user wants to create an alert.

Main Success Scenario:

1. The user indicates to the system that he wants to create an alert.
2. The system shows a dialog with 3 options in order to draw the alert.
3. The user selects an option and communicates his decision to the system.
4. The system shows the map that has been configured to draw an alert.
5. The user draws an alert on the map with the tools that the system has and tells that decision to the system by pushing the correct button.
6. The system shows a popup with the field where the correct information must be introduced.
7. The user introduces the corresponding datum and communicates that to the system.
8. The system introduces the new alert and shows it on the map.

Extensions:

1a. The user wants to modify an alert.
   1a1. The user indicates to the system that he wants to modify an alert.
   1a2. The system shows a quest with the alert content.
   1a3. The user modifies the information and communicates that to the system.
   1a4. The system saves the changes.

1b. The user wants to delete an alert.
   1b1. The user indicates to the system that he wants to delete an alert.
   1b2. The system asks for confirmation.
   1b3. The user accepts.
   1b4. The user deletes the alert and erases it from the map.

2a. The user does not want to continue creating the alert.
   2a1. The user push the cancel dialog button and the use case finishes.
5a. The user want to draw again an alert that has already been drawn.
   5a1. The user pushes the button to draw again the alert.
   5a2. We go back to step number 4.

5b. The user wants to reject the alert that is being created.
   5b1. The user pushes the button to reject the alert and the use case finishes.

7a. The user do not introduce all the necessary datum.
   7a1. The system communicates to the user that not all the datum have been introduced.
   7a2. The user introduces all the datum that where missing and communicates this to the system.
   7a3. We go back to step number 8.

7b. The user wants to draw again the alert.
   7b1. The user clicks on the button to draw again the alert.
   7b2. We go back to step 4.

7c. The user wants to reject an alert that is being created.
   7c1. The user pushes the button to cancel and the use case finishes.

8a. The system can not create a new alert.
   8a1. The system communicates to the user that the new alert could not have been created and which error has impeded generate it.
   8a2. We go back to step 7.

### 9.6 Use case 6: Search for a marker

**Primary actor:** User.

**Precondition:** None.

**Trigger:** The user is searching for a marker.

**Main Success Scenario:**

1. The user selects the option that corresponds to the markers’ browser that is on the main menu.
2. The system shows a new screen with the browser of the markers, as well as all the markers.
3. The user introduces some parameter to filter the research and communicates that to the system.
4. The system searches the markers according to the parameters that have been indicated by the user and shows the new list with the markers that have been found on the system.
5. The user repeats the steps 3 and 4 as much as he wishes.

Extensions:

2a. The system does not find any marker.
   2a1. The system informs to the user about any marker has been found and the use case finishes.

4a. The system does not find any marker.
   4a1. The system informs to the user that any coincidences related to the information that has been introduced have been found.

9.7 Use case 7: Consult a marker

**Primary actor:** User.

**Precondition:** A marker must exist.

**Trigger:** The user wants to consult all the datum related to a marker.

**Main Success Scenario:**

1. The user realizes a research with the marker’s browser.
2. The system shows the markers list according to the searching condition that the user has introduced.
3. The user selects a marker from the list.
4. The system shows all the datum related to the marker that has been selected as well as its position on the map.
5. The user repeats the steps 3 and 4 as much as he wishes.

9.8 Use case 8: Manage the marker

**Primary actor:** User.

**Precondition:** None.

**Trigger:** The user wants to create a marker.

**Main Success Scenario:**

1. The user indicates to the system that he wants to create a new marker.
2. The system shows the map that has been configured to draw a marker.
3. The user draws a marker by clicking on the map and communicates this action to the system by the corresponding button.
4. The system shows a popup with the field where the necessary datum must be introduced.
5. The user introduces the corresponding datum and communicates this action to the system.

6. The system introduces the new marker and shows it on the map.

**Extensions:**

1a. The user wants to modify a marker.
   - 1a1. The user indicates to the system that he wants to modify a marker.
   - 1a2. The system shows a quest with the contents of the marker.
   - 1a3. The user modifies the datum and communicates this to the system.
   - 1a4. The system saves the changes.

1b. The user wants to remove the marker.
   - 1b1. The user indicates to the system that he wants to remove a marker.
   - 1b2. The system asks for confirmation.
   - 1b3. The user accepts.
   - 1b4. The system removes the marker and erases it from the map.

3a. The user wants to replace the marker.
   - 3a1. The user pushes the button to replace the marker.
   - 3a2. We go back to step 2.

3b. The user wants to remove the marker that is being created.
   - 3b1. The user pushes the button to discard the marker and finishes the use case.

5a. The user does not introduce the necessary datum.
   - 5a1. The system communicates to the user that not all the datum have been introduced.
   - 5a2. The user puts the missing datum and communicates it to the system.
   - 5a3. We go back to step 6.

5b. The user wants to replace the marker.
   - 5b1. The user pushes the reposition button for the marker.
   - 5b2. We go back to step 2.

5c. The user wants to discard the marker that is being created.
   - 5c1. The user pushes the button to cancel and the use case finishes.

