

Software Engineering 2: PowerEnJoy  
**Requirements Analysis and  
Specification Document (RASD)**  
Version 1.1



Politecnico di Milano, A.A. 2016/2017

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# 1 INTRODUCTION

## 1.1 Description of the given problem

We are to develop a digital management system for a car-sharing service called *PowerEnJoy*, that exclusively employs electric cars.

The users will be able to interact with the system through a web or mobile application. The system will thus keep track of the users' position monitoring their GPS signal (if active), so as to be able to show them the locations of the available cars within a certain distance. In alternative, users will also be able to find all the available cars in a certain distance from an address of their choice.

In order to benefit from the service, users need to register to the system by providing their credentials and payment information. Then they receive back a password via email that can be used to access the system.

Also, in order to ensure the proper functioning of the system, the *PowerEnJoy* service provides employees whose main duty is to manage cars information in those cases in which the system cannot intervene.

## 1.2 Goals

Here are our application's goals:

- [G1] Allow users to register to the system filling out a form.
- [G2] Allow registered users to access the system by entering their user-name and password.
- [G3] Allow registered users to manage their personal information.
- [G4] Allow registered users to find the locations of all available cars within a certain distance from their current location or from a specified address.
- [G5] Allow registered users to reserve a single car among the available ones in a certain geographical region for up to one hour before they pick it up.
- [G6] Allow registered users to tell the system they are nearby when they reach a car they previously reserved.
- [G7] Allow registered users to see on a screen the amount of money they are being charged for while they are driving.
- [G8] Allow registered users to see on a screen a map showing all the safe areas they can park in.
- [G9] Allow registered users to see on a screen the discount percentage (if any) applied on their bill once the ride has ended.
- [G10] Allow registered users to cancel a reservation paying a fee of 1 EUR.
- [G11] Allow registered users to benefit from a discount percentage in certain cases.
- [G12] Allow registered users to report an issue when they realize a car they reserved is somehow broken.
- [G13] Allow employees to interact with the system and manage cars information.

### 1.3 Glossary

- **User:** a person that interacts with the PowerEnJoy mobile or web application to register into the system.
- **Registered user:** a person already registered into the system that interacts with the PowerEnJoy mobile or web application in various ways. A registered user is identified by the following information:
  - Name.
  - Surname.
  - Email.
  - Username.
  - Password.
  - Card number.
  - Card code.
  - Driver license code.
  - Address.
- **Employee:** a member of the PowerEnJoy staff. He is identified by:
  - Id.
  - Username.
  - Password.
  - Name.
  - Surname.
- **Registration:** the act or process of filling out an online form providing credentials and payment information.
- **Log-in:** process by which a user gains access to the system by identifying and authenticating himself/herself. The user credentials are some form of "username" and a matching "password".
- **Car-sharing service:** model of car rental where people rent cars for short periods of time, often by the hour.

- **Electric car:** automobile that is propelled by one or more electric motors, using electrical energy stored in rechargeable batteries. It is identified by:
  - Location.
  - State: reserved/available, blocked/unlocked, ignited/off, plugged/unplugged, broken/unbroken.
  - Screen.
  - Weight sensors.
  - Doors sensors: to define if they are open or closed.
  - Battery level.
- **Reservation:** arrangement through which a registered user holds a car for his use at a later time. It is identified by:
  - Begin time.
  - End time.
  - Corresponding reserved car.
  - User who made the reservation.
- **Available car:** car that has not been chosen in any user reservation.
- **Reserved car:** car that has been chosen by a user in a reservation.
- **Location/address:** position of a car or a user, identified by longitude and latitude.
- **Geographical region:** circular region whose center is the user's position and whose radius is calculated as a certain distance from the center. It shows all the available cars and their position on the map.
- **Safe area:** area whose position is predefined by the management system. Safe areas are the only ones in which a user is allowed to park a car.
- **Special safe area:** special type of safe area where a car can be recharged.

- **Ride:** it starts when the user ignites the car engine and ends when the car is parked in a safe area (or special safe area) and the user exits the car. It is identified by:
  - Begin time.
  - End time.
  - Used car.
  - User that is driving the car.
  - Total price the user has to pay.
- **Discount percentage:** discount applied on the user's last ride only in certain circumstances.
- **Low battery:** the car's battery level is considered "low" when less than 20%.
- **Discount1:** a 10% discount is applied on the ride if the user takes at least two other passengers onto the car.
- **Discount2:** a 20% discount is applied on the ride if a car is left with no more than 50% of the battery empty.
- **Discount3:** a 30% discount is applied on the ride if a car is left at a special parking area where it can be recharged and the user takes care of plugging it into the power grid.
- **Overcharge:** a 30% overcharge is applied on the ride if a car is left at more than 3 KM from the nearest power grid station or with more than 80% of the battery empty.

## 1.4 Domain assumptions

We suppose that these properties hold in the analyzed world:

- All GPSs always give the right position.
- Addresses entered by the users always exist.
- Cars GPS cannot be switched off.
- All PowerEnJoy cars are registered into the system.
- Cars plates are unique.
- All car doors are closed during the ride.
- Users own a smartphone with Internet connection.
- Users can associate to their profile only prepaid and credit cards.
- The information provided by the user at the moment of his/her registration is valid.
- If a car is no longer associated with the PowerEnJoy service its information is deleted from the database.
- All PowerEnJoy cars are in order.
- The system, once a ride ends, is able to identify if discounts or over-charges are to be applied on the total price.
- The system charges a registered user for a 1EUR fee if he/she cancels a reservation.
- The system charges a registered user for thirty cents for each minute he/her spends driving the PowerEnJoy car.
- The system charges a user for a 1EUR fee if he/she does not pick-up the car within one hour from the reservation.
- PowerEnJoy cars are real.
- If a registered user leaves the car in a non-safe area, he/she continues paying for the reservation until the system notifies him/her via email after ten minutes. The car is no longer reserved and the registered user must pay a fee for abandoning the car.

- There isn't any already existent PowerEnJoy system.
- The car monitors are touch-screen.
- If a car is parked in a special safe area, it is always plugged into the power grid.
- The PowerEnJoy service operates only in the city of Milan.
- All employees are registered into the system.
- The ids of the employees are unique.
- Discounts and overcharges are cumulative: if I get a 10% discount, a 30% discount and a 30% overcharge, in the end I will get a 10% discount over my ride.

## **1.5 Constraints**

### **1.5.1 Regulatory policies**

Upon registration the user must consent to the processing of his/her personal data (name, surname, position...). The company is so committed to handle each user's sensitive data in accordance with his/her privacy.

### **1.5.2 Hardware limitations**

- Mobile application:
  - User:
    - \* 3G connection.
    - \* Space for app package.
  - Registered user:
    - \* 3G connection.
    - \* Space for app package.
    - \* GPS, in order to benefit from the option "Current location".
- Web application:
  - Flash Player 11.2 or later.
  - Modern browser with AJAX support.
  - Ethernet or Wi-Fi connection.

### **1.5.3 Interfaces with other applications**

- Interface with email providers such as Gmail, Hotmail, Libero, Yahoo and so on.
- One interface for each platform (iOS, Android, Windows Phone...).

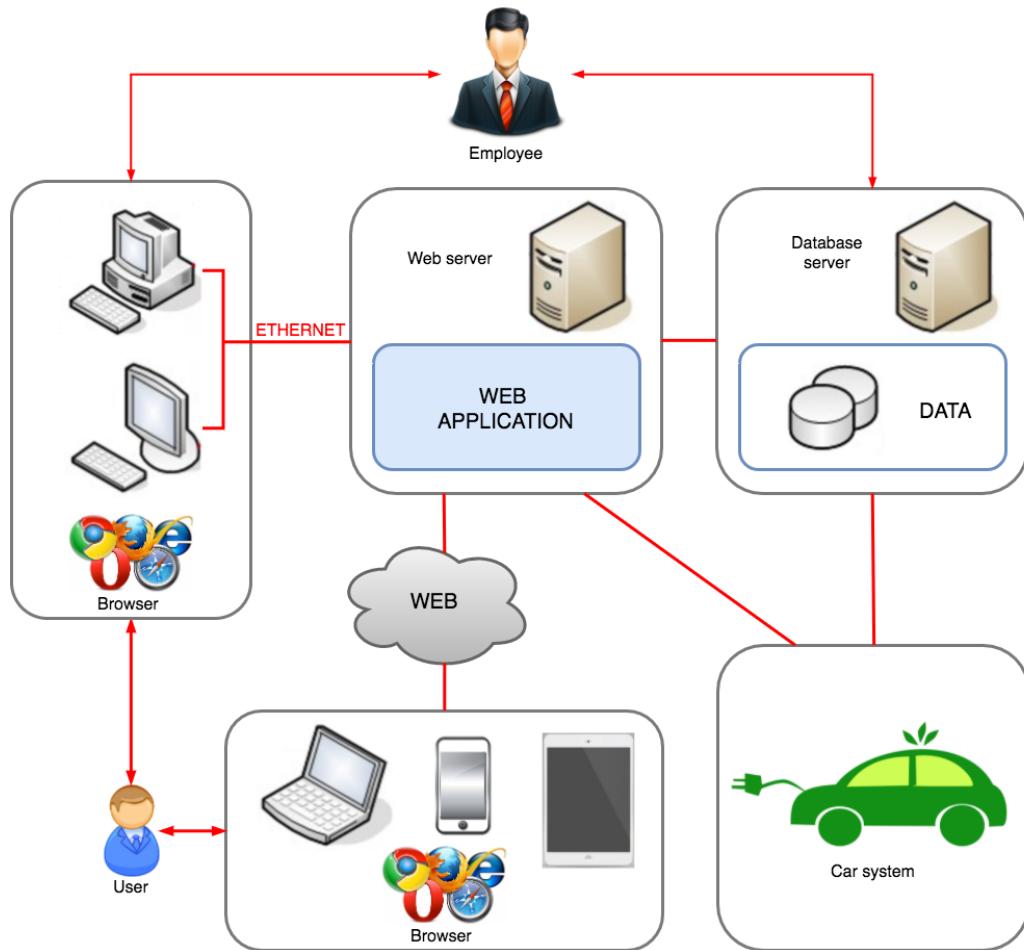
### **1.5.4 Parallel operation**

The application supports parallel operations from different users (registered or not).

## 1.6 Proposed system

The system will be presented both as a web and a mobile application with a client-server architecture, based on the MVC pattern. It will not be integrated with an already existing system.

The server will generate web pages and a database system will be used to store user's information. On the other side, clients will interact with the application (mobile or web) through a Graphical User Interface.



## 1.7 Identifying stakeholders

- Primary:
  - **Users** (both registered and not registered), since they are the ones that benefit the most from using the application and the car-sharing service.
- Secondary:
  - **Other passengers**, since they benefit from the service via someone else.
- Tertiary:
  - **Electric energy providers**, since they are affected by the service's introduction, but they do not directly use it.
  - **Electric cars retailers**, since they are affected by the service's introduction, but they do not directly use it.
  - **The city of Milan**, since it is influenced by the service's adoption.

## 1.8 Reference documents

- Specifications document: Assignments AA 2016-2017.pdf
- RASD sample from Oct. 20 lecture.pdf

## 2 ACTORS

The actors in our system are:

- **User:** he/she can use the application only to register to the system by filling out a form.
- **Registered user:** he/she already owns a password (that he/she received by email at the moment of the registration) and can log into the system with it. After doing this, he/she can perform various actions:
  - View his/her profile and manage his/her personal information.
  - View current promotions.
  - Reserve a car inserting a specific address or letting the system track his/her position with the GPS.
  - Cancel a reservation.
  - Report an issue after unlocking the car.
- **Employee:** he/she can log into the system with a username and a password and then perform various tasks:
  - In case a car is broken, an employee will take care of bringing it to a mechanic and, once fixed, he will change the car's "broken" status from true to false.
  - In case a car is left in a non-safe area, an employee will take care of bringing it to the nearest safe area.
  - In case a car's battery is running low and the car is not plugged into any power grid, an employee will take care of calling a tow truck to bring the car to the nearest special safe area and then plugging it into the power grid.

## 3 REQUIREMENTS

### 3.1 Functional requirements

Assuming that the domain assumptions listed in paragraph [1.4] hold, and in order to fulfill the goals listed in paragraph [1.2], the following requirements can be derived.

Requirements are grouped under each goal from which they are derived.

