Politecnico di Milano

Software Engineering II project:
PowerEnjoy

# Requirements Analysis and Specification Document

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# Contents

**Abstract**

The main purpose of this document is to give a specification of the requirements that our system has to fulfill adopting the IEEE-830 standard for RASD documentation. It also introduces functional and non-functional requirements via high level specification of the system. In the last part a formal model is presented using Alloy.
The information contained in this document is intended for the stakeholders and developers: for the stakeholders this document presents an useful description to understand the project development, meanwhile for the developers it's quite a comfortable way to match the stakeholders' requests and the proposed solutions.

# Part I

# Requirements analysis

# Introduction

## 1.1 Purpose of the system

The aim of this project is to develop a digital management system called PowerEnJoy.
PowerEnJoy is a car-sharing service which uses only eletric-cars and allow the users to easily find a car, thanks to the location services, and to use it.
To encourage the virtuous behaviors of the users some discounts and lots are provided and can be applied to the bill.

## 1.2 Scope of the system

Users have to be registered to the system and provide credentials (as well as payment informations), then a password will be sent that can be used to access the car-sharing service. They can easily find eletric-cars thanks to the location service and reserve them for up to an hour.
When an user is near to a vehicle that she want to drive, she contacts the system telling that she's nearby that specific car, than the system unlock the car letting her to get into it. Then the system automatically calculates the charge during the ride, notifying the user through a screen on the car. Finally when the car is parked in a safe area and the user exits the car, the system stops charging the user and automatically lock the car that become available again.
The system should encourage virtuous behaviour of the users, to do that some discounts can be applied on their last ride. For example a discount of the 10% is applied if the user took at least two other passengers onto the car. Other discounts are applied if a car is left with no more than 50% of the battery empty or if the user left the car in a special park where it can be recharged(20%) and she takes care of plugging the car into the power grid (30%).
On the other side the system charges 30% more on the last ride if the car is left at more than 3 Km from the nearest power grid station or with more than 80% of the battery empty in order to compensate for the cost required to re-charge the car on-site.

## 1.3 Objectives and success criteria of the project

After a first analysis on our average users, the main features that should be provided by our application are:

1. [G1] User's registration
2. [G2] User's account and session management
3. [G3] Immediate payments/charges
4. [G4] Location-related services (car localization: user's location or address should be provided)
5. [G5] Car real-time reservation and related processing
6. [G6] Car un-locking and (automatic) locking

## 1.4 Assumptions

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## 1.5 Actors Identification

- **Guest**: is a person that hasn't already registered to the system or an user that hasn't already log in. She can only proceed with a new registration or log in.
- **User**: we believe that PowerEnJoy can be used by a wide range of people that need only to access the system for benefit. A person became an user after her registration to the system, when she provides her credentials and payment information.
  A tipical user is a person who want to easily move around in a social end eco-friendly way. Usually she uses the service only for short travels near the charging stations.
  Our scope is to create an easy-to-use and efficent system that make the users satisfied and willing to use PowerEnJoy.

## 1.6 Stakeholders Identification

- **Customers**: the purpose of the customer is to maximise the performances of the system and reach the biggest profit possible.
  In our project the main stakeholder is the professor. She expects us to develop a digital menagment system, PowerEnJoy, that provide the functionality normally provided by car-sharing services.
  The role of the professor is to evaluate our ability and level of comprehension of the subject.

- **Producers**: the project is developed and produced by us. We want to apply in practice what we learn during lectures and became able to manage software engineering problems, solving them in a rigorous way and being as accurate as possible. Our project includes a Requirement Analysis and Specification Document (RASD), a Design Document (DD), a testing-related activity, an assessment of the effort and cost required for the development of the project, a code inspection and bug identification activity on an existing open souce project.
  We will develop our project as close as possible to a real application that is ready to be launched in the market.

