INTEROPERABILITY AND ROAMING SERVICES

D3.1– Design and specification of interoperability and roaming services (M9)

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Abstract

One of the main USER-CHI aims is to facilitate the interoperability processes at legal, organizational, semantic and technical levels for electric vehicles charging transactions. To do so, two different tools will be designed and developed: INFRA – Interoperability Framework and INCAR – Interoperability, Charging and Parking Platform. This report includes the services definition and specification of both products. These services will be defined and offered to ensure the excellence of the interoperability services, while simplifying the signing of contractual agreements in order to ensure a barrier-free and operator-independent access to charging stations for end users. Furthermore, integrated real-time information and booking services will be provided to EV drivers to enhance their seamless experience with EV charging and parking daily activities.

Keywords

Interoperability, roaming, use case, functionality, architecture, communication protocols, service design, layer, minimum requirements, organisational, legal, technical, semantic, functional, non-functional.

Copyright statement

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Executive summary

The USER-CHI deliverable D3.1 "Design and Specification of interoperability and roaming services" summarizes the results of task T3.1 "Design and specification of services", whose aim is the definition and specification of two project products; INFRA and INCAR.

This document starts with an introduction to the project, followed by the design of INFRA tool. The set of functionalities and services specification of INCAR product is specified in the section 4. This services specification is grouped by the identified functional blocks and includes the definition of frontend and backend components of the system, and how they communicate with each other, though not covering detailed and specialized software and programming aspects.

The USER-CHI task 3.1 with the presented report D3.1 sets the base for the development of mentioned products, INFRA and INCAR, that shall be carried out in the following task T3.2 and task T3.3 respectively.

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1 Introduction

1.1 Purpose of the document

The purpose of this deliverable is to document the work carried out in Task T3.1 "Design and Specification of interoperability and roaming services". It contains the definition of two different tools: INFRA and INCAR. This task defines the high-level architecture of the INCAR platform, the functionalities provided and the services with their respective components offered by INCAR backend and applications.

In this deliverable the design and the specifications of INFRA is defined and described. The description of INFRA is based on a four-layer approach that specifies four significant aspects of interoperability in which both functional and non-functional requirements determine the realisation of interoperable services.

1.2 Scope of the document

D3.1 provides the identification of the set of use cases of the platform which let the specification of INCAR functionalities grouped in different functional blocks, as well the high-level design of the services to be provided by the system. All descriptions are textual and conceptual, oriented to identify the aspects to be covered in the exchange of information and the behaviour of the services.

D3.1 provides a description of the overall INFRA concept. That includes a description of the four-layer approach specifying the four main pillars in which both functional and non-functional requirements are classified into and benchmarked to determine interoperability. The four main pillars of this approach are the organisational, legal, technical and semantic layer. The description of the four-layer approach also exemplifies the logic of the INFRA framework and describes the process that needs to be run through in order to reach interoperability (e.g. through "interoperability checks").

1.3 Structure of the document

Although both tools included in Task T3.1 aim to resolve interoperability and roaming issues, INCAR will be a software development meanwhile INFRA will consist on a set of rules, guidelines and recommendations. Due to this difference, the way of definition of both tools will not be similar so their design can be detailed in different deliverable sections.

Following this introduction chapter, chapter 3 provides an overview of the overall INFRA design and specification. This Includes a short definition of INFRA, Its overall methodological approach and dimensions (layers).

Chapter 4 presents the whole INCAR specification: list of use cases, functional blocks, platform architecture and services description.

Chapter 5 closes the interoperability and roaming services specification by providing a conclusion.

Finally, chapter 6 collects the references and acronyms employed in the document.

2 Connection to other tasks

2.1 Usage scenarios, T1.2

Task T1.2 will focus on integrating the requirements and types of solutions demanded by the end-users and the five demo sites involved in the project. The usage scenarios will be the final output of this research about needs to be covered by the different USER-CHI products.

The usage scenarios set the baseline for the design and implementation of INCAR platform and therefore act as a reference for the demonstration. However, since the working process for T1.2 ends later than T3.1, the current design and specifications for INFRA and INCAR cannot take into account the whole set of users and pilot site's needs. Nevertheless, the conclusions obtained from T1.2 results will be analysed and any relevant result will be considered as an input for the specifications and design of INFRA in T3.2 and the development of the INCAR platform in task T3.3.