- [G1] Allow users to register to the system by filling out a form.
  - [R1] The system will provide a registration form.
  - [R2] The system will allow not registered users to access only the homepage and the registration page.
  - [R3] Upon registration, the system will check the uniqueness of the chosen username.
- [G2] Allow registered users to access the system by entering their user-name and password.
  - [R1] Registered users must have previously filled out the registration form.
  - [R2] Registered users must have previously received a password via email from the system.
  - [R3] The system will provide a login functionality.
  - [R4] The system will verify the existence of the username-password combination in the database.
- [G3] Allow registered users to manage their personal information.
  - [R1] Registered users must be logged into the system.
  - [R2] The system will provide a personal page for each registered user to manage.
  - [R3] The system will allow registered users to save the personal information they update.
- [G4] Allow registered users to find the locations of all available cars within a certain distance from their current location or from a specified address.
  - [R1] Registered users must be logged into the system.

- [R2] Registered user must have chosen the functionality "make a reservation".
- [R3] Registered user must have provided a valid address (within the city of Milan), corresponding either to their current location or to a specified address of their choice.
- [R4] The system will provide a map showing the location of all the available cars.
- [G5] Allow registered users to reserve a single car among the available ones in a certain geographical region for up to one hour before they pick it up.
  - [R1] Registered users must be logged into the system.
  - [R2] Registered users must have chosen the functionality "Make a reservation".
  - [R3] Registered users must have selected a single car among the available ones showed on the map.
  - [R4] The system must provide a timer that will be activated at the moment of the reservation.
- [G6] Allow registered users to tell the system they are nearby when they reach a car they previously reserved.
  - [R1] Registered users must be logged into the system.
  - [R2] Registered users must have selected a single car among the available ones showed on the map.
  - [R3] The system will provide a mobile functionality that allows the users to unlock the reserved car once they are nearby.
  - [R4] The system will unlock the car once the user is nearby.
- [G7] Allow registered users to see on a screen the amount of money they are being charged for while they are driving.
  - [R1] Each car must have a screen.
  - [R2] The system will provide a functionality that updates the amount of money the user will be charged of every minute that passes.
- [G8] Allow registered users to see on a screen a map showing all the safe areas they can park in.

- [R1] Each car must have a screen.
- [R2] The car screen will provide an interactive and updated map showing all the safe areas.
- [R3] The system will provide a functionality that detects the safe areas.
- [G9] Allow registered users to see on a screen the discount/overcharge percentage (if any) applied on their bill once the ride has ended.
  - [R1] Each car must have a screen.
  - [R2] The system will be able to realize when a user parks into a safe area.
  - [R3] The system will provide a functionality that calculates the ride price after applying the discount percentage/overcharge.
- [G10] Allow registered users to cancel a reservation paying a 1EUR fee.
  - [R1] Registered users must be logged into the system.
  - [R2] Registered users must have previously reserved a car and not yet unlocked it.
  - [R3] The system will provide a functionality that allows registered users to cancel their current reservation.
- [G11] Allow registered users to benefit from a discount/pay an overcharge percentage in certain cases.
  - [R1] The system will provide a functionality that calculates the ride price after applying the discount/overcharge percentage.
  - [R2] The system will recognize the cases in which the user is supposed to benefit from a discount/pay an overcharge percentage.
  - [R3] Registered user must have parked in a safe area and turned off the car ignition.
- [G12] Allow registered users to report an issue when they realize a car they reserved is somehow broken.
  - [R1] Registered users must be logged into the system.
  - [R2] Registered users must have previously reserved a car.
  - [R3] Registered users must have unlocked the car.

- [R4] The system will provide a mobile functionality (not web) that allows registered users to report an issue.
- [G13] Allow employees to interact with the system and manage cars information.
  - [R1] Employees must be logged into the system.
  - [R2] The system will provide a web functionality (not mobile) that allows employees to manage cars information.

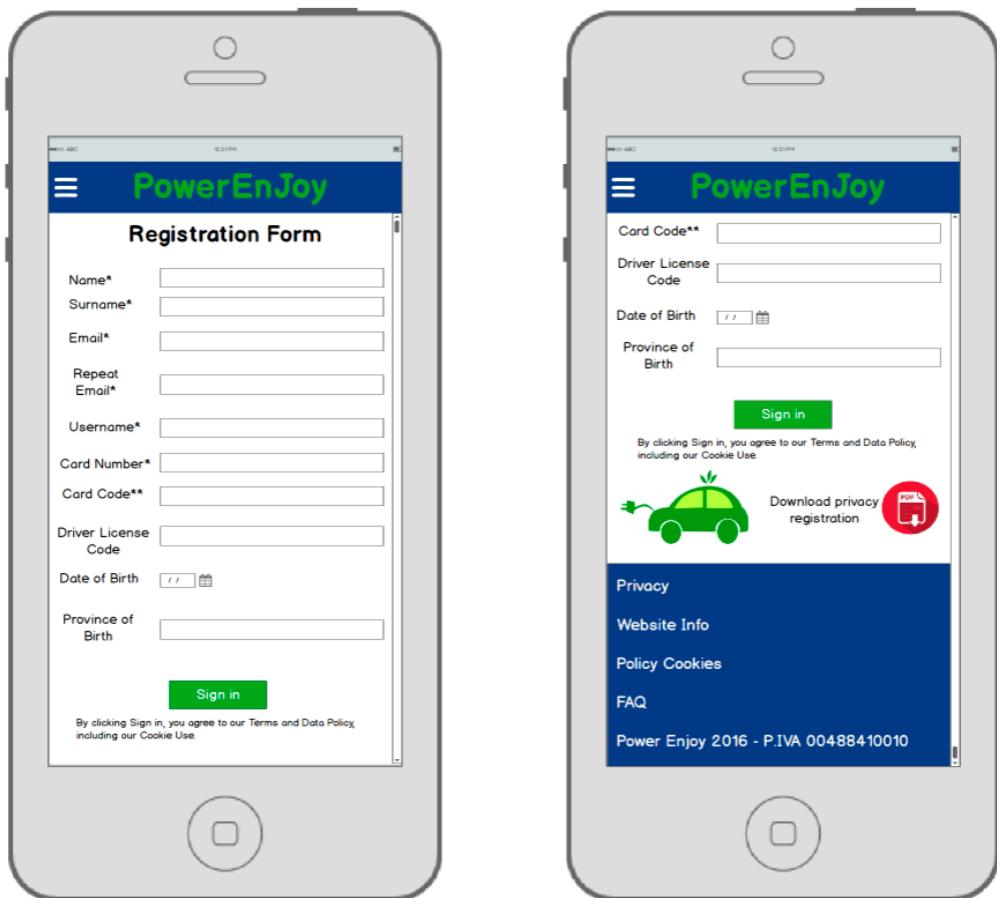
## 3.2 Nonfunctional requirements

### 3.2.1 Mobile interface

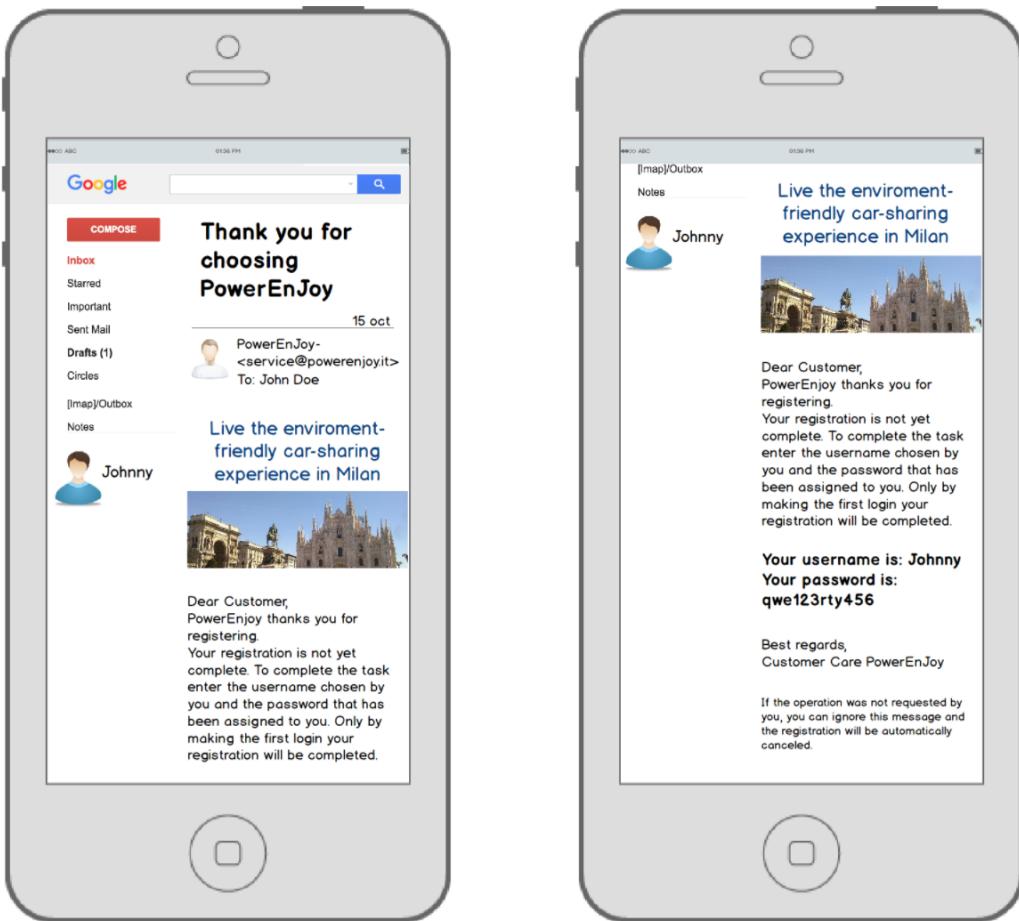
- Homepage:



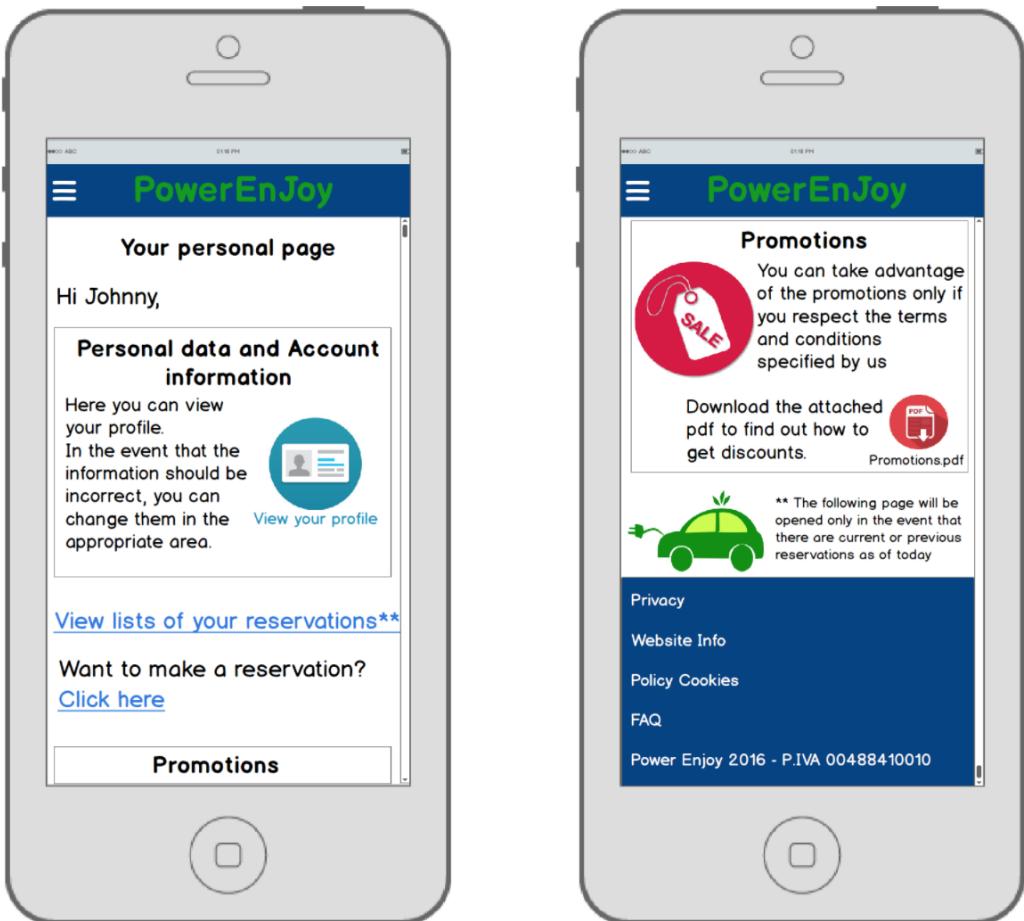
- Registration:



