Power EnJoy
Design Document

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Software Engineering 2 Course Project

Contents

1 Introduction

1.1 Purpose

This is the Design Document for the Power Enjoy Service. It's aim is to provide a functional description of the main architectural components, their interfaces and their interactions, together with the algorithms to implement and the User Interface Design. Using UML standards, this document will show the structure of the system and the relationships between the modules. This document is written for project managers, developers, testers and Quality Assurance. It can be used for a structural overview to help maintenance and further development.

1.2 Scope

PowerEnjoy is a digital management system for a car-sharing service that exclusively employs electric cars. It allows registered clients (Power Users) to use a vehicle paying only on the basis of the actual use during each individual rental. For a more detail description of the domain and the requirements please refer to the Requirement and Specification Document.

The software system is divided into four layers, which will be presented in the document. The architecture has to be easily extensible and maintainable in order to provide new functionalities. Every component must be conveniently thin and must encapsulate a single functionality (high cohesion). The dependency between components has to be unidirectional and coupling must be avoided in order to increase the reusability of the modules.

Futhermore, to increase cohesion and decoupling as much individual components must not include too many unrelated functionalities and reduce interdependencies.

1.3 Definitions, Acronyms, Abbreviation

RASD: Requirements Analysis and Specification Document.

DD: Design Document.

DBMS: Relational Data Base Management System.

DB: Database layer,

UI: User Interface.

Backend: Term used to identify the Application server.

Frontend: The components which use the application server services (web frontend and the mobile applications).

SOA: Service Oriented Architecture.

JDBC: Java DataBase Connectivity.

JPA: Java Persistence API.

EJB: Enterprise JavaBean.

ACID: Atomicity, Consistency, Integrity and Durability.

1.4 Reference Documents

This document refers to the following documents:

- Project rules of the Software Engineering 2 project
- Requirement Analysis and Specification Document (from the previous delivery)

1.5 Document Structure

This document is structured in five parts:

Chapter 1: Introduction. This section provides general information about the DD document and the system to be developed.

Chapter 2: Architectural Design. This section shows the main components of the systems with their subcomponents and their relationships, along with their static and dynamic design. This section will also focus on design choices, styles, patterns and paradigms.

Chapter 3: Algorithm Design. This section will present and discuss the main algorithms for the core functions of the system, independently from their concrete implementation.

Chapter 4: User Interface Design. This section shows how the user interface will look like and behave, by means of concept graphics and UX modeling.

Chapter 5: Requirements Traceability This section shows how the requirements in the RASD are satisfied by the design choices, and which compontents will implement them.

2 Architectural Design

2.1 Overview

This chapter provides a comprehensive view over the system components, both at a physical and at a logical level. This description will follow a top-down approach, starting with the description of the high-level components and their relations and interactions. We will then reason and describe the single components and the functionalities they must implement. We will especially focus on the components that implement the core logic of our application and using sequence diagrams we will describe the runtime behaviour of the system.

We will also include deployment diagrams to show the physical implementation of the system.

2.2 High Level Components

Before describing the actual system architecture we introduce the high level components of our application. Following the requirements and the specification listed on the RASD, we identify what components are needed in order to implement them and only after we have detected them, we will focus on the architecture and explain our architectural decision and the technlogies chosen. It's important to follow this process to generalize our design as much as possibile and abstract from implementation details, in this way we are able to describe only the essence of our system.

The starting point to detect the main components is the Class Diagram described in the RASD.

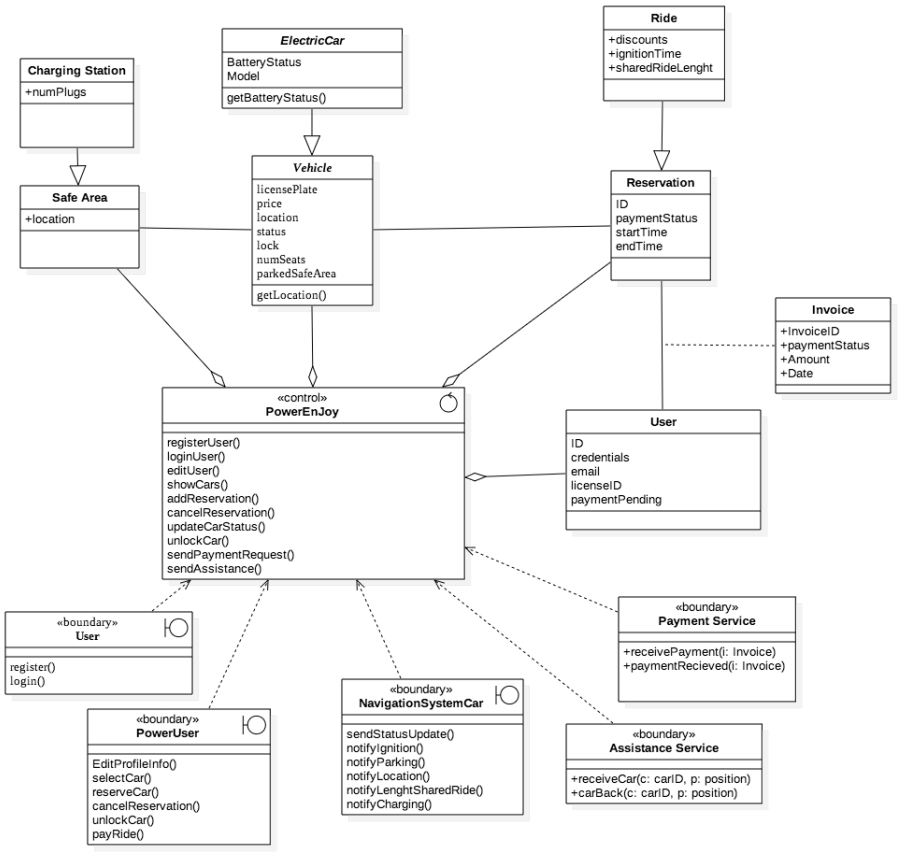


Figure 1: Class Diagram

The structure of the Diagram Suggests at least a three tiers architecture client-server based. The lower part of the Class Diagram shows the actors who are client of the PowerEnjoy section in the middle, the server in this case. Clients will be diveded in proper Clients that are User and Power User, and NavigatorSystemCar, Assistaance Service and Payment Service as External Services. The central section, PowerEnjoy, is the core of the Power Enjoy services and, as just sad, is the server for Client layer and External Services Layer and Client of the last layer, the persistence layer. PowerEnjoy's layer will be the Application server. Charging Station, Safe Areas, Vehicle, Electric Car, Reservation, Ride, Invoice and User (the one on the right) are all in the persistence layer and obviously stored in a database. This layer is the server of the application server, who is the client this time.

The main high level components of the system are the following:

Mobile Application: Power Enjoy is a car sharing service therefore it must be implemented with mobility in mind. Since the majority of the mobile

devices have a GPS module and we need to have access to the user position for our application, it makes sense to require that the main user has our mobile application installed.

Application Server: This component contains all the logic for the system application. It will implement all the required functionalities and communicate both with the mobile application and the external services.

