Contents

1 Introduction

- Aggiungere nei world phenomena il ChargingType
- Inserire "vehicle type" all'interno dell'attore auto (Ho messo consumption per Km perchè altrimenti avremmo dovuto definire una sorta di lista di tipi di macchine)
- Controlla che gli Scenarios siano coerenti con l'UML
- Aggiorna Requirements con spiegazione di EnergySourceStrategy
- Update Scenarios with "Giochini di Emilio" - Better explain in Requirements(not sure) how the system suggest a charge

1.1 Purpose

Due to the recently increase of effort in the battle against the climate change, electric vehicles are slowly becoming the new technology for private transport that the people use everyday. To sustain this type of strategy, we need to develop a clever and capillary charging system.
e-Mobility for All (eMall) is an eMSP that aims to help the final user dealing with the charging need. To do so it will inform the user about the nearby charging stations, their cost and any special offer that they have. Also, it will allow the user to book/cancel/pay a charge and will notify the user when the charging process is terminated. With the integration of the user's calendar, the system will also suggest the user the best moment in the schedule to charge the vehicle. To have a fully integrated system, all the Charging Point Operatorss (CPOs) will have a technological support called CPMS to interface the service with the physical charging stations and to manage all the energy sources like batteries and Distribution System Operatorss (DSOs). Such CPMSs will be in charge of deciding the energy source and, in case of batteries in a charging station it will also manage their charging. These decisions will affect the energy prices, so it is important that a system like this allows also the CPO maintainers to decide it.

1.1.1 Goals

G1 The eMSP shall help the user to select the station;

G2 The eMSP shall allow the user to book/cancel a charge;

G3 The eMSP shall allow the user to perform a charge;

G4 CPMSs shall handle the vehicle charging cycles;

G5 CPMSs shall manage the vehicle charging stations;

1.2 Scope

W1 People charge electric vehicles; [**G1**, **G2**, **G3**, **G4**]

W2 People use web calendar; [**G1**, **G2**, **G3**]

W3 People pay for the charging service; [**G3**]

W4 DSOs supply energy to CPOs; [**G5**]

W5 Some CPOs own batteries; [**G4**, **G5**]

W6 CPOs decide whether to use batteries or DSO supplied energy; [**G4**, **G5**]

S1 The eMSP suggests the user to charge the vehicle; [**G1**]

S2 The eMSP notifies the user when the charging process is finished; [**G3**]

S3 CPMSs acquire information about energy prizes from DSOs; [**G5**]

S4 The user books a charge using the eMSP; [**G2**]

S5 The user asks the eMSP for suggestions about charging station; [**G1**]

S6 The user pays for the service using the eMSP; [**G3**]

S7 CPOs gather the energy source through the CPMS; [**G4**, **G5**]

1.3 Definitions, Acronyms, Abbreviations

eMSP e-Mobility Service Providers

CPO Charging Point Operators

CPMS Charge Point Management System

DSO Distribution System Operators

eMall e-Mobility for All

API Application Programming Interface

RACS Reliable Array of Cloned Services

RAPS Reliable Array of Partitioned Services

GDPR General Data Protection Regulation

1.4 Revision history

1.5 Reference Documents

1.6 Document Structure

2 Overall Description

2.1 Product perspective

2.1.1 Scenarios

It is assumed that in S4,S5,S6,S7 the user is already logged in the system (S2)

S1 User Signs up:
Lucy, wanting to use the system, opens the app, she is prompted to login or register, she chooses to register herself and inserts her personal info (email, password, birthday, payment information, vehicle info); an email is sent with a link to confirm the activation of the account, if the link is clicked within the first 15 minutes the account is activated and the sign up is successful, otherwise it is considered failed and the process must be repeated.

S2 User Logs in:
Jay, after signing up, opens the app and he is prompted to insert his email and password, if the given information are correct the login is successful and he obtain access to his account and the services of the app, otherwise the login is unsuccessful and it must be repeated.

S3 User searches for stations:
Robert, once logged in, inserts the location and the time frame to search for charging stations. Once submitted, a list of available charging stations is displayed, the list is ordered by the distance of the station from the desired location. Via a menu, Robert can choose to order the stations either via distance, price or charging type (super-fast, fast, normal); He can also set to display unavailable stations and set the maximum distance from the chosen location. Robert chooses a station and obtains more detailed information.

S4 User books a charge:
Jessica, after choosing a station, decides to book a charge in it selecting the timeslot. Station location and booked time frame are displayed and she is asked to confirm the booking via a popup. Jessica then receives a confirmation email with the details of the charge (Location, time frame, socket id) and a confirmation pin to insert at the station.

S5 User cancels a charge:
Luke, after booking a charge, wants to cancel it. He opens the app, selects the booking he wants to cancel and presses the Cancel button. A popup appear asking confirmation: if it is pressed the booking is removed, the station returns available and a confirmation email is sent to the user; otherwise the booking is still valid.

S6 User charges the vehicle:
Mary, after booking a charge, arrives at the station, she parks her vehicle at the designed socket and plugs her vehicle in, Mary then inserts the confirmation pin in the socket to start the charge. The socket displays on a monitor the status and the finishing time of the charge. Once the charge is finished Mary receives a notification of finished charge, she gets her vehicle and completes the charge.

S7 User gets charging suggestion based on his calendar:
Josh is a very busy man and also an avid google calendar user, setting up every event with correct time and location. The service accessing his calendar finds the closest available charging station to each vehicle movement, it connects to the vehicle while driving and stores the last charge level and once the battery is below fifty percent Josh gets notified about the possibility to charge his vehicle in an available time-slot and near his movement. Josh liking the idea opens the app and confirms the booking.