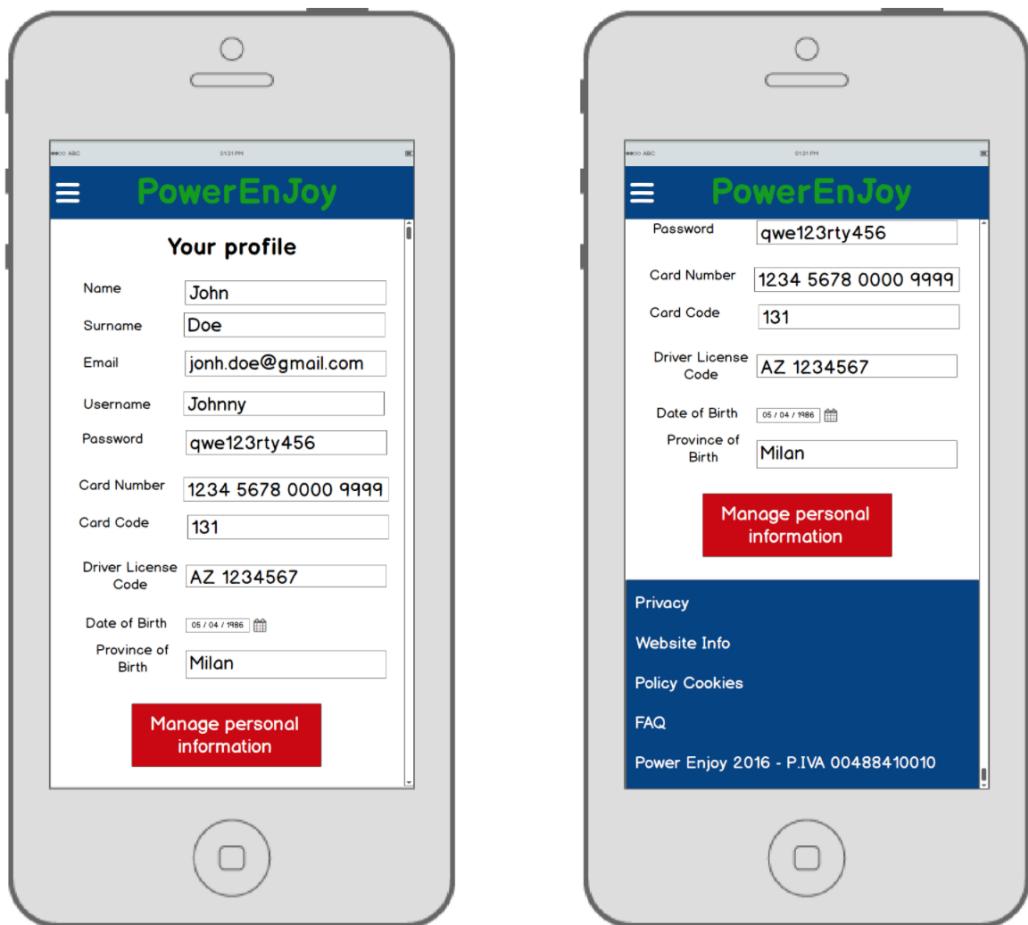
- Receiving the password:



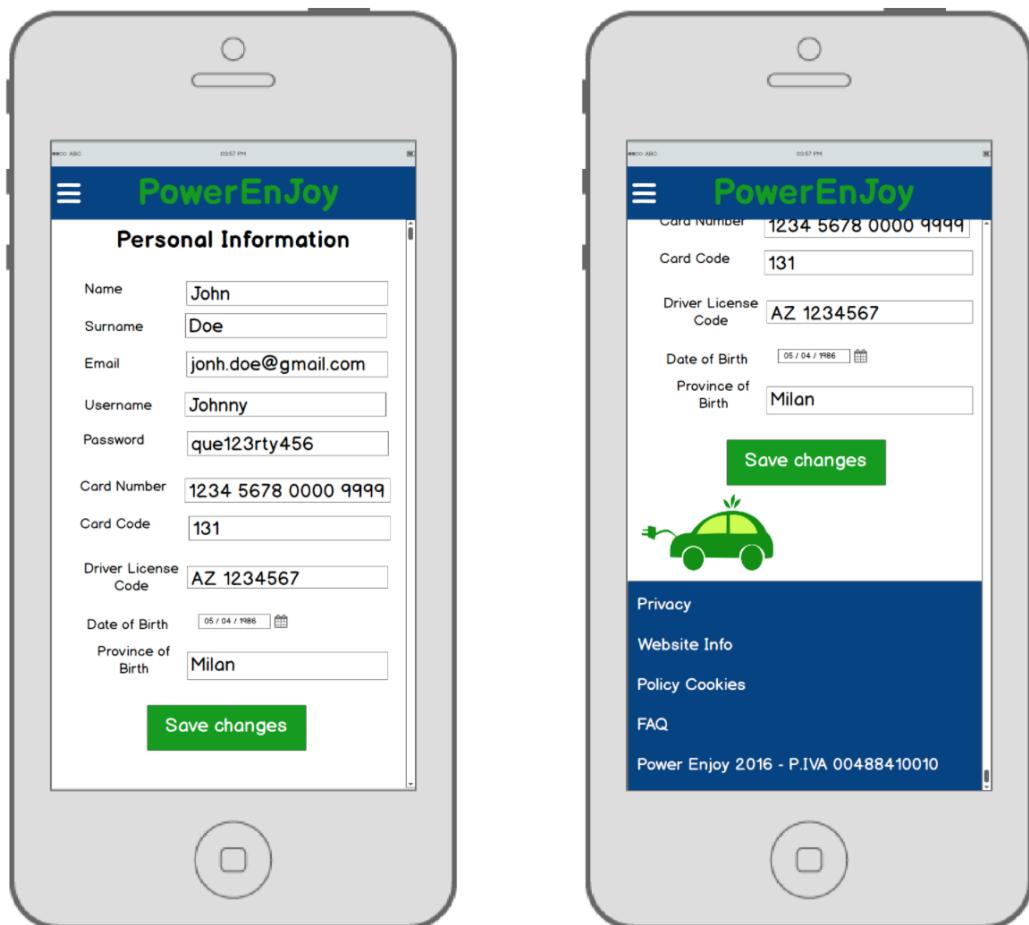
- Personal page:



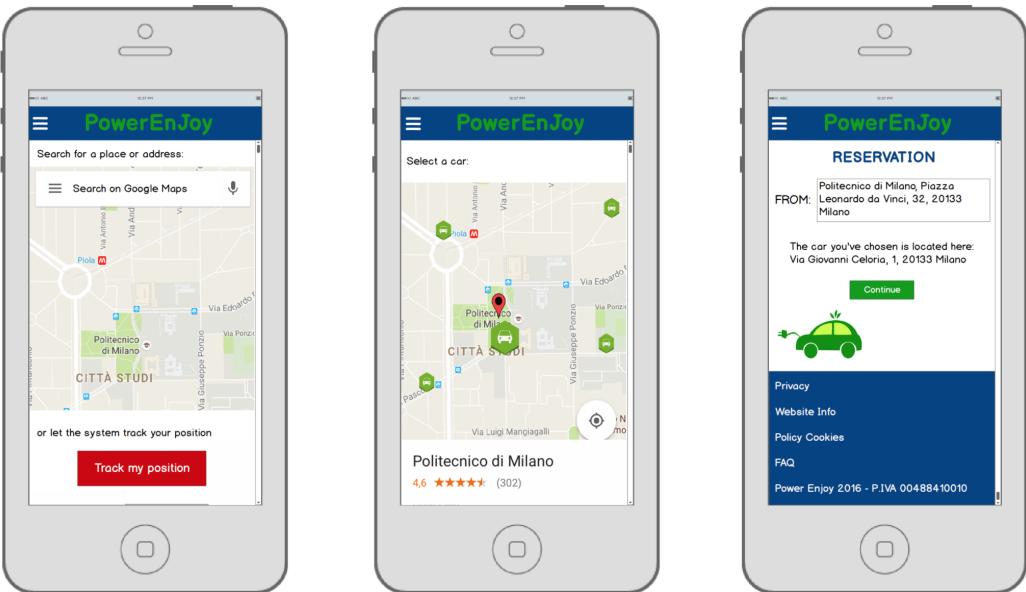
- View profile:



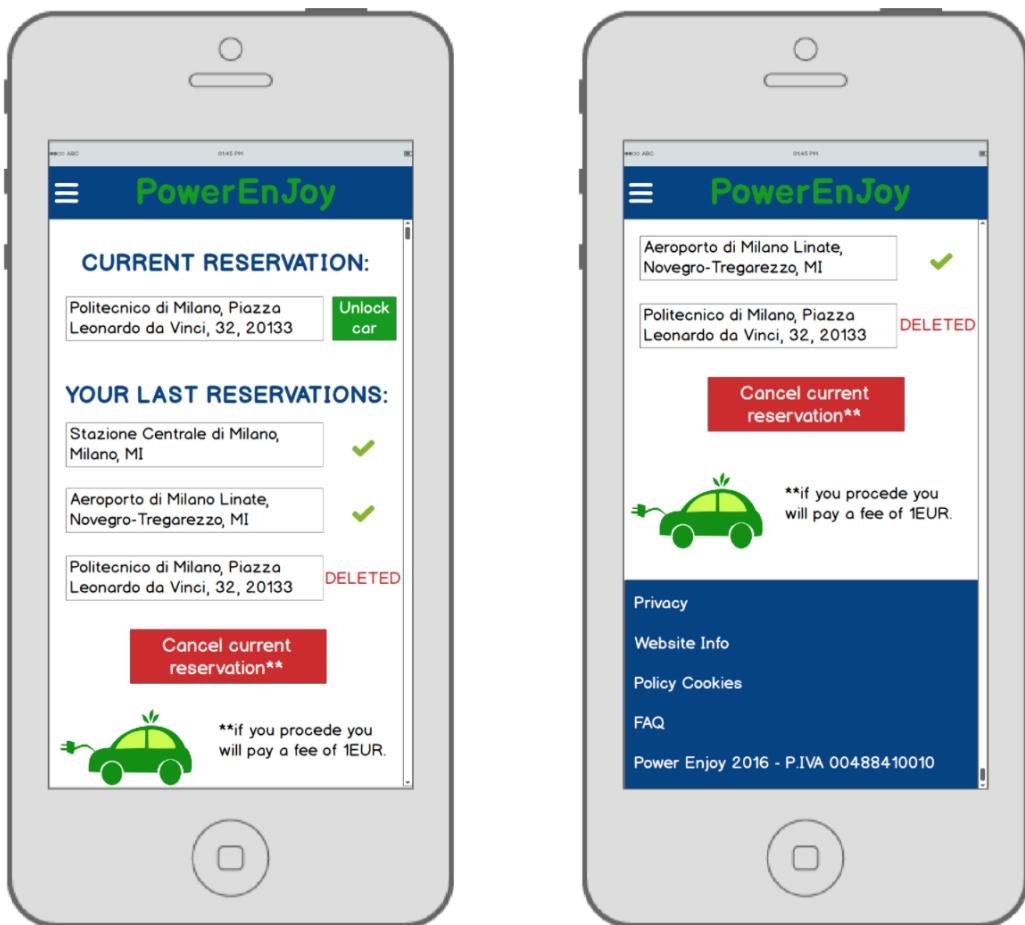
- Managing personal information:



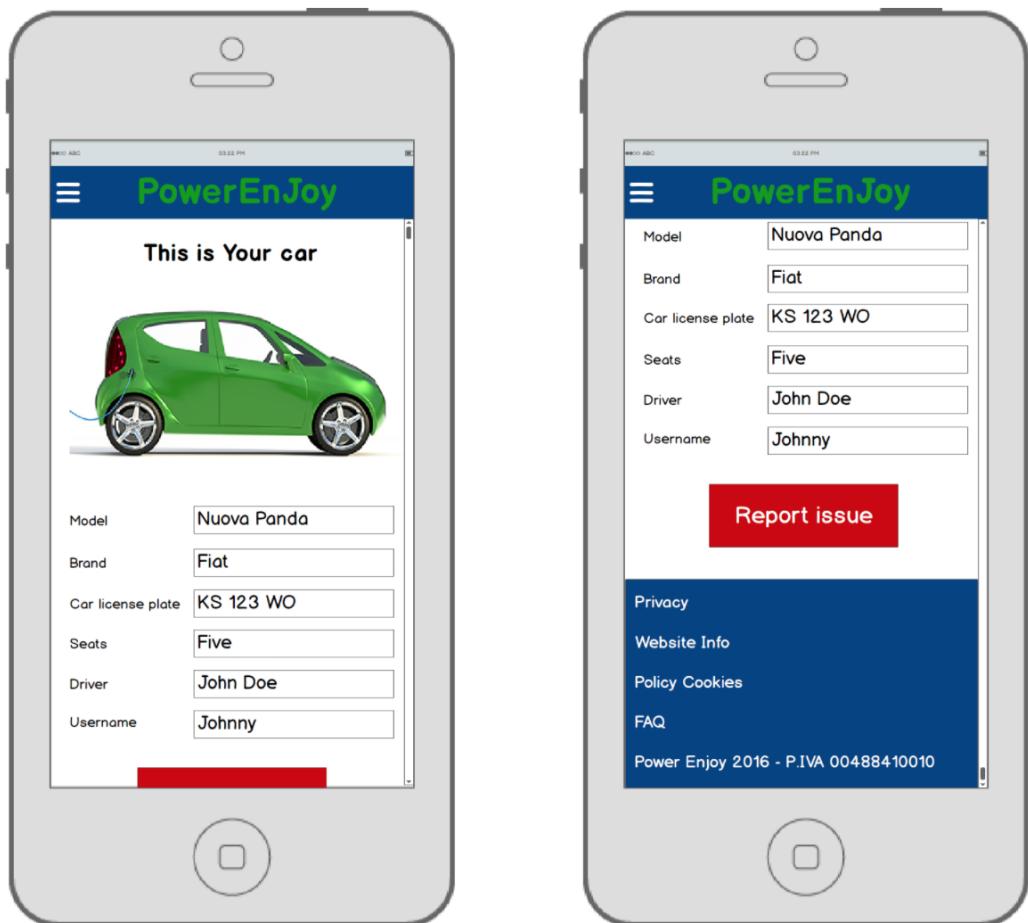
- Making a reservation:



- Deleting a reservation:



- Reporting an issue:



### 3.2.2 Web interface

- Homepage:

The screenshot shows the PowerEnJoy website homepage. At the top, there is a banner with the text "Live the environment-friendly car-sharing experience in Milan" and a photograph of the Piazza del Duomo in Milan. To the right of the banner are fields for "Username" and "Password" with a "Login" button below them. Below the login area is a link "You don't have an account? Sign in".