# Overview of the purposed system

In this chapter the product and its requirements are described in order to provide a background for the "Requirements specification" part and make it easier to understand.

## 2.1 Product perspective

### 2.1.1 User interfaces

The user should be able to interact with the system in three ways:

- Web application: is strongly cross-platform and then accessible from any device that can browse the web
- Mobile application: accessible from smartphones and mobile devices in order to guarantee portability and ease of use
- On-Board computer: accessible from the inside of any PowerEnjoy car, it must be extremely straightforward and let the user focus on the actual interaction

A common and friendly UI should be provided to create a sort of logical connection between the three different applications and make the user feel comfortable.

### 2.1.2 Hardware interfaces

The web application has no other hardware constraints despite the ones specified in subsection 2.4.2, it should run on any device meeting such minimum requirements. Mobile application has to communicate with GPS, Antenna and WiFi modules in order to retrieve location and query the server, requirements easily met by any modern smartphone.
On-Board computers require a car with self-diagnostic and reporting capability.

### 2.1.3 Software interfaces

The web application should support devices running any modern browser while the mobile application will be developed and supported on iOS, Android and eventually WP.
On-Board computer's application is device-specific and will then be designed based on the ad-hoc hardware, embedded OS and APIs.

## 2.2 Product functions

The system that we are to develop must let users register and then login in order to manage their account and actively access the service. The provided functionalities are clearly enumerated in section 1.3 and here graphically described to ease the complete comprehension of the system.

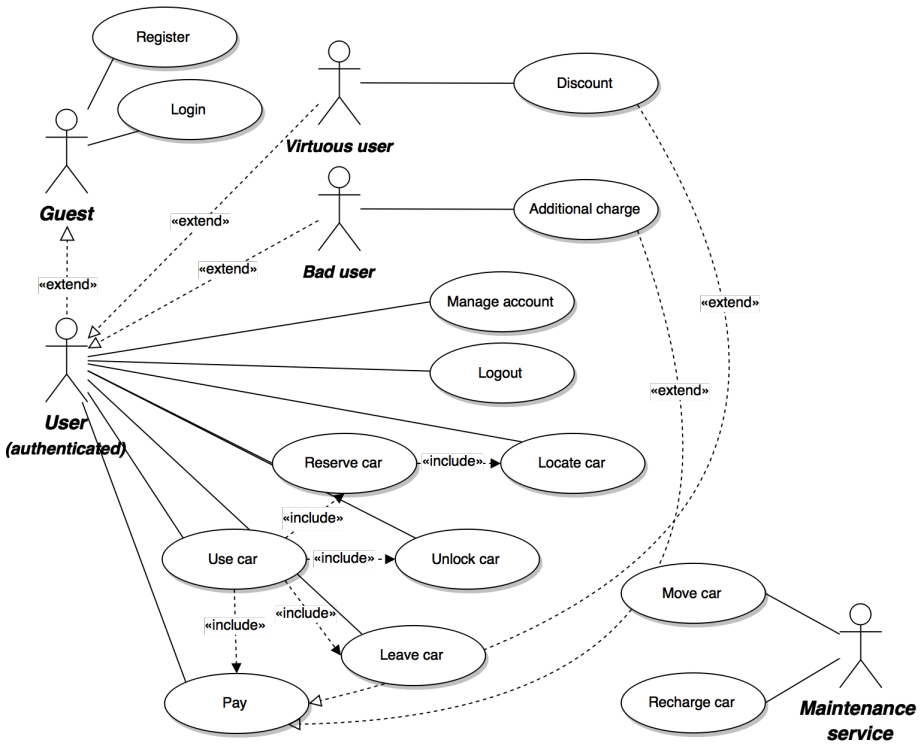


Figure 2.1: Main use-case representing all the functionalities of the system

## 2.3 User characteristics

The application should target users with a valid driving license, being at least 18 and providing a secure payment method, which must be checked before any reservation.
Additional legal requirements might be necessary, especially if the service is intended to spread into foreign countries

## 2.4 Constraints

### 2.4.1 Regulatory policies

Users must allow the system to collect and use personal data according to a privacy policy: data such as personal details, payment methods, transactions and locations are stored and processed in order to provide a higher service quality.