S8 Cpo subscribes to the system:
Judy, the CEO of a famous CPO, wants to subscribe it to eMAll to improve sales and to access the CPMS feature. She opens a Website and select to sign up, she inserts the name, partita iva, a master password and the stations of the CPO. For each station she has to insert the number of charging port, the presence of batteries and, if there are any, wether to use the CPMS automatic source selector or to choose the preferred energy source.

S9 Cpo updates info about its system:
The sysadmin of a CPO, Andy, after logging in with the master password has access to his CPO. Here he can change the number of stations, for each station he can update the number of socket and the energy source. He can also create and update maintainer account inserting the ID and password. For each maintainer he can choose which station the maintainer can maintain.

S10 Cpo employee logs in the service:
Brett a CPO employee wants to access the service, he connects to the site and inserts the ID and password, if correct he logs in; otherwise the procedure fails and must be repeated.

S11 Maintainer maintains his assigned stations
Lisa, a maintainer at a cpo logs in the service, here she can see the info of each station assigned to her. For each station she can: check the status(functioning or not), choose the energy source, update the number of available sockets. She can monitor the consumes, profitability and the usage of a specified station.

2.1.2 UML diagram

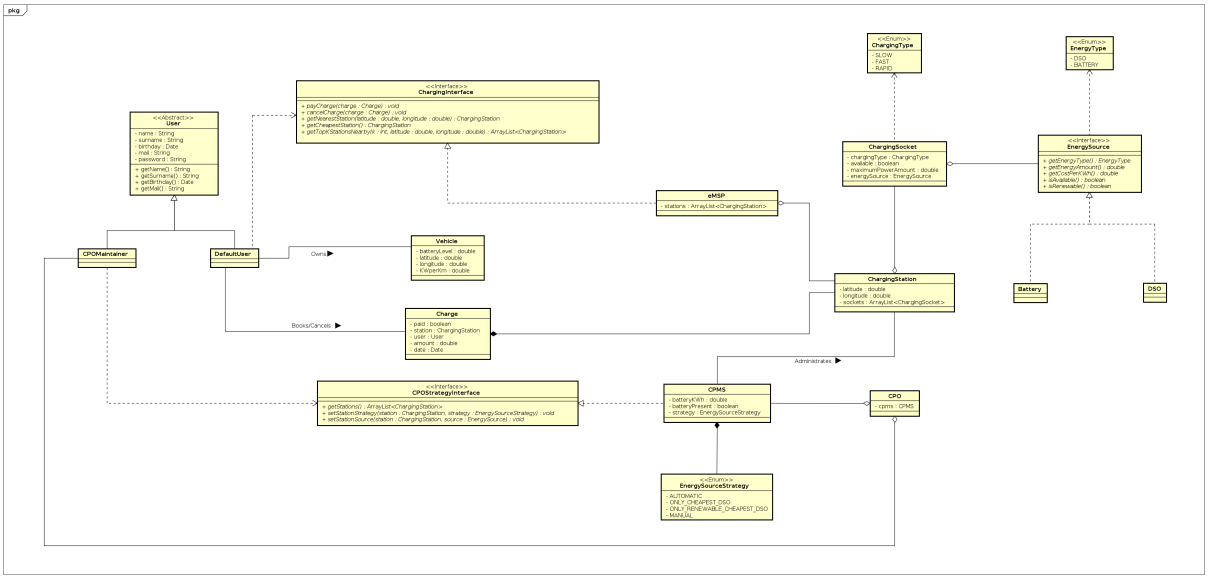

Figure 1: UML

2.2 Product functions

In the following subsections the functions of each subsystem are described.

2.2.1 eMSP

Accessing the eMSP In order to have features with the usage of personal data (like payment method) the system needs authentication. So a registration and login process is present. When registering it's required to give the system Name, Surname, birthday, e-Mail, Password and a Payment Method. For the login, an authentication with e-Mail and password is required.

Performing a charge The principal feature of the system is the ability to help the people to plan a charge for their vehicles efficiently. For this, people can see the availability of charging stations and choose where and in which time slot to charge the vehicle. Also, if a user changes his mind, there is the possibility to delete a previously booked charge with no charge. When the user arrives in the booked socket of the charging station, he has to insert the pin that the application displays in order to let the charging process begin. Always through the application, the user is able to pay for the service thanks to the previously setted payment method. The system also notifies the user when the charging process is completed.

Retrieving informations about charging stations Whenever a user selects a charging station, various informations are shown in order to help the user to make a decision on

which station to choose. Informations reguard location, price, a parameter on how green the energy provided is, special offers and availability of sockets in the station.

Get suggestions about the recharge of the vehicle An additional feature the system offers reguards a proactive suggestion about the recharge of the vehicle. Thanks to the connection of the application with the vehicle and with the electronic calendar, the system is able to suggest to the user where and when to charge the vehicle in order to satisfy certain parameters chosen by the user. These may involve minimizing the cost of the recharge, minimizing the environment impact of our recharge, minimizing the distance from the scheduled appointments.

2.2.2 CPMS

Accessing the CPMS as CPO In order to manage the CPMS an authentication with proper authorization is required. So CPOs can login to the system with e-Mail and password. The CPO has different informations linked to him in the system, like Name, Surname, e-Mail, password, charging stations that he can manage.

