AY 2022/2023

POLITECNICO
MILANO 1863

RASD: Requirement Analysis and Specification Document

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Contents

1 Introduction

Electric mobility (e-Mobility) is a way to reduce the carbon footprint caused by motorized vehicles in urban and sub-urban areas.
Comfortably knowing how to fit the charging process into one's daily schedule is a fundamental step towards that goal.

1.1 Purpose

In the last 3 years the number of electric vehicles has doubled and, with the proposed european legislation on banning diesel fuel by 2035, the future seems to be full-electric. This rapid change requires a better and more efficient infrastructure to serve this ever increasing demand.

eMall (e-Mobility for all) aims to ease the charging process for the users through the *e-Mobility Service Provider's* (eMSP) platform, providing all the needed end-users' services and by actively communicating with multiple *Charging Point Operators'* (CPOs) *Management Systems* (CPMS).

1.1.1 Goals

User goals

- **(G1) Know about the charging stations nearby, their cost, any special offer they have.**

- **(G2) Book a charge in a specific charging station for a certain timeframe.**
  description

- **(G3) Start the charging process at a certain station.**

- **(G4) Notify the user when the charging process is finished.**

- **(G5) Pay for the obtained service.**

1.2 Scope

Shared Phenomena

ID	Phenomenom	Controller
S1	User registers through the application	World
S2	User logs into the application	World
S3	User gets notified by the system about the status of the charge	Machine
S4	User is suggested by the system to go and charge the vehicle, depending on the status of the battery, his daily schedule and the charging type	Machine
S5	User is presented with special offers made available by some CPOs	Machine
S6	The system shows the availability of nearby charging stations	Machine
S7	User pays the cost of the charge through the application	World

World Phenomena

ID	Phenomenom
W1	Power outage in a station nearby area
W2	Physical problem in the charging station
W3	Physical problem in the electric vehicle
W4	Unexpected changes in the user daily schedule
W5	Person other than the user is driving the car

1.3 Definitions, acronyms, abbreviations

Definitions

- **User**: any electric car owner.

- **e-Mobility Service Providers**: company offering an electric vehicle charging service to drivers by providing access to multiple charging points around a geographic area.

- **Charging Point Operator**: charging point stations owner.

- **Charge Point Management System**: charging Point Operator's IT infrastructure. Handles the acquisition of energy from external Distribution System Operators and distributes it to the connected vehicles. It can also makes automatic decisions, such as the amount of energy to be used for each connected vehicle.

- **Distribution System Operator**: entity responsible for distributing and managing energy from the generation sources to the final consumers.

Acronyms

- **EV**: Electric vehicle

- **eMSP**: e-Mobility Service Providers

- **CPO**: Charging Point Operator

- **CPMS**: Charge Point Management System

- **DSO**: (3rd party) Distribution System Operator

- **API**: Application Programming Interface

- **UML**: Unified Modeling Language

1.4 Revision history

- Version 0.1: Setup

    - Created first layout

1.5 Reference documents

- Specification document: "Assignment RDD AY 2022-2023"

- Alloy documentation: https://alloytools.org/documentation.html

- Data on number of electric vehicles: https://www.iea.org/data-and-statistics/charts/global-electric-car-stock-2010-2021

1.6 Document structure

- **Section 1**: introduces the problem, describes every goal of the project and gives an analysis of the world and shared phenomena.

- **Section 2**: gives an overall description of the project and all the interactions that will occur between the system and the final users, including a list of possible scenarios and a description of all the actors involved. It provides also an UML class diagram that will be used as a reference point for the developers.

- **Section 3**: includes all the project's requirements and an in-depth description everything presented in Section 2.

- **Section 4**: shows the Alloy model defined for this project.

2 Overall Description

2.1 Product perspective

In this section we mainly describe some typical scenarios, all the *Product Functions (2.2)* offered by the eMall system and the *UML(2.1.2)* class-diagram.

2.1.1 Scenarios

1. Mister Fontana has just bought an electric vehicle and wants to create an account for the application.

   - He opens the web app and clicks the "Sign Up" button
   - He inserts all the required information in the mandatory fields and presses the "Confirm" button
   - The system verifies that the mail has not been used before. After passing the verification a confirmation e-mail is sent to mister Fontana's mailbox
   - He checks his mailbox to see if he received the confimation e-mail

2. Mister Brambilla is about to finish a meeting and is about to have a 2 hour break. eMall detects that he's about to go on break, and it sends him an e-mail suggesting him to charge his car

   - He receives an e-mail suggesting him to charge his car
   - He logs on the eMall webapp
   - The eMall webapp suggests the closest chargers and the ones with eventual discounts
   - Brambilla selects his preferred charging station and books it
   - eMall prompts a link to help Brambilla get there
   - Brambilla opens the link and heads there