6a. The system cannot create the new marker.
   - 6a1. The system communicates to the user that the marker could not have been created and the error that impedes to create it.
   - 6a2. We go back to step 5.
9.9 Use case 9: Manage alert subscriptions

**Primary actor:** User.

**Precondition:** An alert must exist at the system.

**Trigger:** The user wants to be subscribed to a label.

**Main Success Scenario:**

1. The user selects the option related to subscribe at the principal menu.
2. The system shows a new screen with the list of labels that exist in the system.
3. The user marks the correct option to subscribe to a label.
4. The system adds the subscription to the label.

**Extensions:**

3a. The user wants to filter the research.
   3a1. The user introduces some parameters to filter the research and communicates this to the system.
   3a2. The system does the research according to the parameters that have been indicated by the user and shows the new list of markers that have been found at the system.
   3a3. We go back to the last step.
3b. The user wants to eliminate a label subscription.
   3b1. The user marks the option to stop being subscribed to the label.
   3b2. The system eliminates the label subscription.
3c. The user wants to change the label category.
   3c1. The user selects the option related to managing the label categories.
   3c2. The system shows a dialog with the categories that are available and a field to add new ones.
   3c3. The user wants to select an existent category or to create a new one and communicates it to the system.
   3c4. The system adds a new category to the selected label.

9.10 Use case 10: Manage preferences

**Primary actor:** User.
Precondition: None.

Trigger: The user wants to change the system preferences.

Main Success Scenario:

1. The user selects the option that corresponds to the system preferences.
2. The system shows a new screen with the general options of the system.
3. The user modifies the options that he wants.
4. The system save the changes and modifies the performance of it according to the options that have been defined by the user.

9.11 Use case 11: Filter the layer viewing of the map

Primary actor: User.

Precondition: None.

Trigger: The user wants to change the visibility of a layer.

Main Success Scenario:

1. The user selects the option that correspond with the preferences of the system.
2. The system shows a new screen with the layers that are available.
3. The user changes the visibility that has been chosen.
4. The system saves the changes and modifies the visibility of the layer according to the changes.
5. The user repeats the steps 4 and 5 as much as he wishes.

9.12 Use case 12: Select a base map to be shown

Primary actor: User.

Precondition: None.

Trigger: The user wants to change the base that is showed.

Main Success Scenario:

1. The user selects the corresponding options to the preferences of the system.
2. The system shows a new screen with the base maps that are available.
3. The user chooses the base map that he wants to be showed.
4. The system saves the changes and shows the base map that has been selected.
10. Logic model

After having defined the use cases that appear on the system, now it is necessary to specify the functional part that will be used to create the app. During the next section, the designing model, we will see the sequence diagrams with the operations that will be necessary and how are these related among the different models, controllers, the views and the other elements that could exist on the system.

In this part is also important to list the designing patterns that will be used to create the system.

10.1 Pattern model

During the next section we are going to show the sequence diagrams related to all the cases of the system.
10.1.1 Use case 1: View and navigate on the map

**context** visualizarMapa()

**post** the alerts and markers that exist on the system are colored on the map.
context desplaçarMapa(x:double, y: double)

post The map is focused to the new determined position by the movement.

10.1.2 Use case 2: See the basic information of a graphical element
context obtenirInfoAlertaSeleccionada()

pre. There is an element that has been selected on the graphic, with the “idGraphic” identifier (alert class).

post A popup is shown on the map with the basic information of the alert: id, message, modeActivació and etiquetes.

context obtenirInfoElementSeleccionat()

pre There is an element selected on the graphic, with the “idGraphic” identifier and is from ElementPuntual class.

post A popup is shown on the map with the basic information related to the marker: id, descripció and tipus.
10.1.3 Use case 3: Search the alert

![Sequence diagram of the Use case 3 -- search an alert](image)


**pre**. The research with “idTrigger”, “nometiqueta” and “modeActivacio” are not empty.

**post**. We come back to the alert group in which coincides the research with each identifier, the label name and the activation mode.

10.1.4 Use case 4: Consult an alert

![Sequence diagram of the Use case 4 -- consult an alert](image)

**context** obtenirInfoAlertaSeleccionada(idTrigger: int)

**pre** the alert with the identifier “idTrigger” exists on the system.

**post** The alert information is on the map and it is colored on the map with its polygon.
10.1.5 Use case 5: Manage an alert

![Sequence diagram of the Use case 5 – create an alert](image)

*Picture 25. Sequence diagram of the Use case 5 – create an alert*
**context** crearAlerta (missatge: String, modeActivacio: String, urlNotificacio: String, dadesExtraNotificacio: String, tempsEntreAlertes: int, numMaxNotificacions: int, callbackUrl: String, jsonExtraCallback: String, perfilSeguiment: String)

**exc** crearAlertaArcgisOnline ERROR: the Arcgis Online alert could not have been registered.

**post** The new alert is registered into the local database of the system and in the Arcgis Online post the alert that has been created is drawn on the map.
Picture 27. Sequence diagram of the Use case 5 – modify an alert

pre the alert with the “id” identifier exists on the system.

exc actualitzarAlertaArcgisOnline ERROR: the alert Arcgis Online could not have been updated

post The changes on the alert have been saved on the local database of the system and on the Arcgis Online database.

post the map is colored again with the alert that has been modified.
context eliminarAlerta (alerta: Alerta)
pre the alert “alert” exists.
exc eliminarAlertaArcgisOnline ERROR: the Arcgis Online alert could not have been removed.
post The alert “alert” is removed from the system, as well as the polygon created by the points and the labels that are related to it.

post The alert that has been removed is erased from the map.

