Politecnico di Milano

Software Engineering 2

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POWER ENJOY

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Contents

1 Introduction

1.1 Description of given problem

This project will implement Power EnJoy mobile/web app, which is a service based on electrical car sharing. In this scenario include two principal figures:

-Power EnJoy System/Company.

-Client

The purpose of this project is to implement a car-sharing system using a mobile/web app. This system will allow customers to book electric cars easily and in the same time it will let the company to manage the service in a proper way. Moreover thanks to the new mobile/web app, customers can choose through the nearest car using GPS technology integrated in the new system. A car can be reserved by customers in all geographical region and if it is not used, car will be available again. After that, system will be able to unlock the car when the customer is near so he press a button on Power EnJoy app. Registration on app is required to obtain username and password and to use all services provided by EnJoy company. The use of web app will be only to plan or reserve the trip in the sense that customer will be able to see on map what are the position of available cars, calculate the distance and time from one point to another and the total amount of the trip in according to cost per minute and discounts.
The system also will offer different discount to encourage clients to use the car with more people, to plug the car into the power station and to be more eco-friendly.

1.2 Goal

- [G1] System checks the user's identity through the login procedure.
- [G2] System allows logged customers to see available vehicle and Trip History.
- [G3] Customers will be able to reserve chosen car for 1 hour before they pick it up.
- [G4]User that exceed the pickup time will be charged 1 euro of fee and the car come back available.
- [G5] User that reaches the reserved car is able to open it using the app.
- [G6] System during the trip shows details about the current charges, the safe area for parking and for recharging the vehicles.
- [G7] System computes automatically charges and discounts related to the user's behaviour.
- [G8] System show on the display an ETA.
- [G9] System will include assistance service 24h.

2 Domain Assumption

We suppose that these properties hold in the analyzed world :

- Every user owns a mobile phone with internet connection, GPS system and app compatible.
- Every user is able to open the car using the proper button on mobile app.
- The car has got 3 types of parking handled by the user through 3 different buttons: close car mode,charging mode, take a break mode.
- Every payment made by credit card is guaranteed by external company.
- We assume that exist an external service assistance (open 24h).
- Each vehicle is equipped with high GPS system precision and it is always online (cannot be switched off).
- Each vehicle is always connected online through use of internet data (cannot be switched off).
- Parking areas are always located uniformly in the city.
- Every parking areas contains at least one power station.
- Power EnJoy System is always online and work correctly.
- Driving license is checked by competent authority.
- The cars turns on after the correct entry of a PIN code send by Power EnJoy System on mobile app.
- Number of passengers is between 1 and 4.
- The payment by credit card is made after use of service with a car turned off.
- Each car is unique identified.
- Traffic law must be respected by customers.
- Each customer must be reserve and use only one car a time.
- Customer must be in legal condition for driving.
- Each car is equipped with an iPad, used to manage the car system.
- Reservation about car can be done on web app and mobile app.
- Selected Cars for PowerEnJoy has an advanced Car System, that provides REST API, with different vehicle control possibility.

- The GM cars are connected, and controlled by OnStar Hardware. This system remains active and available for contact after vehicle ignition turned off.
- Since OnStar expected that the car can go in Sleep Cycle after a while. We assume that our shared cars ever go in Sleep Cycle.
- Web Portal only give the possibility to reserve a car and look at Payments History.

3 Glossary

Here we describe terms used in this document.

- Customer/Client: who interacts directly with the system using a mobile app or web app each time that he needs to reserve and uses a car.
- Login procedure: require some information regarding customer and necessary for the operations of the system.
- Power EnJoy: System divided in two part; the first is an mobile/web app available in any application store (apple, android, windows). It work correctly in each device and need only internet connection (3G, 4G or superior) and GPS. The second part of the system is contained inside the car.
- Reservation: is the possibility to reserve only one car one hour before using it. Reservation must not exceed one hour because after that the car returns available.
- Available vehicle : is a car that in a specific time is not reserved and unused by nobody else.
- Fee: is an extra payment charged to customer when he reserved a car without use it.
- Open car: the system unlock the car doors, when the customer is near the vehicle and he has clicked the “open button” on the app.
- Safe area park: are specific delimited area for parking EnJoy cars. They are distributed uniformly in the city.
- Show details: details about current charge, car battery percentage, position on the map, position and availability of the safe areas to park and to recharge are showed on an iPad installed in the car.
- Charging vehicle: some safe area park contain power grid station, in which customers can recharge the vehicle.

- User behaviour: is the intention of customers to park the car in safe park area, to maintain an high level of battery (plug the car into the power grid) or bring at least two other passengers onto the car.
- ETA: Estimated Time of Arrival is displayed on iPad in the car.
- Assistant services: dedicated service to unexpected events.
- PIN Code: Personal Identification Number is a five digit code used to confirm the same client that once he opened the car, he enters in.
- Car unique identified: each car has got a different number on plaque.
- Power station: is composed by plug and it is used to connect and charge the car.
- Close the care mode:is one of the three modality that can be choose on iPad display. Close the car mode is used when you finished to use the car and you want to leave it in a park available. Once out of the car it is locked after 40 seconds.
- Take a break mode: is one of the three modalities that can be choose on iPad display. Take a break mode is used when you need to leave the car only for a limited time. During this time you pay continuously the service.
- Charging mode: is one of the three modalities that can be choose on iPad display. Charging mode is used before you connect the car in power station. In charging modality, customer finish to pay the service and the car can start the charging process.
- REST: Representational State Transfer is one way of providing interoperability between computer systems on the internet.
- GM: General Motors is an american multinational corporation that designs, manufactures, markets, and distributes vehicles and vehicle parts.
- OnStar: is a subsidiary of General Motors that provide subscription-based communications, in-vehicle security, navigation, and remote diagnostic systems.

4 Text assumption

- System assume that each customer can register only once.
- There will be visible cars in range of 300 meters within specified address or gps location.
- Reservation can be expressed in terms of minutes (integer value), no more than 60 starting from the end of reservation process.
- When customer's reservation expires, user will be able to reserve again any car.
- Customer will open the vehicle by mobile application, when is nearby.
- Vehicle ignites engine exactly when doors are unlocked.
- There is already an installed hardware system in the car.
- When customer reach destination, he will park in a safe area.
- Safe area are visible on the map.

5 Explanation of the Signatures

- A Reservation has a Ride when the user reserves a car, when its status is true it means that the user is driving the car reserved while is false in the other cases.
- When a reservation exceed maximum time, the system will set to the current Reservation the true flag on time exceeded and then will be charged fee's payment amount. Vehicle became available and reservation saved.
- Explanation about the enumeration "car status":
  - park: the car is parked
  - charging: the car is plugged into a power station and is charging
  - break: the car is parked but the user has performed a break so later he will drive the car again
  - fault: the car is damaged and it is waiting to be repaired
  - drive: the user is driving the car
- The park status models the fact that the park is available or not, a park P becomes unavailable when a car C is parked on the park P

- The status of the power station is influenced by the status of the relative park in particular:
  - Park unavailable → the power station is unavailable also if it's not plugged into the car.
  - Park available → the power station is available.

6 System Vehicle Interaction

6.1 Introduction

Facing out the different solutions available in the automotive industry. We've analyzed the opportunities in electric vehicles. General Motors will sell starting from 2017 Opel Ampera-e, an electric vehicle with 200 miles range autonomy. GM has given to us thanks to our request, the access to developer resources, description of API, and developer credentials. This car has already installed OnStar Hardware technologies. In addition we insert in each car an iPad with an installed App which interact only with PowerEnJoy Server.

6.2 Proposed System

The design of this system needs to use technology already developed. Since Remote API servers expect to interact with another server, System's architecture must reflect this line.
Architecture will consider a web server that communicates with the user's phone and the iPad but on the other side invokes command on Remote API Server.

GM vehicle uses REST API, so the proposed system will use API in according to the follow summary table:

Number	API Name	Description	API use
1	Subcribers	List subcribers on an Account	N
2	Subcriber	Get a specific subscriber on an Account	N
3	Vehicles	List vehicles on an Account	Y
4	Vehicle	Get a specific vehicle on an Account	Y
5	Start Vehicle	Remotely start the vehicle	Y
6	Cancel Start Vehicle	Remotely stop the vehicle	Y
7	Lock Vehicle Door	Remotely lock the vehicle doors	Y
8	Unlock Vehicle Door	Remotely unlock vehicle doors	Y
9	Vehicle Location	Retrieve the location (latitude/-longitude) of a vehicle	Y
10	Alert	Remotely alert (horn honk/flash lights) a vehicle	Y
11	Turn By Turn Route	Request to send directions to a vehicle based on destination and start location	Y
12	Send Destination	Request to send destination to the onboard navigation unit of a	Y
13	Retrieve Diagnostics	Query a vehicle for diagnostic data	Y
14	Batch	Request to send a set of commands for vehicle(s) for fleet clients	N
15	Telemetry Data Service	Location data stream.	Y
16	Trip Data Service	Data collected during a trip including: Seatbelt, Hard Braking, Hard Acceleration, Engine Idle etc..	Y
17	DTC	Data stream of active Diagnostic Trouble Codes.	Y
18	Remote Vehicle Disable/Enable	Ability to immobilize and remobilize the vehicle.	Y
19	Electric Vehicle Services	Services available to electric and hybrid vehicles.	Y

Moreover, in order to perform check on vehicle data, system will use following data of electric vehicle:

- EV Battery Level
- EV Charge State
- EV Estimated Charge End
- EV Plug State
- EV Plug Voltage

6.3 Security Aspect

Concerning interaction between Web Server and Remote API server:
There is not any direct interaction between PowerEnJoy App and GM Servers. GM Vehicle service uses OAuth 2.0 security grants. Once authorization has been granted, an access token will be returned. That token is required to invoke APIs. PowerEnJoy Servers uses only Https protocol communications.