3. Mister Fontana is on vacation and since he's new to the area he wants to know which charging stations are nearby

   - He opens the web application and logs-In

- He navigates to the interactive map section

- He clicks the "current position" button

- He gets notified by the web application that his GPS position is not turned on

- He turns on the GPS and then searches all the nearby stations by simply clicking the "current position" button and viewing the map

4. Miss Sala will go to the hairdresser next sunday. She knows that in the parking lot near the hairdresser there's a charging station and she wants to make sure that a spot will be available that day, so she decides to book a spot for that charging station

   - She opens the web application and logs-In

   - She selects the "Book a spot" option

   - She compiles the requested fields with date, time of arrival and location and selects confirm

   - The system checks if a charging spot for that date and time is still available, in that case a confirmation message is shown and the booking is saved. If no spot is still available an "unsuccesful booking" message is shown and the booking is aborted

   - After successfully booking a spot the system sends a mail with a recap of the booking

   - Miss Sala after reaching the charging station on the booked time-frame unlocks the booked charging spot via the web app and can start the starting process

5. Mister Ferrari has booked a charging spot for saturday. He realizes that he has lost the keys to his car, and will not make it in time. While he searches for his keys he forgets to delete the reservation.

   - The system locks the charging spot while waiting for mister Ferrari

   - 5 minutes after the booked time, if the reservated user doesn't show up, the charging spot is unlocked and the reservation is cancelled

- Other users can now start using the previously reserved charging spot

6. Mister Rana wants to start the charging process and pay, since he's arrived at the booked station near his office

  - He opens the web application and logs-In
  - He navigates to the "booking list" section
  - He plugs-in the charging cable to the car
  - He selects the right station and clicks the "start charging" button
  - He's then asked to pay inside the web app and he pays with his credit card
  - He finally sees that the car has started to charge
  - When the charging ends he gets notified by the application

7. Mister Rossi wants to plan his trip to Rome with his electric car. He would also like to save money by selecting the cheapest charging stations along the itinerary.

  - He opens the web-application and he logs-In
  - He plans his trip inside the navigation system or the in-app map
  - He then sorts the charging stations by the charging price and the special offers
  - He books the cheaper ones that covers the right amount of distance from each other

8. Mister Lamborghini wants to delete his booked charge since his schedule changed and he can no longer make it there in time.

  - He opens the web-application and he logs-In
  - On the webapp he opens his "bookings list"
  - He then selects the one he wants to delete and clicks on "cancel booking"
  - An email of the succesful cancellation is sent and the system deletes the previous reservation
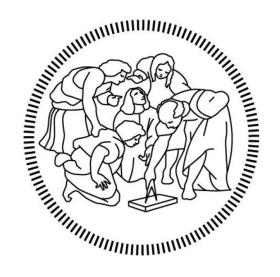
2.1.2 Class diagram

Text *daily plan* footnotemark[1].

- **Type of Data 1**
  Text

- **Type of Data 2**
  Text

Image of the class diagram

---

[1]Text

Figure 1: High-level UML

2.2 Product functions

2.2.1 Sign-up and shared functions

- **Sign-up:** let the user sign-up thorugh an email and a password.

2.2.2 Other function 1

- **Text:** text

2.3 User characteristics

The application has been thought for anybody that owns an electric car and wants to plan his charging process. Because of this, the potential user base comprises of any electric vehicle owner with a device connected to the internet. The user should also be capable of interacting with a webapp

2.4 Assumptions, dependencies and constraints

- D1: Users have access to the internet while using the web application

- D2: The infrastructure of the charging stations is reliable and works 99% of the time

- D3: User's car works properly while charging

- D4: Information about the charging stations offered by the CPMS are accurate (such as position, state and availability)

- D5: The DSO's infrastructure is working and their data is reliable

- D6: Information about the user's schedule is correct and meaningful

- D7: Users own an IT device to connect to the application

- D8: Each user registers only once, and always feeds correct information to the app

---

[1]Text

- D9: The data supplied by the user's devices are correct (battery charge, current position)

- D10: ass. 10

- D11: ass. 11

- D12: ass. 12

- D13: ass. 13

- D14: ass. 808

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[1]footnote

3 Specific Requirements

3.1 External Interface Requirements

3.1.1 User Interfaces

Users should interface the web application through devices that must be connected to the Internet. The service will be accessed through a web browser from the web site domain (i.g. www.eMall.com). As the service will be used by a lot of different kinds of users, the web application interface should be as simple and intuitive as possible.

3.1.2 Hardware Interfaces

Since the system provides a web application, there's not an hardware interface. In order to give a complete experience, the system should be given the access/permission to the user's GPS position or navigation system.

3.1.3 Software Interfaces

To access the application a web browser is required. Additional software like a calendar and GPS is necessary for accessing all the funcionalities of the application. The software will also take advantage of some interfaces to accomplish its requirements. An external API is necessary to visualize on maps the user location and the near charging stations.

