eMall – e-Mobility for All

Requirements analysis and specification document (RASD)

Software Engineering 2
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1 – Introduction

The unique challenges posed by climate change have recently led to a growing push in the adoption of new technologies to reduce carbon emissions. In particular, road transportation accounted for more than 70% of the total transport emissions in the EU, which in turn was responsible for about a quarter of the EU's total CO_2 emissions in 2019 (source: shorturl.at/anryE).

Electric vehicles represent a viable solution to tackle this problem, but they require specific infrastructure and knowledge about availability of chargers, cost of energy and distribution.

eMall, a new startup based in Italy, is aiming at improving the experience of charging an electric vehicle. Their new app will be able to take care of every aspect of charging, by displaying the location and properties of charging stations nearby and making smart suggestions that take into consideration both economic and logistical factors.

1.1 – Purpose

The system should provide the user with information about every charging point location nearby. Each location should present the characteristics of its charging stalls: cost, availability, charging speed, compatibility with the charging port, special offers.

The user through the system should also be able to book a charge at a specific location for a certain timeframe, selecting through the GUI a charging station and inserting a starting time and ending time (to be able to create a real schedule, as to give the other users the possibility to book a consecutive timeframe if they're willing to).

The system should also allow the user to manage the whole charging process: they should be able to start the charging, to monitor its status and to be notified when it is done or when the booked timeframe has finished and make the user pay for the service.

Additionally, the system should provide some smart suggestions to the users, based on their location, their schedule (by having access their calendar), the current offers, the battery status of the vehicle and the availability of charging stations.

1.1.1 – Goals

Goal	Description
G1	Provide the user the information about the nearby Charging Points (this includes their cost and the special offers they provide)
G2	Make the user able to book a specific Charging Point in a specific timeframe
G3	Make the user able to start and monitor the charging process, from the start to the end
G4	Notify the user when the charging process is finishes or when the booked timeframe expires
G5	Make the user able to pay for the charging service

G6	Provide the user with smart suggestions about the charging port to go charge to, based on their location, schedule, prices and special offers (if available)

1.2 – Scope

The system should interact with the end user, so the UI should be easy to use in order to be accessible to a widest range of people possible, as electric cars are spreading rapidly and such a system could further amplify this phenomenon. It should also communicate in the backend with CPOs (Charging Point Operators), through their CPMSs, which are entities that own and manage charging stations; the system interacts with more than one CPO to broaden the offer to the end user.

Each CPO, as stated previously, has its own CPMS (Charging Point Management System) which manages their physical infrastructure. For instance, it monitors the status of every socket and regulates the flow of energy to each of them while a vehicle is charging.
Furthermore, the CPMS is responsible for choosing the best DSO (Distribution System Operator) to retrieve energy from, based on the current price and the mix of energy sources used to produce power. With this information, the CPO can decide and set the prices per unit of energy and also create special offers for end users.

Additionally, CPMSs are tasked with managing energy storage (if present) of a certain charging station: if supplied with physical batteries, they can opt not to buy energy from DSOs and instead use the one stored in the batteries, otherwise energy can be purchased from the DSOs and partially used to recharge them. These decisions can be both made automatically or with input from a human operator.

Each of the entities previously mentioned (the system, CPOs and DSOs) can communicate through specific APIs. The system can communicate with one or more CPMSs, each owned by a different CPO, retrieving the external status of a charging station (location, number of charging sockets available, speed of every socket, cost, estimated time left until a socket is freed).