10.1.6 Use case 6: Search a marker

context cercarElements(idElement:int, tipus: String): Set(id: int, descripcio: String, tipus: String) String

pre The search with “idElement” and “tipus” are not empty.

post The markers group come back and the research coincides with its identifier and its class.

10.1.7 Use case 7: Consult a marker

context obtenerInfoElementSeleccionat(id: int)

pre the marker that corresponds to the “id” identifier exists on the system.
The information related to the marker is showed and colored on the map with its point.

10.1.8 Use case 8: Manage the marker

![Sequence diagram of the Use case 8 – create a marker](image1)

![Sequence diagram of the Use case 8 – create a marker 2](image2)
**context** crearElement (idElement: int, tipus: String, descripcio: String, coords: Set(x: double, y: double))

**post** the new marker is saved at the local database of the system.

**post** the new marker is colored on the map.

**Picture 35.** Sequence diagram of the Use case 8 – modify the marker

**Picture 36.** Sequence diagram of the Use case 8 – modify the marker 2
context modificarElement (idElement: int, tipus: String, descripcio: String, coords: Set(x: double, y: double))

post save the local database of the system keeps the marker changes.

post the marker that has been modified is colored on the map.

context eliminarElement (element: ElementPuntual)

pre the marker exists on the system.

post the marker is deleted of the system.

post the marker is removed from the map.
10.1.9 Use case 9: Manage the subscribed alerts

**Picture 38. Sequence diagram of the Use case 9 – Subscribe an alert**

context `insertarSubscripcio (etiqueta: String): String`

pre the label exists in the system.

post the subscription to the Arcgis Online server is inserted.

post the subscription to the local datum base of the system is created.
context eliminarSubscripcio (etiqueta: String): String
pre the label exists in the system
post the Arcgis Online server subscription is removed.
post the subscription is removed from the local datum of the system.

context canviarCategoria (etiqueta: String): String
pre the label exists in the system
post the label category is changed by the new label category.
10.1.10 Use case 10: Manage preferences

**context** activarNotificaciones ()
**post** the notifications of the system are activated.

**context** desactivarNotificaciones ()
**post** the notifications of the system are deactivated.

**context** activarRotacionMapa ()
**post** the map rotation is activated.
**context** activarRotacio ()
**post** the rotation of the map is activated.

![Sequence diagram of the Use case 10 – deactivate the map rotation](image)

**context** desactivarRotacio ()
**post** the rotation of the map is deactivated.

![Sequence diagram of the Use case 10 – activate scroll infinite map](image)

**context** activarScrollInfini ()
**post** the infinite scroll of the map is activated.
context desactivarScrollInfinit ()
post the infinite scroll of the map is deactivated.

context activarTracking ()
post the monitoring of the device location is activated.
context desactivarTracking ()
post the location monitoring of the device is deactivated.

context canviarPerfil (nouPerfil: String)
pre the profile “nouPerfil” is one of the profiles that are available at the system.
post the new monitoring profile of the device is updated.

10.1.11 Use case 11: Screen the layer viewing of the map

context activarVisibilitat (idCapa: int)
pre “idCapa” can be identified and corresponds to the alert layers or to the punctual elements.
post the “idCapa” that corresponds to the identifier is showed.
context desactivarVisibilitat (idCapa: int)
pre the “idcapa” exists and corresponds to the alerts’ layer or the markers.
post” the “idCapa” that corresponds to the identifier is hidden.

10.1.12 Use case 12: Select the base map to show

context canviarMapaBase (mapaBase: String)
pre the base map “base map” is one of the map that are availables for the system.
post the base map used by the system is updated.

10.2 Design patterns

In this section we will see the designing patterns that our system uses. As our system has been developed by Android, the patterns that are basically used are the ones that Android need, more than any others. During the next part are showed:
10.2.1 MVC-MVP

During the design of the system, the Model-View-Controller has been taken into account with the aim to separate the different layers and take advantage of the MVC pattern. The problem is that the Android system has been created in a way that makes really difficult doing this, because some of the elements that are required to make it work do not follow this pattern.

The same happens with the Model-View-Presenter (MVP), but this pattern fits better, because that is the way that elements like fragments, activities and listAdapters work.

For this reason we will apply a mixture of both patterns. We are going to use the model part to represent the datum layer, the controller layer for the methods and functions that are necessary to communicate with the visible layer and, finally, the presentation layer that connects the view layer with the model layer.

10.2.2 ViewHolder

ViewHolder\textsuperscript{[19]} is a pattern used in Android to obtain performance when doing a scroll on a list, because it avoids having the object that is being used to show the information on the screen and only does this the first time. Then, the object is reused showing the new datum every time we move. In this system, we have different views that include lists to show the information, and, for this reason we apply this pattern.

