Politecnico di Milano
School of Industrial and Information Engineering
Master of Science in Computer Science and Engineering

Software Engineering 2 Project

eMall - eMSP system

Requirement Analysis and Specification Document

Authors:
Federico Bono
Daniele Cipollone

Academic Year 2022/2023

Milano, 21/12/2022
Version 1.0

1 Introduction

1.1 Purpose

The purpose of this document is to analyze and define the goals and requirements to later design, on behalf of the e-Mobility Service Providers (eMSPs), the infrastructure for the eMall App.

1.1.1 Goals

G1	Allow users to find charging station nearby and their tariffs
G2	Allow users to book a charge session in one of the Charging Point
G3	Allow users to authenticate to the Charge Point and start the charging session
G4	Allow users to check the status of an active charging session
G5	Allow users to be notified when the charging process is completed
G6	Allow users to pay for the charging session

1.2 Scope

Electric mobility (e-Mobility) is a way to limit the carbon footprint caused by our urban and sub-urban mobility needs. When using an electric vehicle, knowing where to charge the vehicle and carefully planning the charging process in such a way that it introduces minimal interference and constraints on our daily schedule is of paramount

eMall App is a platform that helps the end users to plan the charging process, by getting information about Charging Points nearby, their costs and any special offer; book a charge in a specific station, control the charging process and get notified when the charge is completed. It also handles payments for the service.

In the e-Charging ecosystem, there are many different actors involved that we need to keep into consideration while collecting requirements and designing the system. The first information to consider is that Charging Points are owned and managed by Charging Point Operators (CPOs) and each CPO has its own IT infrastructure, managed via a Charge Point Management System (CPMS).

In order to comunicate with each actor, the OCPI (Open Charge Point Interface) protocol is used.

1.2.1 World Phenomena

As this system will act as a middleman between the users and the various Charging Point CPMSs, we thought that splitting the phenomena between "user side" and "CPMS side" can help to better understand.

User side

WP1	User decides to charge the electric vehicle
WP2	User goes to the Charging Point
WP3	User connects the Electric vehicle to the Charging Slot
WP4	User disconnects the Electric Vehicle from the Charging Slot

CPMS side

WP5	Charging Point starts to provide energy to the Electric Vehicle of the User
WP6	Charging Point ends to provide energy to the Electric Vehicle of the User
WP7	CPO starts the maintenance of a Charging Slot
WP8	CPO completes the maintenance of a Charging Slot

Payment Service Provider side

WP9	Payment provider charges successfully the payment method registered by the user
WP10	Payment provider fails to charge the payment method registered by the user

1.2.2 Shared Phenomena

User side

SP1	User registers an account
SP2	User verifies the email for his account
SP3	User add payments information for his account
SP4	System shows the nearby available charging points to the user
SP5	User books a charging session through the system
SP6	System send information about a charging session to the User
SP7	User starts the charging session through the system

CPMS side

SP8	System books the charging session for the user via the CPMS
SP9	CPMS send to the System the charging session details
SP10	System authenticate the charging session for the CPMS

Payment Service Provider side

SP11	System send cost information to the Payment Provider to charge the User
SP12	Payment Provider send to the system the payment process details (eg. status)

1.3 Definitions, Acronyms, Abbreviations

1.3.1 Definitions

Charging plug	Physical connector that allow to transfer energy to the connected vehicle
Charging slot	Physical device with multiple Charging plugs that can charge electric vehicles
Charging Point	Physical structure composed by multiple Charging Slots
Maintenance of a charging slot	Activity/activities that results in a momentary unavailability of the charging slot
Payment information	information required by the payment provider to be able to charge the user for the service (e.g. credit card number)
Charging session	period of time when the vehicle is connected to a charging plug for charging
Booking period	period of time between the booking of a charging session and the beginning of the charging session
Guest Guest User	Unregistered user
User Enabled User Active User	Registered user with confirmed email and payment method
Unconfirmed User	Registered user without confirmed email
Pending User	Registered user with confirmed email but no payment method set up
Payment Service Provider	External service that provides API to process payments

1.3.2 Acronyms

eMSP	e-Mobility Service Provider
CP	Charge Point / Charging Point
CPO	Charging Point Operator
CPMS	Charging Point Management System
OCPI	Open Charge Point Interface
EV	Electric Vehicle

1.4 Revision History

- v1.0 - 21 December 2022

1.5 Related Documents

OCPI specifications document (OCPI-2.2.1.pdf)

1.6 Document structure

The document is structured in six sections:

1. Problem introduction, associated goals of the project. In this section you can also find the scope of the project, the various phenomena occurring and the definitions and abbreviations used in this document.
2. The second section contains a overview of the systems, the details about the users types and the main functions. Class diagrams, statecharts and domain assumptions are used to introduce the various scenarios.
3. In this section are specified the different requirements of the system, the various use cases and the mapping between functional requirements and the goals of the system.
4. Alloy is used to conduct the formal analysis of the system.
5. Total effort
6. References used

2 Overall description

2.1 Product perspective

2.1.1 Scenarios

1. **User wants to start using the platform**
   Bob has bought a new electric car and wants to start using the eMall network to charge it. Bob goes to the app store to download the official application, opens it and taps on the "Signup" button to initiate the user registration flow. He inserts all the necessary information and, after submitting the form, he's granted access to the system.