2.2 Technical and legal requirements, T1.3

This task will focus on collecting the requirements that USER-CHI solutions should consider when developing the products and the standards and normative restrictions that USER-CHI solutions must accomplish at all 5 partner countries and a selected set of at least 5 other relevant EU countries. These requirements will have two basic levels: technical and legal. All these requirements will be the inputs to define the services and specifications that USER-CHI solutions must accomplish.

This connected task presents the same situation as the previous one: the established delivery date for T1.3 is after T3.1 end date. As a result of T1.3, we will have the whole set of requirements which are considered a very relevant input for both the INFRA framework and INCAR platform specification and implementation. Apart from T1.3 conclusions, relevant technical aspects and requirements such as platform architecture, services components or communication protocols are already known, therefore they are presented in this report.

3 INFRA design and specification

The aim of this chapter is to provide an overview of the overall Interoperability Framework (INFRA) concept. That includes both a description of INFRA design and its specification. INFRA is based on a four-layer approach that will be described in-depth within this chapter. The description of the four-layer approach will include the specification of the four layers which are classified into a "global layer" and "specific layers". Furthermore, the functional and non-functional requirements will be specified. Also, the process that needs to be run through to reach interoperability (e.g. through "interoperability checks") will be outlined. The overall concept of INFRA is based on the existing demand for interoperability for services on the electromobility market focusing mainly on (public) EV charging infrastructure and electromobility roaming services.

3.1 Definition

The overall INFRA concept represents a framework and a product of USER CHI that provides an overview to various stakeholders under which conditions interoperability can be reached resulting in improved usability of charging infrastructure by addressing different barriers that currently do not allow for interoperability, e.g.:

- multiple/different e-roaming platforms with proprietary protocols,
- different authentication and billing technologies such as RFID cards, smartphone apps, QR codes and means of payment resulting in difficulties to access charging stations
- payments between CPOs and EMSPs when a user using a charging point operated by one CPO wants to charge at charging point owned by another CPO (e.g. on a long trip or journey)
- legal barriers on the local, regional, and national level

INFRA, therefore, will consist of a set of rules, guidelines and recommendations to support highly interoperable processes among the electromobility stakeholders along the two TEN-T corridors, satisfying four layers of interoperability.

3.2 Methodological Approach of Four Layers ("Four-Layer Approach")

The overall INFRA concept is based on the four-layer approach. It comprises of an organisational, legal, technical and semantic layer addressing different fields of interoperability regarding electromobility services and the five technical USER-CHI products INCAR, CLICK, SMAC, INDUCAR and INSOC. INCAR - Interoperability, Charging and Parking Platform is directly linked to INFRA in terms of the application of interoperability.

INFRA offers a sequence of multiple steps and iterations considering the organisational, legal, technical and semantic layer to incrementally approach the overall interoperability of a USER-CHI product or electromobility service (see Figure 1). A detailed, separated description of the organisational, legal, technical, and semantic layer is provided in the subchapters 3.2.1, 3.2.2.1 and 3.2.2.2. The organisational level is also referred to as "global layer", whereas the legal, technical, and semantic layer is each referred to as "specific layer".

The four-level approach follows a top-down mechanism and aims at compiling and checking the common or minimum interoperability requirements for a technical USER-CHI product or electromobility service that will be developed and implemented within the project. Within this top-down mechanism, multiple steps must be accomplished. The dependencies and sequences between the different steps and components of INFRA are indicated by arrows in different colours (see Figure 1).

In **¡Error! No se encuentra el origen de la referencia.** the overall design of INFRA and the four-layer approach is reflected. The main condition of INFRA is the need for the demand for interoperability that aims at making better use of e-mobility services from a user/consumer perspective. As a first step, the **introductory definition** of all terms, goals, functions, and system boundaries of the product, together with the product developers´ objectives for interoperability need to be established **(step 1)**. This first step addresses mainly (but not only) the product developers of each of the responsible project partner(s) and aims at building a common understanding of all stakeholders involved in this process.

After elaborating the introductory definitions for each of the five technical USER-CHI products, the definitions will be discussed within the **organisational layer** with all stakeholders involved in the implementation process of the respective products in order to achieve a uniform and common understanding. At this stage, the definition will be revised or adapted, if necessary **(step 2)**.