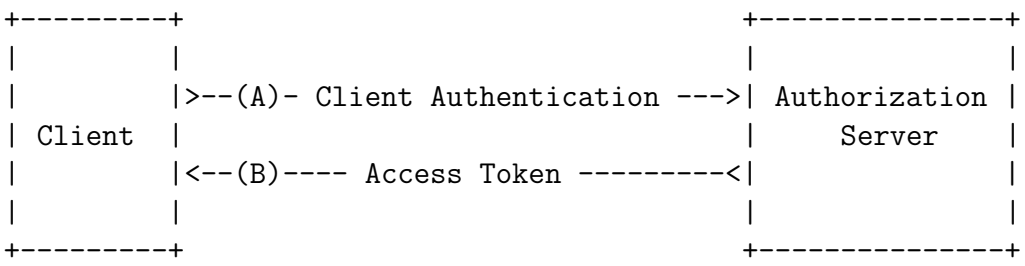
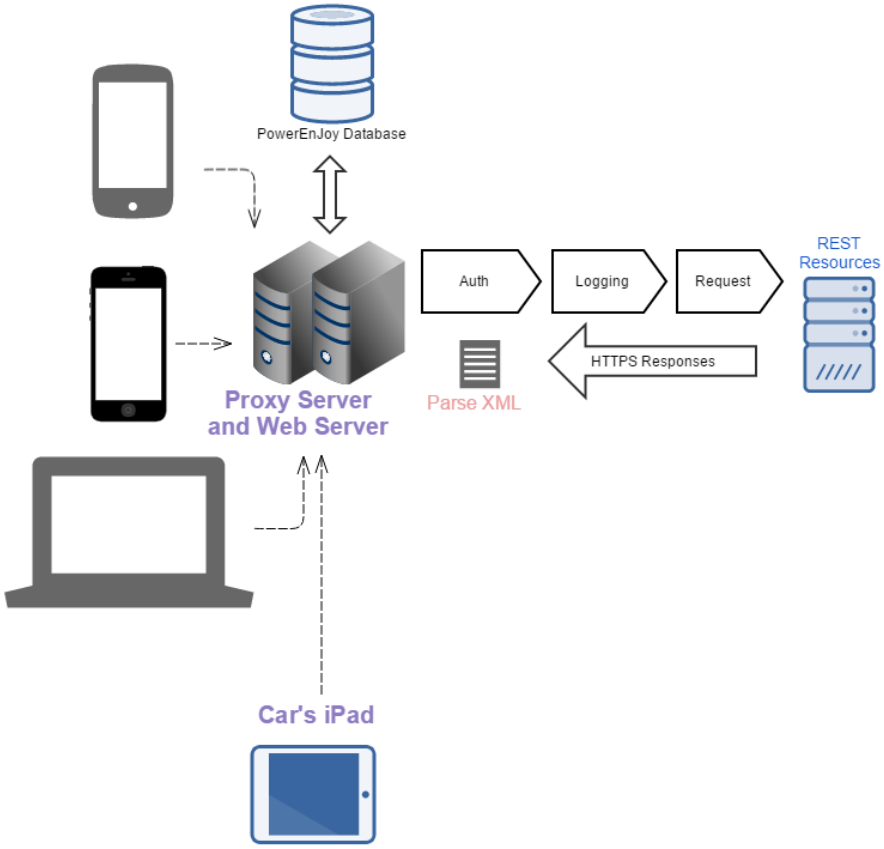
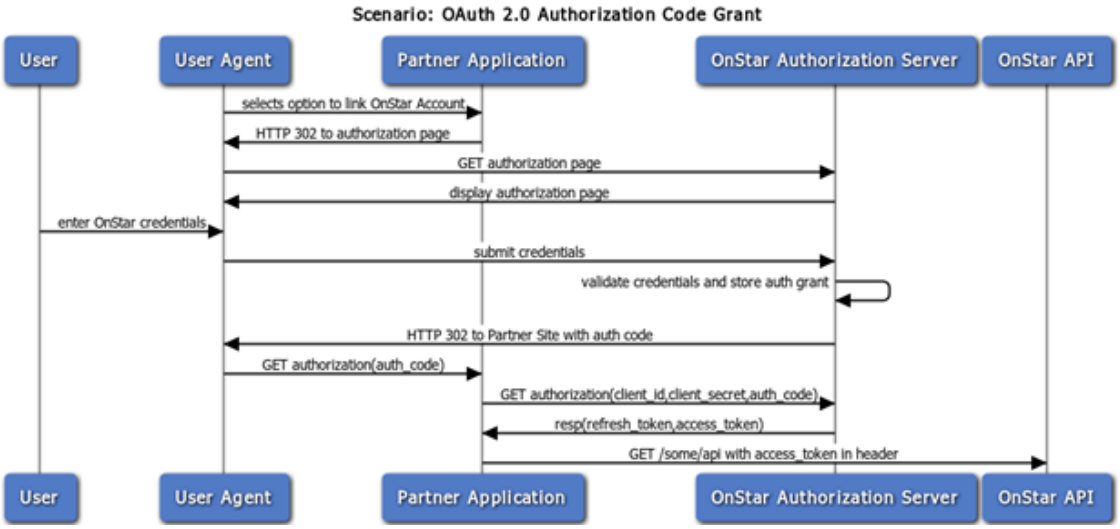


Figure 1: Client Credentials Flow ref: RFC6749

6.4 Ref Architecture



6.5 Client Credentials Flow



7 Functional requirements

- [G1] System checks the user's identity through the login procedure.
  - The system should be able to verify the username and password.
  - If the combination of email and password is correct the system logs the user into the system.
  - If the combination of email and password is incorrect the system invites the user to repeat the login procedure.
- [G2] System allows logged customers to see available vehicles.
  - The system must be able to detect the position of the user using the GPS.
  - The system must be able to detect the position of the available cars using the GPS.
  - The system must show in the map the available cars and the position of the user in the mobile app/web app.
  - In the same scene the user is able to see the his history trip.
- [G3] Customers will be able to reserve chosen car for 1 hour before they pick it up.
  - The system should receive request for the reservation of the available car.
  - The user must be able to cancel his reservation until he has not picked up the car yet.
  - The system applies a 1 euro fee to the user who cancels the reservation.
  - The system must be able to change the state of the car from "available" to "reserved".
  - The system must count down the time for 1 hour in which the car is kept reserved for the user.
- [G4] User that exceed the pickup time will be charged 1 euro of fee and the car come back available.
  - At the end of the count down the system must be able to charge the user of 1 euro.
  - At the end of the count down the system must be able to change the state of the car from "reserved" to "available".
- [G5] User that reaches the reserved car is able to open it using the app.
  - The system must recognize the proximity between the car and the user using the GPS.

  - The system must allow the user to press the button only in the mobile app to open the vehicle.
  - The system must stop the countdown when the user opens the car.
  - The system must be able to change the state of the car from "reserved" to "drive".

- [G6] The system during the trip shows details about the current charge, the safe area for parking and for recharging the vehicles.
  - The system should be able to charge the specific user per minute showing him the total cost of his trip.
  - The system shows in the navigation system the safe area for parking.
  - When the user reaches his destination and pushes the button "close the car" the system starts a 40s countdown after which it closes the car.
  - When the user pushes the button "take a break", the system shows a "resume your trip" button on the iPad in the car, a countdown of 40 seconds starts and on a mobile app of the user reappear open the car button. When the countdown value is equal to zero, the car system close the doors. As soon as the user wants to resume the trip, he has to click on the "open the car" button, the system open the car doors and it send to the user a new pin code to insert in iPad display. When the user is sit on the car to continue his trip, he has to click ok "Resume you trip" button.
    During this "break" time, the user is continuously charged.
  - When the user pushes the button "charge the car" the system starts a 3 minutes countdown in which the user is able to plug the vehicle into the power station, if he does it he obtains the 30% discount else he pays the full price. When the user leave the car it status remain unavailable for two hours. After that car status come back available.

- [G7] The system computes automatically charges and discounts related to the user behaviour.
  - The system must be able to detect the battery level.
  - The system must be able to apply a discount to the user.
  - If the system detects the presence of at least 3 people in the vehicle at the end of the ride the system applies a 10 % discount in the last ride.
  - If the system detects that the user has left the car with more than 50% of battery it applies a 20% discount to the user.
  - If the system detects that the user has left the car in a charging area and moreover he has plugged the car to the power station it applies a 30% of discount to the user.

  - If the user leaves the car more than 3km away from the nearest power station or if the user leaves the car with less than 20% of the battery the system applies a 30% surcharge to the user.

- [G8] System show on the display an ETA.
  - The navigation system computes the destination and shows information about the ETA and the route on the iPad installed into the car

- [G9] System will include assistance service h24.
  - The system allow the user to ask for assistance every time it is needed, the assistance call will be then handled by the assistance company.

8 Scenario identifying

8.1 Scenario 1

Pietro is a manager who works in different areas of Milano, he has an eco-friendly philosophy that's why he choose Power Enjoy everyday for his work. Now he has just leave his office and he has another meeting so he opens the Power Enjoy App on his iPhone 7 Plus and search for available cars nearby. Luckily there are many cars in the area, he pushes the "reserve the car" button in his App and is ready to "open" the vehicle. His ride is quite long, he enjoys the information available on the screen like the ETA that let him to inform his collaborators about the time of arrival. When he reaches the place using the iPad on the vehicle he finds a safe park equipped with power station to charge the car. After the connection with the power station he is notified about the charge and the 30% discount on his ride.

8.2 Scenario 2

During the week Francesca needs to bring her children at school near her workplace. She and her family live on the outskirt and they have got a single car used by husband. In the Francesca's neighborhood public transportation don't work very well because train and bus, often are late. When Francesca knew the discount of 10% applied by Power EnJoy system if you bring at least two other passengers onto the car, she decided to register to it. During the morning Francesca choose the nearest car from her home and clicks the button "reserve" on the app. After breakfast she go to take the car with her children and when they reached it, Francesca clicks the button "open the car" and they can enter. When they are sit on the car, the system using a pressure sensors installed under the seats, applies automatically a discount of 10% at the end of service. Now thank to Power EnJoy she can save more money than buy three tickets for the train or bus and thanks to distributed safe areas of parking when she arrives near her workplace/children school, she can park EnJoy's car without the problem of looking for public parking area.

8.3 Scenario 3

Gabriele is a student who enjoys the nightlife that Milano offers, he used to spend every saturday evening turning around the most famous clubs of the city and after the clubs the public service is poor so he comes back home using the power Enjoy's cars. Unluckily he lives in a suburbs 5 km far from the nearest suggested power station and he is too tired to walk so he parks right in front of his home paying a 30% surcharge.

8.4 Scenario 4

Simone is a devoted customer, he often uses PowerEnJoy in everyday life, to move around the city, and he prefers to save money. Before start driving, once he seated

in, the system ask to him if he want to save money. After positive response chosen by Simone, he can insert his destination. The system will identify, in according to save money, what's the suggested station nearby the arrival address where Simone has to park in. So, he follows the instruction provided by the system, reaches the destination and parks well. After clicked "close car button" on iPad display, Simone leave the car and after 40 seconds, the system locks doors and finalize payment applying all the possible reduction.

8.5 Scenario 5

Alexandra had never used a car sharing app. She needs to travel every morning to reach work Office. So she decided to try PowerEnJoy App. After installed it, the App request to register into the system, so she inserted all the requested information, then verify the email address by open the link given by an automatic email. Logged in, Alexandra has seen some texture that specify what are the passages to follow in order to use the App.

8.6 Scenario 6

Ernesto has reserved a car nearby his position on Mobile phone. Ernesto follows directions to reach the vehicle walking. When he is in front of the specified car, Ernesto tap "open the car" on the mobile App. Now the EnJoy App will show the secret pin code, that enable to power on the car. The car System also shows all information about trip, level of battery, estimated time of arrival.