**CAR FLEET**

The PowerEnJoy fleet is at your disposal: you can easily pick the most convenient vehicle according to your needs.

With the PowerEnJoy app you can see your bookings and hire the nearest vehicle.

ANDROID APP ON Google play    Available on the App Store

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- User registration:

PowerEnJoy

<http://www.powerenjoy.it>

## PowerEnJoy

### Registration Form

Name*	<input type="text"/>	Surname*	<input type="text"/>
Email*	<input type="text"/>	Repeat Email*	<input type="text"/>
Username*	<input type="text"/>		
Card Number*	<input type="text"/>	Card Code**	<input type="text"/>
Driver License Code*	<input type="text"/>		
Date of Birth	<input type="text"/> / <input type="text"/> / <input type="button" value="Calendar"/>	<b>Sign in</b>	
Province of Birth	<input type="text"/>		

By clicking Sign in, you agree to our Terms and that you have read our Data Policy, including our Cookie Use.

 Download privacy registration 

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- User receives the password:

Gmail

https://mail.google.com/mail/#inbox

Google

COMPOSE

Inbox

Starred

Important

Sent Mail

Drafts (1)

Circles

[Imap]/Outbox

Notes

Johnny

PowerEnJoy- <service@powerenjoy.it>  
To: John Doe  
15 oct

**Thank you for choosing PowerEnJoy**

**Live the environment-friendly car-sharing experience in Milan**



Dear Customer,  
PowerEnJoy thanks you for registering.  
Your registration is not yet complete. To complete the task enter the username chosen by you and the password that has been assigned to you. Only by making the first login your registration will be completed.

**Your username is: Johnny**  
**Your password is: qwe123rty456**

Best regards,  
Customer Care PowerEnJoy

If the operation was not requested by you, you can ignore this message and the registration will be automatically canceled.

- Registered user's personal page:

PowerEnJoy

<http://www.powerenjoy.it>

# PowerEnJoy

## Your personal page

Hi Johnny,

**Personal data and Account information**

Here you can view your profile.  
In the event that the information should be incorrect, you can change them in the appropriate area



[View your profile](#)

[View lists of your reservations\\*\\*](#)

Want to make a reservation? [Click here](#)



**Promotions**

You can take advantage of the promotions only if you respect the terms and conditions specified by us.

Download the attached pdf to find out how to get discounts.



[Promotions.pdf](#)



\*\* The following page will be opened only in the event that there are current or previous reservations as of today

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- Registered user's profile:

PowerEnJoy

<http://www.powerenjoy.it>

## PowerEnJoy

### Your profile

Name	John						
Surname	Doe						
Email	john.doe@gmail.com	Password	que123rty456				
Username	Johnny						
Card Number	1234 5678 0000 9999	Card Code	131				
Driver License Code	AZ 1234567						
Date of Birth	05 / 04 / 1986	Province of Birth	Milan				
		<b>Manage personal information</b>					
Privacy	Legal Seat	Website Info	Contact us	Documents	Policy cookies	FAQ	Power Enjoy 2016 - P.IVA 00488410010

- Registered user manages his/her personal information:

PowerEnJoy

<http://www.powerenjoy.it>

## Personal information

Name	John		
Surname	Doe		
Email	john.doe@gmail.com	Password	que123rty456
Username	Johnny		
Card Number	1234 5678 0000 9999	Card Code	131
Driver License Code	AZ 1234567		
Date of Birth	05 / 04 / 1986	Province of Birth	Milan
		<b>Save changes</b>	

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- Registered user makes a reservation:

The screenshot shows the PowerEnJoy website interface. At the top, there's a search bar with the URL "http://www.powerenjoy.it". The main header "PowerEnJoy" is displayed in a large, green, stylized font. Below the header, a blue banner contains the word "RESERVATION" in white. To the right of the banner is a search bar with the placeholder "Search for a place or address:" and a "Search on Google Maps" button. Further right is a microphone icon for voice search. Below the search bar, a message says "or let the system track your position:" followed by a red "Track my position" button. The central part of the page features a map of the Politecnico di Milano campus area. A green box highlights the starting point: "FROM: Politecnico di Milano, Piazza Leonardo da Vinci, 32, 20133 Milano". On the map, several green hexagonal icons with car symbols indicate available parking spots. A red pin marks the location of the chosen car, which is located on Via Giovanni Celoria. The map also shows other buildings like the Faculty of Veterinary Medicine, the Faculty of Agricultural Sciences, and the Istituto Neurologico Carlo Besta. At the bottom left, a message states "The car you've chosen is located here: Via Giovanni Celoria, 1, 20133 Milano". To the right of this message is a green "Continue" button. The footer of the page includes links for Privacy, Legal Seat, Website Info, Contact us, Documents, Policy cookies, FAQ, and the company's P.IVA number: Power Enjoy 2016 - P.IVA 00488410100.

- Registered user deletes a reservation:

PowerEnJoy

<http://www.powerenjoy.it>

# PowerEnJoy

## CURRENT RESERVATION:

Politecnico di Milano, Piazza Leonardo da Vinci, 32, 20133 Milano

## YOUR LAST RESERVATIONS:

Stazione Centrale di Milano, Milano, MI	
Aeroporto di Milano Linate, Novegro-Tregarezzo, MI	
Politecnico di Milano, Piazza Leonardo da Vinci, 32, 20133 Milano	DELETED

Cancel current reservation\*\* \*\*if you proceed you will pay a fee of 1EUR.

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### 3.2.3 Employee

- Employee's personal page:

PowerEnJoy

http://www.powerenjoy.it

# PowerEnJoy

Welcome to the area reserved to the PowerEnJoy employees

Your personal data:

Name	Jack
Surname	Smith
ID	CC4767IA

Your personal photo

Edit a car's information:

Search by plate:

Or select a car among the ones listed below:

AW 123 GE

BROKEN

CD 456 EF

LOW BATTERY

FG 789 TS

OK

1 2 3 >

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- Employee manages a car's information:

PowerEnJoy

<http://www.powerenjoy.it>

## PowerEnJoy

### CAR FOUND!

<b>Edit car's info:</b>	Model	Nuova Panda	
	Brand	Fiat	
	Plate	KS 123 WO	
	Seats	Five	
	Broken	<input checked="" type="checkbox"/>	
	Reserved	<input type="checkbox"/>	When a check mark is added it means that the machine has the listed feature.
	Blocked	<input type="checkbox"/>	
	Ignited	<input type="checkbox"/>	
	Plugged	<input type="checkbox"/>	



**Save changes**

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### 3.2.4 Car

- Car screen asking for destination:



- Car screen with map and information about the ride:



- Car screen after the destination is reached:



### 3.2.5 Architectural considerations

We will use the following technologies:

- **MySQL**, for the storage of all the information related to both the PowerEnJoy application and the users.
- **Mapping service**, to keep track of the position of both cars and registered users (only the ones who allow it).
- **PHP**, to build the back-end of the application.
- **JavaScript, HTML, CSS** and **Bootstrap**, to create a responsive and well-designed website.
- **PhoneGap**, to create a responsive mobile application.
- Modern browser with JavaScript and AJAX support.
- **Java** for Android and iOS apps, using original SDK.
- Internet/Ethernet connection for data communication.
- **SMTP (Simple Mail Transfer Protocol)**, to transfer emails from a server to another with a point-to-point connection.

## 4 SCENARIOS

Here is the description of the possible scenarios.

### 4.1 Scenario 1

After having lunch with his friends, Johnny decides to not take the subway in order to get home. Instead he wants to benefit from the PowerEnJoy service he registered to the week before.

He logs into the system through the mobile application he previously downloaded on his smartphone and, providing his credentials, he is able to find the location of the available cars near the restaurant.

Since none of the cars is near enough, he closes the application without making any reservation.

### 4.2 Scenario 2

Tonight Johnny has to attend a family dinner but, since he is late, he tells his sister, who was supposed to pick him up, to go ahead without him.

Just before leaving his house, he realizes it is a public holiday and therefore there are no public transports available. In order to reach his family's house, he then decides to benefit from the PowerEnJoy service.

He logs into the system website using his laptop and, providing his credentials, he manages to find an available car not far from his house. He reserves the car and, doing so, he is able to attend the family dinner only ten minutes late.

### 4.3 Scenario 3

After having dinner together, a group of friends decides to go see a movie. Johnny suggests to use the PowerEnJoy service even though none of them has ever registered to it.

Having the smartphone with the best Internet connection, Jack offers to register. After downloading the mobile application, he fills out the registration form providing the required credentials and payment information.

After receiving the password via email, he logs in for the first time and he is able to make a reservation. Once the destination is reached, Jack discovers with pleasure that he can benefit from a 10% discount since he took two other passengers onto the car with him.

Pleased with the service, the group decides to use it also to get back home.

## **4.4 Scenario 4**

Laura, a British environmentalist tourist, decided to visit his friend Johnny in Milan.

One night she tells him she would love to visit the city, so Johnny suggests her to register into the PowerEnJoy system he already used.

Since Laura is a bit reluctant, Johnny tries to convince her by showing her the service website and pointing out that all cars are electric. He also shows her where to keep track of the promotions and how to manage her personal information.

Persuaded by her friend, Laura decides to register into the system the day after.

## **4.5 Scenario 5**

After spending the afternoon at his university, Johnny decides to go visit his girlfriend whose house is forty minutes from him.

He then chooses to use the PowerEnJoy service, aware that there are lots of safe areas near his girlfriend house.

After logging into the system and reserving a car, he decides to bring her a gift and remembers that there is a florist next to his university. Once the flowers are chosen, he realizes that more than an hour has passed since his reservation. He takes his smartphone out of his pocket and realizes he received an email, saying that he has been charged with a 1EUR fee for not showing up in time and that the car he reserved is no more available.

Aware of his mistake, he decides to not overthink it and starts searching for another available car. Once he finds it, he gets there immediately and starts driving to reach his girlfriend's house.

## **4.6 Scenario 6**

After deciding to invite his friends over for lunch, Jack realizes there is nothing in the fridge and hurries to the grocery store. After leaving his house, he notices a PowerEnJoy car right in front of him and he chooses to use it instead of taking the bus.

Once the car is reserved, Jack unlocks it and proceeds to the grocery store. After reaching his destination, he sadly realizes there are no free safe areas nearby and decides to leave the car in a generic parking lot, sure that it does not change anything.

Once he is finished with the grocery shopping, he wants to reserve another PowerEnJoy car and, taking his phone out of his pocket, he finds out that

he has received an email saying:

*More than ten minutes have passed since you parked the car in a non-safe area. Your reservation has been canceled and an employee will be sent to move the car to a safe area. For this reason you have been charged with a 10EUR fee.*

Aware of his mistake, he has no other option than to reserve another car. After doing so, he heads back home, sadly realizing he could have avoided to pay that much money.

## 4.7 Scenario 7

After a long day at work, Dave realizes it is raining outside and does not want to walk back home. He then decides to benefit from the PowerEnJoy service, that he has been using for the last month and really appreciate.

Sitting in the hall, Dave starts looking for a car on the mobile application and finally gets the results: there is a car parked a few blocks away and he decides to reserve it.