### 2.4.2 Hardware limitations

Hardware requirements are extremely different depending on the application that is being considered; in this document, though, the on-board computer's hardware won't be discussed. The web application development demand two main hardware constraints:

- Stable internet connection
- Modern(supported) web browser

The mobile application will be deployed for mobile devices, so even the memory constraints are consistents:

- ARM architecture
- At least 1GB of RAM
- At least 50MB of available storage
- Up-to-date operating system (minimum API level or OS version)
- Stable internet connection
- GPS module may be useful but not necessary to access the service

### 2.4.3 Parallel operation

The system must support heavy parallel processing because of the high number of users that are to access the service potentially at the same time.

### 2.4.4 Reliability requirements

The system must be opportunely reliable in order to support users while accessing the service, a 3-nines availability (~9hours/year) is more than enough for a non life-critical system

### 2.4.5 Safety and security considerations

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## 2.5 Assumptions and dependencies

In order for the system to work properly some domain assumptions are needed:

- Sensors and devices needed to support the functionalities of the system are already installed on vehicles
- Cars are equipped with a standard diagnostic connector and are using OBD-II communication protocols
- The GPS signal is sufficiently accurate ($\pm 5m$ accuracy with A-GPS)

## Developer Overview

Here a complete class diagram of our system is presented before splitting up the functionalities and provide an in-depth overview:

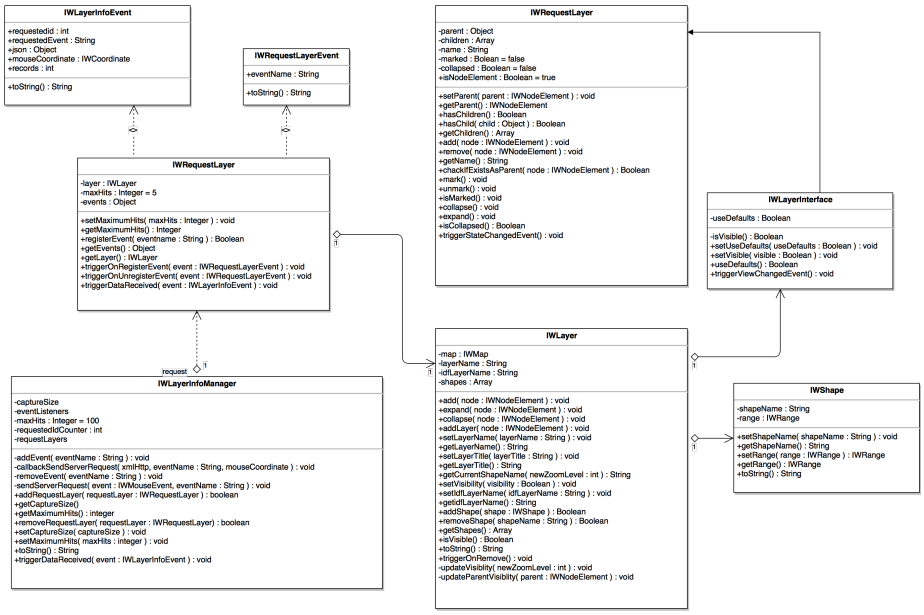


Figure 2.2: Complete class diagram of the system

# Part II

# Requirements specification

# Specific requirements

## 3.1 External Interfaces

### 3.1.1 User interfaces

As stated in section 3.5.1 and subsection 2.1.1 the application's UI must be extremely user-friendly and functionally equivalent across devices.
Regarding the mobile UI a 3-page mockup is presented (fig. 3.1) to highlight the most important functions:

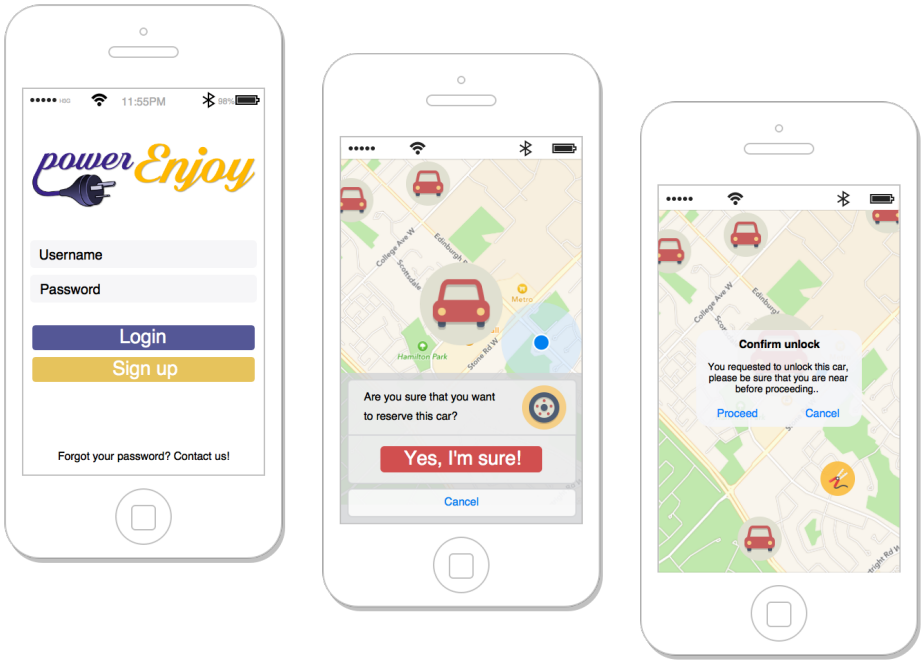


Figure 3.1: 3-page mockup representing the main pages of the mobile application

- Login: the first page presented to the end-user is a simple login/signup page where she can login using her credentials or register to the system
- Car reservation and localization: this is probably the most important use-case, the user will be able to browse and find nearby cars, eventually requesting a reservation
- Unlock: the user will request to unlock the car through a procedure similar to the one described in point 2 above, than a confirmation will be asked to enforce security and advise the user to really locate the car before unlocking it

Additional in-detail mockups are presented in section 3.3 along with the use-cases specification.

The web application will be really similar in features to the mobile application, the main use-cases are in fact the ones presented above in figure 3.1; a basic mockup is presented (fig. 3.2) to provide completeness:

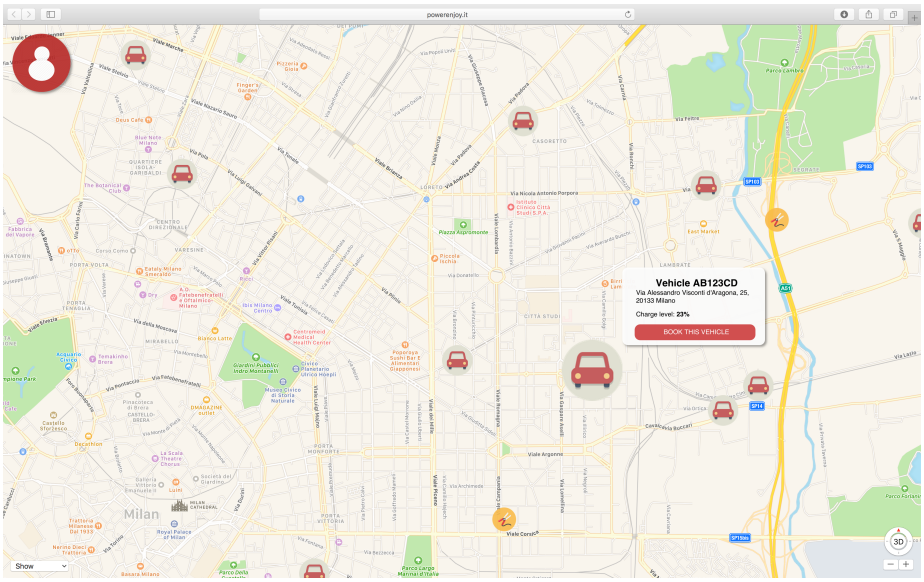


Figure 3.2: 1-page mockup representing the main page of the web application

### 3.1.2 Hardware interfaces

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### 3.1.3 Software interfaces

- Database Management System
  - **Name**: MySQL
  - **Version**: 5.7.16
  - **Source**: http://www.mysql.com
- Java Virtual Machine
  - **Name**: JEE
  - **Version**: 7
  - **Source**: http://www.oracle.com/technetwork/java/javaee
- Application Server
  - **Name**: GlassFish
  - **Version**: 4.1.1
  - **Source**: https://glassfish.java.net
- Operating System
  - Application must be able to run on any SO which supports JVM and DBMS specified before

### 3.1.4 API interfaces

To provide location services we use the W3C Geolocation API combined with the GeoNames API for reverse geocoding.
As well described on the producer's website, this combination gives us an accurate way to retrieve the user position for any location on Earth. More information on https://dev.w3.org/geo/api/spec-source.html and http://www.geonames.org/export/web-services.html.

### 3.1.5 Communication interfaces

| Protocol | Application | Port |
|---|---|---|
| TCP | HTTP | 443 |
| TCP | HTTPS | 80 |
| TCP | DBMS | 3306(default) |

## 3.2 The world and the machine

For a first domain analysis of the PowerEnJoy application we use "The World & The Machine" model by M. Jackson and P. Zave.
This approach let us identify the entities inside the domain that interact with the application ("The World"), entities to be developed ("The Machine") and the intersection ("Shared Phenomena") between the world and the application, that are all world informations known or managed direclty by the application.

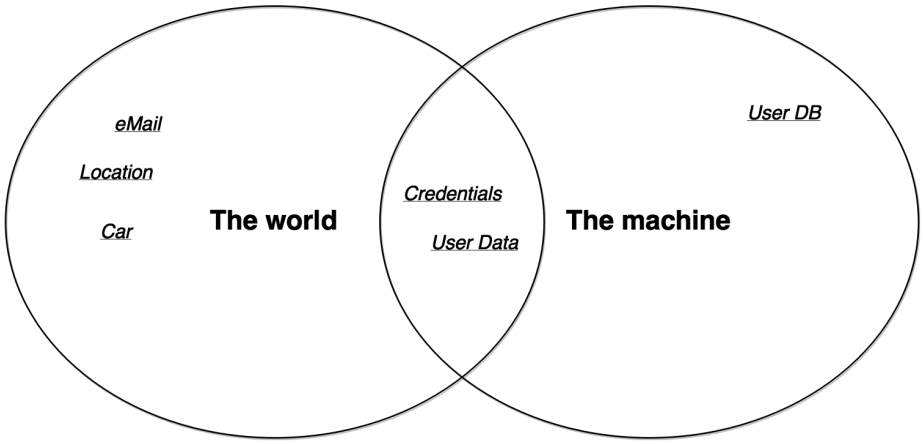


Figure 3.3: The world and the machine system model

## 3.3 System Functions

Looking at the objectives and success criteria of the project described in section 1.3, we can derive the functional requirements that PowerEnJoy have to implement. We choosed to group them by the actor involved in the function.