8.7 Scenario 7

Riccardo is a boy that live alone in Milano and he started his first job as an employee. This weekend he decided to go to visit his family that lives on the other side of city. Riccardo reserved a EnJoy car and he knows that there is a 30% discount if the car is left in charge. He doesn't have much money to spend in trip and for this reason he decided that when he will reach other side of Milan he will search an available power station near his family home. Once he reached the power station, he click on button "charge the car" on iPad display, he connects the car to the power station and the system will provide to charge Riccardo with the cost of the trip less 30%.

8.8 Scenario 8

Simon is an important director, he works in the city center and he lives with his family far from the city in a peaceful area. Simon has just realized about the public service strike and so to come back home he chooses to use Power Enjoy service. From the office he logs into the web app and reserves a car near the workplace to come back home. After 30 minutes he reaches the car, he inserts the address in the system and leaves. When he arrives the system suggests him the safe parks near his house but unfortunately they are not equipped of power stations and the car

has less than 20%. The system signals him that in this condition he will pay a 30% surcharge, he accepts and comes back home.

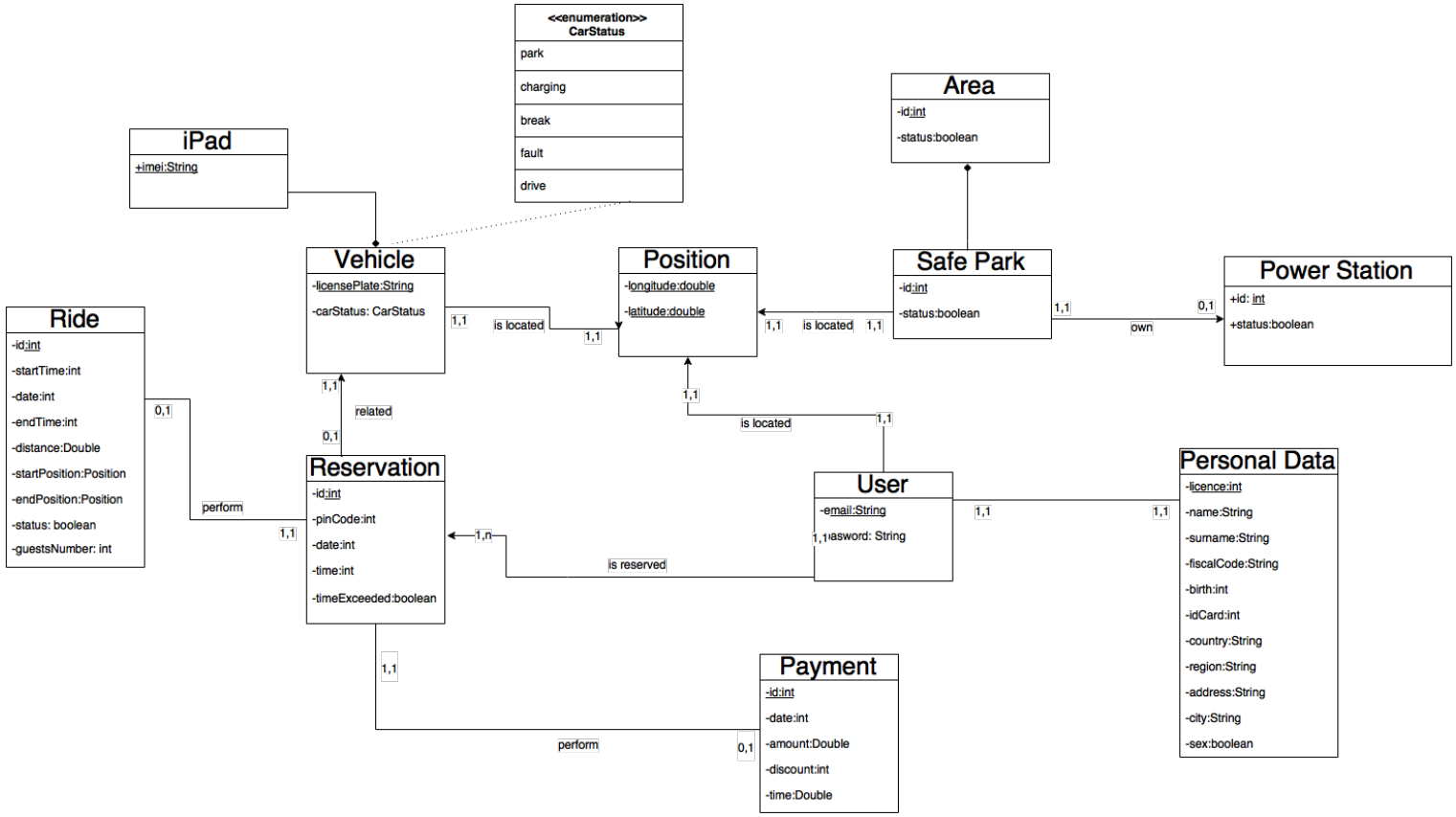
8.9 Scenario 9

Davide has reserved an EnJoy car for going to visit his friends from other side of Milan. When he started to use the car, he remembered that he have to go to take his clothes in laundry. So during the trip to reach his friends, Davide went first to laundry and left the car in front of store and he activated take a break modality clicking on "take a break" button on iPad display. After 40 second the car system locks the doors. As soon as Davide come back to re-take the car, has to click on "open the car" button on his mobile app so the system unlocks the doors and when he entered into a car have to reinsert a new pin code sent by the system. After that Davide press the "resume trip" button on iPad display to go to his friends.

8.10 Scenario 10

Michael is a man that live near safe area park with power station. Each time that he needs to use the car, go to the park and he usually find a fully charged vehicle. When he starts the ride, the car battery is 100% full but after few kilometers, necessary to reach the workplace, the battery level is 95% full, so enough to take the 10% discount on the last ride.

9 UML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-address:String
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Payment
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-amount:Double
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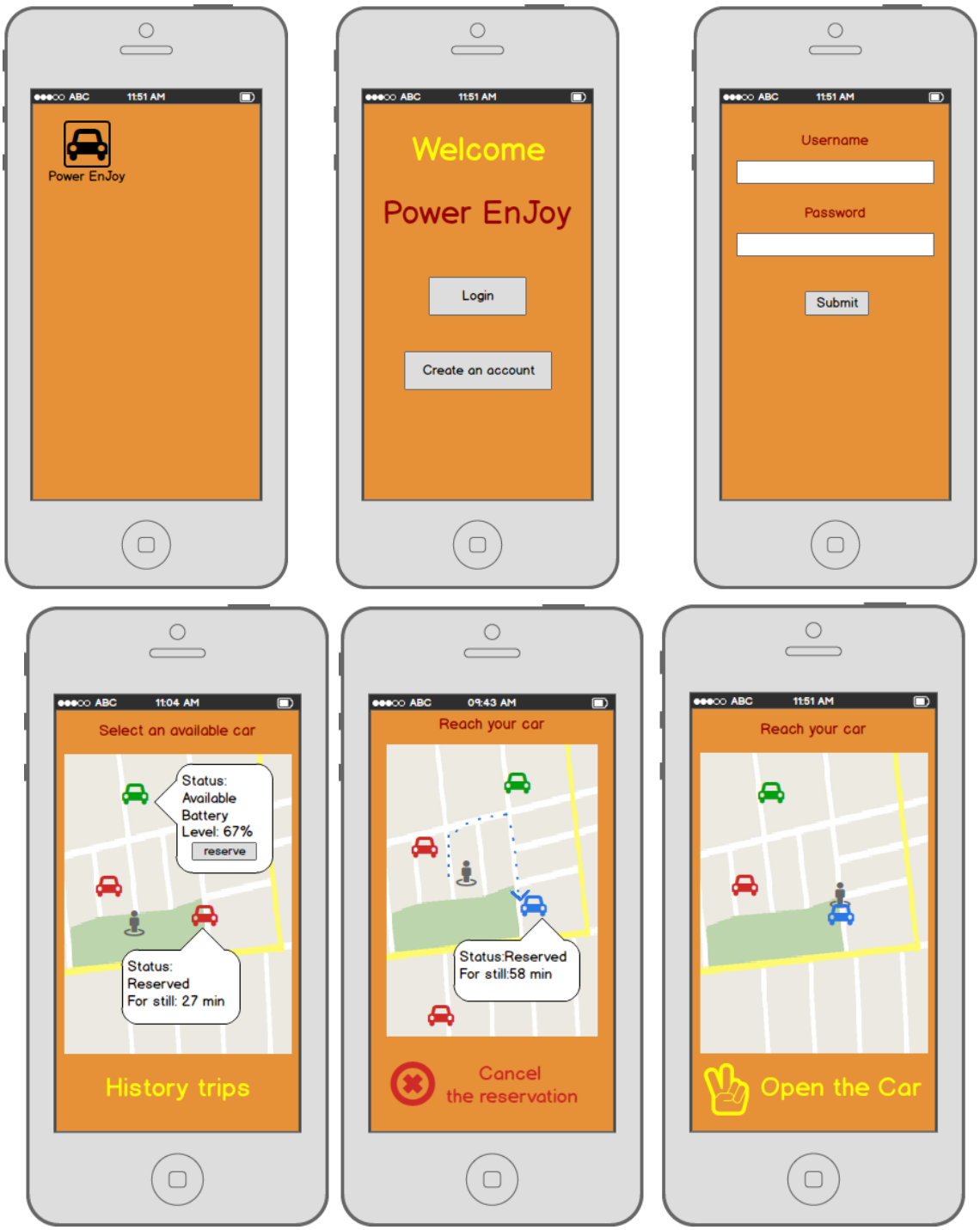
1,1
is located
0,1
own
related
perform
1,n
is reserved