10.2.3 Factory

In Android, when we change from one activity to another, a class called Intent is used. Intent uses the factory pattern.

10.2.4 Adapter

In Android, when we want to define a personalized kind of view, for example a list, adapters are used. As their name says, adapters use the adapter pattern design.

10.2.5 Builder

The Geotrigger library uses this pattern to do the requests and to receive the answers that the ArcGis server sends. The pattern is there when the requests are being done.

10.2.5 Singleton

Finally, we will use the singleton pattern to obtain an only instance of determinate classes to centralize the resources management using only one access point. For example, used by the class that is in charge of manage the datum base.
11. Deployment model

On the next picture we can see the development model of the project. As we explained during the first phase, the system is composed by 3 big elements and another one that is optional.

The first element (the Android device), includes the two APIs that have been used to view the map as well as the information that has to be showed and for the management of the alerts. This element also includes the database that is required to save all the local information that we have said before. It is important to say that the BD that must been used, even it is based on the datum base motor of Android (SQLite), it will be spatial, this is necessary to keep the geographical information of the markers and the alerts.

This device will be communicated with the second element, the ARCGIS Online server, that is the only one that has available the geotrigger service that is in charge of saving the alerts, and the one that does the alert testing process that will be done every time it receives information with the new position from the device.

Finally, when this server finds an alert that must be activated, sends the information that has been stocked up on the device through the third element, the push server of Google. This Google server has a service called Google Cloud Messaging, which firstly verifies if all the datum is correct, for example verifies that it is less than 4KB, and does the notification delivery to the device.
12. Presentation model

Finally we have the storyboards. With these screens we want to create a graphic view of the target that we want to achieve and a view to see how all the system elements will be distributed on it.

It is important to say that in any case we are showing the final version and, for this reason, even we want the essence, the structure and the interaction form with the app be like this, the final version can have little differences as the images used for this screens, names, etc.

The number of screens we can show will be reduced with the aim of not spread out a lot this monitoring document.

12.1 Principal screen

This image shows the main screen of the app, with the main buttons and some configuration options that will be maintained when opening again the app.

![Principal screen](image-url)

*Picture 54. Model presentation – Principal screen*
12.2 Interaction with the elements of the map

Here we can see how to interact with the elements of the map, in this case with an alert. On the first screen it is possible to see how it performs when clicking on an alert and shows the main information of the alert and a button to know more about it. The second screen shows the edit and remove options, that we will see when doing a long click.

Picture 55. Model presentation – Interaction map 1

Picture 56. Model presentation – Interaction map 2
12.3 Creating alerts – by radius (circle)

Here we can see the creation being created. First we select the geometry class (a circle this time). Then the geometry is generated and, finally the alert parameters are configured.

![Picture 57. Presentation model – creating alerts](image)

![Picture 58. Presentation model – creating alerts 2](image)
12.4 Browser

Finally, we show the browser screen. On this screen we can search alerts, markers and an addresses. In this case, we can see the alerts section where we can see the alerts list next to a button to find them on the map and a little screen with its information. Some options to filter or enclose the research are also included.

![Browser Screen](image)

*Picture 59. Presentation model – browser*
13. Implementation model

13.1 Introduction

Once the defined tasks have been done during the software designing phase it is time to proceed with its implementation. To accomplish with the planning timing of this phase, it is really important to have a good knowledge about the elements that are related to the implementation, the working environment, the programming language, the external libraries, etc.

Due to the experience on this development field, even having used some new library that was totally unknown and with little community support, the implementation has been done with any problems.

The app code can be found here: (usuaruser and password: tfg_jaume_lopez):

https://bitbucket.org/lopeess/geoalert_andstudio

On the following sections we will see the graphic interface results, the components that have been used and the internal performance of the application.

13.2 Graphic interface

Having into account that the Android devices are very large and have different characteristics, we will focus on the tablets, for this reason, the app is executed in horizontal to take the maximum advantage of this. But, in order to do the checking this has also been adapted to be used on smartphones.

The main screens are showed after.

13.2.1 Principal screen

This picture shows the main screen of the application. Mainly we can see the map with the graphic elements that have been previously added, that is to say, the alerts, the markers and three buttons. The floating button used to focus on the map, the top button on the left to show the menu with the different options that are available and the top button on the right to open the configuring preferences.
13.2.2 Interaction of the elements of the map

Here we can see how to interact with the map elements. Even that in this case we show the interaction with an alert, the performance is the same with a marker. On the first screen we can see the performance when clicking on an alert that shows the main information of the alert.
The next screen shows the edit and remove options that we will see at the sides on the bottom of the screen when doing a large click.

Picture 62. Implementation model – select an alert

If there are many alerts in the same zone, on the information popup will appear two navigation buttons to select which alert information we want to see. To know which alert is selected the alert contour is re-marked.

Picture 63. Implementation model – select an alert 2
13.2.3 Available options

With the top menu on the left, we can see the options that are available on the system. It is possible to access by pushing the button or doing a movement from to the left from the left side of the screen to see the side panel.