2. **User wants to check for charging station availabilities**
   Bob wants to charge his car, he opens the eMall app and, using the integrated map view starts looking for a nearby charging station. After tapping on one of the available Charging Points, the application displays the status of the station, the available charging docks and their connectors as well as the price rates applied.

3. **User wants to book a charge for a certain time frame**
   Bob opens the app, searches for an available station and, after opening the station details, he taps on the "book" button to start the booking process. The application asks for a time frame and a connector type, and after checking for availability, it books the connector and returns the booking reference to Bob.

4. **User wants to start a charge at the station**
   Bob goes to a station and wants to start charging his vehicle, with a booking for that time frame, he simply needs to park the car in the correct spot, connect it with the correct plug and enable the charge flow via the app. Without a booking, he needs to look for an available spot via the app and start a booking process for it.

5. **User wants to be notified at the end of the charge**
   Bob started the charging process a couple of hours ago for a 2 hours time frame. The system checks the booking time-frame and sends a notification to Bob's smartphone with the details of the charging process (e.g. cost and battery status)

6. **User wants to pay for the service**
   Bob goes to retrieve his car from the station, he uses the app to complete the charging process and the system automatically bills his credit card / Paypal account with the required amount.

2.1.2 Class Diagram

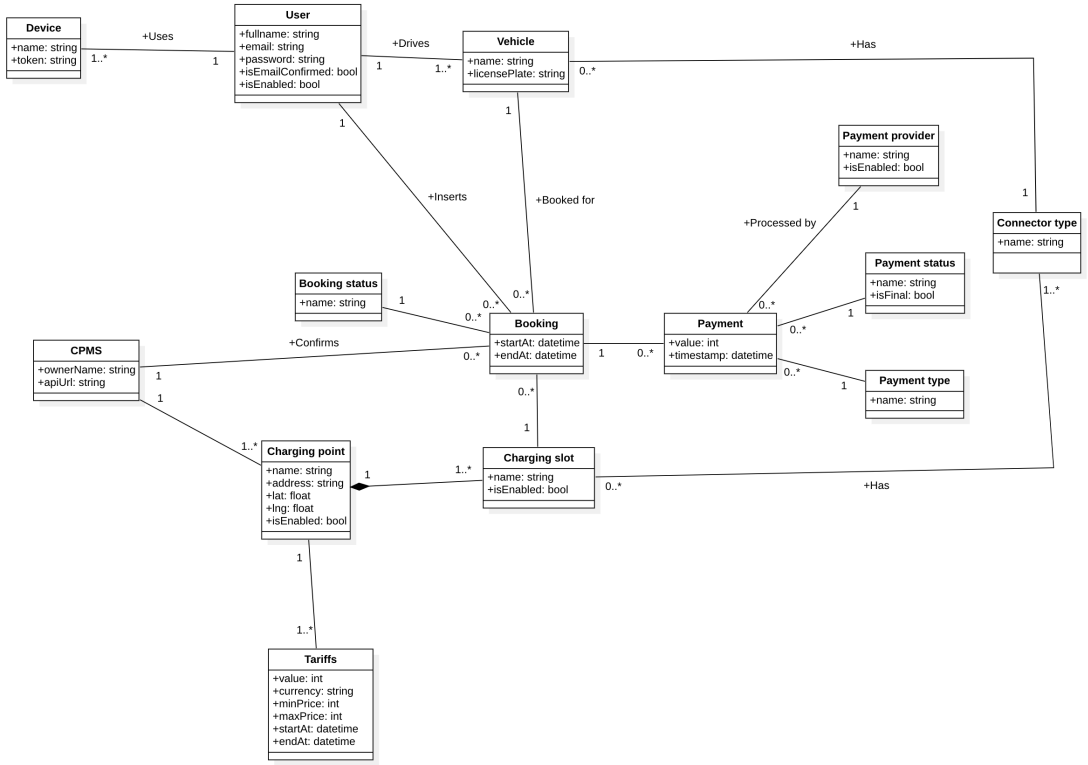

Figure 2.1: Class diagram of the eMSP system for eMall

2.2 Product functions

Before going deeply into details about the product functions that needs to be developed and the related requirements, we first need to quickly introduce two base requirements needed to contain the scope of this project:

- As the system acts as a middleware between the User and the Charging Points, a structured communication protocol is needed. This system will be design to communicate using the Open Charge Point Interface (OCPI) standard.
- As OCPI enables a very complex pricing system, to keep the scope of the project simple, the system will set a per-KW price based on the pricing of the various Charging Point. The prices are automatically synced with the prices of the CP.