2FA for CPO? only login so that the registration will be done by the sysadmin (in this case, add this figure in the rest of the document). If not added manually but we accept registration, it should be authorized by a sysadmin or something like that

Manage the energy source for a charging station An authorized CPO can manage stations choosing manually how to charge vehicles, so if he wants to use batteries or DSO's energy in base of their cost and environment impact. In base of these decisions, CPOs can decide the cost of a charge and special offers to increase visibility of the station in order to promote greener solutions. Whenever the cost of the energy of some DSO is parcticulary convenient the CPO can also decide to store it in the batteries. If the CPO wishes, the CPMS can also work in automatic mode, so the system is able to make all the decisions written above.

2.3 User characteristics

We consider the following actors in the eMall system:

- **A1 Unregistered user:** A user that needs to register before accessing all the eMall or CPMS services;
- **A2 Registered default user:** A user that has access to all the eMall features. This actor is associated to an electric vehicle and can visualize the nearest stations, book/cancel/-pay a charge, visualize the status of a charge and activate the automatic suggestion service based on the agenda;
- **A3 Registered CPO maintainer user:** A user that has access to all the CPMS features. These features allow the maintainer to configure the CPMS depending on the energy source strategy and visualize all charging stations statuses;

2.4 Assumptions dependencies and constraints

2.4.1 Assumptions

DA1 Users insert genuine data in the forms;

DA2 Users(Including CPOs) do not use the system with malicious intent;

DA3 All the electric vehicles can be charged by all the stations (no incompatibility);

DA4 All the user have an active internet and GPS connection always available while using the service;

2.4.2 Constraint

C1 If a User wants to change the time slot of a charge he is required to cancel and re-book the charge;

3 Specific Requirements

3.1 External interfaces requirements

3.1.1 User interfaces

R1 The eMSP must allow the users to register (providing email, password, payment method and his infos);

R2 The CPMS must allow the CPOs to register (providing email, password, id-station, partita iva, number of possible charging slots);

R3 The system must allow the CPOs to modify the possible charging slots in their stations;

R4 The system must verify the correctness of the identification data for the CPOs;

R5 The system must allow the user to login;

R6 The system must allow the user to choose a specific station, a timeslot;

R7 The system must notify the user when the charging process is finished via a notification;

R8 The CPMS must allow the CPOs to choose the mode (manual or automatic) of operation

3.1.2 Hardware interfaces

3.1.3 Software interfaces

3.1.4 Communication interfaces

3.2 Functional requirements

R1 The system must provide information () about the stations nearby;

R2 The system must reserve a position for a user who registered for a charge through the application;

R3 The system mustn't have collisions in the booking of charges; (non si possono registrare più di X user per timeslot sovrapposti)

R4 The system must take the service money from the user payment method after the charging is finished;