![Implementation model – Available options](image)

13.2.4 Alerts creation

Here we can see how to create an alert. Firstly, we have to select the alert shape among the three possible options:

- A circle
- Free style
- With precision
In the two first cases, once the alert is created the system offers the option to accept, cancel or re-draw. The two last options are hidden at a pull-down menu, as it can be seen on the next picture.
In the case of creating an alert with the precision class, instead of doing this with the redrawing button, it will be done with the edition button. The edition button allows many options: undo, redo, remove a marker or redraw a polygon. The edition button also has an option to add a point using a magnifying glass.

To finish the creation, after accepting the polygon that has been created, the system will show a quest to fill the datum related to the alert.
13.2.5 Subscriptions

On the next screen different labels related to the alerts that exist on the system to subscribe in or to remove the subscription. Moreover, we could classify the labels into categories and filter the results to find one in particular easily.
13.2.6 Browser

Here we show the browser screen. On this screen we can search for alerts and for markers. In both cases, we can see the alerts lists or the markers and a little screen with its information. Options to filter or enclose the research are also included.

*Picture 70. Implementation model – alert browser*

*Picture 71. Implementation model – Markers’ browser*
13.2.7 Manage the layers

In the menu option to manage the layers we can adjust the alerts visibility and the markers and change the base map.

![Manage the layers](image)

*Picture 72. Implementation model – manage the layers*

13.2.8 Preferences

Finally, we can see the screen where we will find the general preferences of the system that we can change in relation to the geographical alerts and in relation with the map.
13.3 Parts of the system

13.3.1 Programming environment

Firstly, we had to decide which programming environment we were going to use for the development. There are only two prepared to program using Android code. On one hand, we have the Eclipse environment that together with a Google plugin is able to add the integration required for the development. Nowadays, is not possible to use it because there are not more updates. So now we are using Android Studio of Google, which is based on IntelliJ program (while the project was being done, more updates appeared). We are using the 1.4 version.

13.3.2 Programming language

On this case has not being necessary to choose the programming language because Android uses Java and that is the reason why we have used it.

13.3.3 Principal library

The main library is the SDK, which forms the different methods or functionalities for each version. In our case, we have compiled the code with the las version, the level number 23 of the API, which appeared two weeks ago for the Android 6.0 systems.

During the testing phase we verified that the new permissions service of Android 6.0 makes the user give permissions individually to the apps that are installed out of Google Play public repository of Android applications.
The minimum API level to execute this app is 16, corresponding to the Android 4.1 version.

### 13.3.3 External libraries

During the implementation some external libraries have been used. Most of them were Google libraries used for the correct functioning of the devices’ components with the different Google API versions. Moreover, with the new components that appeared with the lollipop version and the new viewing style: Material Design.

A part from these libraries, two more have been used, the ones that have been selected during the decisions phase that was into the analysis of existent technologies:

- **Geotrigger SDK v1.2**
  
  This library is the responsible for the alert service that is to say that, this library is the one that can initiate the following of the device position, to decide if any alert is activated and send the notification if this happens.

  Furthermore, this library allows to create the requests to create the alerts on the ArcGis online server, to modify this alerts, to change the following profile...

- **Arcgis Android 10.2.7**
  
  This library is responsible of showing the map, of managing the layers and the stick on information. This library offers many functions to configure and interact with the map.

### 13.4 Internal functioning

The intern functioning of the app is the designed structure with the sequence diagrams, but at this point, we will try to explain how the generation and reception of alerts performance works.

- **Creating alerts**
  
  Using different methods of the library on the map we have written about and with the events that have been added by the main library, it is allowed to draw a polygon interacting with the screen. In order to do tis the dots x-y and the coordinates of the map, for its view representation. This polygon will be showed in a temporal creation layer.

  After all this, a conversion of the coordinates system of the dots of the map polygon is done, because the map uses a projection system and the detection system that is on the online server uses the geographical coordinates.

  Finally, we send the datum of the polygon that has been transformed with the other datum to the online server. If everything has gone right, this alert will also be added to our local datum base. The polygon will be colored on the alert layer erasing the polygon of the temporal layer.

- **Alert reception**
To receive the alerts the service must be activated when we initiate the app. It will be maintained even if we get out of the app and we could receive notifications even if the app is not opened. This service can be stopped at the preferences section of the app, with the general options of Android or by refreshing the device.

When the service is active, the location changes of the device are sent to the service that checks if a notification must be sent. To activate a notification the device must get into or out of a concrete zone determined by the alerts that have been created. Moreover, it is important to accomplish some additional restrictions as the maximum number stablished for each alert or the minimum time between notifications.
14. Tests

The testing becomes essential when the system development is finished. Even that, during the development phase some test have been done when the different sprints where finished, it is important to test the system when everything is done. These final testing will help us to make sure that the system works properly and also to see if the requirements and the objectives that have been specified before have been accomplished.

In order to make the tests, different devices have been used (smartphones and tablets) to verify if it was correctly adapted to the different sizes and resolutions. The testing has been used with the smartphones to verify the efficiency of the alerts, because the tablets that have been used during the test did not have datum connection.