- Guest
    1. Registration
    2. Log-in

- User
    1. Find a car
    2. Reserve a car
    3. Unlock a car
    4. Use a car
    5. Payment
    6. Lock a car

### 3.3.1 Sample section

This section is here just to provide a standard template for the system functions, before the functional requirements enumeration a brief description may be useful

**Functional requirements**

**Scenario 1**

**Scenario 2**

**Scenario n**

**Use-case table**

**Use-case diagram**

**Activity/State-chart diagram**

**Sequence diagram**

**Mockups**

### 3.3.2 Registration

**Functional Requirements**

- She has to provide her credentials.
- She has to provide her payment information.
- The system shall give back a password that can be used for log-in.

**Scenario 1**

Mark has been told that a new awesome car-sharing service just launched, he than decide to download the mobile application and register as a new user. After filling the sign-up module a confirmation e-mail is sent to Mark containing his new credentials.

**Scenario 2**

Susan was browsing the net when an advertisement caught her attention, it says: "PowerEnJoy is the new planet-friendly car sharing service! Register now and get a discount on your first ride!". She than clicks the advertisement and opens the web application: the first page is a Sign-up page and Susan fills up her personal informations and confirms. Unfortunately the informations provided are not complete and the system signals an error, she notices that the driving licence's informations are missing and compiles the remaining part of the module before submitting it and receiving a confirmation e-mail.

**Use-case table**

| | |
|---|---|
| Actors | Guest |
| Goal | G1 |
| Entry conditions | • The Guest has to have internet access.<br>• The Guest entres the Sign-up page in the browser/ mobile application. |
| Flow of events | • The Guest is shown a form to fill with her personal e-mail, name, surname, tax code and phone number.<br>• The Guest fills the form and confirm her provided information.<br>• The Guest is shown a form to fill with her drive license's information.<br>• The Guest fills the form and confirm her provided information.<br>• The Guest is shown a form to fill with her payment information.<br>• The Guest fills the form and confirm her provided information.<br>• The system sends a confirmation e-mail to the Guest's personal e-mail with an activation link.<br>• The Guest clicks the link in the system's e-mail.<br>• The system allocates the User in the database.<br>• The system sends an e-mail to the User's e-mail with her personal pwd.<br>• The system loads the User's homepage. |
| Exit conditions | The Guest is registered to PowerEnJoy and became an User. Now the User is in her homepage. |
| Exceptions | • The Guest provides an e-mail or a phone number or a tax code already used (in this case the system signals an error).<br>• The Guest does not fill one or more fields in a form (in this cases the system does not allow to proceed and signals an InformationLack).<br>• The Guest provided wrong payment information (in this case the system signals an error).<br>• The Guest provided wrong drive license information (in this case the system signals an error).<br>• The system is not able to complete the operation due to some internal issues or connection broken (the system signals a CennectionToSystem-Fail). |

### 3.3.3 Log-in

**Functional Requirements**

- The user has to provide her ID.
- The user has to provide her pwd.

**Scenario 1**

Susan has just registered to PowerEnJoy and loads the home page in order to login, she than enters her credentials and submit the form. The credential are checked and Susan is redirected to the web application as a logged user.

**Scenario 2**

Mark is a typical PowerEnJoy user, he got used to the credentials form submission and types his password quickly. The password is not recognized by the system and Mark is asked to check his credentials. He than types more accurately and finally gets redirected to the web application.

**Scenario 3**

A guest confused the login form with the registration one and after submiting the form is told that such user is not registered to the PowerEnJoy service. She than clicks on "Register to PowerEnJoy" and follows the registration procedure.