3.2.1 Use case diagrams

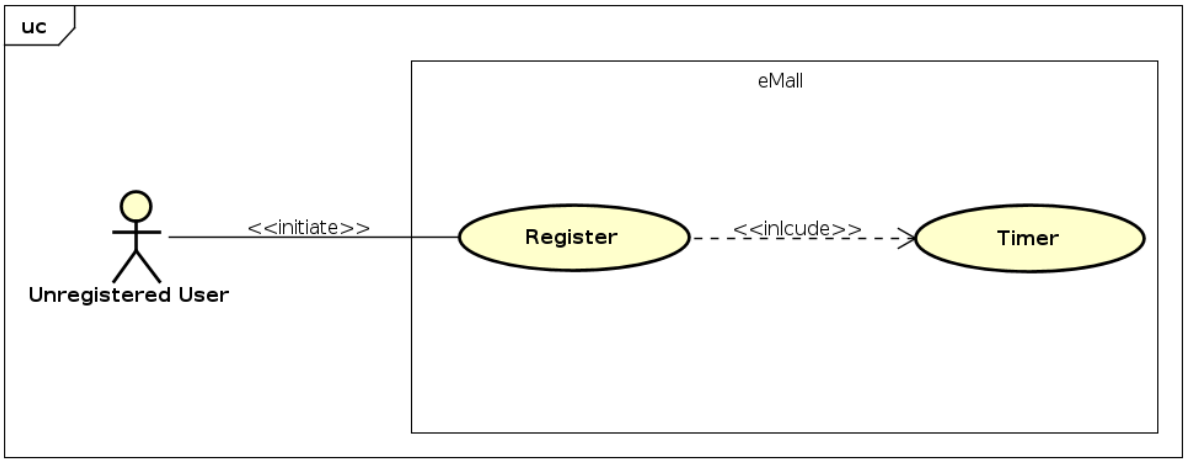

Figure 2: Unregistered user use case

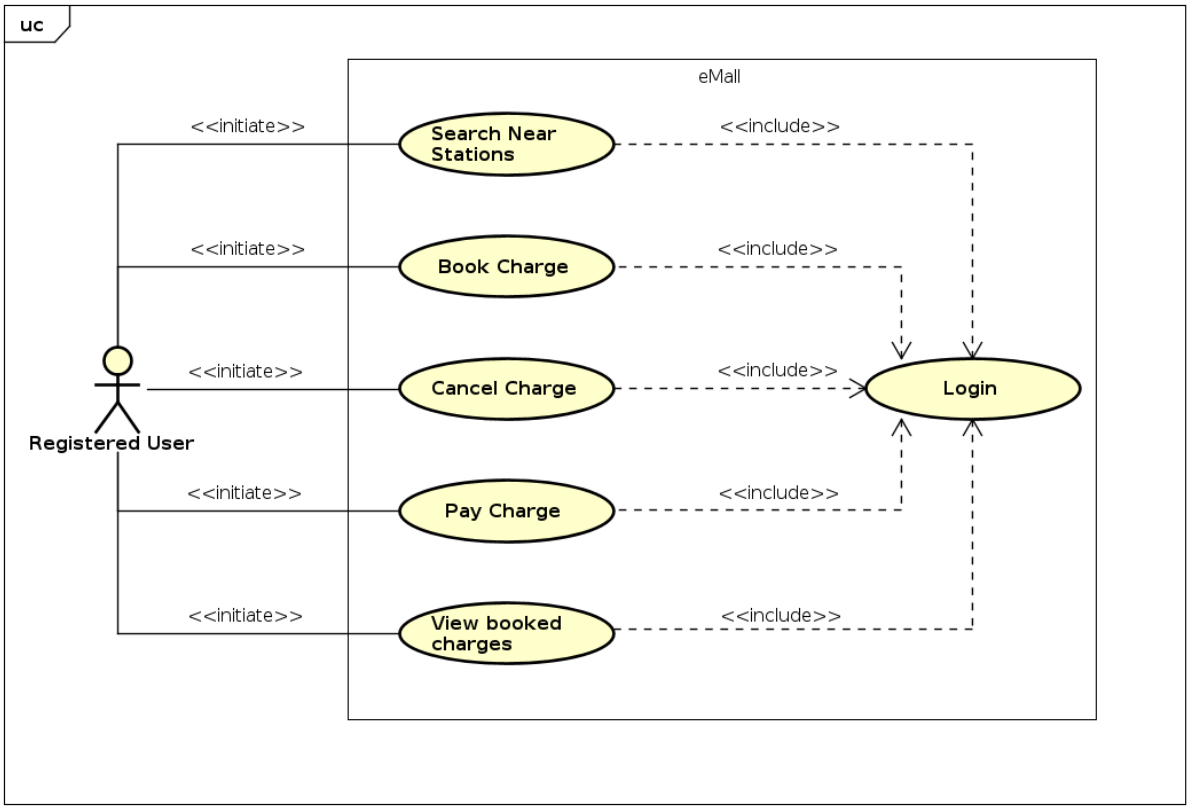

Figure 3: Registered user use case

3.2.2 Sequence diagrams

Per quanto riguarda il sistema CPMS, come si "registra" il CPO maintainer? Nell'UML forse conviene chiamare l'interfaccia eMSP e poi l'attore che la implementa eMall. In questo modo possiamo far sì che le charging sockets utilizzino quell'interfaccia per poter ricavare le info sulla carica quando un utente inserisce il codice.

Below there are some sequence diagrams to show how the basic actions should be over time.

Correggere sequence perform a charge, c'è un sync message tra chargingSocket ed eMall "updateChargingStatus" che non restituisce controllo