The devices that have been used are:

- Samsung Galaxy Tab S. 8.4” screen, O.S. 5.0.1 version
- Tauleta Nexus 7 2012. 7” screen, O.S. 4.4 version
- Tauleta Energy Sistem Neo 2. 10.1” screen, O.S. 4.4 version
- Smartphone Nexus 5. 5” screen, O.S. 6.0 version
- Smartphone LG G3. 5.5” screen, O.S. 5.0 version
- BQ Aquaris M5. 5” screen, O.S. 5.0 version
- Samsung Galaxy Ace 2. 3.8” screen, O.S. 4.1.2 version

We can divide the test into two different types. On one hand, we have the testing related to the general functioning of the system, the direct interaction of the user with the app. And, on the other hand, the testing related to alerts, and, as a result, the system reaction depending on the environment and the notifications reception.

On the testing part referring to the system functioning, 3 iterations of trials were done, using all the devices that have been mentioned before. 5 different users took part on the first iteration (4 of them knew nothing about this app). These people could find some problems and say their opinion about if the app was easy to be used. The results were the followings:

- **Problems that appeared:**
  - The subscribing screen was blank
  - A concrete marker had a different name depending on the screen where the user was.

- **Impressions:**
  - The creation of the alerts was attractive and intuitive.
  - It is missing a sign to explain where the user is.
  - The user does not know how to differentiate an alert when more than one are selected at the same time.

After having the results we started to solve the bugs, and thanks to the testers we take into account the possibility of adding a button to centre the map according to the actual position and, finally, it was included on the second iteration. The edge of the selected alerts was remarked to differentiate them from the rest of the alerts.
After having applied all the changes, a second version was distributed and we get new results:

- **Problems that appeared:**
  - Some categories were repeated.
  - The subscriptions change their state after the scroll.
  - The system is no able to save the state when changing the app and coming back to it.

- **Impressions:**
  - Some users said that the button to center the map was annoying in some screens.

With the new results, firstly, we solved the errors that the users found. Secondly, we studied the best way to find a solution for the button to center the map. And, thirdly, an option into the preferences was added to hide that new button.

Finally, a third iteration was done:

- **Problems that appeared:**
  - When coming back from another app our app was freezed.

- **Impressions:**
  - A browser to filter taking into account the address.

Thanks to this last iteration a new error that appeared could be solved in order to try to improve the apps management. Respecting to the browser suggestion, we have to say that this is an improving that was took into account at the design phase and, finally, it will appear as a future improvement. Nowadays, the users have the forth version without error notifications.

As we have said, the other testing part was related to the efficiency of the trials, taking into account that the system offers the possibility of using 3 different functioning profiles. Some test have been done to each of them. The available profiles are the following:

- **Rough Mode:** Minimum consumption of battery, low precision: 500 meters.
- **Fine Mode:** High consumption of battery, high precision 50 meters. Uses GPS every 5 seconds.
- **Adaptive Mode:** The app is adapted to the context (closeness to the alerts, velocity of the movement, etc.) the average of the accuracy is 100 meters. Uses GPS when it is near.

Taking into account the different profiles and the different uses that our users have done, we have got general results. Even that the majority have got promising results, some of them had many troubles. The next chart shows the percentages of the final results of the notifications that had to arrive:
<table>
<thead>
<tr>
<th></th>
<th>Rough</th>
<th>Fine</th>
<th>Adaptative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notifications that have been arrived</td>
<td>48%</td>
<td>93%</td>
<td>89%</td>
</tr>
</tbody>
</table>

Table 29. Results of the test about the notifications that have arrived

As we can see the adaptive mode, that is the most recommended because it is the most equilibrated, has similar results to the precision profile. The engine created to save battery is the one that has failed more because, as it uses the aerial triangulation to decide the position, in many cases the notifications did not arrive.

In contrast, even we could not determinate in a direct way the impact on the battery, the general impression is that the rough mode and the adaptive mode have had a similar response having a low impact on the battery. But, the fine mode has had an important impact on the battery because the use of the GPS is more intensive.

In conclusion, we can say that using the adaptive mode, we can obtain good results even I think that the system could be more improve to have better results, because depending on the use the reliability is really important.
15. Conclusions

15.1 Objective resolution

At this point we have to think about if we have reached the objective that we proposed at the beginning of this project.

The objective of this project was to offer a mobile app to view and manage the markers, and to manage the alerts taking into account the context where the user is. It is completely personalized depending on the user’s needs. And that is what we have achieved.

The app that we have created allows to manage the markers by creating, modifying and removing the elements. Even more, we have included a browser to allow the user to find the markers easily and to see their information (the related datum and the position where it is).

The app offers the possibility to manage the geographical alerts depending on the position and depending on the context by using labels referred to the notifications that we want to receive. Moreover, this app was focused like an API without any concrete client to have the possibility of offering different options and purposes depending on the user’s needs. For example, we can create an alert only to remind us to make a call when arriving home, or to send an email when arriving at work.

For all these reasons, even that, finally, the delivery term has been affected and not all the optional objectives proposed at the beginning could have been implemented, we can say that the main objective could have been achieved.