The third step focuses on compiling and checking the legal, technical, and semantic requirements for interoperability within the corresponding layers (**step 3**). The outcome of those **three specific layers** will form the minimum or common requirements to be met for legal, technical and semantic interoperability of a product and/or an electromobility service and, thereby, determines their overall interoperability after processing through all three steps of INFRA. This means that the individual results of all specific layers are incorporated into the minimum or common requirements to ensure the overall interoperability of a product or electromobility service.

The legal requirements on national, regional and local level constitute one of INFRA's four essential pillars for interoperability and feed into the outcome of the **legal layer.** It will feed into the definition of minimum or common legal requirements.

The technical requirements are the second fundamental pillar for interoperability and will not only contribute to the minimum or common requirements, but also form the basis for formal agreements between all involved stakeholders. Therefore, the outcome of the **technical layer** will not only be incorporated into the minimum or common requirements, but also in the legal layer by analysing the correlation between charging protocols and standardised B2B contract solutions to reduce number and dissimilarity of necessary contracts.

Semantic requirements are primarily related to technical requirements, as they focus on technical aspects in terms of charging protocols for data exchange among EMSPs, roaming platforms and CPOs. The outcome of the **semantic layer** will therefore feed directly into the technical layer and thus become part of it.

Whether the interoperability requirements for each specific layer have been met is indicated by blue and red arrows, with blue arrows indicating compliance and red arrows indicating non-compliance. When the individual requirements for interoperability of a USER-CHI product are accomplished for all three specific layers (dependencies illustrated with blue arrows), the **minimum or common requirements are met,** and the fourth step is completed successfully (**step 4.1**).

In case that the individual **requirements** for interoperability of a product (dependencies illustrated with red arrows) **are not met** for one or more of the three specific layers, the fourth step is not completed successfully. Therefore, the **product itself or its requirements must be modified** (**step 4.2**). The iterations required for this are illustrated with dashed red arrows in the INFRA methodology and may be done once or several times. After conducting the necessary modifications either at the level of specific layers or at the cross-sectional organisational layer, accordingly the methodology of INFRA must be run through again from step 2 or step 3.