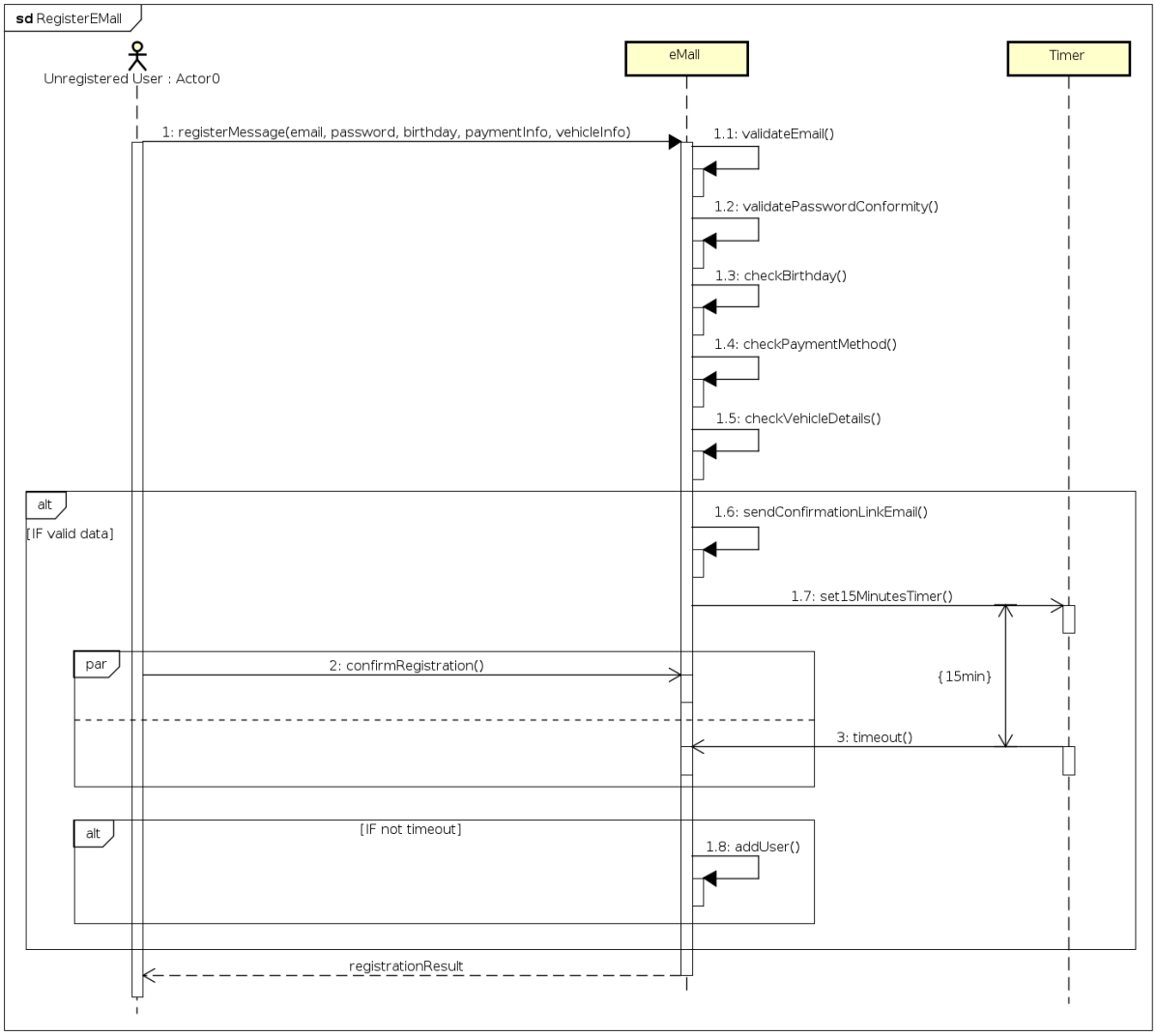

Figure 4: Registration into eMall sequence

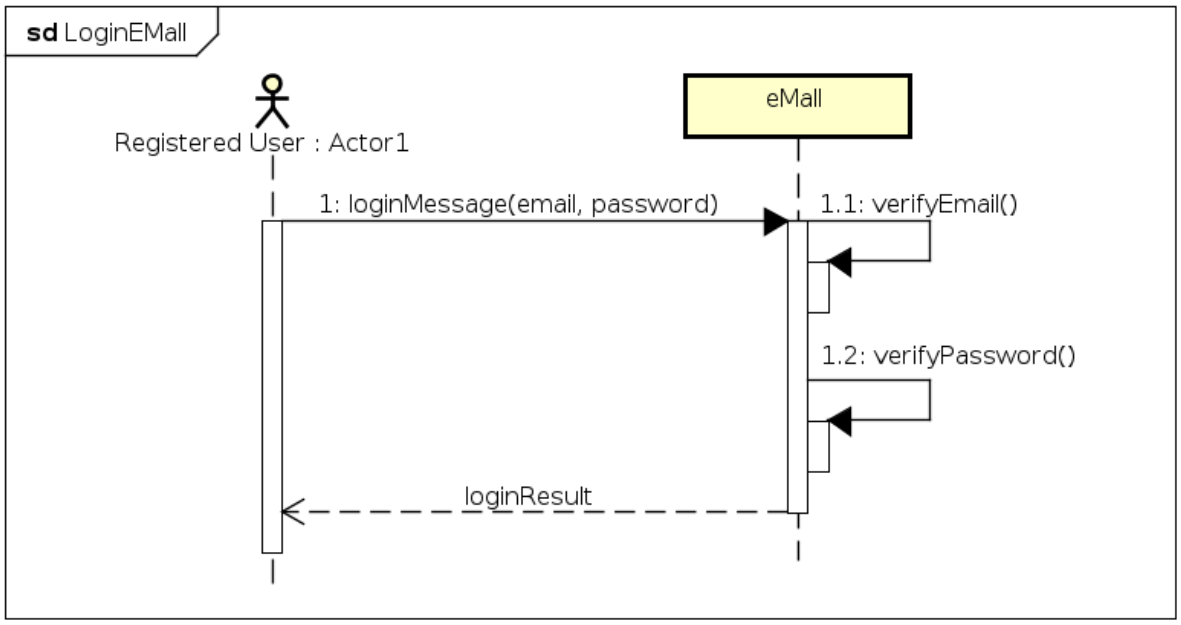

Figure 5: Login into eMall sequence

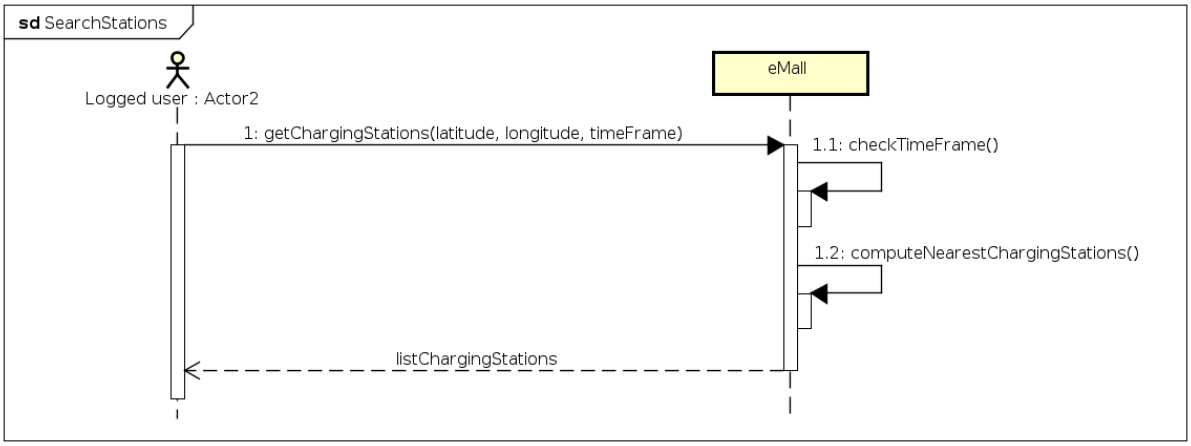

Figure 6: Get the nearby charging stations

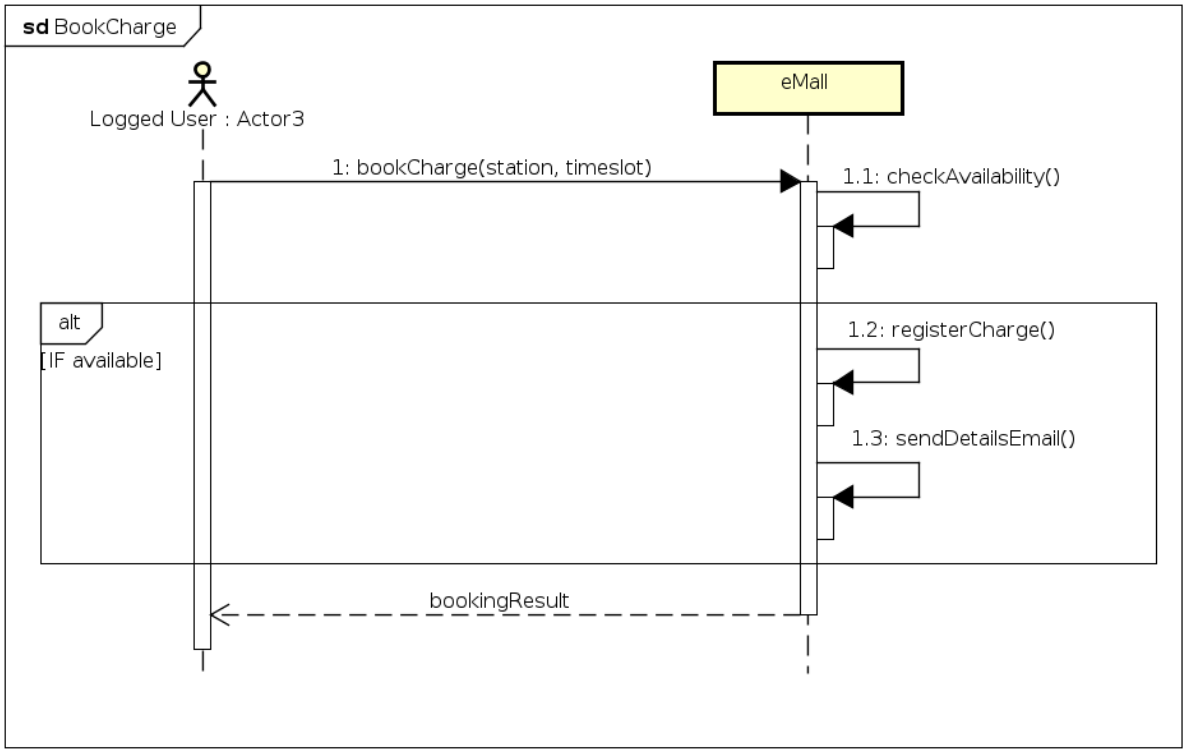

Figure 7: Book a charge sequence

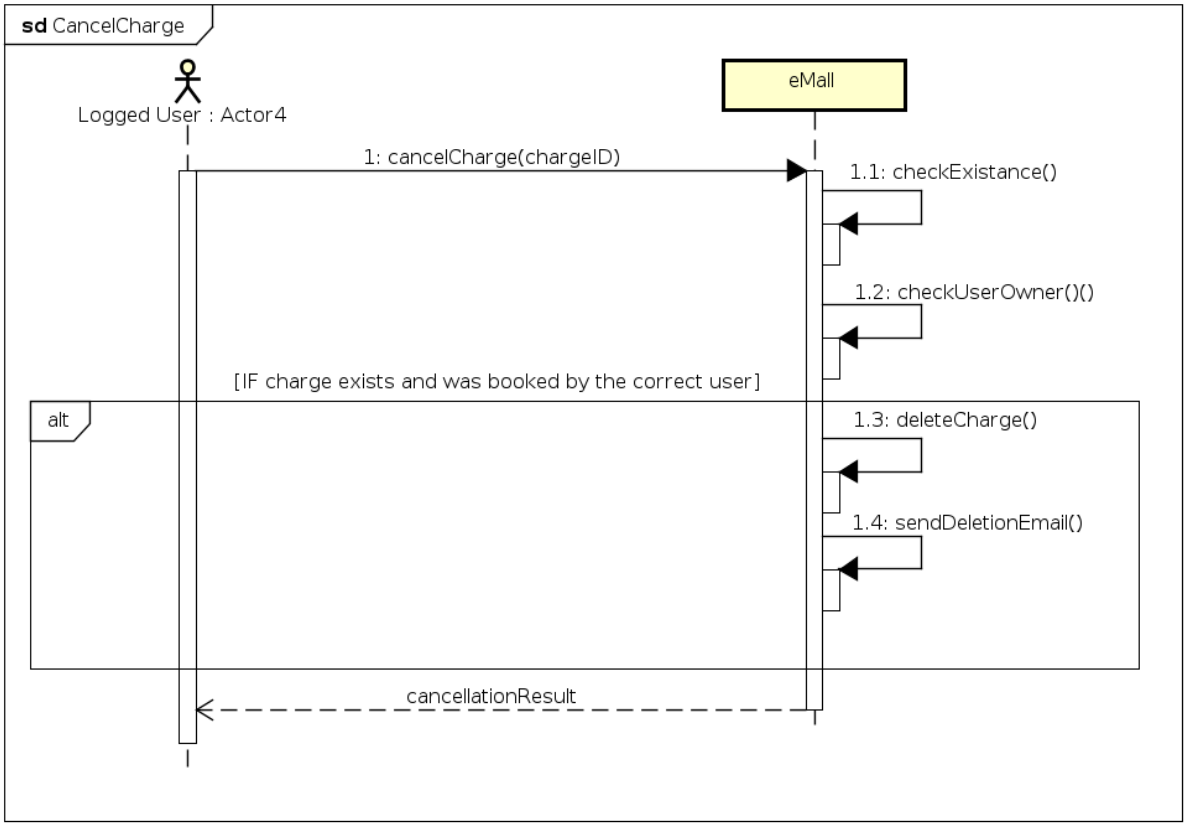

Figure 8: Cancel a charge sequence

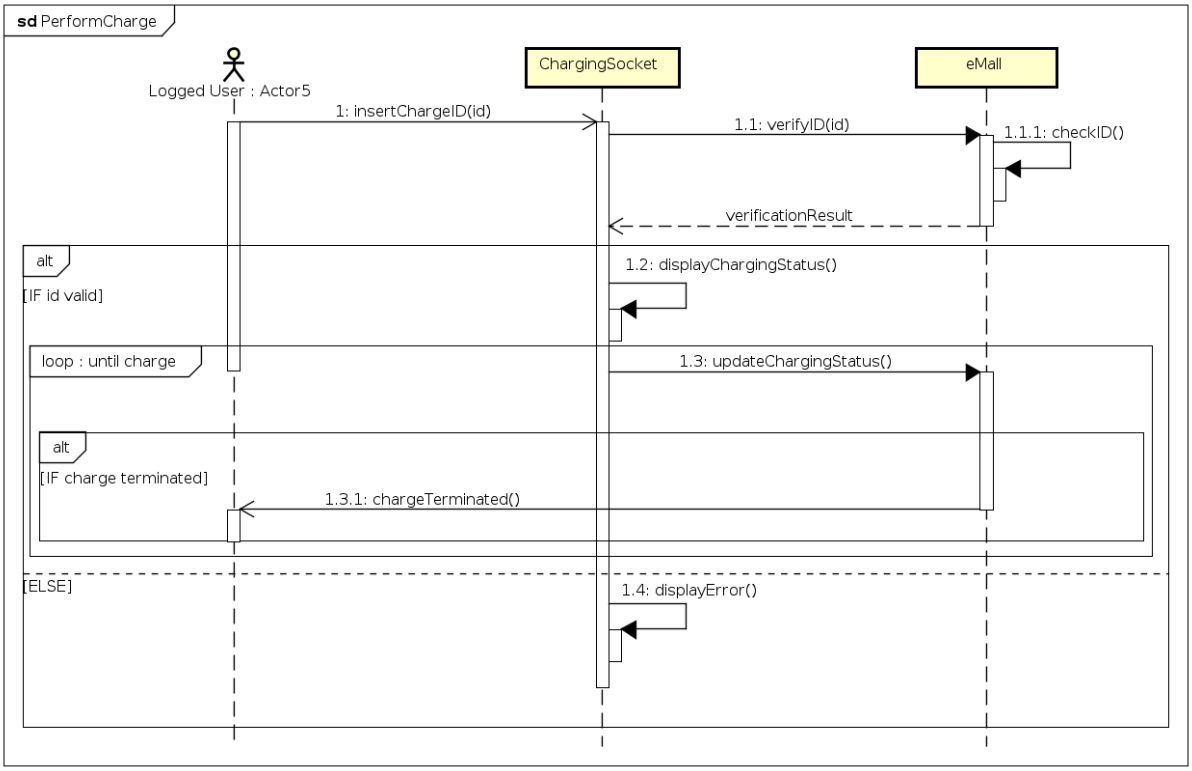

Figure 9: Perform a charge sequence

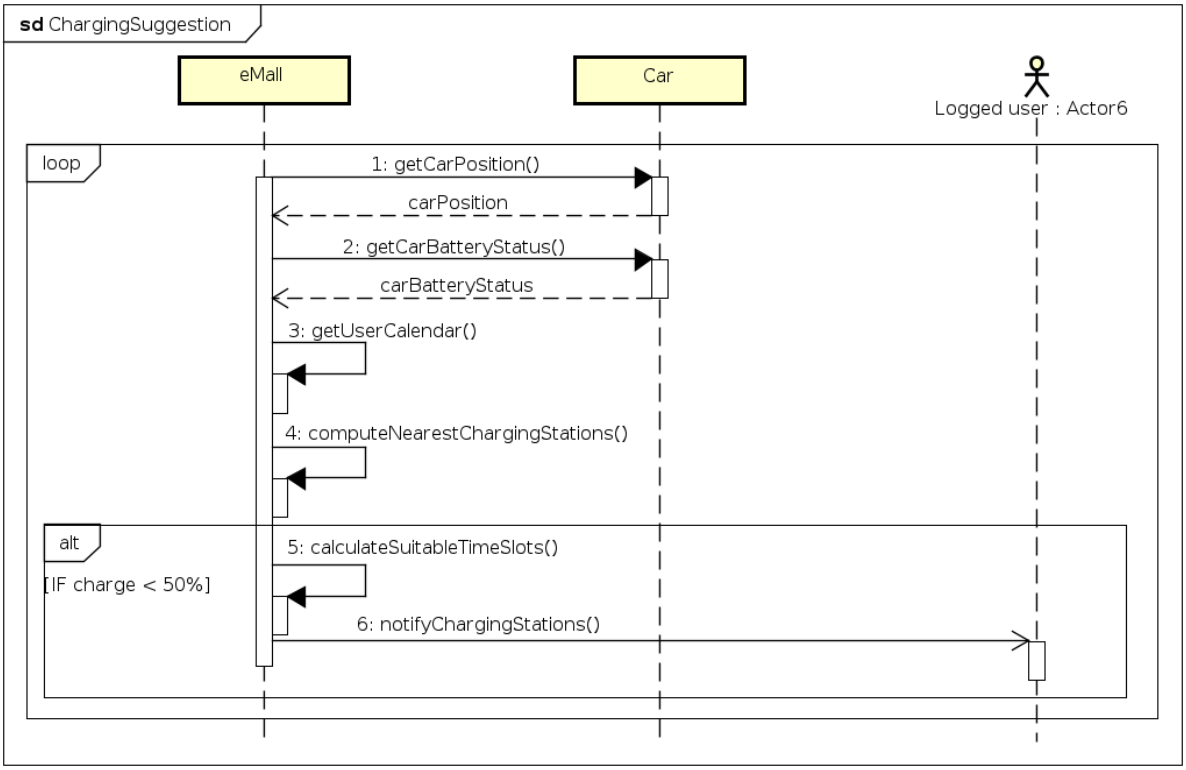

Figure 10: Charging suggestions via calendar sequence

3.3 Performance requirements

The system in general needs to manage a large collection of electric car users/CPOs and it needs to supply the heaviest services (like computing the cheapest nearest stations) in a reasonable amount of time. Because of that the system shall guarantee a baseline load of 1000000 users/CPOs still with a response time not greater than 5 seconds. To achieve the goal, the system shall be able to decentralize all the computation as possible, trying to make the client responsible of the heaviest loads.

3.4 Design constraints

3.4.1 Standards compliance

The system must meet the following standards:

- **General Data Protection Regulation (GDPR) law**: The system must be compliant with the current GDPR law about users privacy;