1.2.1 – World Phenomena

ID	Description
WP1	The user wants to charge their vehicle
WP2	The user books a certain charging station in a certain timeframe
WP3	The user goes to the selected charging station
WP4	The CPMS of the CPO acquires energy from a DSO, based on the prices the latter offers and the mix of sources it acquires the energy from
WP5	The CPMS of the CPO distributes the energy to the different connected vehicles
WP6	The CPMS of a CPO decides the prices for a specific charging point based on the prices it acquired it from a DSO
WP7	The CPO decides whether to store energy in the batteries of a charging point (if any)
WP8	The CPO decides whether to use the energy stored in the batteries of a charging port (if they are available) or to use the one directly purchased from a DSO or a mix of both

1.2.2 – Shared Phenomena

SP1	The user selects a charging port to go charge to
SP2	The user starts the charging process
SP3	The user monitors their charging process
SP4	The user gets notified about the ending of their charging process
SP5	The user pays for the charge
SP6	The eMSP retrieves the information about the external status of a charging station from the CPMS of the CPO which manages it (this includes the number of charging sockets available, their type, their cost, and, if all sockets of a certain type are occupied, the estimated amount of time until the first socket of that type is freed)
SP7	The eMSP retrieves the information about the internal status of a charging station from the CPMS of the CPO which manages it (this includes the amount of energy available in its batteries, if any, number of vehicles being charged and, for each charging vehicle, amount of power absorbed and time left to the end of the charge)
SP8	The eMSP actually starts and monitors the charging process accordingly to the request of a user through an API provided by the CPMS of the CPO managing a certain charging station
SP9	The eMSP retrieves the information about current energy cost from the CPMS of the CPO which manages a certain charging station
SP10	The eMSP provides the user with smart suggestions about the best charging stations to go charge to (based on their location, schedule and status of charging stations nearby)

1.3 – Definitions, Acronyms, Abbreviations

- eMall – e-Mobility for All
  The system we are analyzing and specifying in this document

- eMPS – e-Mobility Service Provider
  A company (like e-Mall) which offers the user various features regarding the e-Mobility field, from locating a charging station, to starting the charging process and paying for it

- CPO – Charging Point Operator
  A company which manages the energy supply and the features of a physical charging station

- CPMS – Charging Point Management System
  The backend infrastructure of a CPO, which takes decisions and interfaces with providers of energy

- DSO – Distribution System Operator
  A company which produces and provides electric energy to CPOs

- SPX – Shared Phenomenon X
  A phenomenon related to the system in analysis and the domain which it operates in

- WPX – World Phenomenon X
  A phenomenon happening in the domain which the analyzed system operates in. The specified World Phenomena are relevant for us because system operations derive from them

- GX – Goal X
  A purpose the system wants to be able to reach

- API – Application Programming Interface
  An interface which a system offers for other systems (human beings or softwares) to be able to perform specific operations or retrieve information on it

1.4 – Revision History

➢ First release: RASD v1.0 **INSERIRE DATA QUA**

1.5 – Reference Documents

➢ Specification document: "*Assignment_RDD_AY_2022-2023_v3*"
➢ Alloy code documentation: https://alloy.readthedocs.io/en/latest/language/

1.6 – Document Structure

The document is organized in six well defined sections, which are as well divided into sub sections accordingly to modularity and concept separation.

- **Section 1: Introduction**
  This section provides the context of the problem, the scope, the main goals and the phenomena (either the shared ones and the world ones), summarized in the 2 tables in section 1.2. At the end of section 1 we can also find this paragraph, the reference documents and the abbreviations and definitions necessary to understand the technical and non sections.

- **Section 2: Overall Description**
  This section provides a high level description of the problem and the system itself. Here we can find various use cases and scenarios that can happen with regard to the application, further details about the shared phenomena and domain assumptions. Furthermore here are specified the requirements about the features the system offers and hardware and software constraints too.

- **Section 3: Specific Requirements**
  In section 3 every aspect mentioned in section 2 is specified with regard to information which can be useful to further development of the application. We can find external

interface requirements, functional requirements and performance requirements, as well as design constraints and software attributes.

- **Section 4: Formal Analysis using Alloy**
  In section 4 a formal analysis on the phenomena is performed using Alloy code.

- **Section 5: Effort Spent**
  Section 5 includes a table with the details about the effort spent on each section by each member of the group tackling the project.

- **Section 6: References**
  Here we can find all the reference to documents and web pages used to draw up this document.