10 Non Functional Requirements

10.1 App




ABC 09:17 AM
Insert this pin into the IPad
that you find in the car
58930
ABC 09:17 AM
Registration
First Name
Last Name
Email
Repeat Email
Password
Repeat Password
Sex
Female
Male
Birth day
/ /
Next
ABC 09:17 AM
Registration
City
Region
ZIP Code
Tax Code
Identify Card
N° Identity Card
Release Date
Expiration Date
/ /
/ /
Submit
ABC 09:17 AM
Your history trip
Duration: 20min 0sec
Price: 4€
Discount: 0%
Duration: 7min 0sec
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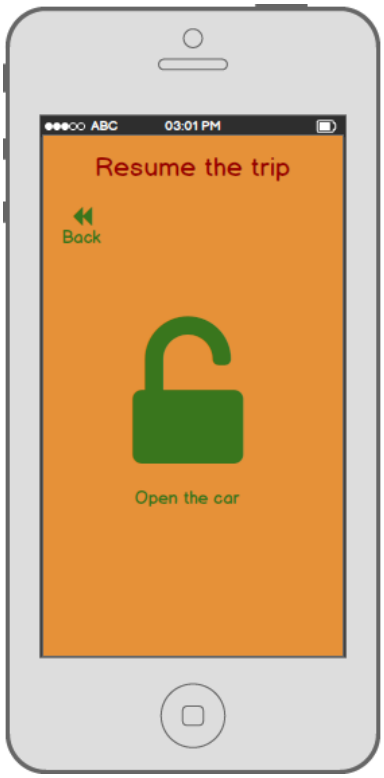
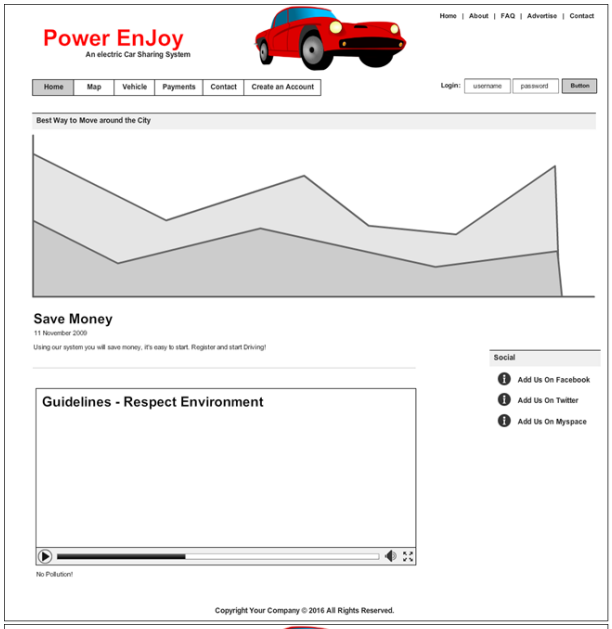
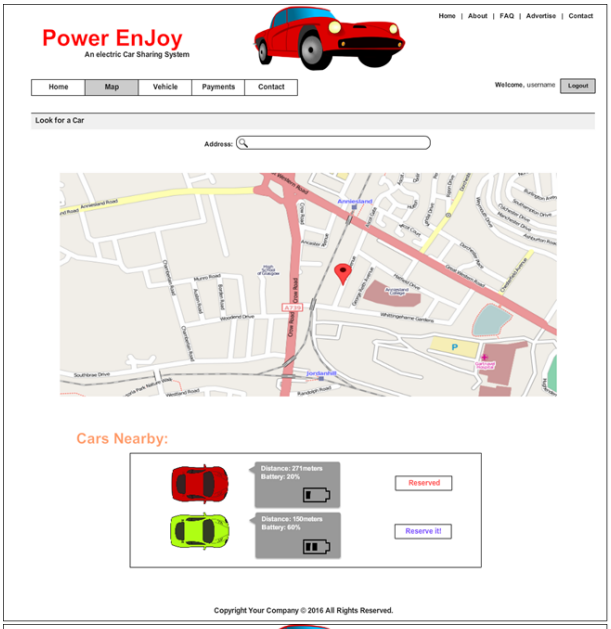
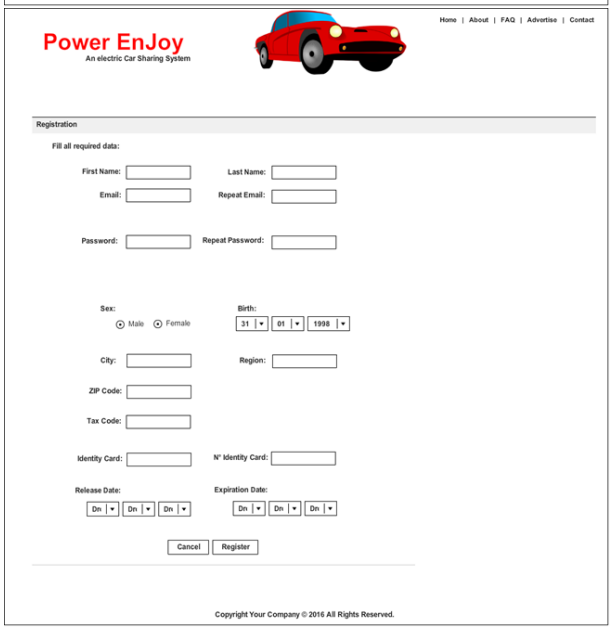
Price: 5,4€
Discount: 10%
Duration: 15min 0sec
Price: 2,1€
Discount: 30%


ABC
03:01 PM
Resume the trip
Back
Open the car

10.2 Web App


Power EnJoy
An electric Car Sharing System
Home | About | FAQ | Advertise | Contact
Home
Map
Vehicle
Payments
Contact
Create an Account
Login:
username
password
Button
Best Way to Move around the City
Save Money
11 November 2009
Using our system you will save money, it's easy to start. Register and start Driving!
Guidelines - Respect Environment
No Pollution!
Social
Add Us On Facebook
Add Us On Twitter
Add Us On Myspace
Copyright Your Company © 2016 All Rights Reserved.


Power EnJoy
An electric Car Sharing System
Home | About | FAQ | Advertise | Contact
Home
Map
Vehicle
Payments
Contact
Welcome, username
Logout
Look for a Car
Address:
Cars Nearby:
Distance: 271meters
Battery: 20%
Reserved
Distance: 150meters
Battery: 60%
Reserve it!
Copyright Your Company © 2016 All Rights Reserved.


Power EnJoy
An electric Car Sharing System
Home | About | FAQ | Advertise | Contact
Registration
Fill all required data:
First Name:
Last Name:
Email:
Repeat Email:
Password:
Repeat Password:
Sex:
Male
Female
Birth:
31
01
1998
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Tax Code:
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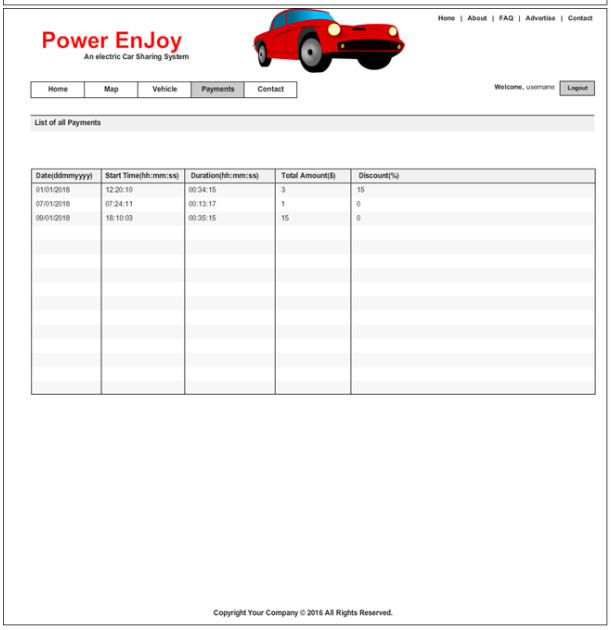
N° Identity Card:
Release Date:
Expiration Date:
Dm
Cancel
Register
Copyright Your Company © 2016 All Rights Reserved.


Power EnJoy
An electric Car Sharing System
Home | About | FAQ | Advertise | Contact
Home
Map
Vehicle
Payments
Contact
Welcome, username
Logout
List of all Payments
Date(ddmmyyyy)
Start Time(hh:mm:ss)
Duration(hh:mm:ss)
Total Amount($)
Discount(%)
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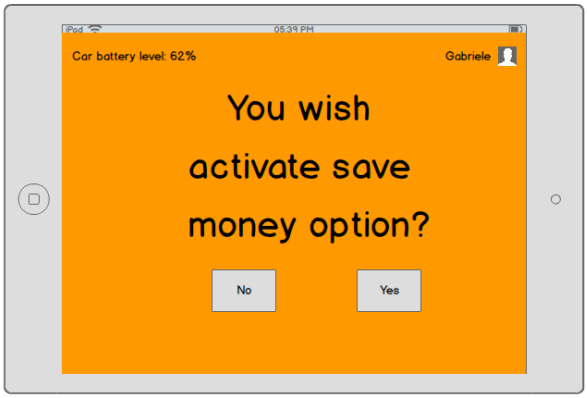
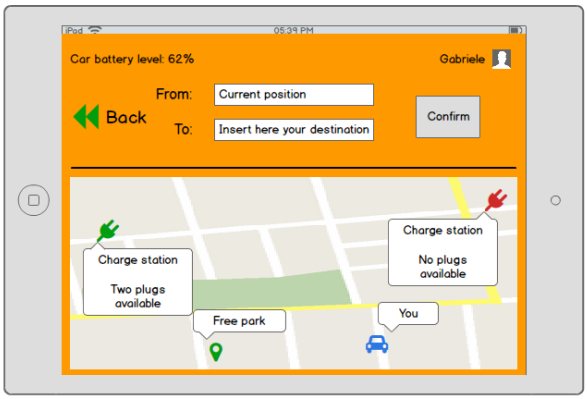
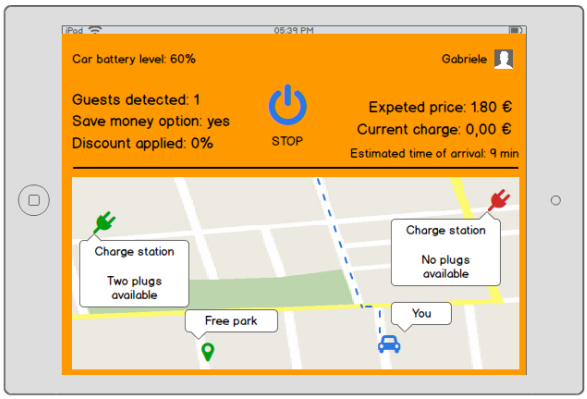
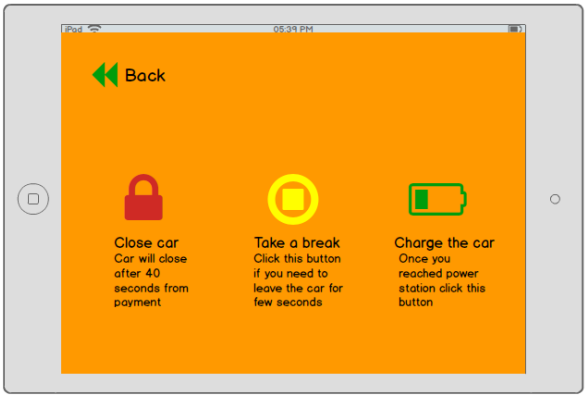
0
Copyright Your Company © 2016 All Rights Reserved.