- **Android and iOS**: The system must be compatible with the current versions and reasonably still used previous ones of Android and iOS.

3.4.2 Hardware limitations

Because the system consists of a smartphone app, the main hardware limitation is the computational capability of a smartphone processor. Hence the application must be compatible with a low computational capability.

3.4.3 Other constraints (TODO MAYBE)

3.5 Software system attributes

3.5.1 Reliability

About the reliability, the system should prefer a fail safe scenarios, where the actual service can behave slower than expected but still consistent with the results. To do so the system should be distributed data wise but also performance wise, allowing a scalability factor while being open for maintenance without completely going down. Some good techniques are Reliable Array of Cloned Services (RACS) and Reliable Array of Partitioned Services (RAPS) which put the reliability very high in the architecture.

3.5.2 Availability

Because as stated before a complete period of down would not be great for this type of service, eMall has to prefer the availability over the actual conformity of response time. Thus the availability should be as high as possible but greater than 99.99% and must use some techniques to avoid down time during maintenance.

3.5.3 Security

Because the system will handle different personal user data, and because one of the standards that it has to follow is the GDPR law, it is required a certain level of security around the system. So an encryption of the user passwords must be adopted and the access to the user's data must be restricted only to the user itself. It is important that not even the system administrator could access the user's data in respect of the privacy laws.
It needs to be highlighted also that according to the GDPR laws, the user has the right to revoke the consent about the usage of the data by the platform. This means that whenever a user decides to delete the account from the system, all the data must about the user must be deleted permanently.

3.5.4 Maintainability

As stated in the Reliability and Availability sections, a good pattern for the whole system would be to consider the maintenance as less invasive as possible, using duplicated data and services. Thus with this idea it would be not complicated to just maintain a single or a restricted amount of nodes per time. This way the user would only experience at worst slowdowns but never actually downtime.

3.5.5 Portability