Web Server: This component does not contain any application logic, it's used to provide a web interface interface to the user. It helps to separate presentation from logic.

Web Browser: Using a web browser the user is able to communicate with the Web Server to obtain the required web pages.

Database: This components is responsible for data storage and retrieval which is crucial for our application. It will not implement any logic but it stores all the information needed for the correct functioning of our service. It must guarantee ACID properties and be accessible from the Application Server.

To give a complete overview of the system, we list also the external services which are not part of our system but with which the system depends to implement some functionalities (please refer to the RASD for a more detailed description).

High level components which are not part of our system:

Assistance Service: Power Enjoy is in charge of the management of the car-sharing system. All the secondary functionalities (recharging vehicles on-site, bringing cars back from unsafe areas and fixing malfunctions) are handled by an assistance service. This components provides an API to handle all the assistance request.

Payment Service: Every Power Enjoy user, in order to use our service, is required to have an account registered to a third party payment service, with a valid payment method. This components provides an API to handle all the payments functionalities.

Car On Board System: Every Power Enjoy vehicle comes with a pre-installed on board system which registers and notifies all the car activity. This components provides an API to monitor and remotly control every vehicle.

In the figure below we rapresent all the components listed above in a layered fashion, highlighting the relations among the different parts:

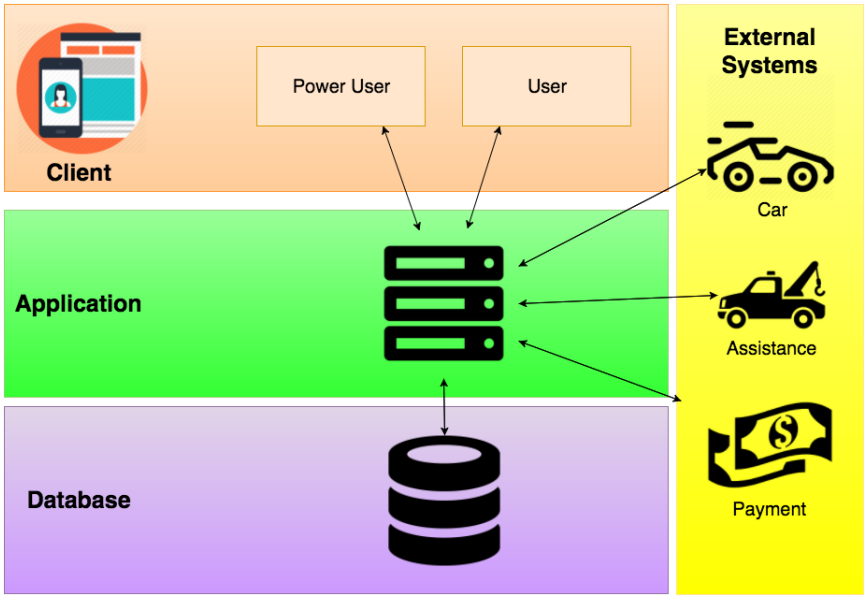


Figure 1: High Level Components

From this diagrams it's important to point out:

- This layered rapresentation suggests a four tier architecture
- Separating Application Server and the Web Server improves scalability. We expect Power Enjoy usage to grow in differents cities and in this way we're able to seperate the tasks and optimize each layer individually to support increasing loads.
- The Application Server is the bottleneck of our system. Every other components is in relation with it, therefore it's performance is stricly related to the performance of our system. But since every components expects different functionalities from the Application Server we can parallelize using threads and split the work load among different modules.

2.3 Component View

In this subsection we will look inside every single component and describe all the internal subcomponents. It's important to identify the relevant modules without increasing granularity to much. This will allow to have an efficient load balance in the present and it will be easy to integrate new functionalities in the future.

In a divide-and-conquer fashion for every component we will specify the implementation chosen and at the end we will how to connect the single components.

2.3.1 Application Server

This components implements the logic of the Power Enjoy Application, it's the core of our business and in this part of the document we'll explore the subcomponents inside. To provide a natural continuation from the RASD, we will start from the Class Diagram, and we will focus on the control object. We will look at the singles control functions, logically group them in cohesive groups and map them in modules of our system.

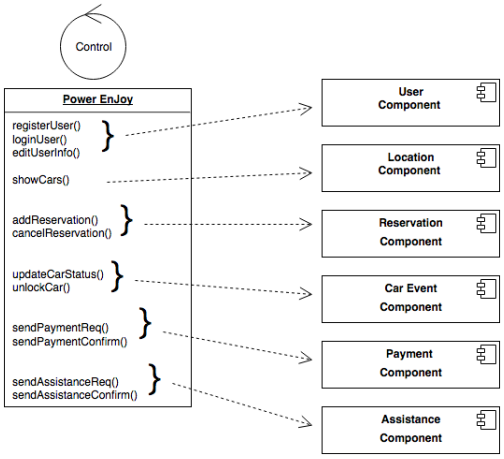


Figure 2: Mapping of control function to subcomponents of our system

A brief desription of the functionalities expected from each module:

User Component This module provides the logic for a User and a Power User regarding all the user management features, namely: user login, user registration, user deletion, user profile editing. It will perform all the validation of the credentials received before inserting them into the system.

Location Component This module handles the position of each car and user of the system. It's used to show cars on the map and to perform proximity checks to unlock vehicles. It also stores location of Safe Areas and Charging Stations.

Reservation Component This module is responsible to manage all the current reservation and to accept new reservations from Power Users. and for avoiding undesiderable behaviours (reservation of an unavailable car, double-booking and multiple reservations). It's strongly connected to the Car Event Component. This module keeps track of all the ride informations.

Car Event Component This modules interfaces with the API of the car on board system. It's a "low level" component that collects all the car data for other components to use and can be used to remotly control the vehicle.

It will signal to the interested component all the events of the car (car locking/unlocking, motor ignition, malfunctioning).

Payment Component This modules interfaces with the API of the Payment Service to request payments and receive confirmations. It will not perform the fee calculation but it will receive the final price and check for price variations via other components It will also flag/unflag users as banned in case of Pending Payment.

Assistance Component This modules interfaces with the API of the Assistance Service to request assistance (recharge on site, fix malfunctions, bring car back from unsafe to safe areas) and receive confirmations once the assistance is provided. Once a car is fixed it will update the car informations (e.g. new position, new battery level).

Time Component This is an utility component, it will be responsible for timing features such as expiration of the reservation and unsafe park timing. This helps to avoid the necessity of introducing stateful components.

Implementation Choice

This component will be implemented using:

- Jave Enterprise Edition 7 (JEE7) - the platform incorporates a design based largely on modular components running on an application server which is a natural consequence from the description above. It also provides support for large-scale, multi-tiered, scalable, reliable, and secure network applications. This modularity helps to handle such complex system and it make easy to insert the functionalities in the future.
- Enterprise JavaBeans (EJB) to encapsulate all the business logic of the modules described above.
- GlassFish as the Application Server - the server provides services such as security, transaction support, load balancing and supports the JEE7 platform.