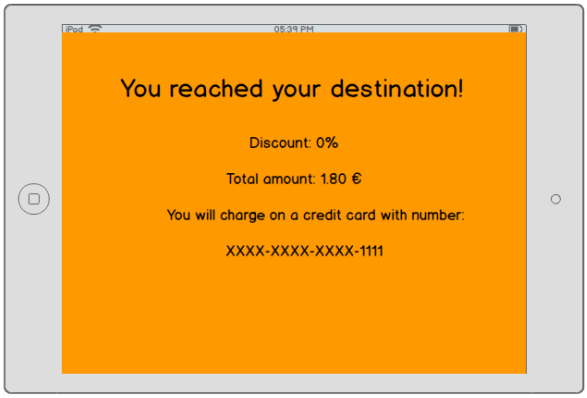

Hi, Gabriele
Insert your pin code here...
1
2
3
4
5
6
7
8
9
Delete
0
Confirm

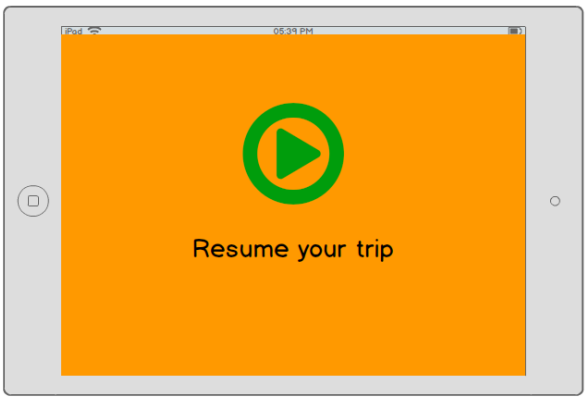

Car battery level: 62%
Gabriele
You wish
activate save
money option?
No
Yes

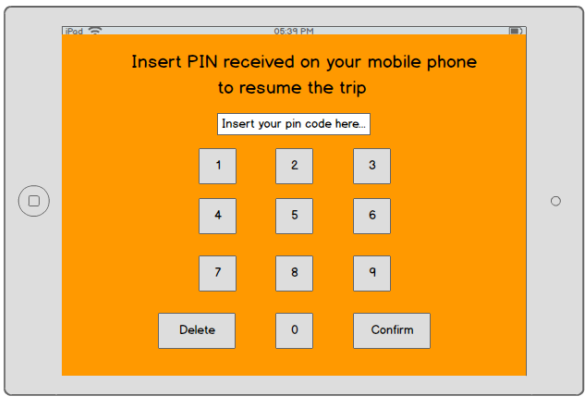

Car battery level: 62%
Gabriele
Back
From:
Current position
To:
Insert here your destination
Confirm
Charge station
Two plugs available
Charge station
No plugs available
Free park
You


Car battery level: 60%
Gabriele
Guests detected: 1
Save money option: yes
Discount applied: 0%
STOP
Expeted price: 1.80 €
Current charge: 0,00 €
Estimated time of arrival: 9 min
Charge station
Two plugs available
Charge station
No plugs available
Free park
You


Back
Close car
Car will close after 40 seconds from payment
Take a break
Click this button if you need to leave the car for few seconds
Charge the car
Once you reached power station click this button

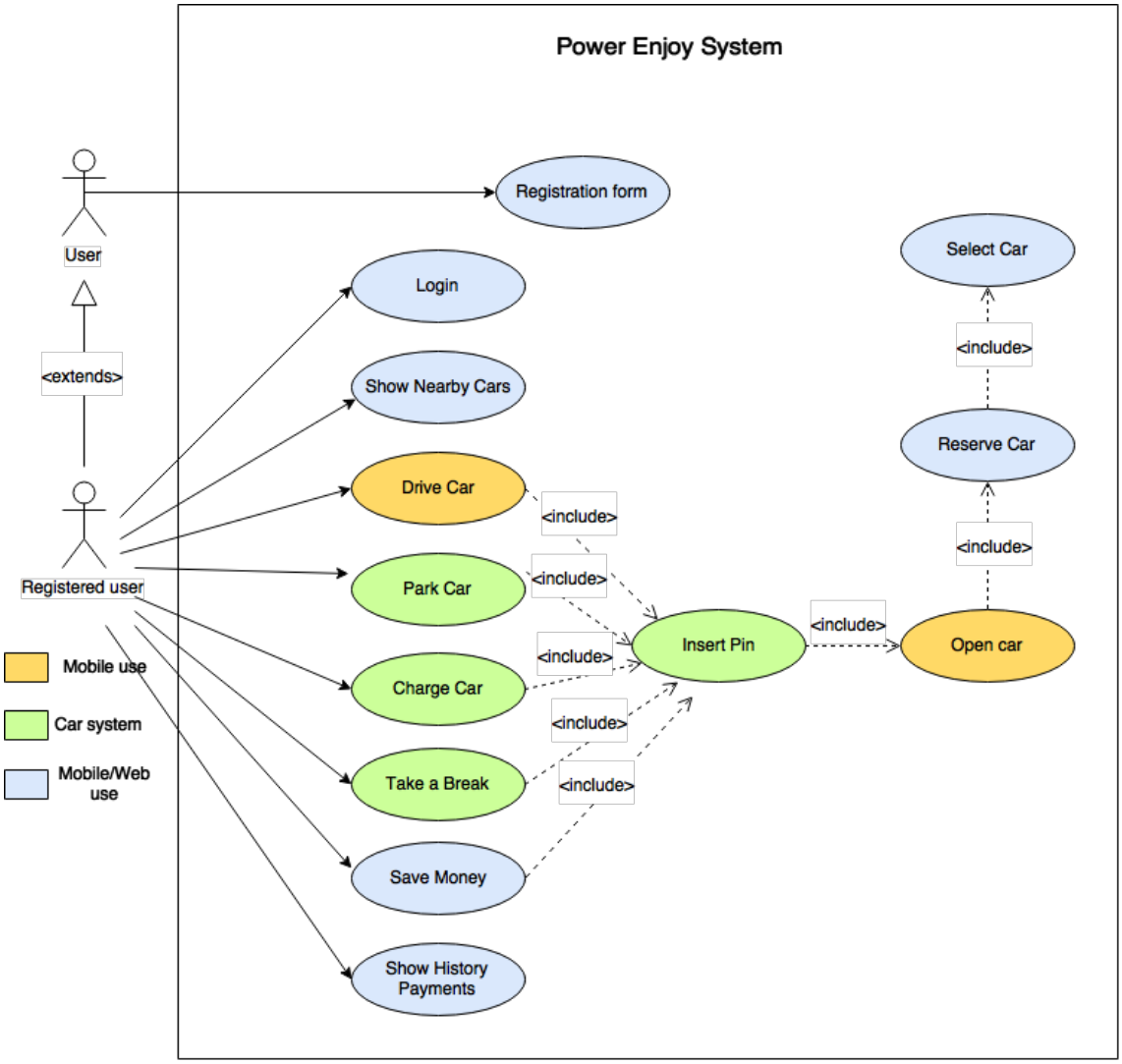

You reached your destination!
Discount: 0%
Total amount: 1.80 €
You will charge on a credit card with number:
XXXX-XXXX-XXXX-1111


Resume your trip


Insert PIN received on your mobile phone to resume the trip
Insert your pin code here...
1
2
3
4
5
6
7
8
9
Delete
0
Confirm

11 Use Cases

11.1 Use Cases Diagram



11.2 Use Cases Description

Name: Handle the system.
Actors: Administrator user.
Description: This special use case is dedicate to special user that is administrator user. This figure can access into the system only by Web App using a special credential that the system recognise such as administrator of the system.

Name: Registration form.
Actors: User.
Entry Conditions: User have to download Power EnJoy mobile app or enter into Power Enjoy website.
Flow Of Events:

- User clicks on "create an account" button.
- User have to insert all your personal data in according to the information required.
- User have to click on "submit" button at the end of the input form.

Exit Conditions: The system check if there is not an another user already registered that has the same data on the database system. After that the web app or mobile app will show you the position of cars on the map.
Exceptions: If the user enters the wrong data or already existing data, the system will be not able to accept the user request so the system will ask to the user to enter personal data again.

Name: Login.
Actors: Registered user.
Entry Conditions: The user must be registered .
Flow Of Events:

- The User opens the App/Web app.
- The User clicks on Login button.
- The System redirects the user to the form where he has to insert username and password.
- The System check the validation of username and password.
- The System redirects the User to the "select a car" page.

Exit Conditions: The user has submitted the correct username and password.
Exceptions: The username and password submitted by the user are not correct.

In this case, the system does not redirect the taxi driver to the "select a car" page but notifies him that an error has been made and allows to input his code and password again.

Name: Show Nearby Car.
Actors: Registered user.
Entry Conditions: the user must be Logged in.
Flow Of Events:

- The System shows to the User a map with all the vehicles and them position.
- The User sees the states of the vehicles (Available,Reserved).

Exit Conditions: There are no exit conditions.
Exceptions: If there are not car near the user, the mobile and web app will show empty map.

Name: Select car.
Actors: Registered user.
Entry Conditions: User must be logged in Power EnJoy system.
Flow Of Events:

- The user clicks on a car symbol shown on a map in mobile and web app.
- Lot of information about car status and position are shown.

Exit Conditions: There are no exit conditions.
Exceptions: The cars have got different states: available, reserved, charging or damage. If the state of one car is charging or damage state, it is not showed and so not even selected.

Name: Reserve car.
Actors: Registered user.
Entry Conditions: User have to select a car.
Flow Of Events:

- The user clicks on a car symbol shown on a map in mobile and web app.
- Lot of information about car status and position are shown.
- User has to click on "reserve" button on mobile app or web app.

Exit Conditions: The user Reserves a car.
Exceptions: There are not exception conditions.

Name: Open car.
Actors: Registered user.
Entry Conditions: Car must be reserved by user less than 1 hour before he performs the action .
Flow Of Events:

- After reservation process, "open car" button is shown on mobile app only.
- The user must be positioned near the car.
- The user has to click on "open car" button on mobile app only.
- The system recognises that the user is near the car.
- The system unlocks the reserved car doors.

Exit Conditions: When the user is near to reserved car and click the "open car" button, the system compares the user position with the car position, and if it is less than 2 meters, the system unlocks the doors.
Exceptions: If the reserved car is not open by corresponding user within one hour, reserved car state come back "available" for other reservation.

Name: Drive car.
Actors: Registered user.
Entry Conditions: The user must have opened the reserved car.
Flow Of Events:

- When the user opened the car, a pin code (composed by five integer) is automatically shown on mobile app only.
- The iPad inside the car automatically turn on and show an text field and a keyboard (composed by integer only) .
- The user has to touch the iPad display to insert the pin code shown on his mobile app.
- The system checks the match between pin code shown and pin code sent.
- The iPad system shows a widow that contain all information about trip.
- The user can drive the car.

Exit Conditions: The system checks if the pin inserted by user have a match with the pin code received on user mobile app. If the match exists, the system makes the car totally available to drive it.
Exceptions: If the pin code insert by the user is incorrect, the system allows to reinsert it again on iPad.

Name: Take a break.
Actors: Registered user.
Entry Conditions: The user must have opened the reserved car.
Flow Of Events:

- After insert pin code process, the iPad system shows a window that include all information about the trip and one button in which the user can choose the modality of the trip.
- The user has to touch "stop" button in iPad display and a new window is shown.
- The iPad system shows three different button:"close car", "take a break" and "charge the car" that corresponding in three different modalities.
- The user has to click to "take a break" button.
- The car system starts a countdown of 40 seconds, after that it locks the doors.
- The iPad system shows "insert pin" window again but the car status remains set to reserved to the same user.
- The user mobile app re-shows "open the car" button.
- The user comes back to the car and click "open the car" button.
- The user receives a new pin code by the system and he put it on a iPad display.
- The user clicks on "Resume the trip" button.
- The system makes the car totally available to drive it.
- The system charges the user continuously.