15.2 Changes on the planning

As we have mentioned on the plan part, we have done two changes in relation to the initial version. The first one, only changes the order of some of the phases in order to be able to implement the configuring part of the servers to test more deeply the different technologies during the information search phase.

The second change has affected directly to the deadline, changing it from the 29th June to de 19th October, almost 4 months more. The main reason of this, is the change that has been due to the timetable availability to create this project because of a change on my working contract. They increased my amount the hours per week so I could not dedicate more hours per week during my workday.

15.3 Budget changes

Even that the problems and the changes on the plan have not affected to the project budget (because the amount of hours to dedicate on each phase was previously defined). But, as we have seen previously, there has been one that has affected to our initial budget. On this case, the budget has been a little bit lower because it has not been necessary to include a server to see if the alerts have been activated.

The reason of this budget change is that after having finished the study about the technologies that exist, we thought about using de ESRI solution that uses its own server.
15.4 Future improvements

The main improvements for the future are the ones that we had defined as optional improvements, as we can see on the following report. These improvements and others are:

- **Add privacy to the alerts**
  It could be really useful to offer public and private alerts. The public alerts would be visible for everybody while the private ones would only be seen and used by the alerts’ creator. People could subscribe to the public alerts created by other people.

- **Information and searching by address the alerts and the markers**
  Add the address where an alert or a marker is and be able to search it using this parameter.

- **Streets browser**
  Include the geolocation to search the streets.

- **Search the address of a point**
  Include the opposite geolocation to find the address related to a point.

- **Manage simple tracks**
  Allow to create, modify and manage simple tracks that could be related to alerts or markers of the system.

- **Add external layers**
  Offer the possibility to add layers with local files with the correct format or from an email.

- **Manage styles**
  Even that nowadays the markers can be defined with a concrete style, it could be interesting to import an external symbology and apply it to the markers of the system or to the files imported of the external layers.

15.5 Personal opinions

Until you do the final degree report you do not realize about the real meaning of doing a project. At the beginning, you do not know where you have to start and, at the end, you do not know how to finish it because you always think on improving it and adding functionalities to your idea.

This project has made me grow up a lot as an informatics engineer, because I have learned how to apply all the knowledge learned during the degree satisfactorily. It is not all about typing code and implementing an idea that has been designed by another person. The satisfaction after having created an app taking into account an idea that has been redrawn, the
initial objectives, a planning is awesome and has no price, because the project has been what you imagined at the beginning.

I could verify about the difficulties that appear during the first phases of these kind of projects. On its phases an error during the design process or during the taking decisions part can have big repercussions. It has also been a little bit difficult because I had to do all the project alone, with no help.

But as positive points I can remark that I had the possibility to choose the topic, I could work according to my way of doing things and I could take my own decisions. These facts helped me in achieving good results and the feeling of having done things well.

But, the most important thing is that this project has been a good experience for me, this project has made my dream of becoming an informatics engineer coming true and I am really proud of it.
Annex 1 – Initial *Gantt* diagram

<table>
<thead>
<tr>
<th>Nombre</th>
<th>Duración</th>
<th>Inicio</th>
<th>Fin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Planificació del projecte (GEP)</td>
<td>80h</td>
<td>16/02/2015</td>
<td>23/03/2015</td>
</tr>
<tr>
<td>2 Recerca d’informació</td>
<td>30h</td>
<td>24/03/2015</td>
<td>30/03/2015</td>
</tr>
<tr>
<td>3 Anàlisi i disseny</td>
<td>120h</td>
<td>31/03/2015</td>
<td>24/04/2015</td>
</tr>
<tr>
<td>4 Implementació aplicació Android</td>
<td>100h</td>
<td>27/04/2015</td>
<td>22/05/2015</td>
</tr>
<tr>
<td>5 Implementació servidor d’alertes</td>
<td>60h</td>
<td>22/05/2015</td>
<td>10/06/2015</td>
</tr>
<tr>
<td>6 Configuració servidor google i connectivitat</td>
<td>30h</td>
<td>10/06/2015</td>
<td>16/05/2015</td>
</tr>
<tr>
<td>7 Proves generals</td>
<td>40h</td>
<td>17/06/2015</td>
<td>23/06/2015</td>
</tr>
<tr>
<td>8 Finalització de la documentació</td>
<td>20h</td>
<td>24/06/2015</td>
<td>26/06/2015</td>
</tr>
<tr>
<td>9 Preparació defensa del TFG</td>
<td>50h</td>
<td>29/06/2015</td>
<td>02/07/2015</td>
</tr>
<tr>
<td>Tiempo Total</td>
<td>510h</td>
<td>16/02/2015</td>
<td>02/07/2015</td>
</tr>
</tbody>
</table>

*Picture 74. Gantt diagram*
Annex 2 – *Gantt* diagram with the first planning changes

![Gantt diagram](image)

*Picture 75. Gantt diagram*
Annex 3 – *Gantt* diagram with the last planning changes