The next figure will show the Application Component implemented as session beans logically grouped in EJBContainers.

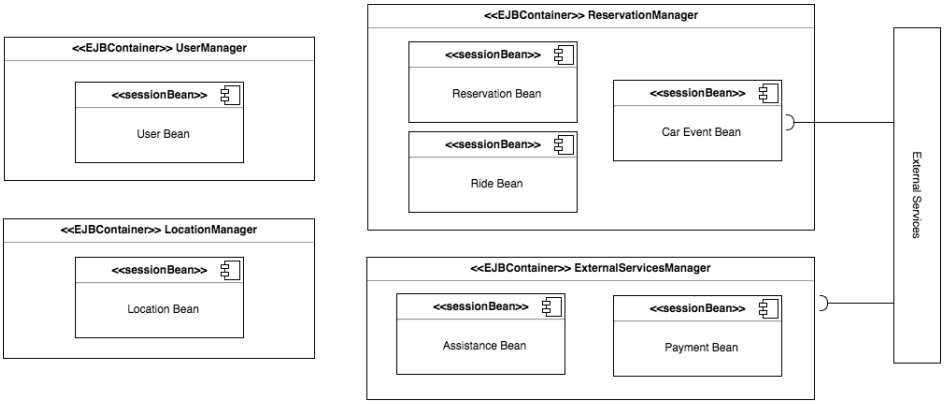


Figure 3: Application as Java Entity Beans

For the sake of clarity some information have been hidden from the diagram aboce but can be found in the next sections.

In Section 2.5 we will provide more details on the interfaces of each module.

In Section 2.6 using UML Sequence Diagrams we highlight the relationship between each component during a runtime analysis of our system.

2.3.2 Database

To design the Database Component is auspicable to start from the Class Diagram proposed in the RASD. The upper section of the diagram, Power Enjoy excluded, describe the information the system need to process to guarantee a correct and efficient service. Is clear that this set of informations must be persistent. The fact that a great number of data is usefull for a lot of functions in the system is a good proof that a database is needed, it also could make the work and the functioning very cleen and easy to handle for programmers, designer, devices and also users.

(img class diag)

The DBMS must guarantee the correct functioning of concurrent transactions and the ACID properties; a relational DBMS is sufficient to handle the data storage required by the application. The database structure will be here described by a ER Diagram. Class Diagram suggests eight main entities: User, Invoice, Vehicle, ElectricCar, Safe Area, Charging Station, Reservation, Ride. The division between Vehicle and ElectricCar was born to give the possibility to think, in the future, on differentiating the service adding different tipes of Vehicles to the fleet. We would try to make this possibility alive in the database as well. In the Application server emerges that a division of reservation and ride is useless. One component can handle the entire job, so the same reasoning will be translated into the DBMS. Another aspect is possible to detect by the Class Diagram is the importance of positioning: we have position of Users, Vehicles and Safe Areas. Could be usefull, to avoid redundancies or at least to reduce the Database size, have an entity entirely devolved to positioning, related with

User, Vehicle, Ride and Safe Area.According to this reasoning, we add the entity Position.

(img ER diag)

ER Diagram is perfectly readable and understandable but some parts need a more accurate description User and Vehicle have a (0,1) relation with Position. This data is collected and refreshed constantly by GPS system, the 0 means a malfunctioning deny a correct data, so it will set to NULL. An alternative could be a relation (1,1) who takes in the database the last notified position. ElectricCar, intuitively, is a specification of Vehicle. It has the attributes "BatteryLevel" and "IsCharging" that are characteristics proper of electric cars.

DBMS will be realized to exploit a microservices architecture. The database will be divided into sections, each of them will interacts with a spicific bin defined in the application server. In particular User Component will interact with the database who contain informations about the user, based on the User entity in the ER diagram. Location Component will manage the database produced by the Position entity togeter with Safe Area and Plug Station entities, Payment Component rely to the Invoice entity and the respective database, Car Event Component is linked to the Vehicle database, made by the Vehicle entity and its specifications. Reservation Component has a respective DBMS described by the Reservation entity. Assistnce component rely to an external DBMS managed by the assistance service. Obviously all DBMS will be connected as in the ER schema. A microservices structure will enhance performaces of DBMS, focusing the interaction just between the involved components and not questioning every time the entire database.

(img microservices)

The DMBS will be written in MySQL. MySQL, as the most common language for query ad relations, can perfectly handle the simple structure of the database. The connection between BDMS and the upper layer (application server) will be managed with Java Persistence API, choice made to maintain the same language used for the application server (Java)

(parte vecchia)

- JDBC/JPA JDBC (Java Database Connectivity) was chosen as connector between Database and the application server. Java database connectivity interface (JDBC), incfact, is a software component that allows Java applications to interact with databases. To enhance the connection, JDBC requires drivers for each database. These drivers connect to the database and implement the protocol to transfer query and respective results between the client and database. JDBC was chosen because it is available for any DBMS also thanks to the ODBC bridge. ODBC infact allows programmers to make SQL requests that will access data from DB distinct without having to know the proprietary interfaces of each DB. In this way it is easier to change the database without altering the application layer. The Java Persistence API (JPA) is a Java application programming interface specification that describes the management of relational data in

applications using Java Platform, Standard Edition and Java Platform, Enterprise Edition.

- The access to the DBMS is not implemented with direct SQL queries: instead, it is completely wrapped by the Java Persistence API (JPA). The object-relation mapping is done by entity beans. The Entity Beans representing the database entities (Figure 2.5) are strictly related to the entities of the ER diagram (Figure 2.4).

2.3.3 External Services

Are considered External Services all systems that interact with the applicaton server, not developed in this project. The car board computer, the Assistance Service and the Payment System. Car Board computer must work as a connection between the car and the application server and between the car and users. The functionalities Of the board computer must be at least: 1) Showing message directed to the user from the application server (ongoing fee). 2) Must calculate the shared ride time. 3) Sending information via messages about the car (battery level, status, position, passengers, shared ride,...) to the application server. Assistance Service is the Server/Application/Program used by an assistance office to interact with the application server. The interaction between Application Server and Assistance Service will be bidirectional: the application server must send the information about a malfunctioning car togheter with the problem and the Assistance system must notify the application server the mafunctioning car is redy for power enjoy service again. Payment System is the system the server access to lets happen a payment. Paypal could be an example. Systems of this kind alredy exists so the application server will rely to them, the interaction is standard: Application Server send the fee and the Payment System, after executing the transaction, respond with the outcome, positive or negative.

About the languages of implementation, nothing can be suggested for the Payment Systems because they aredy exists, about board computer and Assistance Service the choice of the language is free, the only suggestion is to consider the language of the application server to guarantee an efficent communication. Conveniently, the communication wwith Application server will be implemente via RESTful APIs defined by the partners (external services).

Car On Board System

aaaaaaa

Payment System

aaaaaaa

Assistance System

bbbbbbb

2.3.4 Client

The main and surely most important section of the client layer is the Mobile Application. The Power Enjoy service require an high mobility fo the user, so focusing the interaction with the users in an application for a mobile device optimize the functionality of the service. Obviously a GPS manager is required to detect constantly all users location variations.