The system should concretize in an APP for the user's smartphone, so it is important to develop the application as cross platform as possible. Doing so eventual updates and modifies won't need any modify to be actually portable from a device to another.

3.6 Requirements

3.6.1 External Interface Requirements

4 Formal Analysis Using Alloy

5 Effort Spent

- 15/11/2022: 15:00 - 18:00 Federico, Emilio and Matteo
- 16/11/2022: 08:30 - 10:00 Emilio
- 17/11/2022: 21:00 - 23:00 Federico, Emilio and Matteo
- 18/11/2022: 10:00 - 12:00 Emilio and Federico
- 21/11/2022: 19:00 - 20:00 Matteo
- 22/11/2022: 14:30 - 16:00 Matteo
- 23/11/2022: 10:30 - 11:30 Matteo
- 24/11/2022: 21:30 - 22:30 Matteo and Federico
- 25/11/2022: 09:00 - 09:30 Federico
- 25/11/2022: 19:00 - 19:30 Matteo
- 26/11/2022: 08:30 - 09:00 Federico
- 26/11/2022: 16:00 - 17:00 Federico, Emilio and Matteo
- 28/11/2022: 08:30 - 09:00 Federico
- 28/11/2022: 10:00 - 12:00 Emilio
- 30/11/2022: 22:00 - 23:00 Emilio
- 28/11/2022: 08:00 - 08:30 Federico
- 01/12/2022: 16:00 - 17:30 Matteo
- 01/12/2022: 20:30 - 21:30 Emilio
- 01/12/2022: 21:30 - 23:00 Federico, Emilio and Matteo
- 04/12/2022: 19:00 - 20:00 Emilio
- 05/12/2022: 09:00 - 09:30 Federico
- 05/12/2022: 11:00 - 11:45 Emilio
- 05/12/2022: 15:00 - 16:30 Matteo
- 05/12/2022: 19:15 - 19:50 Emilio
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