Exit Conditions: The user can leave the car for few minutes, without lose the reservation on it.
Exceptions: There are no exceptions.

Name: Charge.
Actors: Registered user.
Entry Conditions: The user must have insert the pin into iPad system.
Flow Of Events:

- After insert pin code process, the iPad system shows a window that include all information about the trip and one button in which the user can choose the modality of the trip.
- The user has to stop the car in a safe area.
- The user has to touch "stop" button in iPad display and a new window is shown.
- The iPad system shows three different buttons:"close car", "take a break" and "charge the car" that corresponding in three different modality.
- The user has to click to "charge the car" button.
- The car system starts 3 minutes countdown.
- The user has to connect the car in a power station.
- The system locks the doors and disables the car.
- The system charges the user, shows the payment informations, applies the discount of 30% in addition to other eventually discounts.
- The user clicks on "Resume the trip" button.
- The system makes the car totally available to drive it.
- The system charges the user continuously.

Exit Conditions: The user can leave the car for few minutes, without lose the reservation on it.
Exceptions: There are no exceptions.

Name: Park car.
Actors: Registered user.
Entry Conditions: The user had inserted the pin into iPad system.
Flow Of Events:

- After insert pin code process, the iPad system shows a window that includes all informations about the trip and one button in which the user can choose the modality of the trip.
- The user has to stop the car in a safe area park.
- The user has to touch "stop" button in the iPad display and a new window is shown.
- The iPad system shows three different buttons:"close car", "take a break" and "charge the car" that corresponding in three different modalities.
- The user has to click to "close car" button.
- The car system starts 40 seconds countdown.
- The user has to leave the car car within 40 seconds after that the system closes the doors and disables the car.
- The system applies the correct discount, shows the payment information and charge the user.

Exit Conditions: The user is out to the car and it is closed.
Exceptions: There are no exceptions.

Name: Save money option.
Actors: Registered user.
Entry Conditions: The user had inserted the pin into iPad system.
Flow Of Events:

- The system shows a window in which asks to the user if he wants to enable save money option.
- The user has to click yes on iPad display.
- The system shows a window in which the user has to insert his destination.
- The system searches and shows the nearest power station to the destination.
- The user has to follow the correct indications shown on the map.

Exit Conditions: The user take a discount due to the connection of the machine to the power station.
Exceptions: There are no exceptions.

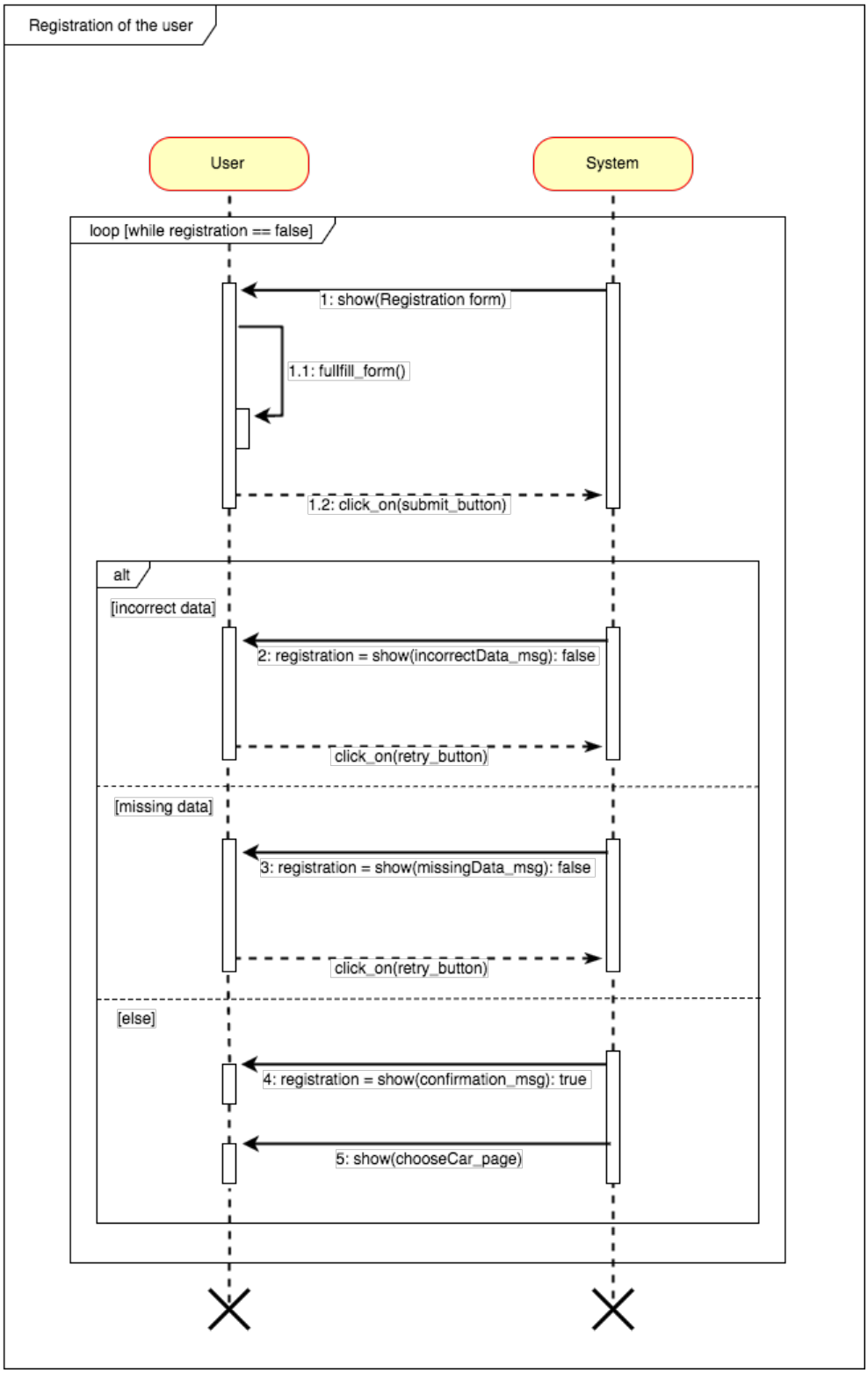
Name: Show History Payments.
Actors: Registered user.
Entry Conditions: The user has performed at least one ride.
Show History Payments.

- After the LogIn the user clicks on the "history payments" button.
- The System displays the details about the history trips of the user.

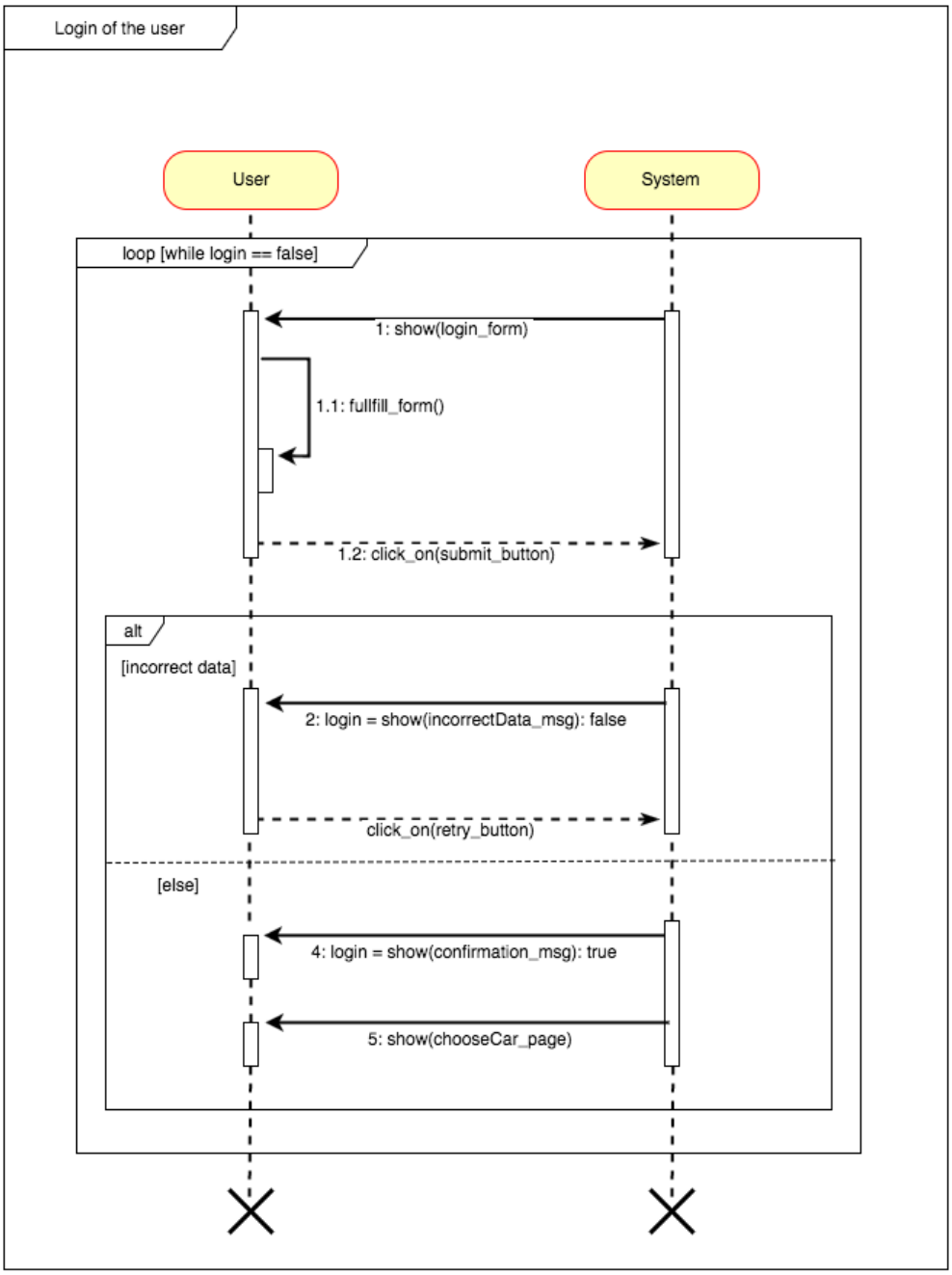
Exit Conditions: The user clicks on back button.
Exceptions: The user hasn't performed a ride yet, in this case the button can't be pushed.