(img clientdiag)

Mobile application can handle all the functionalities required by the application server alone. But to have a more efficient service, is smart to focus the attention on the reservation function. The main service is to reserve and ride cars offered by power enjoy, so the other side functions are surely relevant but obviously obscured by the reservation option. Having this assumption, rises the problem of managing personal datas and collecting information about Power Enjoy service on a not-optimized app. Adding a Web Page seems to be an optimal strategy to solve the problem. A Web Page is unconfortable to reserve a car, because an app can be faster than internet, so the reservation option can be erased from the page. Without the Reservation, the web page become an optimized platform to manage all side functionalities, in particular the profile informations management. A Web Page require a modification of the architecture: Web Server: This component does not contain any application logic, it's used to provide a web interface to the user. It helps to separate presentation from logic. Web Browser: Using a web browser the user is able to communicate with the Web server to obtain the required web pages. A tier is added to the original architecture, so now the system is described by a four tier client-server architecture, with a Web Server Layer who is a bridge between Web Page and Application Server. Separating Application Server and Web Server improves scalability. We expect Power Enjoy usage to grow in differents entities and in this way we are able to separate tass and optimize each layer individually to suport increasing loads. JAX-RS to implement proper RESTful APIs are the suggested languages to realize the communication of the application server with the client layer and the Web server.

(parte vecchia)

- Spiegazione del perche' mobile-first.
- Spiegazione del perche' aggiungere un webserver
- Diagramma della mobile app (con gps ecc...)
- JAX-RS to implement proper RESTful APIs to interface with clients and the Web Server;

- • To interface with external systems, existing RESTful APIs defined by the partner (payment handlers, maintenance system) will be used.

2.4 Deployment View

In this subsection we'll move on the physical side of our application, describing his deployment with the support of UML diagrams.