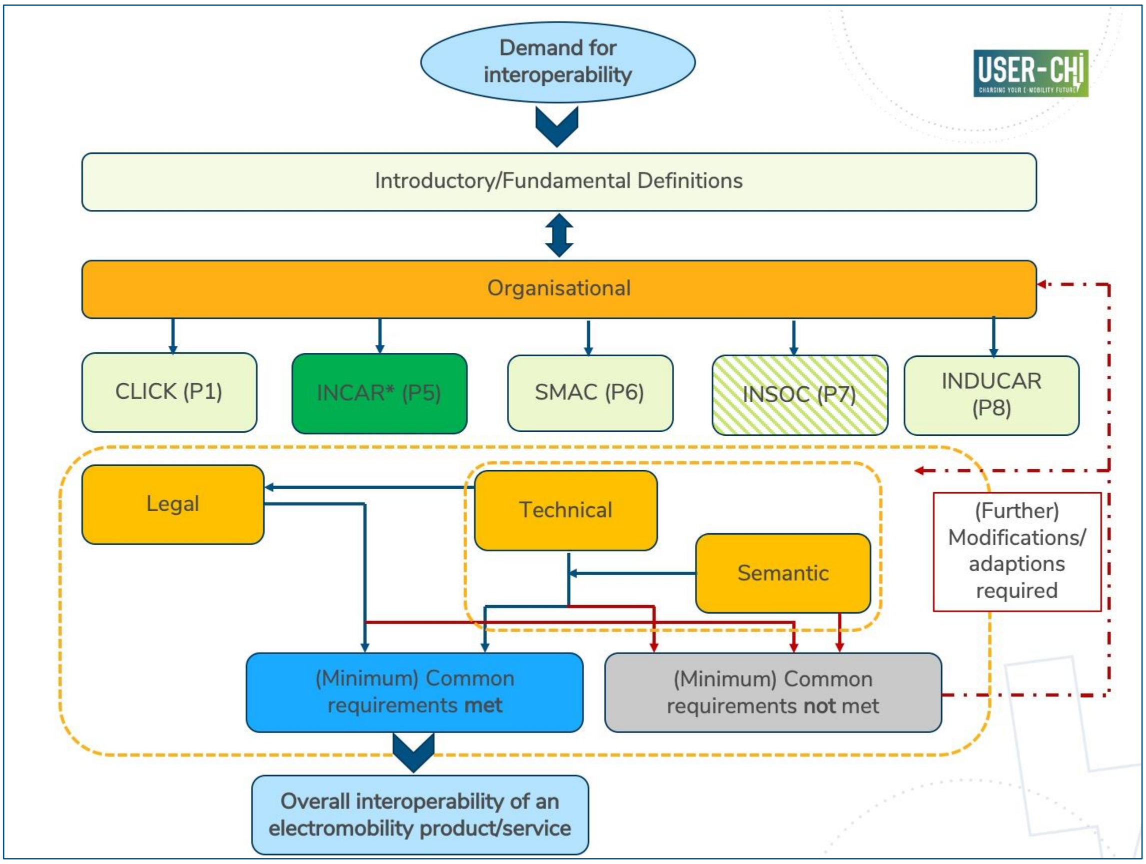


FIGURE 1: OVERALL STRUCTURE AND DEPENDENCIES WITHIN INFRA

3.2.1 Global Layer (Organisational Layer)

The organisational layer of INFRA is also referred to as the global layer. The aim of this layer is to find a common understanding and common grounds among all stakeholders that are involved in the implementation process of electromobility services within the electromobility "ecosystem" aiming for interoperability. This results in the specification of role schemes and the different understandings of goals, functions, system boundaries and responsibilities of the implementation of an electromobility product that may arise.

Therefore, the organisational layer includes identifying and approaching the relevant stakeholders for each product to perform a process of communicative validation. In general charge point operators (CPOs), electromobility service providers (EMSPs) and roaming platforms, as well as public bodies, e.g. municipalities and stakeholders from the energy sector (distribution system operators, metering point operators, utility companies), can be considered as the most relevant stakeholders in the ecosystem of electric vehicles and charging services (Figure 2).

The expected result of successfully completing this validation process is twofold. First, a role scheme that is recognised by all stakeholders expressing their responsibilities has been established. Second, a streamlined and consistent understanding of the goals, functions and system boundaries of the product and their interdependencies in achieving interoperability has been found.