12 Sequence Diagram

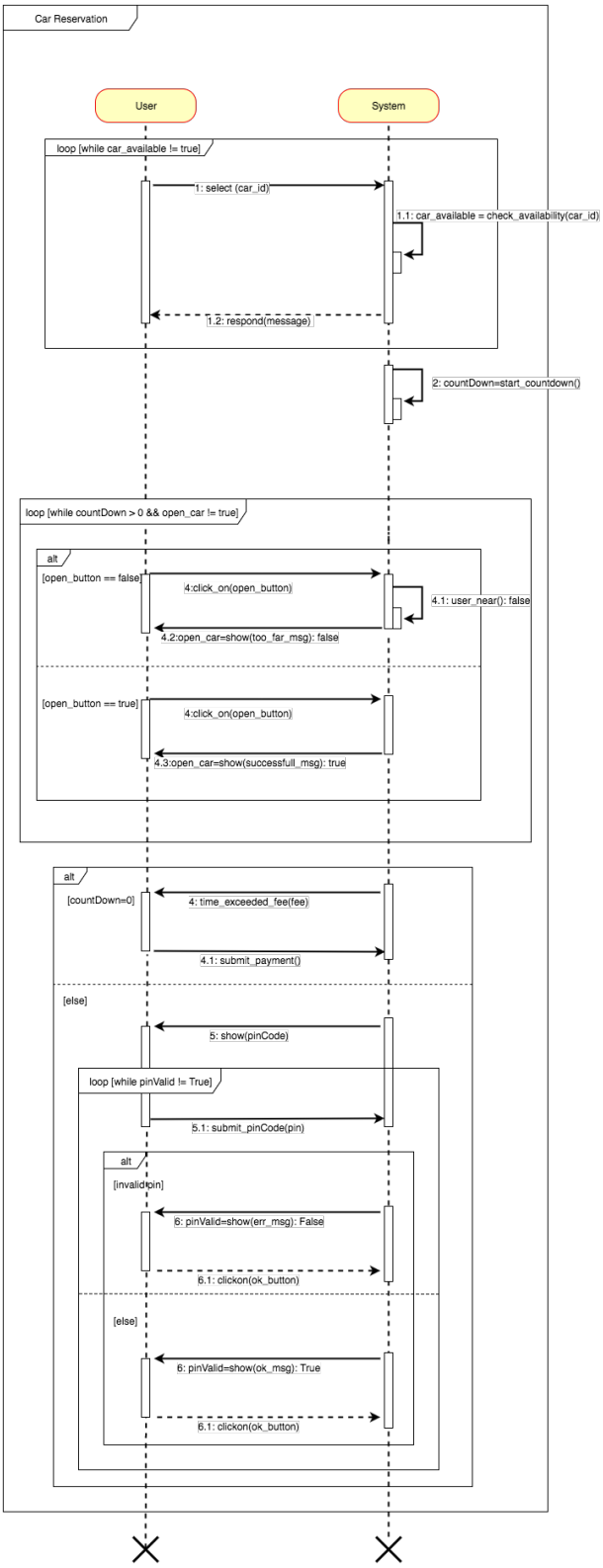
12.1 Registration of the User



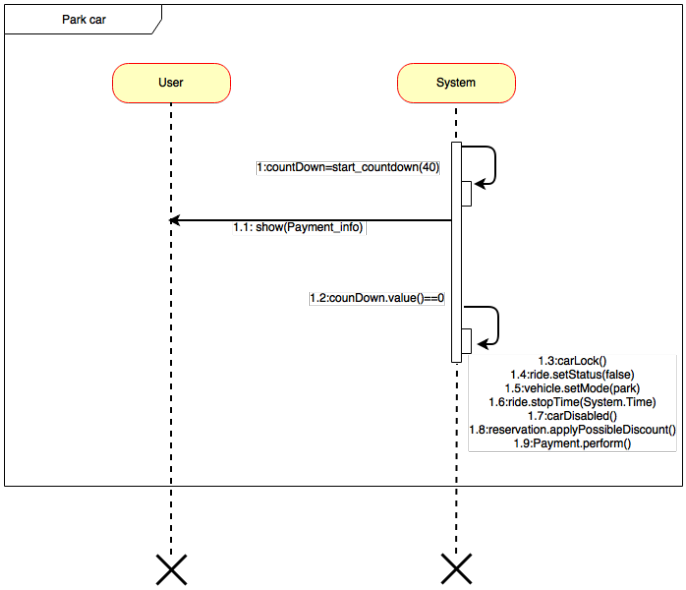
12.2 Login of the User



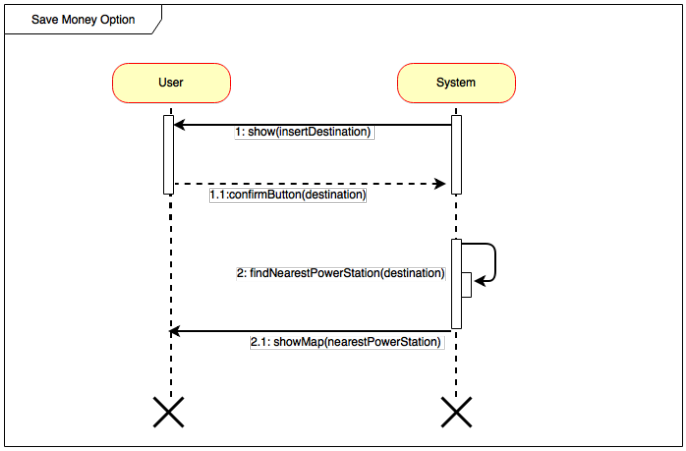
12.3 Car Reservation



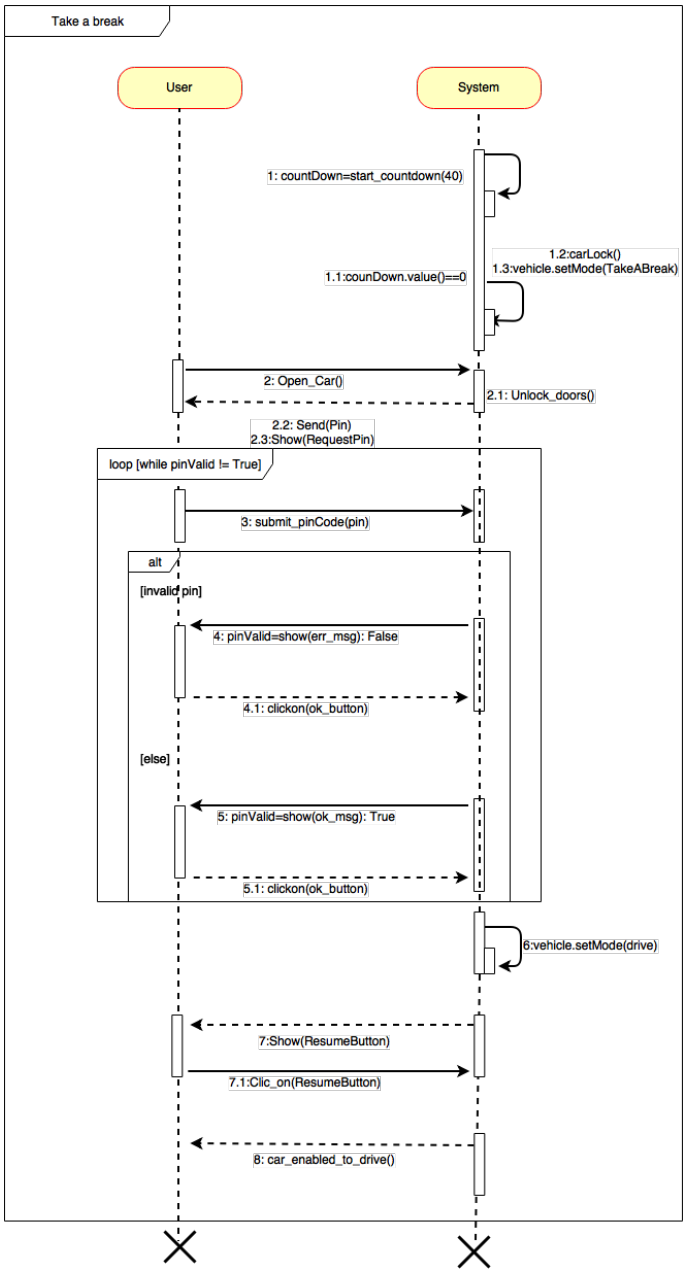
12.4 Park Car



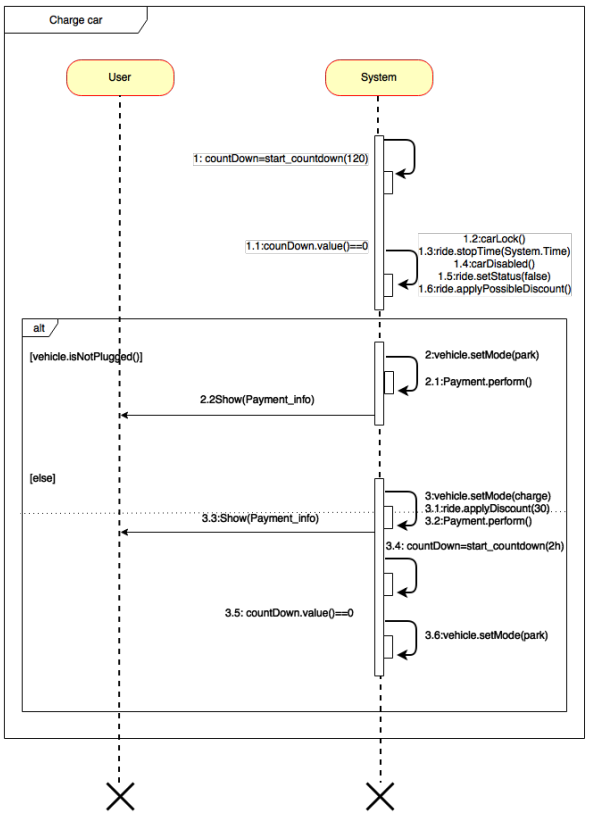
12.5 Save Money



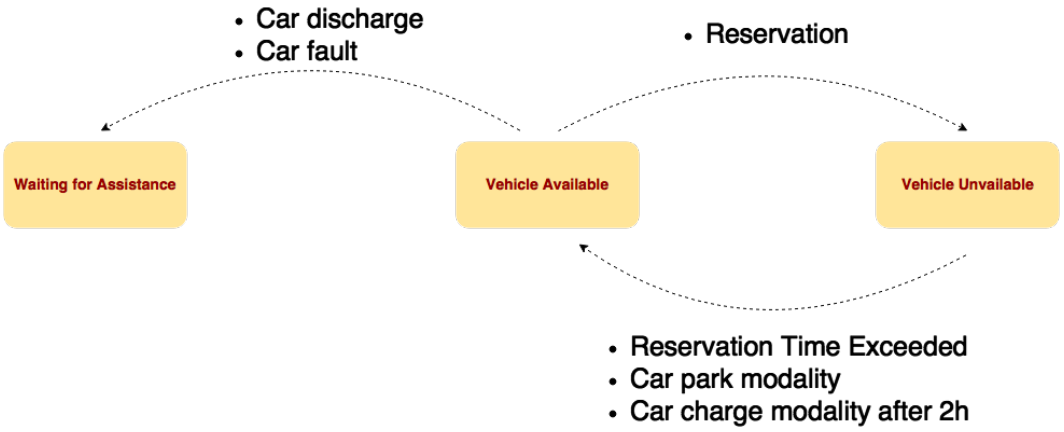
12.6 Take a Break



12.7 Car Charging



13 Car State


• Car discharge
• Car fault
• Reservation
Waiting for Assistance
Vehicle Available
Vehicle Unvailable
• Reservation Time Exceeded
• Car park modality
• Car charge modality after 2h