2.5 Component Interfaces

Application Server to Database

JPI - DOA volendo

Application Server to Front-Ends

REST-API

Application Server

QUESTA DA FARE ASSOLUTAMENTE, LE ALTRE FORSE NON SERVONO

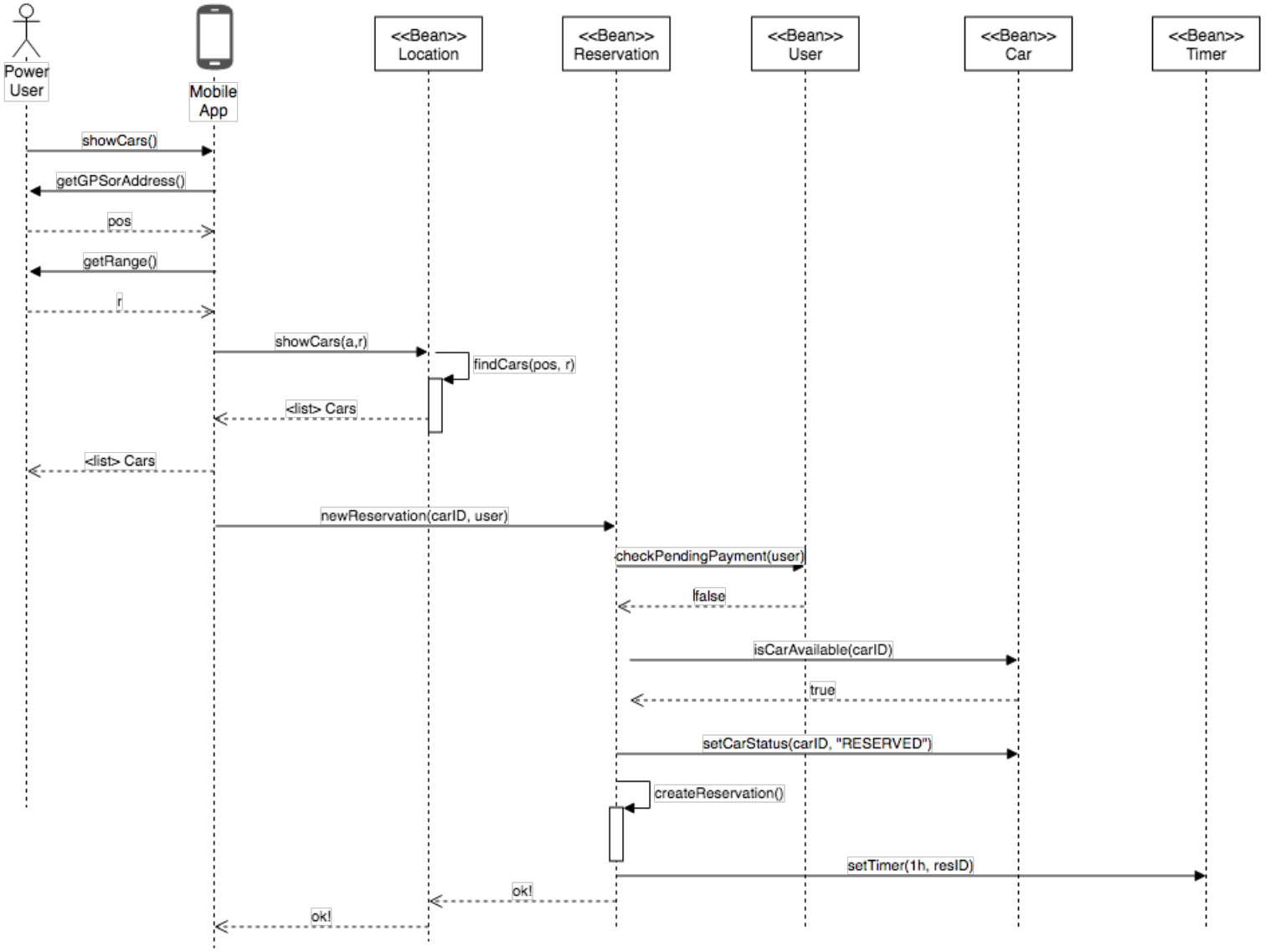
Application Server to External-System

REST-API

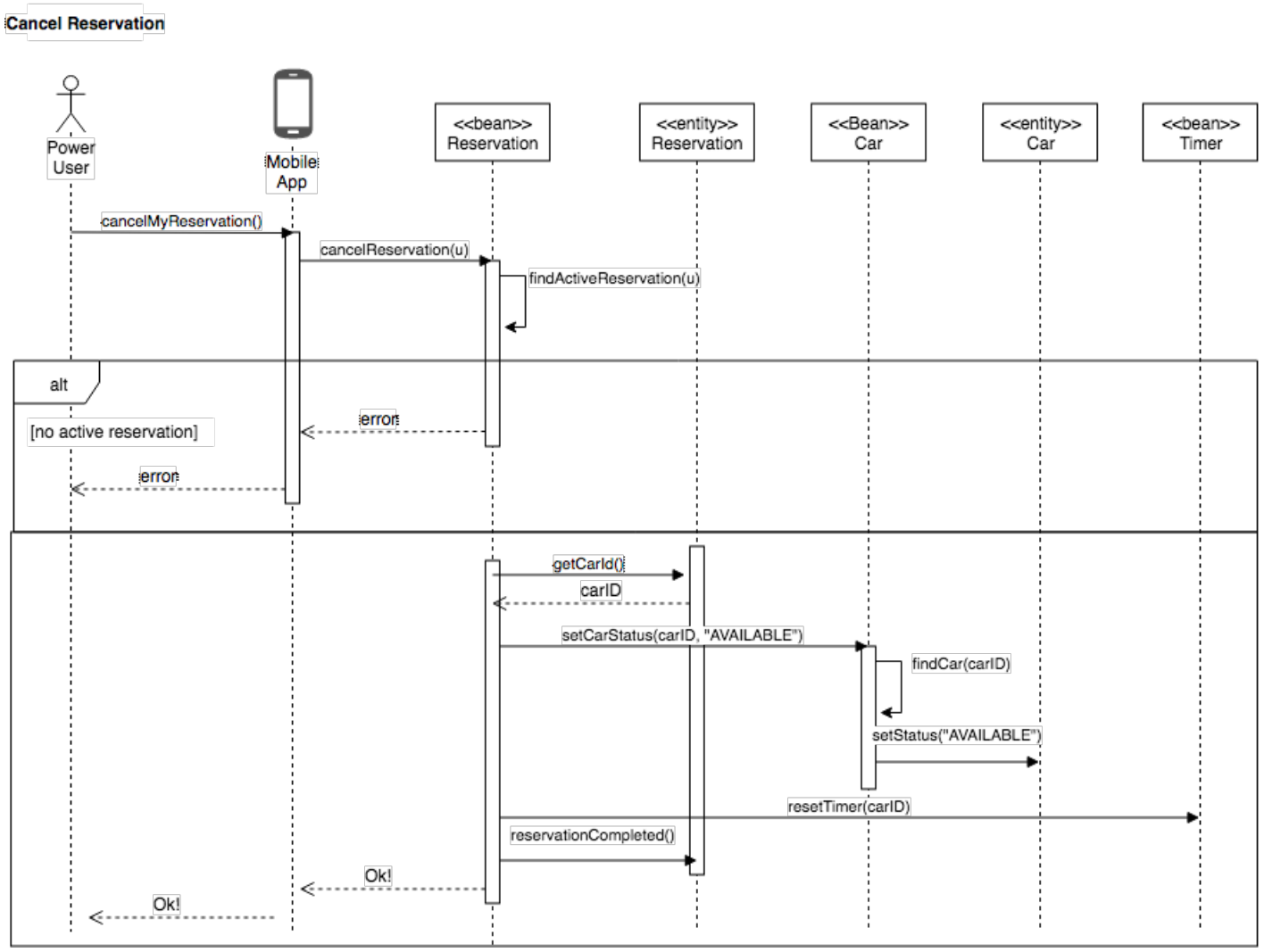
2.6 Runtime View

In this section we will describe the dynamic behaviour of the system. In particular, it will be shown how the software and logical components defined in section 2.3 interact one with another, using sequence diagrams for the more meaningful functionalities of the system. We decided not to represent the database in the sequence diagram, because the interaction with the database is totally abstracted by the entities via the Java Persistence API.