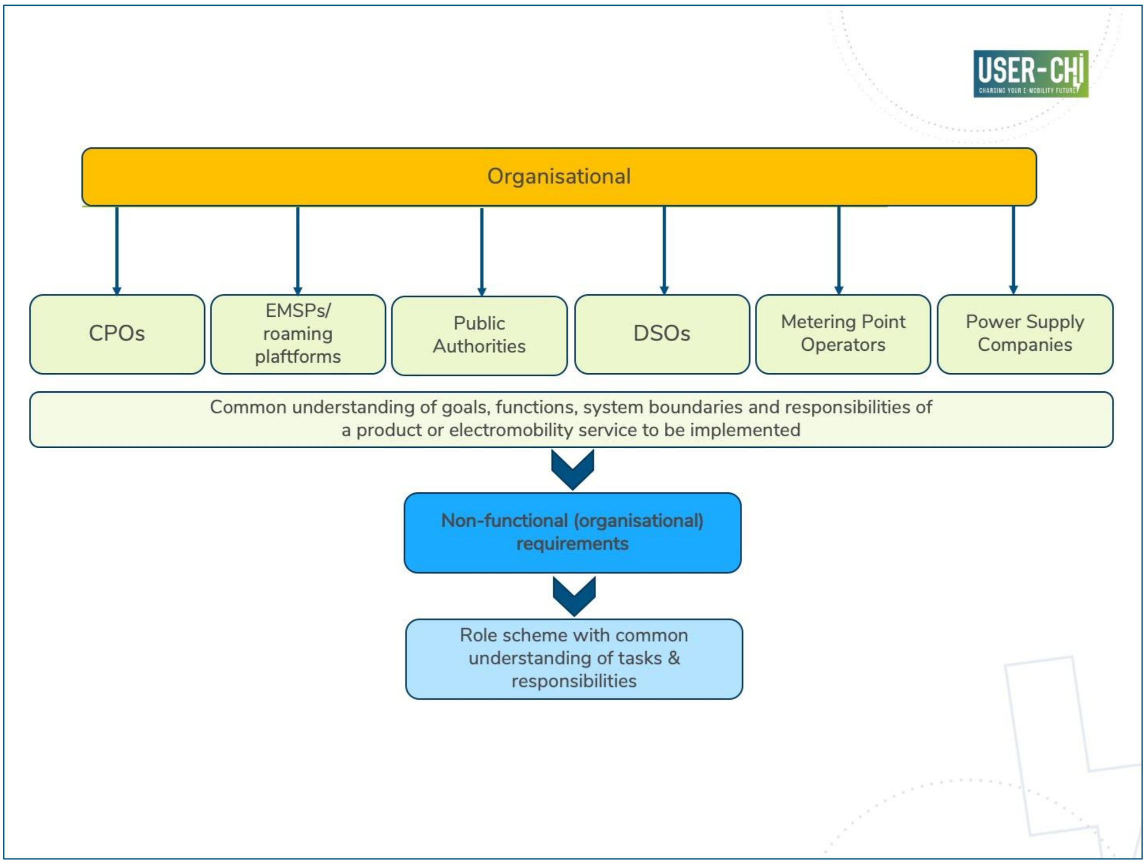


FIGURE 2: COMPONENTS AND SUBSTRUCTURE OF INFRA'S ORGANISATIONAL LAYER

3.2.2 Specific Layers

The legal, technical and semantic layers are also referred to as "specific layers". The semantic requirements are an essential part of the technical requirements. Within this subchapter, both technical and semantic layer will be described together.

The following descriptions and figures include examples of the most important components and issues for interoperability and will be supplemented by further requirements in the course of the application and implementation of INFRA in the upcoming Task 3.2 INFRA – Interoperability Framework implementation of WP3. The list is therefore not exhaustive and reflects a preliminary work status based on this deliverable. Similar to the overall process of applying INFRA, the specific layers are also executed following a top-down mechanism.

3.2.2.1 Legal Layer

The legal layer of INFRA aims at identifying national, regional and local barriers for legal interoperability addressing various fields of law affected by electric vehicles, charging services and infrastructure on European and national level. As described in chapter **¡Error! No se encuentra el origen de la referencia.**, T1.3 will provide essential input to the legal requirements for interoperability, which will be collected by means of a comprehensive survey of selected project partners from the five USER-CHI countries and electromobility stakeholders from five other European countries.

The outcome of the legal layer will not only provide the knowledge about the legal feasibility of interoperability, but also analyse the issue of how to reduce contractual complexity and heterogeneity of B2B agreements for access to charging networks, particularly in spite of INCAR platform.

According to Figure 3 an overview of the most relevant fields of law for interoperability of charging services and infrastructure can be summarised as energy law (e.g. Directive 2019/944/EU), “electromobility law” (e.g. Directive 2014/94/EU), road, traffic and transportation law (e.g. Directive 2007/46/EC), measuring and calibration law (mostly with focus on concerns of consumer protection on national level), data protection law (e.g. Directive 2016/679/EU) as well as construction and planning law (e.g. Directive 2018/844/EU). Within the elaboration and execution of the legal layer for each product further fields of law will be complemented accordingly.

Beside the European regulation applying to all member states, the different national and regional legal frameworks will be particularly relevant in the context of “interoperability checks”.

Successfully completing the legal layer of step 3 will contribute to the non-functional requirements within INFRA ensuring legal interoperability and forming the basis for formal agreements between stakeholders.