<table>
<thead>
<tr>
<th>No.</th>
<th>Task Description</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Planificació del projecte (GEP)</td>
<td>90h</td>
<td>16/02/2015</td>
<td>23/03/2015</td>
</tr>
<tr>
<td>2</td>
<td>Recerca d’informació</td>
<td>30h</td>
<td>24/03/2015</td>
<td>24/04/2015</td>
</tr>
<tr>
<td>3</td>
<td>Cerca de tecnologies existents</td>
<td>25h</td>
<td>24/03/2015</td>
<td>27/03/2015</td>
</tr>
<tr>
<td>4</td>
<td>Anàlisi resultats i presa de decisions</td>
<td>5h</td>
<td>24/04/2015</td>
<td>24/04/2015</td>
</tr>
<tr>
<td>5</td>
<td>Configuració servidor geològic i connexió</td>
<td>30h</td>
<td>30/03/2015</td>
<td>03/04/2015</td>
</tr>
<tr>
<td>6</td>
<td>Implementació llibretera Geografer ESRI</td>
<td>60h</td>
<td>06/04/2015</td>
<td>03/04/2015</td>
</tr>
<tr>
<td>7</td>
<td>Anàlisi i disseny</td>
<td>120h</td>
<td>27/04/2015</td>
<td>15/07/2015</td>
</tr>
<tr>
<td>8</td>
<td>Model de requisits</td>
<td>12h</td>
<td>27/04/2015</td>
<td>30/04/2015</td>
</tr>
<tr>
<td>9</td>
<td>Model conceptual</td>
<td>20h</td>
<td>01/05/2015</td>
<td>11/06/2015</td>
</tr>
<tr>
<td>10</td>
<td>Model de casos d’ús</td>
<td>30h</td>
<td>06/05/2015</td>
<td>15/06/2015</td>
</tr>
<tr>
<td>11</td>
<td>Model lògic</td>
<td>15h</td>
<td>17/06/2015</td>
<td>07/07/2015</td>
</tr>
<tr>
<td>12</td>
<td>Model de presentació</td>
<td>15h</td>
<td>08/07/2015</td>
<td>13/07/2015</td>
</tr>
<tr>
<td>13</td>
<td>Model de desplegament</td>
<td>8h</td>
<td>14/07/2015</td>
<td>15/07/2015</td>
</tr>
<tr>
<td>14</td>
<td>Implementació aplicació Android</td>
<td>100h</td>
<td>26/08/2015</td>
<td>29/09/2015</td>
</tr>
<tr>
<td>15</td>
<td>Gestió d’alertes</td>
<td>40h</td>
<td>20/08/2015</td>
<td>04/09/2015</td>
</tr>
<tr>
<td>16</td>
<td>Subscripcions</td>
<td>15h</td>
<td>10/08/2015</td>
<td>14/09/2015</td>
</tr>
<tr>
<td>17</td>
<td>Gestió d’elements puntuals</td>
<td>12h</td>
<td>15/08/2015</td>
<td>17/09/2015</td>
</tr>
<tr>
<td>18</td>
<td>Cercador</td>
<td>20h</td>
<td>18/08/2015</td>
<td>24/09/2015</td>
</tr>
<tr>
<td>19</td>
<td>Gestió capes</td>
<td>8h</td>
<td>25/08/2015</td>
<td>28/09/2015</td>
</tr>
<tr>
<td>20</td>
<td>Patró區域化</td>
<td>5h</td>
<td>25/08/2015</td>
<td>28/09/2015</td>
</tr>
<tr>
<td>21</td>
<td>Proveu generals</td>
<td>40h</td>
<td>02/10/2015</td>
<td>12/10/2015</td>
</tr>
<tr>
<td>22</td>
<td>Finalització de la documentació</td>
<td>20h</td>
<td>13/10/2015</td>
<td>19/10/2015</td>
</tr>
<tr>
<td>23</td>
<td>Preparació defensa del TFG</td>
<td>30h</td>
<td>20/10/2015</td>
<td>26/10/2015</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>510h</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Picture 76. Gantt diagram*
References

[1] This World Map Shows Every Device Connected To The Internet. Pamela Engel [Consulted: 10th March 2015]  

Available: http://es.wikipedia.org/wiki/Sistema_de_informaci%C3%B3n_geogr%C3%A9fica

Available: https://langleruben.wordpress.com/%C2%BFque-es-un-sig/


Available: http://carto1mexico-velazquez.blogspot.com.es/2013/03/los-metodos-de-representacion.html

Available: http://ca.wikipedia.org/wiki/Projecci%C3%B3_Universal_Transversa_de_Mercator

[8] El sistema de coordenades UTM. Sara Ibáñez Asensio [Consulted: 12th March 2015]  
Available: https://riunet.upv.es/bitstream/handle/10251/10772/Coordenadas%20UTM.pdf?sequence=1


Available: http://runrun.es/tech/135995/funcionalidades-y-detalles-de-google-now.html

Report

Net view map for the active management of markers on Mobile devices (Android)

Available: 


Available: [https://www.oneoctopus.es/desarrollo-android/el-patron-viewholder/](https://www.oneoctopus.es/desarrollo-android/el-patron-viewholder/)

Available: [http://es.slideshare.net/jkumarr/design-pattern-in-android](http://es.slideshare.net/jkumarr/design-pattern-in-android)