After getting close enough to the car, he unlocks it and, getting in, realizes with surprise that the car monitor is broken. After spending a few minutes contemplating his options, Dave remembers that the service offers the possibility to report an issue. After doing just that, he receives an email saying:

*Thank you for your report. We will send an employee right away to bring the car to the nearest mechanic. We are very sorry for the inconvenient.*

He then exits the car and decides to walk back home, for the first time in his life disappointed by the service.

## 4.8 Scenario 8

Every morning Alex goes to the university by bike in order to avoid air pollution. Class after class, it is finally time to head back home, but when Alex reaches the courtyard where she parked her bicycle, she realizes it is no longer there. It was stolen!!

Upset by the fact, she decides to use the PowerEnJoy service to reach the nearest police station and report the theft. After logging into the system, she reserves a car not far from her and, after unlocking it, starts her ride.

Once the police station is reached, Alex parks the car in a special safe area right in front of it. She then plugs the car into the power grid and happily sees on the monitor that a 30% discount has been applied on the ride's total price.

## **4.9 Scenario 9**

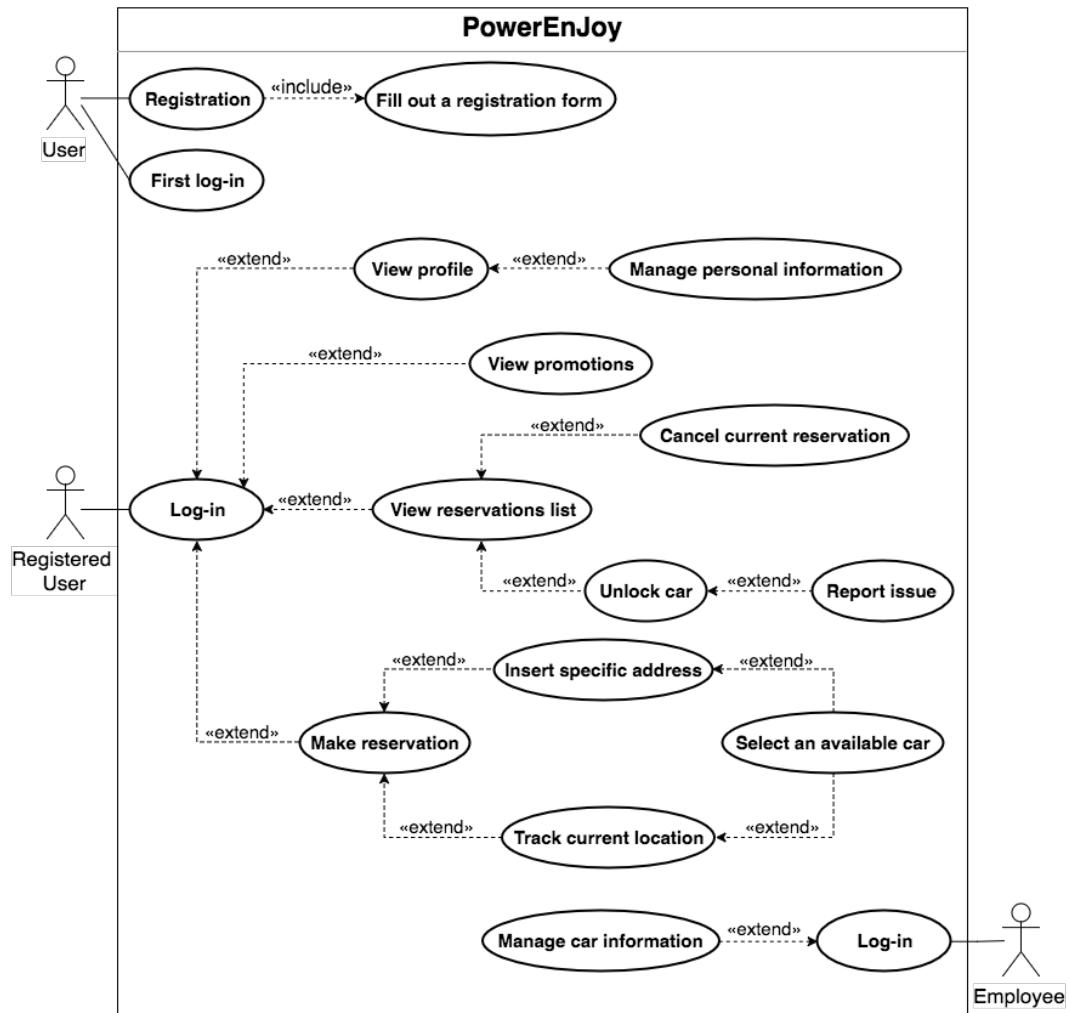
Stephen started working as an employee at the PowerEnJoy company last month.

Every morning, once he reaches the PowerEnJoy building, he checks if everything is in order with the company's cars. Today, after logging in, he realizes one of the cars has a low battery and is not plugged into any power grid. As a good worker he is, he calls the tow truck to bring the car to the nearest special safe area and dresses up to go out and reach it.

Once he gets to the special safe area, it is just a matter of minutes before the tow trucks arrive with the PowerEnJoy car. Finally, after the car is positioned near the power grid, Stephen takes care of plugging it into it and then heads back to the PowerEnJoy building to take care of other issues.

## 5 UML MODELS

### 5.1 Use case diagram



## 5.2 Use case description

In this paragraph all our use cases are described.

- User registration by filling out a form [[Sequence Diagram](#)]:

<b>Name</b>	User: registration, fill out a registration form, first login
<b>Actors</b>	Generic user
<b>Entry conditions</b>	There are no entry conditions.
<b>Flow of Events</b>	<ol style="list-style-type: none"> <li>1. The user downloads the mobile application or accesses the service's website.</li> <li>2. The user clicks on the "Sign in" button.</li> <li>3. The user enters his credentials and payment information.</li> <li>4. The user clicks again on the "Sign in" button.</li> <li>5. The user receives a password via email.</li> </ol>
<b>Exit conditions</b>	The user makes his first login with the assigned password and the username he chose.
<b>Exceptions</b>	The username is already taken or the user did not fill in all the mandatory fields.

- Registered user login [[Sequence Diagram](#)]:

<b>Name</b>	Registered user: login
<b>Actors</b>	Registered user
<b>Entry conditions</b>	The registered user has previously registered to the system.
<b>Flow of Events</b>	<ol style="list-style-type: none"> <li>1. The registered user accesses the service's website or opens the mobile application.</li> <li>2. The registered user enters his credentials into the corresponding fields.</li> <li>3. The registered user clicks on the "Login" button.</li> </ol>
<b>Exit conditions</b>	The registered user is able to see his personal page.
<b>Exceptions</b>	The username-password combination does not exist into the database.

- Registered user views his profile [[Sequence Diagram](#)]:

<b>Name</b>	Registered user: view profile
<b>Actors</b>	Registered user
<b>Entry conditions</b>	The registered user has previously logged into the system.
<b>Flow of Events</b>	<ol style="list-style-type: none"> <li>1. The registered user accesses his profile by clicking on the "View your profile" button.</li> </ol>
<b>Exit conditions</b>	The registered user is able to see his profile page.
<b>Exceptions</b>	Wrong button clicked.

- Registered user manages his personal information [[Sequence Diagram](#)]:

<b>Name</b>	Registered user: manage personal information
<b>Actors</b>	Registered user
<b>Entry conditions</b>	The registered user has previously logged into the system.
<b>Flow of Events</b>	<ol style="list-style-type: none"> <li>1. The registered user accesses his profile by clicking on the "View your profile" button.</li> <li>2. The registered user can modify his personal information by clicking on the "Manage personal information" button.</li> <li>3. The registered user makes some changes (or none).</li> <li>4. The registered user clicks on the "Save changes" button.</li> </ol>
<b>Exit conditions</b>	The registered user's personal information is updated.
<b>Exceptions</b>	Wrong data entered.

- Registered user cancels his current reservation [Sequence Diagram]:

<b>Name</b>	Registered user: cancel reservation
<b>Actors</b>	Registered user
<b>Entry conditions</b>	The registered user has previously logged into the system.
<b>Flow of Events</b>	<ol style="list-style-type: none"> <li>1. The registered user clicks on the "View the list of your reservations" button.</li> <li>2. The registered user visualizes the page showing all his reservations.</li> <li>3. The registered user clicks on the "Cancel current reservation" button.</li> </ol>
<b>Exit conditions</b>	The registered user's current reservation no longer exists and is added to the past reservations' list labeled as "Deleted".
<b>Exceptions</b>	The registered user has no current or past reservations.

- Registered user reports an issue after unlocking the car [Sequence Diagram]:

<b>Name</b>	Registered user: unlock car, report issue
<b>Actors</b>	Registered user
<b>Entry conditions</b>	The registered user has previously logged into the system, made a reservation and selected a car.
<b>Flow of Events</b>	<ol style="list-style-type: none"> <li>1. The registered user visualizes the list of his previous and current reservations from his personal page.</li> <li>2. The registered user clicks on the "Unlock car" button next to his current reservation.</li> <li>3. The registered user visualizes the car's information.</li> <li>4. The registered user checks the car for possible issues.</li> <li>5. The registered user clicks on the "Report issue" button.</li> </ol>
<b>Exit conditions</b>	The registered user's current reservation is deleted.
<b>Exceptions</b>	The car presents no issues.

- Registered user makes a reservation by selecting a car [Sequence Diagram]:

<b>Name</b>	Registered user: make reservation, insert specific address/current location, select available car
<b>Actors</b>	Registered user
<b>Entry conditions</b>	The registered user has previously logged into the system.
<b>Flow of Events</b>	<ol style="list-style-type: none"> <li>1. The registered user clicks on the "Click here" button from his personal page.</li> <li>2. The registered user enters a valid address or lets the system track his position by clicking on the "Track my position" button.</li> <li>3. The registered user visualizes all the available cars on a map.</li> <li>4. The registered user chooses one of the available cars shown on the map.</li> <li>5. The registered user clicks on the "Continue" button to reserve the car.</li> </ol>
<b>Exit conditions</b>	The registered user is able to see the page with all his previous and current reservations.
<b>Exceptions</b>	A non valid address is entered. None of the available cars is selected by the registered user. The registered user's GPS is not active although he has chosen the "Track my position" option.

- Employee logs into the system and manages a car's information [Sequence Diagram]:

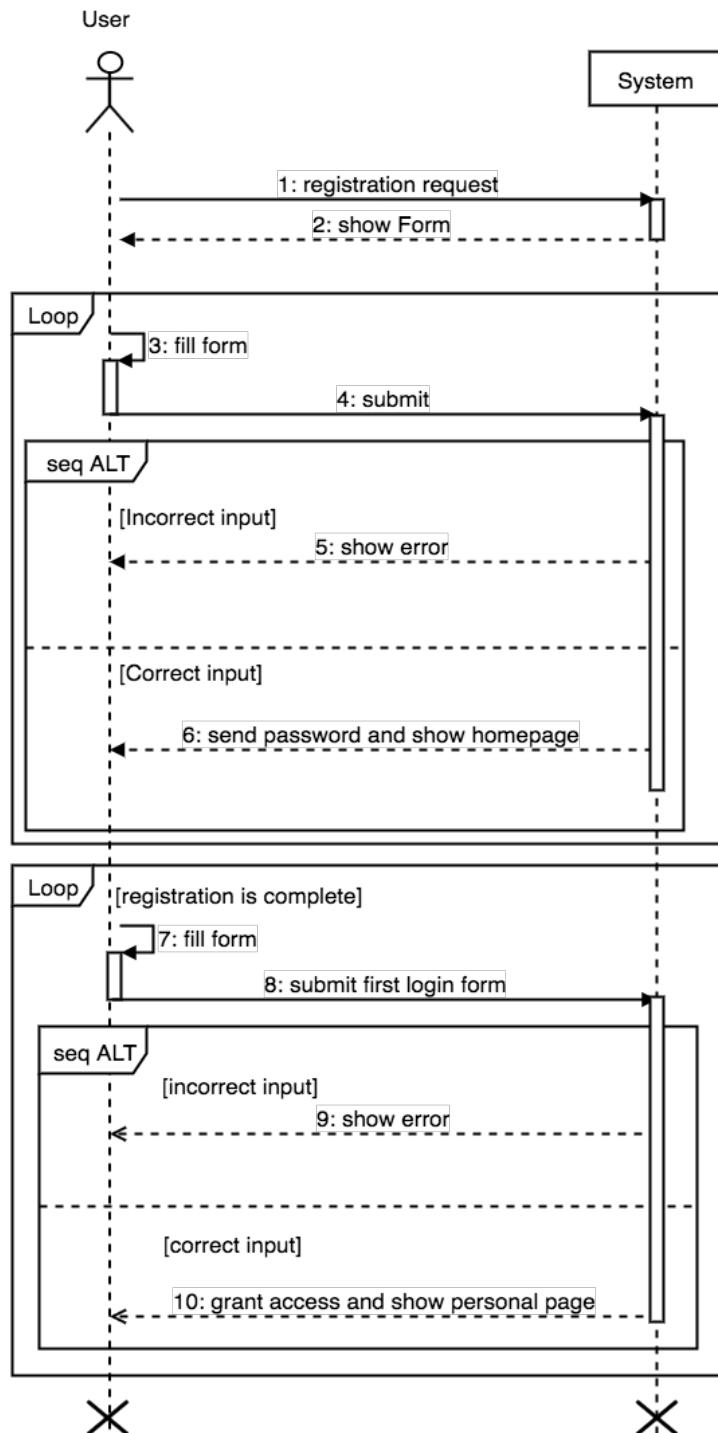
<b>Name</b>	Employee: login, manage car information
<b>Actors</b>	Employee
<b>Entry conditions</b>	The employee has previously been added to the database.
<b>Flow of Events</b>	<ol style="list-style-type: none"> <li>1. The employee opens the website homepage.</li> <li>2. The employee logs into the system by providing his/her credentials.</li> <li>3. The employee visualizes the list of all PowerEnJoy cars.</li> <li>4. The employee selects a car directly from the list or by searching its plate.</li> <li>5. The employee visualizes the chosen car's information.</li> <li>6. The employee manages the car's information.</li> <li>7. The employee clicks on the "Save changes" button.</li> </ol>
<b>Exit conditions</b>	The car's information is changed and the employee visualizes the list of all PowerEnJoy cars.
<b>Exceptions</b>	Wrong credentials are given. The searched plate does not exist. Non valid values are entered into the car's information fields.