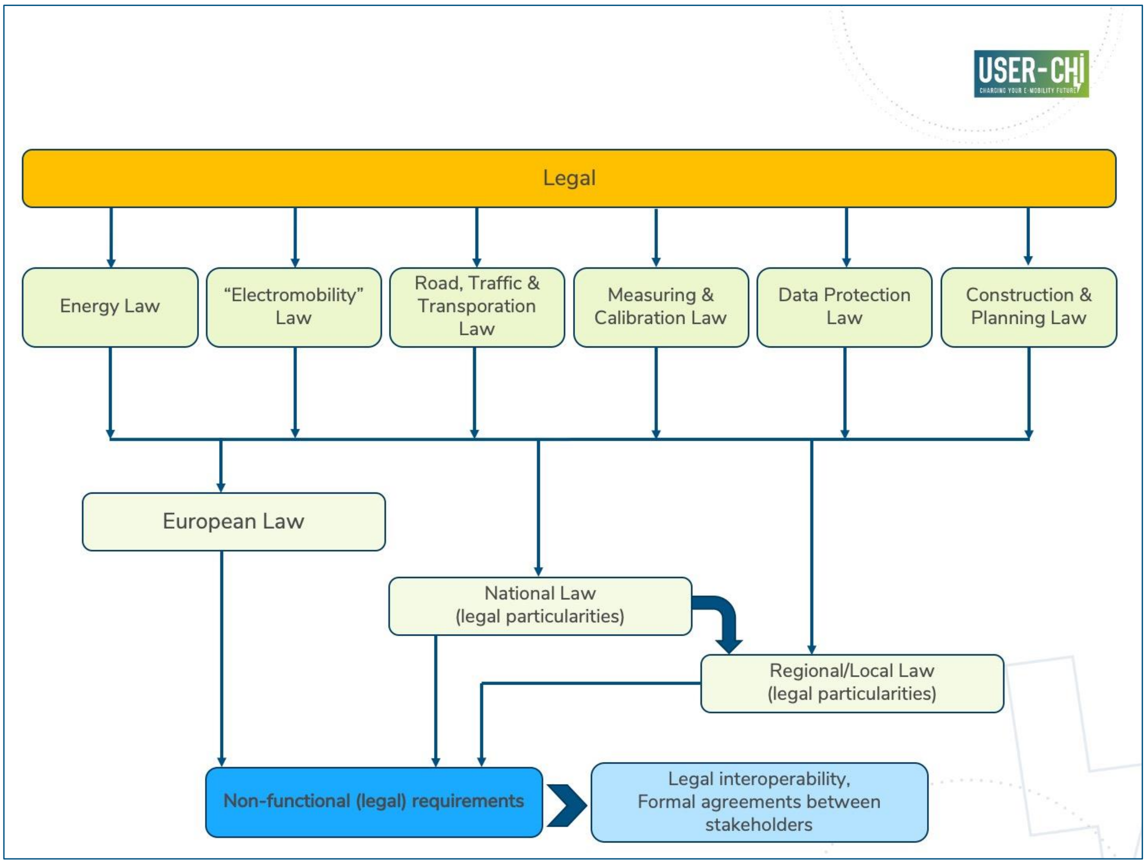


FIGURE 3: COMPONENTS AND SUBSTRUCTURE OF INFRA'S LEGAL LAYER

3.2.2.2 Technical and Semantic Layer

The technical and semantic layers of INFRA aim at identifying and specifying the technical requirements for interoperability for all key aspects involved in providing charging services and infrastructure. This includes both hardware and semantic (communication technology) requirements for electric vehicle supply equipment, payment for charging services, billing, data sharing processes and data management among CPOs, EMSPs and roaming platforms as well user authentication and roaming for an extended user access to charging infrastructure.

As shown in Figure 4 the semantic requirements of the technical layer are focussed on roaming and user authentication, enabled by standardised interfaces and data exchange processes based on open charging protocols.

Similar to the legal requirements, T1.3 will also provide essential input to the technical requirements for interoperability, which will be collected by means of a comprehensive questionnaire focusing on the project's five technical products. The survey will be carried out in parallel with the legal survey with selected project partners from the five USER-CHI countries as well as electromobility stakeholders from five other European countries.

Successfully completing the technical and semantic layer of step 3 will not only contribute to the functional requirements within INFRA, thus ensuring technical interoperability, but also promoting formal agreements between different stakeholders of charging networks and CPOs.