3.1.4 Communication Interfaces

Internet connections will be mandatory since the web application must communicate with the web server and the CPMS APIs. Communication with the CPMS will be ASYNCRONOUS/etc..

3.2 Functional Requirements

3.2.1 List of Requirements

ID	Requirement
R1	The system must allow registered and logged-in users to use the app.
R2	The system must allow registered users to log-in using their e-mail
R3	The system must show the user the nearby charging stations through an interactive map.
R4	The system must be allowed to use the user's GPS location in order to view the nearby charging stations, if given permission.
R5	The system must notify the user when the charge has finished.
R6	The system must noitify the user about discounted prices.
R7	The system must show the user the prices of the charging stations.
R8	The system must access the User calendar schedule in order to suggest the best charging timeframes, if given permission.
R9	The system must suggest the user on which charging stations to go based on the car battery and his daily schedule.
R10	The system must communicate with the CPMS in order to retrieve all needed information about the charging stations.
R11	The system must allow the user to book a charging spot for a future date.
R12	The system must allow the user to cancel a future reservation for a charging spot.
R13	The system must allow the user to pay for the charge.
R14	The system must respect the GDPR and the user's privacy.

R15	The system must unlock the reserved charging spot if the user doesn't show up.
R16	The system must allow the user to start or stop the charge via the application.
R17	The system must notify the user of the upcoming booked sessions.

3.2.2   Mapping

G1	help
D2	app
D3	used

G2	TEXT
D2	TEXT
D3	TEXT
D8	TEXT

G3	initiatives
D2	app
D3	used

3.2.3 Use Cases

3.2.3.1 Use Cases Diagram

- **Policy Makers**

Figure 3: Policy Maker - Use Case Diagram

- **Farmers**

Figure 4: Farmer - Use Case Diagram

- **Agronomists**

Figure 5: Agronomist - Use Case Diagram

3.2.3.2 Use Cases Description For more details 3.2.4.

- **Shared Use Cases**

Sign Up

Use Case	Sign Up
Actor	U
Entry condition	User wants to register in the system
Flow of events	1. text
Exit condition	User data are saved into the system and registration ends successfully
Exceptions	1. text An error message is shown and the flow of events starts again from point 3

- **U**

- **text**

- **Use Cases to requirement mapping** 0

1)Sign Up	R3) text
	R2) text

3.2.4 Sequence Diagrams

- **Shared Sequence Diagrams**

Sign Up

Figure 6: Shared Sequence Diagram - Sign Up Sequence Diagram

- **Farmers**

3.3 Performance Requirements

text

3.4 Design Constraints

3.4.1 Standards compliance

text

3.5 Software System Attributes

3.5.1 Reliability

text

3.5.2 Availability

text

Component	Availability	Downtime
cell here	cell here	cell here
cell here	cell here	cell here

3.5.3 Security

3.5.4 Maintainability

3.5.5 Portability

4 Formal Analysis using Alloy

4.1 Formal Analysis Purpose

The following analysis aims to formally prove the correctness of the system model by exploiting Alloy verification tool. To achieve so, we test the model by checking if some of the previous defined goals are met.

Specifically, we stress:

- **(G3)** :

Plus, we runned some empty predicates `show` to generate some more general instances of the app system.
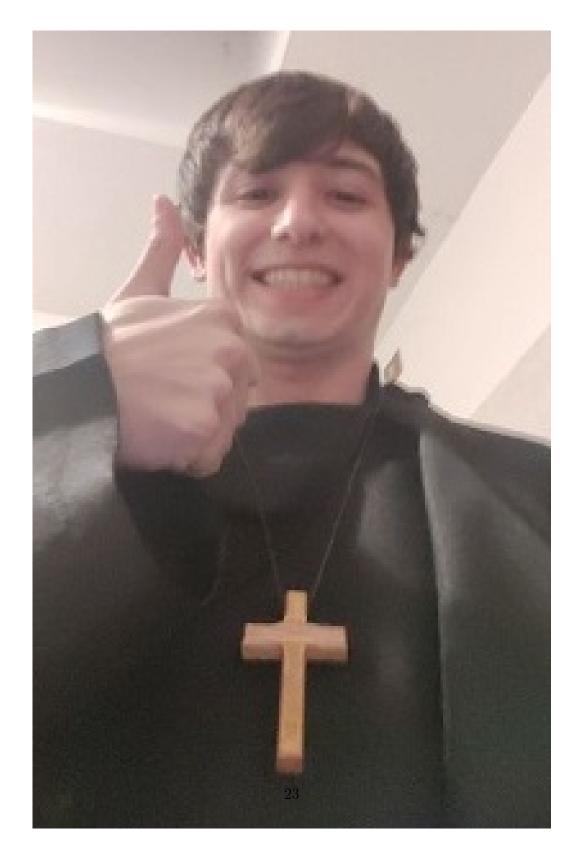
Figure 2: Sign Up BPMN