### 5.3 Class diagram

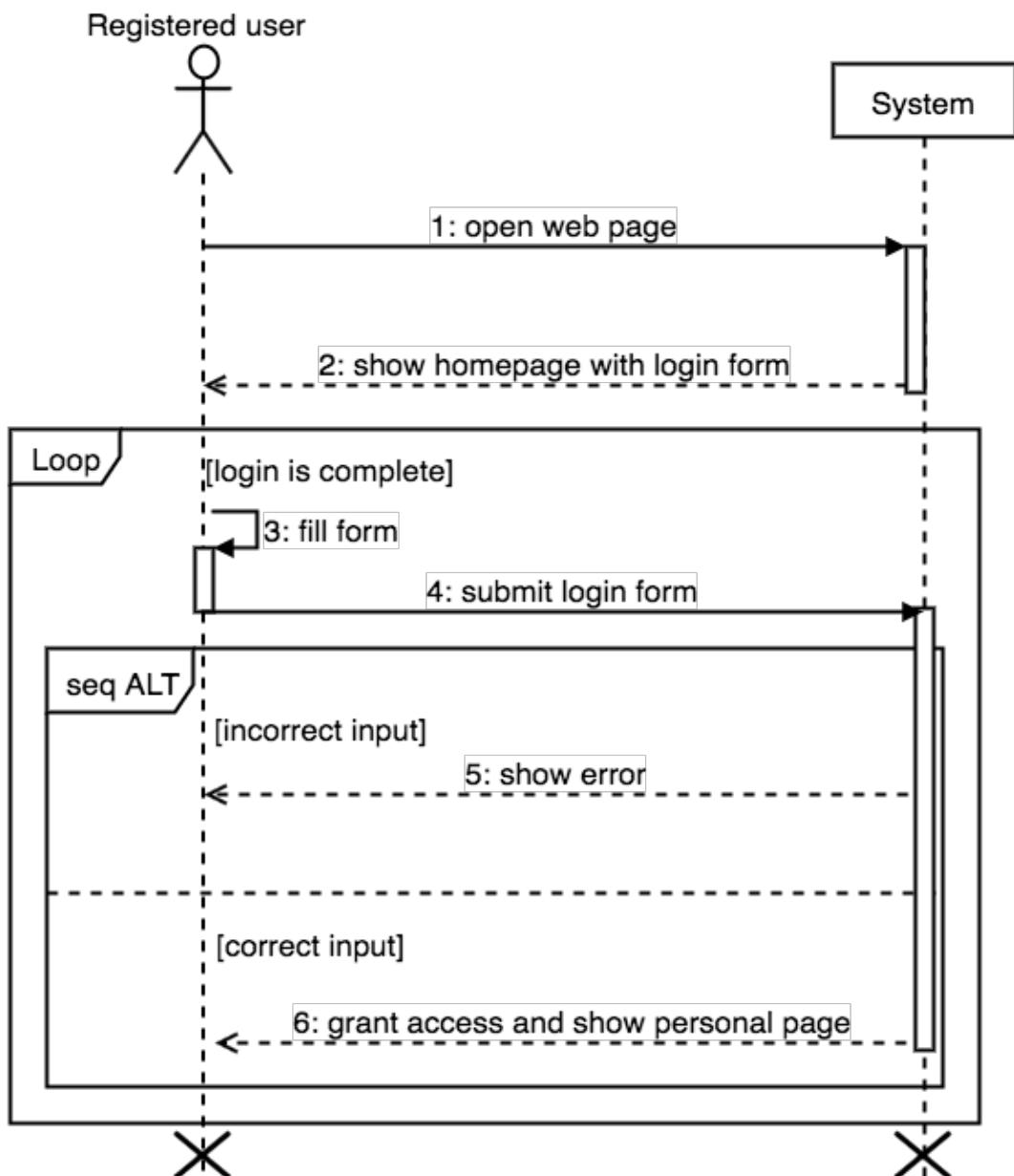


## 5.4 Sequence diagrams

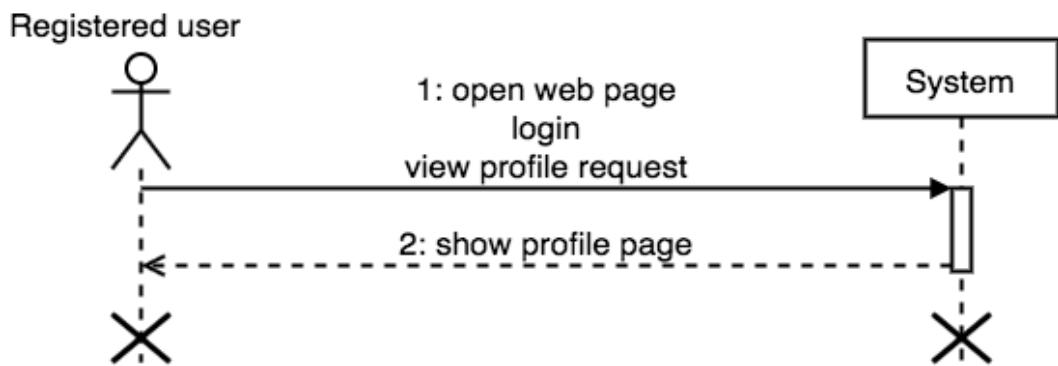
- User's registration:



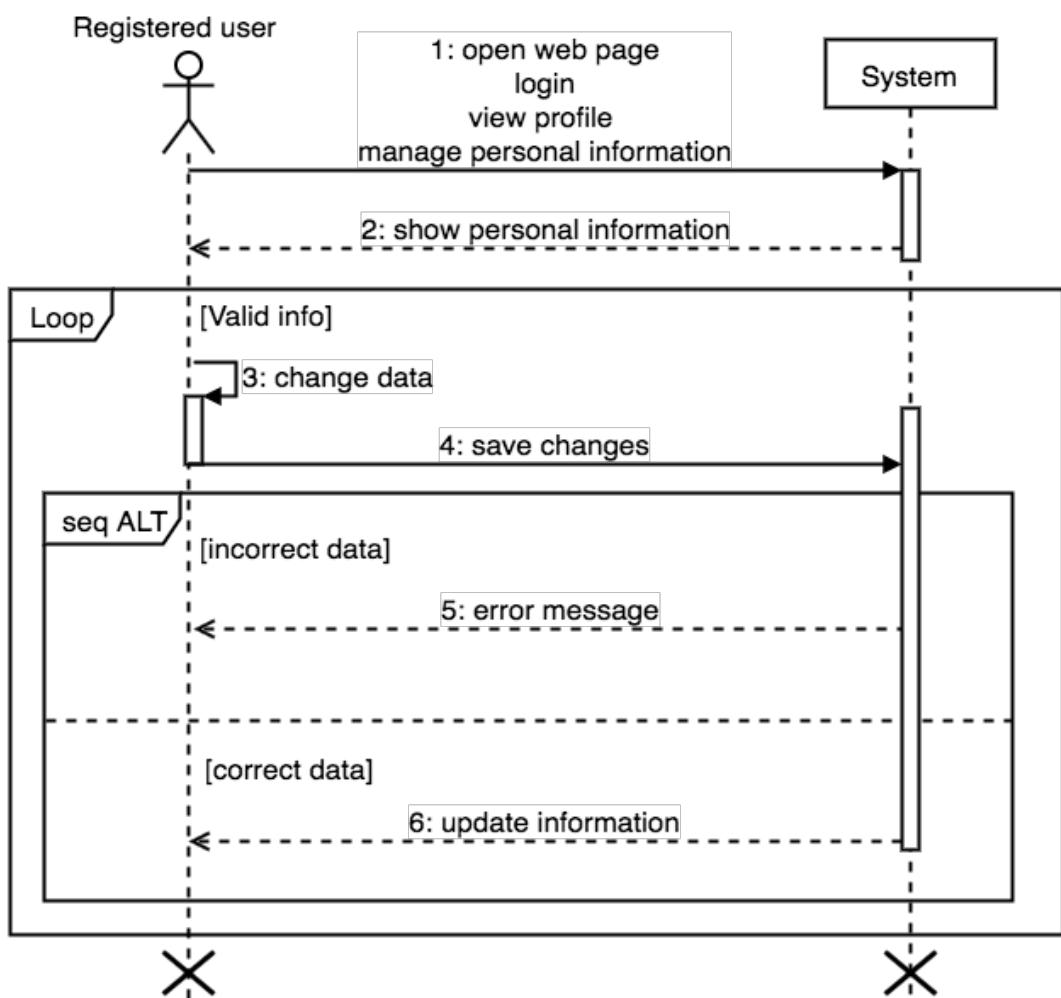
- Registered user login:



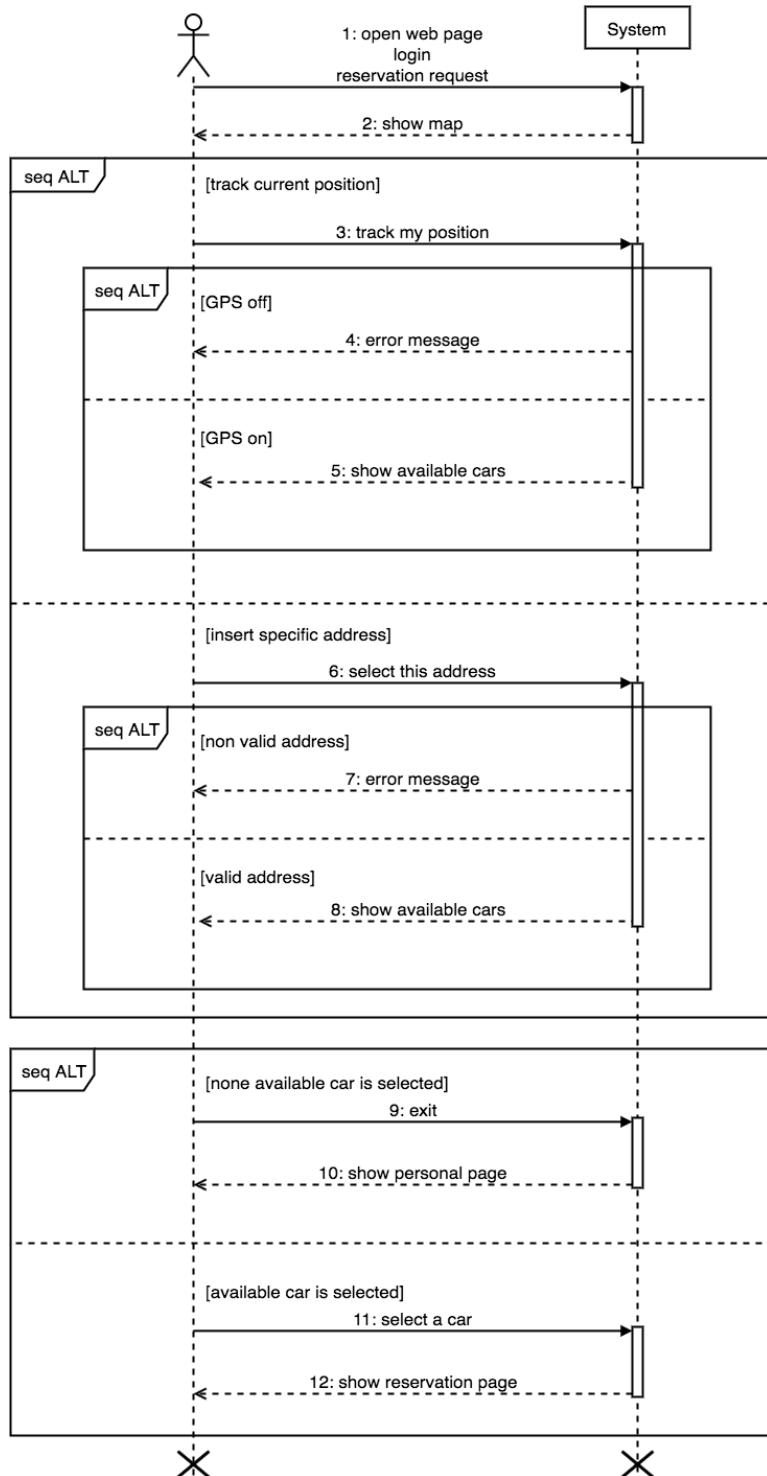
- Registered user views his profile:



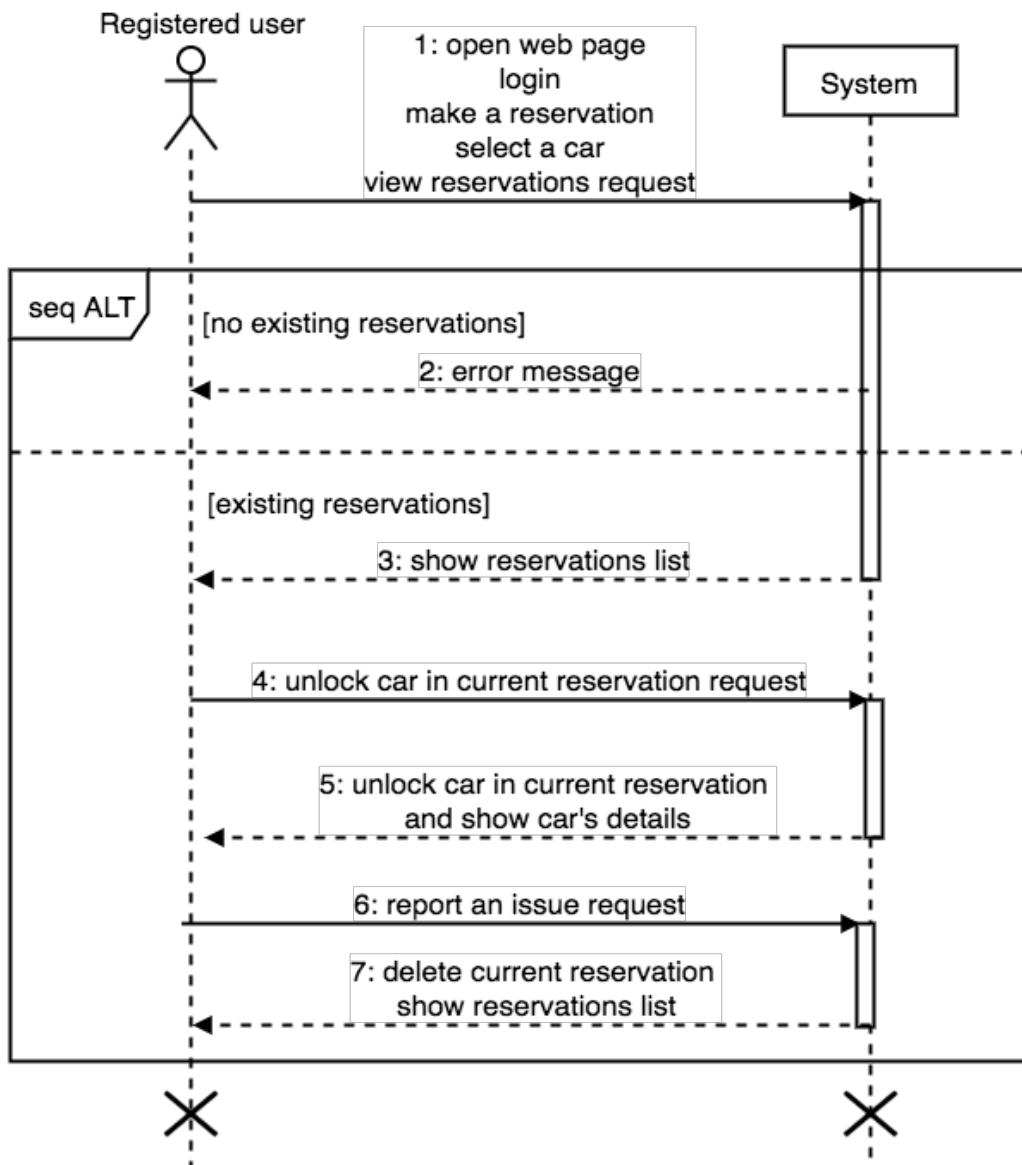
- Registered user manages his personal information:



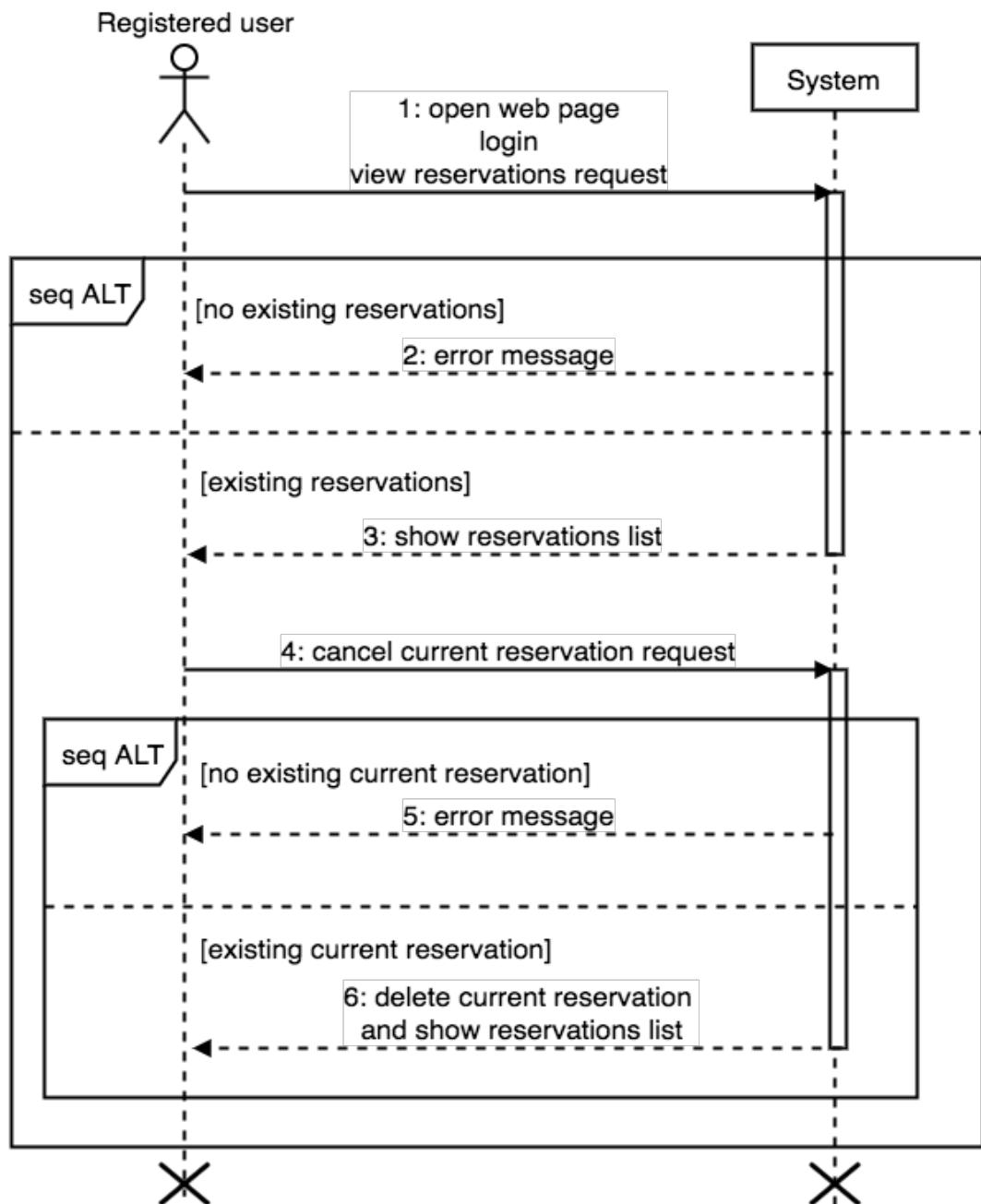
- Registered user makes a reservation by selecting a car:



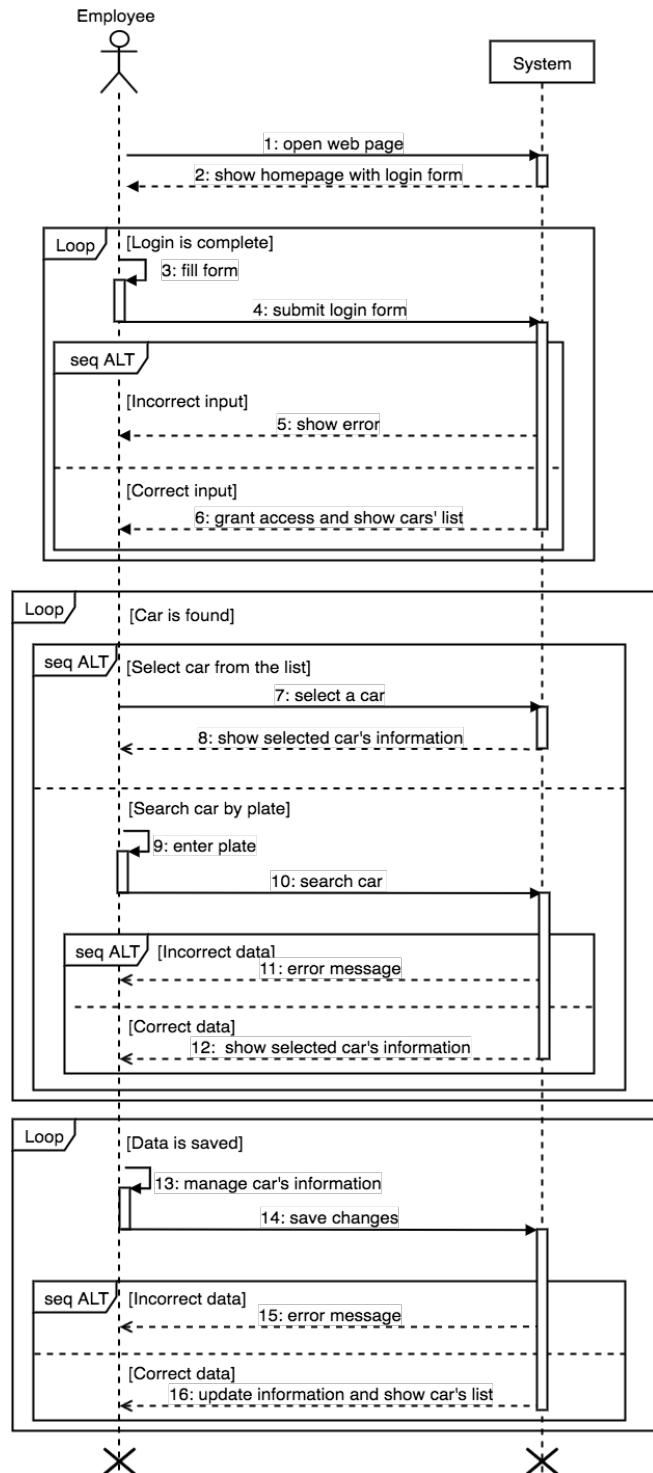
- Registered user reports an issue after unlocking the car:



- Registered user cancels his current reservation:

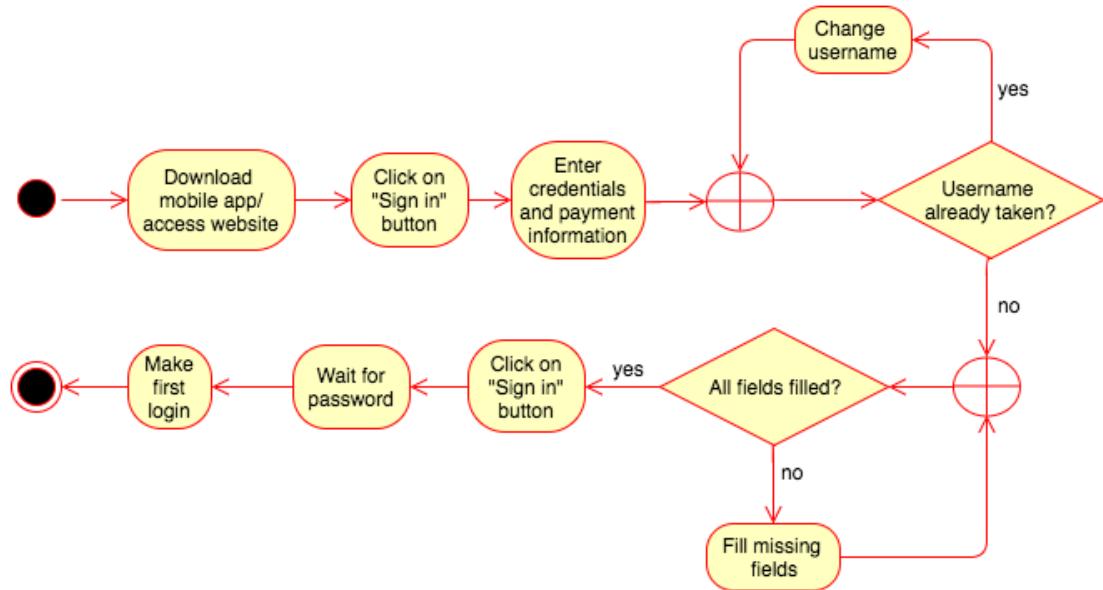


- Employee manages car's information:



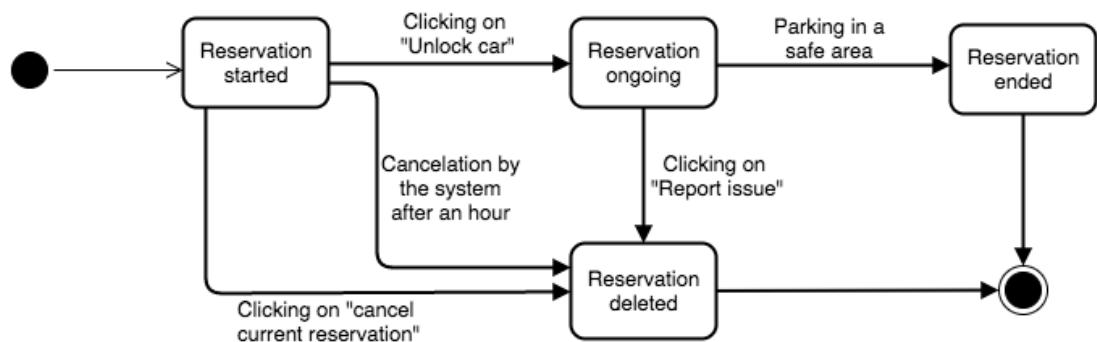
## 5.5 Activity diagram

User's registration by filling out a form:



## 5.6 State diagram

Reservation:



## 6 ALLOY

### 6.1 Model

```
open util/boolean

sig Username {}

sig Address {
    longitude: Int, //should be double
    latitude: Int //should be double
} {
    longitude > 0
    latitude > 0
}

fact differentAddresses {
    all a1, a2: Address | (a1 != a2) <=> (a1.latitude != a2.latitude) || (a1.longitude != a2.longitude)
}

sig Time {
    hour: Int,
    minute: Int
} {
    hour >= 0
    minute >= 0
}

abstract sig Discount{
    totalDiscount: Int
}
{
    totalDiscount > 0
}

one sig Discount1 extends Discount{}

one sig Discount2 extends Discount{}

one sig Discount3 extends Discount{}

fact CarsAndReservations {
    #(Reservation) = #(Car.reserved)
}
```

```

sig Reservation {
    reservedCar: one Car,
    user: one RegisteredUser
}

fact uniqueCarReservation{
    no disj r1,r2: Reservation | (r1.reservedCar = r2.reservedCar)
}

fact uniqueUserReservation{
    no disj r1,r2: Reservation | (r1.user = r2.user)
}

fact carNotReserved{
    all c: Car | no r1: Reservation | c.reserved = False && r1.reservedCar = c
}

fact pluggedCarsInSafeArea2 {
    all sa: SafeArea, c: sa.cars.elems | c.plugged = True <=> sa.specialArea = True
}

sig SafeArea {
    specialArea: one Bool,
    cars: seq Car
}

fact noDuplicatesInSafeArea {
    all sa: SafeArea | not sa.cars.hasDups
}

fact differentCarSafeArea{
    all c:Car | no disj sa1,sa2: SafeArea | (c in sa1.cars.elems && c in sa2.cars.elems)
}

```

```

sig Car {
    plate: Int,
    location: one Address,
    reserved: one Bool,
    broken: one Bool,
    ignited: one Bool,
    weightSensors: Int,
    plugged: one Bool,
    screen: one Screen,
    lowBattery: one Bool
} {
    plate > 0
    weightSensors > 0
    weightSensors <= 5
}

fact allScreensAreOwned{
    Car.screen = Screen
}

fact uniqueCar{
    no disj c1,c2:Car | (c1.plate = c2.plate)
}

fact carAddress {
    no disj c1,c2 : Car | (c1.location = c2.location)
}

fact carScreen {
    no disj c1,c2 : Car | (c1.screen = c2.screen)
}

fact carBroken {
    all c: Car | (c.broken = True) => (c.reserved = False)
}

fact carIgnited {
    all c: Car | (c.ignited = True) => (c.reserved = True && c.broken = False)
}

```

```

fact carPlugged{
all c: Car | (c.plugged = True) => (c.ignited = False)
}

fact carLowBattery {
all c: Car | (c.lowBattery = True) => (c.reserved =False)
}

sig Screen {
time: one Time,
discount: Discount
}

fact discountPassengers {
all c:Car, s: Screen | (c.weightSensors >= 3) => s.discount = Discount1
}

fact discountBattery {
all c:Car, s: Screen | (c.lowBattery = False) => s.discount = Discount2
}

sig RegisteredUser{
cardNumber: Int,
username: one Username
} {
cardNumber > 0
}

fact allUsernamesAreOwned{
RegisteredUser.username=Username
}
fact uniqueUsername {
no disj u1, u2: RegisteredUser | (u1.username =u2.username)
}

fact uniqueCardNumber{
no disj u1, u2: RegisteredUser | (u1.cardNumber = u2.cardNumber)
}

```

```

assert reservationAndRegisteredUser{
  all r:Reservation | r.user in RegisteredUser
}
check reservationAndRegisteredUser

assert numberCarReservedAndReservation{
  all c:Car, r: Reservation | c.reserved = False => c!=r.reservedCar
}
check numberCarReservedAndReservation

assert notSpecialSafeAreaDoesNotHavePluggedCar {
  all sa: SafeArea, c: Car | sa.specialArea = False && c.plugged = True => c not in sa.cars.elems
}
check notSpecialSafeAreaDoesNotHavePluggedCar

pred show0{
  #SafeArea=4
  #Car=5
}
run show for 6

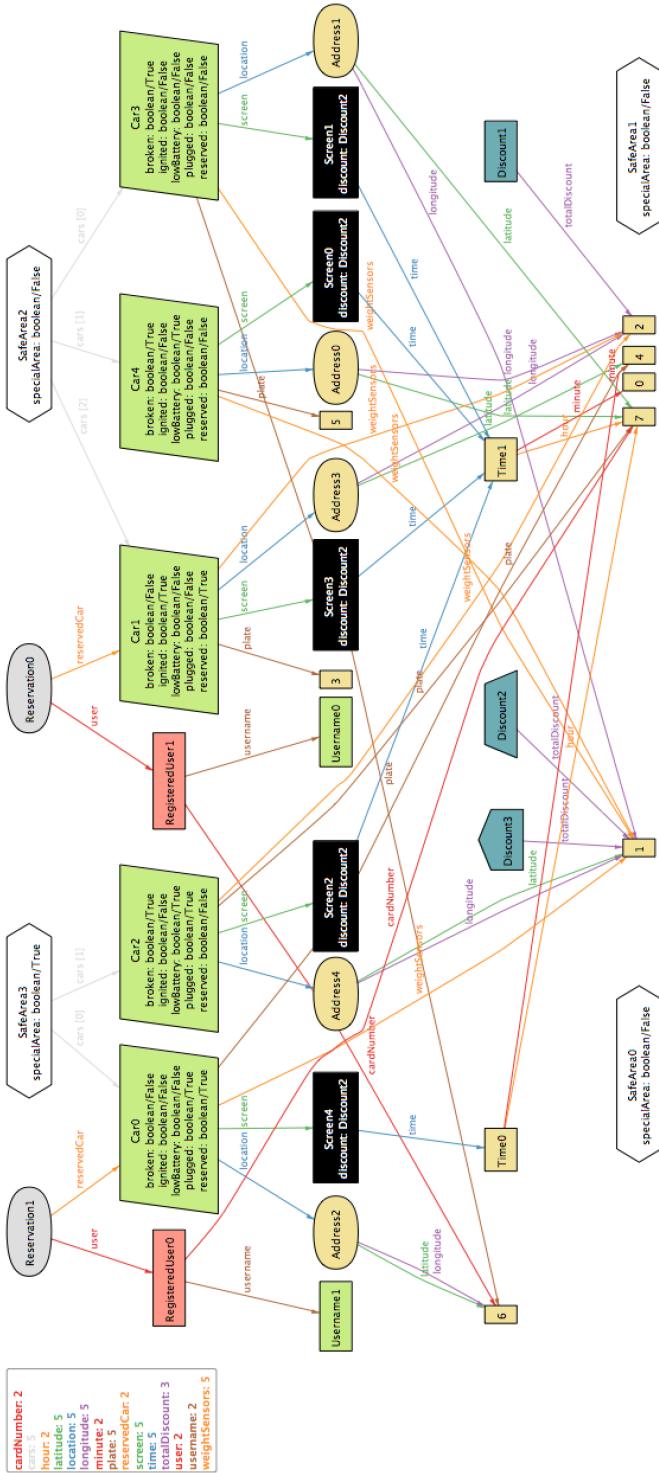
```

## 6.2 Alloy result

**4 commands were executed. The results are:**

- #1: No counterexample found. reservationAndRegisteredUser may be valid.
- #2: No counterexample found. numberCarReservedAndReservation may be valid.
- #3: No counterexample found. notSpecialSafeAreaDoesNotHavePluggedCar may be valid.
- #4: **Instance found.** show is consistent.

### 6.3 World generated



## **7 FUTURE DEVELOPMENT**

Expanding the PowerEnJoy service to other cities in Italy, starting from Rome; this requires the introduction of new maps, created by adding the missing addresses.

## 8 USED TOOLS

The tools we used to create this document are:

- **draw.io**

To create the UML models.

<https://www.draw.io>

- **GitHub and GitHub Desktop**

To collaborate with the team and keep track of the changes in the document.

<https://github.com> and <https://desktop.github.com>

- **Balsamiq**

To design the mockups.

<https://balsamiq.com>

- **TeXstudio**

LaTeX editor we used to write this document.

<http://www.texstudio.org>

- **BasicTeX**

Distribution of the LaTeX system.

<http://www.tug.org/mactex/morepackages.html>

- **Alloy Analyzer 4.2**

To build strong and consistent models.

<http://alloy.mit.edu/alloy/>

## **9 HOURS OF WORK**

This section includes information about the number of hours each group member has worked towards the fulfillment of this deadline.

Since we decided to work together every day, the worked hours are going to be the same for each group member. We think this is the best way to achieve good results.

### **9.1 Agosti Isabella**

- 20/10/16: 3h
- 27/10/16: 2h
- 29/10/16: 3h
- 30/10/2016: 3h
- 02/11/2016: 2h
- 03/11/2016: 3h
- 04/11/2016: 3h
- 05/11/2016: 8h
- 06/11/2016: 2h
- 07/11/2016: 3h
- 10/11/2016: 3h
- 11/11/2016: 5h
- 12/11/2016: 8h
- 13/11/2016: 4h

## 9.2 Cattivelli Carolina

- 20/10/16: 3h
- 27/10/16: 2h
- 29/10/16: 3h
- 30/10/2016: 3h
- 02/11/2016: 2h
- 03/11/2016: 3h
- 04/11/2016: 3h
- 05/11/2016: 8h
- 06/11/2016: 2h
- 07/11/2016: 3h
- 10/11/2016: 3h
- 11/11/2016: 5h
- 12/11/2016: 8h
- 13/11/2016: 4h

## 10 CHANGELOG

- v1.1
  - Domain assumptions added.
  - Explanation added to the worked hours section.
  - Car added to the proposed system's architecture.
  - Changes in class diagram.
  - Changes in use case diagram.
  - New actor added: employee.
  - Employee's use case description and corresponding sequence diagram added.