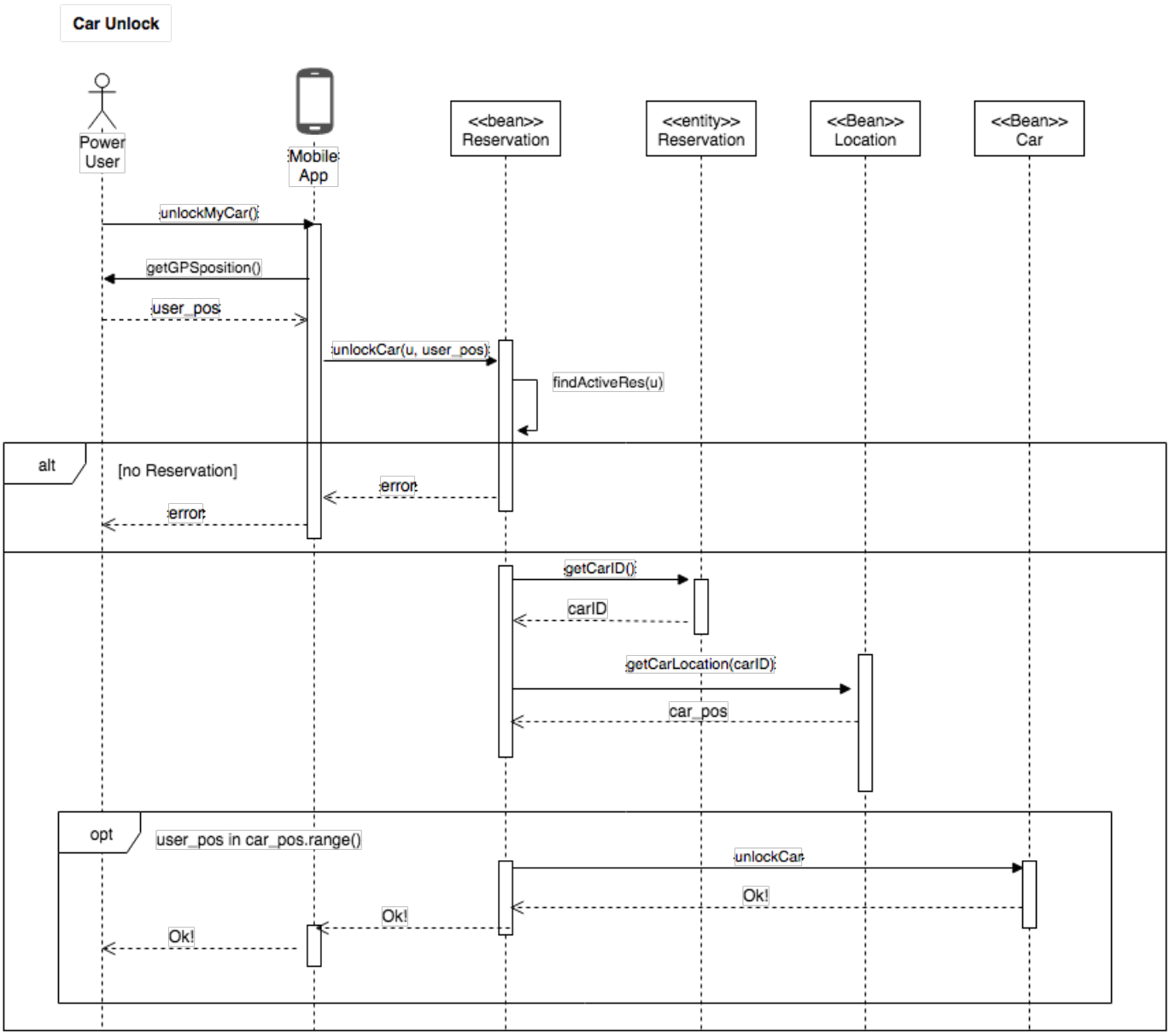
Create Reservation



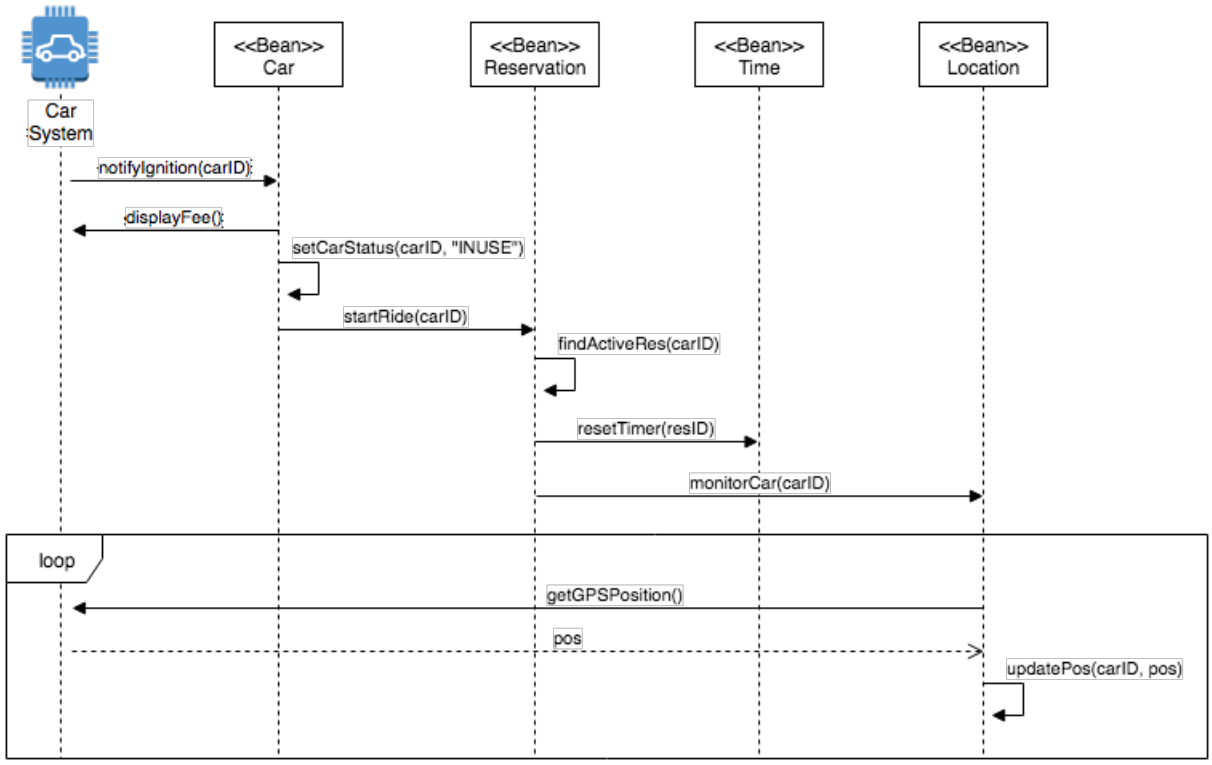
Cancel Reservation



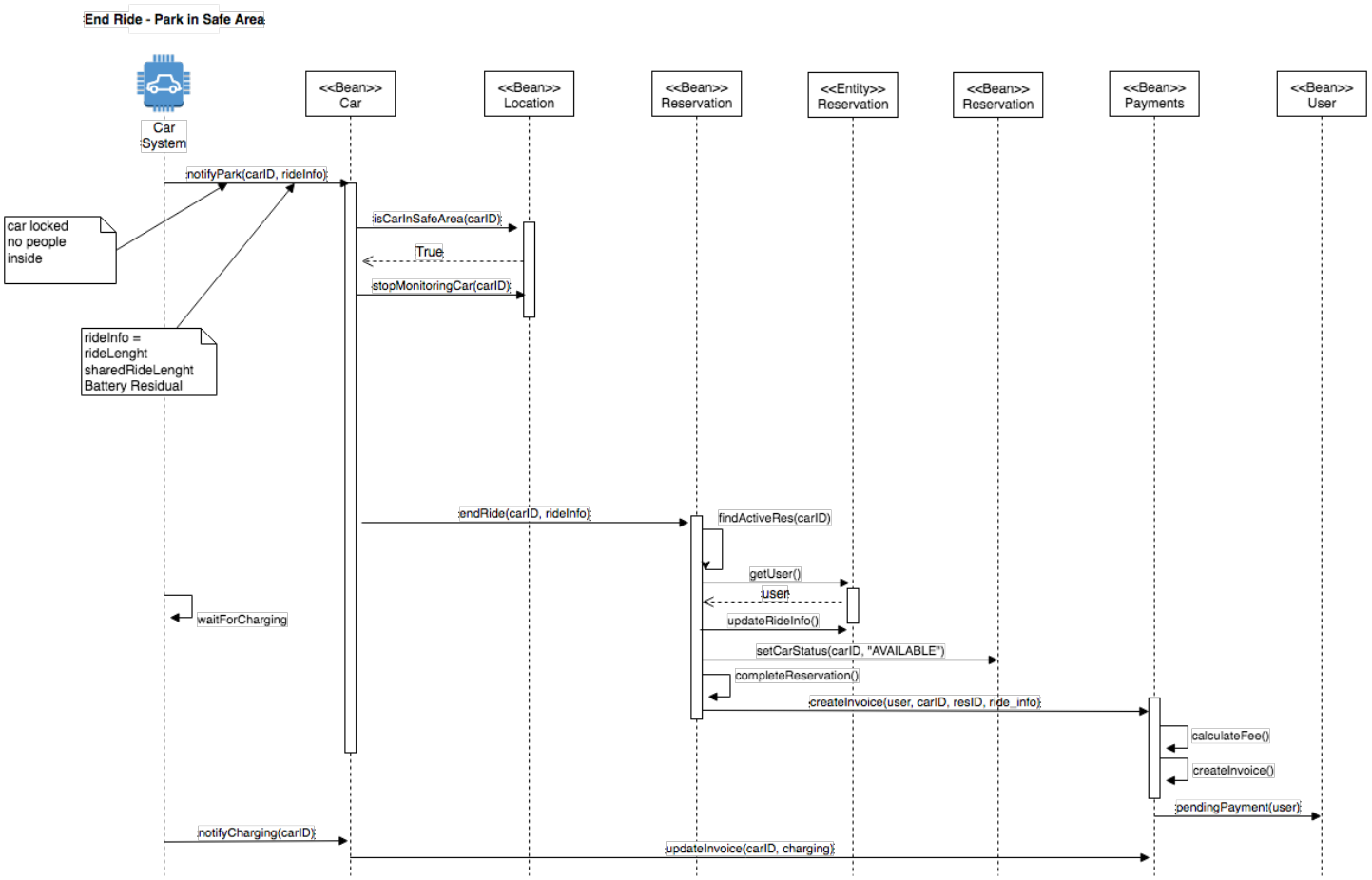
Unlock Car


Car Unlock
Power User
Mobile App
<<bean>> Reservation
<<entity>> Reservation
<<Bean>> Location
<<Bean>> Car
unlockMyCar()
getGPSposition()
user_pos
unlockCar(u, user_pos)
findActiveRes(u)
alt
[no Reservation]
error
error
getCarID()
carID
getCarLocation(carID)
car_pos
opt
user_pos in car_pos.range()
unlockCar
Ok!
Ok!
Ok!