14 Alloy

```
open util/boolean

sig PowerStation{
}

sig Position{
longitude:Int,
latitude:Int
}

sig Payment{
id: one Int,
date:Int,
amount:Int,
discount:Int,
time:Int
}
{
amount>0
}



sig Ipad{
imei:one ImeiCode
}

sig ImeiCode{
}

sig Area{
park:some SafePark,
id:Int,
status:Bool
}

sig LicencePlate{
}

sig Vehicle{
licence:one LicencePlate,
position:one Position,
```

```
carstatus:one CarStatus,
system: one Ipad
}

sig PersonalData{
licence: Int,
name: one UserName,
surname: one UserSurname,
fiscalCode: one UserFiscalCode,
birth:Int,
idCard: Int,
country: one UserCountry,
region: one UserRegion,
address: one UserAddress,
city: one UserCity,
sex: Bool
}

sig UserName{}
sig UserSurname{}
sig UserFiscalCode{}
sig UserCountry{}
sig UserRegion{}
sig UserAddress{}
sig UserCity{}

sig User{
email:one UserEmail,
password:one UserPassword,
personalData:one PersonalData,
position:one Position
}

sig UserEmail{
}
sig UserPassword{
}

sig Ride{
id: one Int,
startTime:Int,
date:Int,
endTime:Int,
distance:Int,
```

```
guestsNumber: Int,
startPosition: one Position,
status: one Bool,
endPosition: lone Position
}

sig Reservation{
timeexceeded: one Bool,
user:one User,
pinCode: Int,
id: one IdReservation,
date:Int,
time: Int,
vehicle: one Vehicle,
payment: lone Payment,
ride: lone Ride
}

sig IdReservation{
}



sig SafePark{
id:one IdSafePark,
status:one Bool,
powerStation:lone PowerStation,
position:one Position
}

sig IdSafePark{
}

fact paymentAssigned{
all pay:Payment| pay in Reservation.payment
}

fact rideAssigned{
all rid:Ride| rid in Reservation.ride
}

fact safeParkInArea{
all sp:SafePark| sp in Area.park
}
```

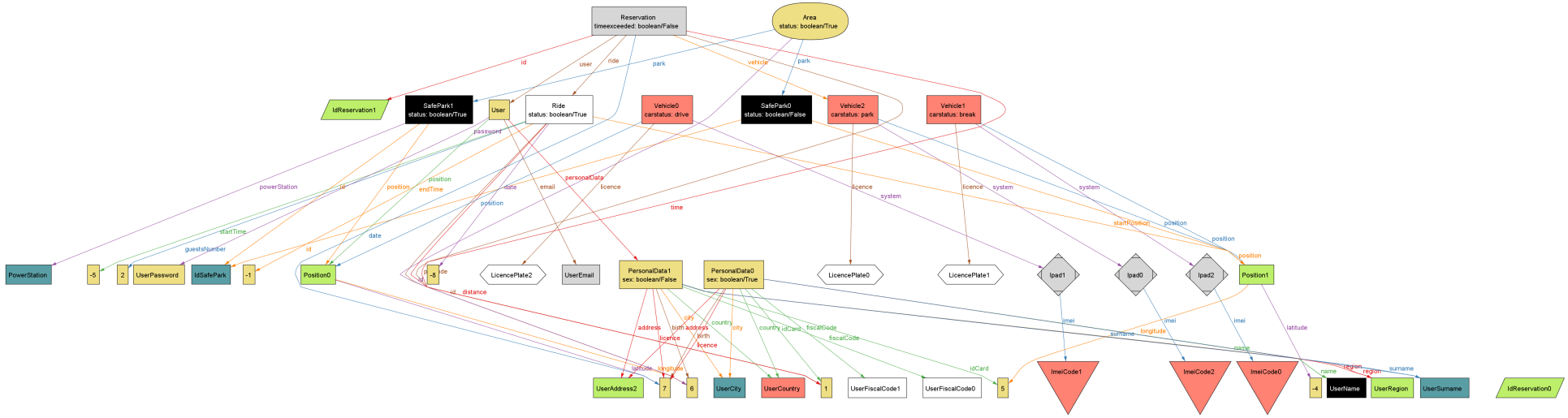
```
fact exclusivePark{
all v1: Vehicle |v1.carstatus=park
implies (v1.carstatus!=break
&&v1.carstatus!=charging&&
v1.carstatus!=drive
&&v1.carstatus!=fault)
}


fact exclusiveBreak{
all v1: Vehicle |v1.carstatus=break
implies (v1.carstatus!=park
&&v1.carstatus!=charging&&
v1.carstatus!=drive
&&v1.carstatus!=fault)
}


fact exclusiveCharging{
all v1: Vehicle |v1.carstatus=charging
implies (v1.carstatus!=park
&&v1.carstatus!=break&&
v1.carstatus!=drive
&&v1.carstatus!=fault)}

fact exclusiveFault{
all v1: Vehicle |v1.carstatus=fault
implies (v1.carstatus!=park
&&v1.carstatus!=break&&
v1.carstatus!=drive
&&v1.carstatus!=charging)}


fact exclusiveDrive{
all v1: Vehicle |v1.carstatus=drive
implies (v1.carstatus!=park
&&v1.carstatus!=break&&
v1.carstatus!=charging
&&v1.carstatus!=fault)}


fact numberOfGuests{
all r1:Ride |(r1.guestsNumber>=1 &&
```

```
 r1.guestsNumber<=4)
}

fact parkAreaAtLeastaPowerStation {
all a1:Area|#a1.park.powerStation>0
}

fact numberOfPassengers {
all r1:Ride | (r1.guestsNumber>=1 &&
 r1.guestsNumber<=4)
}

fact ExistPaymentAfterRide{
all r1:Reservation| ((r1.ride.status in False)
 iff (#r1.payment =1))
}

fact carUniqueIdentified{
no disjoint v1,v2:Vehicle | v1.licence=v2.licence
}

fact timeExcededRule{
all res:Reservation| (res.timeexceeded in True)
 implies (#res.ride=0)
}

fact noMoreCarAtOneTime{
no r1, r2:Reservation| (r1.user=r2.user) &&
 (r1!=r2 )&&
 (r1.ride.status in True) &&
 (r1.ride.status in True)
}

pred Ride.existPayment[]{
this.status in False
}

fact noCarDrivenByMoreUsers{
no v1:Vehicle,r1,r2:Reservation| r1!=r2 &&
 r1.vehicle=v1 && r2.vehicle=v1 &&
 r1.ride.status in True && r2.ride.status in True
}

assert noCarMoreUser{
```

```
no r1,r2:Reservation| r1!=r2 &&
r1.vehicle=r2.vehicle &&
 r1.ride.status in True &&
 r2.ride.status in True
}

fact noParkSamePos{
all p1, p2:SafePark|(p1!=p2) implies
 (p1.position!=p2.position)
}

fact exclusivePaymentReservation{
no pay1:Payment,r1,r2:Reservation| r1!=r2 &&
 r1.payment=pay1 && r2.payment=pay1
}

fact exclusiveRideReservation{
no ride1:Ride,r1,r2:Reservation| r1!=r2 &&
r1.ride=ride1 && r2.ride=ride1
}

fact timeExceededImpliesPayment{
all res1:Reservation| (res1.timeexceeded in True) iff
 (res1.ride=none && res1.payment!=none)
}

pred Reservation.carInUse{
this.ride.status.isTrue&&this.ride!=none
}

pred Reservation.isExpired{
this.timeexceeded in False && this.ride=none
}

assert noPayIfNotRideAndTimeexceededFalse{
all res1:Reservation|res1.isExpired implies
 res1.payment= none
}

assert rideStatusTrueImpliesNotPayment{
all res1:Reservation| res1.carInUse implies
 res1.payment = none
}
```

```
fact carParkedImpliesSafeParkOcuupied{
all v1:Vehicle, p1:SafePark|
(v1.carstatus!=drive &&
 v1.position=p1.position &&
 v1.carstatus!= none &&
  v1.position!= none &&
  p1.position!= none) implies
   (p1.status in False)
}

fact noMoreOneimeiForIpad{
no ipad1, ipad2:Ipad|
ipad1.imei=ipad2.imei &&ipad1!=ipad2
&&ipad1!=none&&ipad2!=none
}

fact noMoreOneIpadForCar{
no v1, v2:Vehicle|v1.system=v2.system &&v1!=v2&&
v1!=none&&v2!=none
}

fact ipadAssigned{
all ipad:Ipad| ipad in Vehicle.system
}

enum CarStatus{park, break, charging,drive,fault}

pred show(){
Reservation.payment=none
}
check rideStatusTrueImpliesNotPayment
check noPayIfNotRideAndTimeexceededFalse
check noCarMoreUser
run show for 3
```

15 Alloy Generated



16 RASD v.1.3 modification

- Add Administration figure

17 Used tools

The tools used to create this RASD document are:

- Google Drive: used to write simultaneously text parts.
- GitHub: to deliver the document.
- Balsamiq: for mobile app and car system mockup.
- Mockflow: for web app mockup.
- Draw.io (Google extension): for UML schema and User Case schema.
- Gliffy: to design diagrams.
- Alloy Analyzer 4.2: to prove the consistency of our model.
- TeXstudio: LaTeX editor.
- Skype: used to do video-conference .

18 Hours of work

We have often worked together at university or using skype during the week-end.

Gabriele Bressan

- 22/10/16 3h
- 23/10/16 1h 30m
- 28/10/16 2h
- 29/10/16 3h
- 30/10/16 3h
- 4/11/16 3h
- 5/11/16 3h
- 6/11/16 4h 30m
- 11/11/16 5h
- 12/11/16 5h

Simone de Santis

- 22/10/16 3h
- 23/10/16 2h
- 25/10/16 3h
- 26/10/16 3h
- 30/10/16 2h
- 31/10/16 3h
- 1/11/16 2h
- 2/11/16 2h
- 6/11/16 3h
- 11/11/16 5h
- 12/11/16 5h

Pietro Di Marco

- 25/10/16 2h
- 30/10/16 3h
- 31/10/16 4h
- 2/11/16 3h
- 5/11/16 2h
- 6/11/16 3h
- 7/11/16 3h
- 8/11/16 3h
- 11/11/16 4h
- 12/11/16 4h

References

[1] Security Aspect: ref: RFC6749

[2] REST Arch (University of California): UCI

[3] GM Developer Site(only for registered developer): GM