**Use-case table**

| | |
|---|---|
| Actors | Guest |
| Goal | G2 |
| Entry conditions | • The Guest has to be sucessfully registered to PowerEnJoy.<br>• The Guest entres the Log-in page in the browser/ mobile application. |
| Flow of events | • The Guest insert her ID and pwd.<br>• The Guest clicks the Log-in button.<br>• The system loads the User's homepage. |
| Exit conditions | The User is in the PowerEnJoy homepage. |
| Exceptions | • The Guest provides wrong username-password pair (the system signals a LoginError).<br>• The Guest doesn't fill both the fields (the systems signals an InformationLack).<br>• The system is not able to complete the operation due to some internal issues or connection broken (the system signals a CennectionToSystemFail). |

## 3.4 Performance Requirements

The system shall support about 500000 terminals in the first implementation. At the same time the system should accept 1000 simultaneous users, and at least 90% of the transactions should be process in less then 3 seconds.
The amount of information handled by the system is on the order of few Terabytes. Most of the information can be dividen into location service info, cars status info, users info and reservations info.
The performance will also depends by the Internet connectionâĂŹs speed and reliability. In order to provide a service always available, the server should have a stable Internet connection with an adequate bandwidth. The interactions between the user and the system has to be reduced to a minimum, in order to not overload the net.

## 3.5 Software System Attributes

### 3.5.1 Usability

The use interface has to be user-friendly. It has to be simple, intuitive and well-organized. A typical user has not a previous knowledge of the system and we shall do it as easily to use as possible.

### 3.5.2 Reliability

The system should be avaible 24/24, 7/7, 365/365. On the other side the system has to be supported by an Internet connection that reliability depends by their providers.
It should be permitted to have little stops for maintenance. If ocasionally the system has an unexpected stop however it can be accepted as the system don't cover a critical function.

### 3.5.3 Portability

Our system should be very portable due to the very wide range of users. It should be compatible to all the major hardware and software components, Our mobile application should work on the most used mobile operative systems. The web application needs to be supported by all the most used browsers. The code should be developed so that only a minor part should be adapted at the specific operation system.
The cars on-board computers operation system have to be compatible with the system.

### 3.5.4 Maintainability

The maintainability of the system is guarantee by the administrator. The development of a 100% bug-free software is desiderable but impossible to achive, so the administrator has to fix the system every time is needed. The administrator can also access to the data of the system for manually modify or update them.

### 3.5.5 Consistency

In order to not lose the data in case of system fault they have always to be duplicate in a backup server.

### 3.5.6 Security

We need to apply security protocols at different levels for ensure a correct access to the data. First of all each user can access to her page using her personal ID and pwd, as esplain in the user interface. The pwd is gived by the system and should be an alphanumeric code of 8 digits, with at least two upper case letter,

randomly selected. The pwd have to be univoc.
Secondly every acess to the database have to filtered in order to avoid an uncorrect managment and the incosistency of the data.
Thirdly we have to guarantee a safe interaction between the cars on-board computers and the system.
Finally the connection with the system respect the https protocl, wich ensure the quality and the privacy of the connection.

# Alloy modelling

## 4.1 Signatures

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## 4.2 Facts

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## 4.3 Asserts

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## 4.4 Predicates

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## 4.5 Results

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## 4.6 Generated Worlds

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### 4.6.1 General world

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### 4.6.2 Maybe some other world

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# Appendix A: Used Tools

## A.1 LaTeX

Used to format and redact this document

## A.2 *g*it

Used as version control system in order to lead development

# Appendix B: Hours of work

These are the hours of work spent by each group member in order to redact this document:

- Ruaro Nicola: 18 hours
- Gregori Giacomo: 15 hours
- Total worktime: 33 hours

# Appendix C: Revisions

These sections will be eventually redacted during future post-release updates in order to approach the RASD modifiability providing a comfortable and higly effective way to trace changes:

## C.1 Changed assumptions

## C.2 Removed goals

## C.3 Modified use-cases

## C.4 Modified diagrams

# Glossary

**charging station** an area used to re-charge and store electric cars.

# Acronyms

**GPS** Global Positioning System.

# Bibliography

[1] IEEE Std 830, *Recommended Practice for Software Requirements Specifications*, 1998

[2] Luca Mottola and Elisabetta Di Nitto, *Software Engineering 2: Project goal, schedule and rules*, 2016