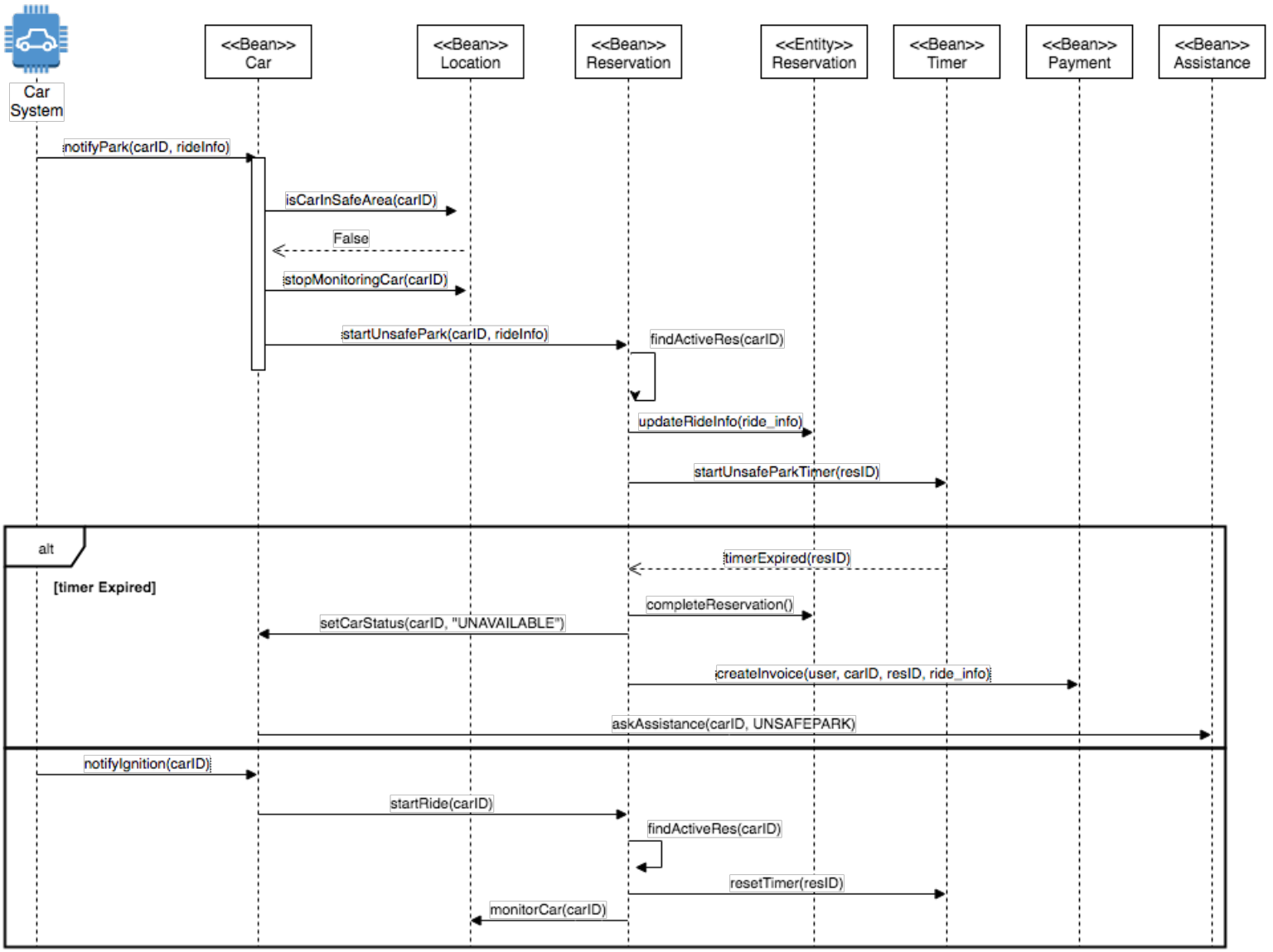
Start Ride


Car System
<<Bean>> Car
<<Bean>> Reservation
<<Bean>> Time
<<Bean>> Location
notifyIgnition(carID)
displayFee()
setCarStatus(carID, "INUSE")
startRide(carID)
findActiveRes(carID)
resetTimer(resID)
monitorCar(carID)
loop
getGPSPosition()
pos
updatePos(carID, pos)

End Ride (Safe Park)



End Ride (Unsafe Park)



2.7 Selected Architectural Styles and Pattern

Starting from the class Diagram, at the beginning of the design process we had a three tiers client-server based architecture, but the end result is a four tiers client based-server architecture. Since the modification is quite relevant, is usefull to summarize again the high level components, in order to give a clear vision of the system. The first tier as usual is the Client tier: Client tier contain all sections who interact with the user. In this section there are Mobile Application and Web Page. The server tier is splitted in two: Web Server and Application server. Web server is an efficient solution to connect the Web Page to the application server. I has a relation of client-Server with application server, where Web server is the client. Applicatio Server manage all the Power Enjoy logic. Is the core of the System and is able to communicate with all components as server or client (except for the Web page). The persistence tier is filled with the DBMS, designed to exploit microservices so the entities will be reasonable divided in more than one storage. An other tier, assimilable with the client tier, is the layer of the External Services, the one with the Car, Assistance and Payment Service. It has a relation Client-Server with the Application server as client and collect all Services different from the users who require just an exchange of messages with the application server.

3 Algorithm Design

Focus of the most relevant algorithmic part: FIND ZONE()

4 UI Design

4.1 Mobile Application

The mobile application, as usual, will have a recognizable icon that can be added on the desktop. When the application is opened, the display will show the login screen.

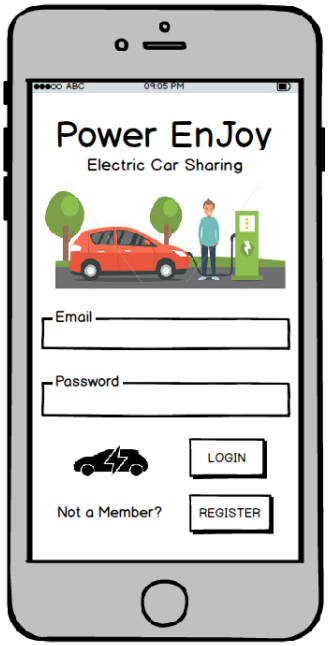


Figure 1: Mockup

E-mail and Password are required for the login. Insert wrong credential cause the refresh of the page with a notification explaining the problem, without giving information about the wrong field. In this screen is possible to register new Users by the button "REGISTER". Clicking leads to the registration screen, it is a form who must be filled entirely and correctly to have a successfull regstration. The fields must be at least "name", "Surname", "Driving Licence", "E-Mail" and "Payment System", add other fields could be halpfull but not strictly necessary. If some datas are not acceptable, a notification will be displayed and the form will be reuploaded. After the login, the display show the Main Screen.

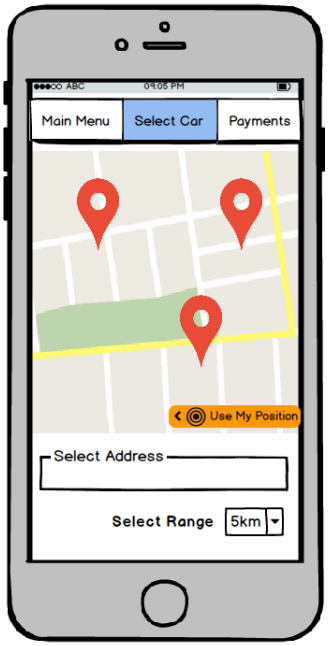


Figure 1: Mockup

On the screen is possible to see the map of the city, if is available the center will be the user position, if it is not available the center will be the center of the city. In the upper side there is a menˇ with the sections "Main Menˇ", "Select Car" and "Payments". Main Menˇ open a list of fields. It contains the field "Modify Profile" that lead to a screen equal to the Registration Screen previously described. In the Main Menˇ list is auspicable to put all functionalities not strictly related to the reservation and the payment, this will make more clean and simple the application. Payments allows to pay the unpayed fee, if there is. If there are no unpayed fee will be shown a message like "You payed the last fee, there is nothing to pay more". If there is a payment pending the massage will be "There is a pending payment. You have to pay 5Ä (example)." and a button will start the payment procedure. Select car is the basic screen of the application. In this section is possible to set the center point of research and the research range, user should be guided to choose his position as center even if is possible to put any position as center of the research. When center and range are available for the server, it starts to search cars. Cars will be shown on the map and user can click on them to see the car informations.

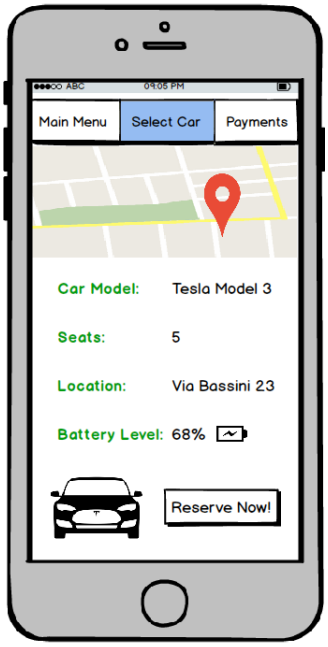


Figure 1: Mockup

Informations must be about the battery and the location, could be usefull add other information as model and number of sets. A button "Reserve Now" will start the reservation. When the reservation starts the display will show a one hour countdown, the timer indicates the time to the expiration of the reservation. An unlock button and a cancel button will be in the screen as well. If the unlock button is pushed not near enough, will be dislayed a message that notify the problem. When the car is ignited the countdown stops and the application go in standby, in the logic the application switch from reservation to ride. Only the application is in standby, not the entire phone. Application will wake up when the car is turned off. If the car is in an unsafe area, "You left car in an unsafe area" will be displayed togheter wit an unlock button and a one hour countdown. At the end of the countdown the ride will end If the car is in a safe area the ride will end. When a reservation or a ride ends, a payment notification is shown. It should be like "Your reservation has ended. Your fee is 8Ä. Thanks for using Power Enjoy Service". A confirmation button allows to go back to the Main Scree. The payment message is not shown if the reservation is canceled. Is important to underline that on the payment notificatio will NEVER appear the word "ride": ride is usefull for the logic but its existence is useless for the user, so is usefull to avoid the use of two terms. Every time is not specified, the "go back" button of every mobile system will accomplish the "go back" function.

The application must be as simple as possible, the main idea is to make every

marginal utilities, like the main menˇ options, obscured by the main functionality. This reasoning increase usability thanks to the focus on the reservation.

The language to write the application obviously will change from a operating system to another. The application must run on Android and iOS. For Android the language will be Java and for iOS the language will be Swift.

4.2 Web Page

Web Page is a support of the application. The presence of a dowload link should be as constant as possible.

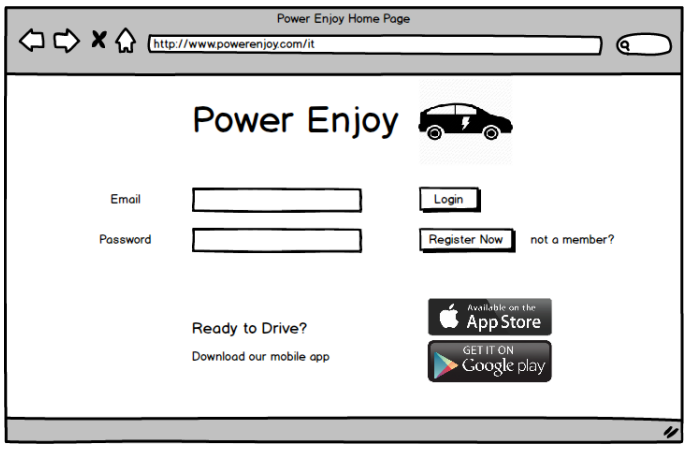


Figure 1: Mockup

The main purpose of the web page is to give the possibility to the user to have a more efficient way to manage side functions. The app will focus on the reservations, and the web page allow to have a better interface for the options of the main menˇ list. The main page is very similar to the access screen of the application and the consequences of the buttons are the very same.

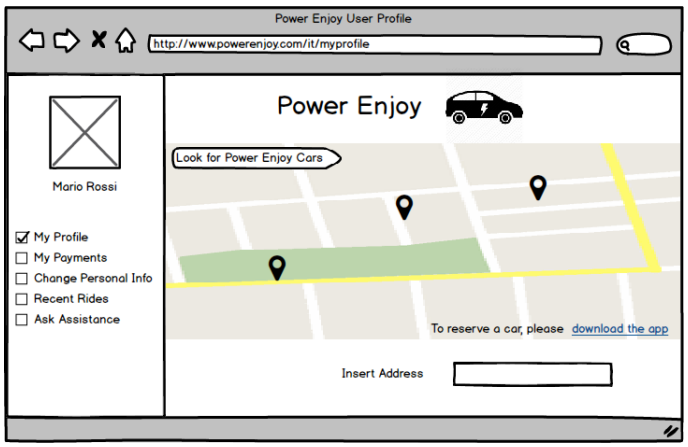


Figure 1: Mockup

On the main page the is a list on the left. From the lists fields is easy to manage the profile, from the personal information to the history of payments. On the main page is also possible to see Power Enjoy Cars distribuited on the map. This possybility doesn't allow to reserve a car, this is possible only via application

The web page should be written in XML or JSON, to allows quick and efficient data transfer through textual data files over HTTPS.

5 Requirements Traceability

Explain how requirements defined in the RASD map to the design elements that you have definited in this document.

6 Effort Spent

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