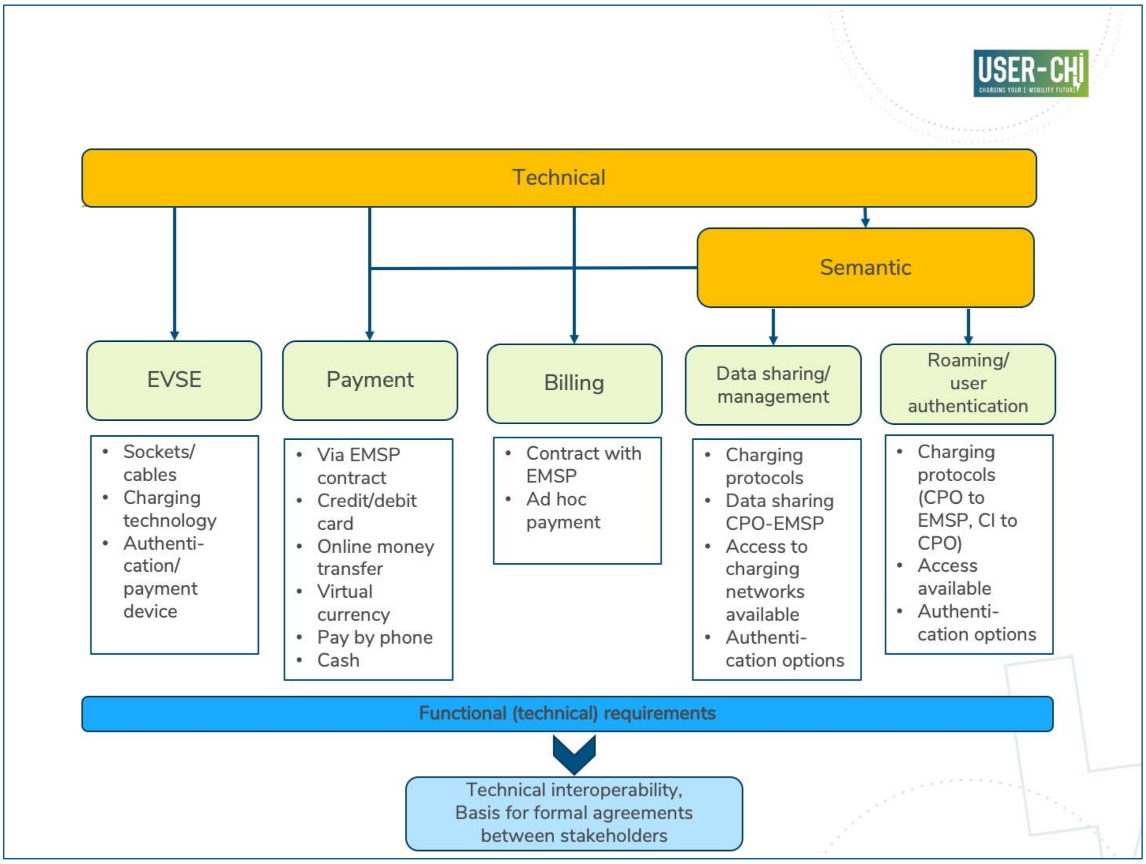


FIGURE 4: COMPONENTS AND SUBSTRUCTURE OF INFRA'S TECHNICAL AND SEMANTIC LAYERS

3.2.2.3 Functional and non-functional requirements

Each technical USER-CHI product must meet the pre-assigned/defined interoperability requirements from all layers to achieve overall interoperability. Nonetheless, not all requirements to be met are essential for the technical functionality of a product.

Therefore, it can be distinguished between **functional** and **non-functional requirements** for interoperability, considering not only the legal and organisational dimension (non-functional) but also the solely technical functionality of a USER-CHI product or service.

Legal interoperability depends to a large extent on the applicable legal framework, which is binding for all stakeholders, whereas technical interoperability is primarily subject to technical standardisation as well as competition and market aspects and is ultimately not implicitly mandatory. For instance, competitors in a market segment may use proprietary technical solutions to differentiate themselves from each other and thus prevent interoperability, but they may also voluntarily create technical interoperability through standards and thus contribute to the technical functioning of products.

4 Interoperability, Charging and Parking Platform specification

The purpose of this chapter is to document the work carried out during the definition and design of INCAR: Interoperability, Charging and Parking Platform. With this objective, the first subsection defines the guiding use cases for the INCAR platform and for the related services and final user devices that will be implemented. The use cases specified are the main input for the specification of the whole set of platform functionalities and services. After that section, the high-level design of the architecture of INCAR is presented, displaying the identified functional blocks of the platform. Finally, the different platform services, components, devices, graphic user interfaces and the communication between all of them will be shown.

4.1 Use cases

The purpose of this section is to document the work carried out during the use case definition. It will outline what a use case is and which are the main functionalities of INCAR product for the correct design of use cases. Later, the format in which the use cases are documented and their corresponding structure is detailed. Finally, the whole use cases identified are presented.

4.1.1 Use case concept

A use case is a technique for capturing potential requirements of a new system. Each use case provides one or more scenarios that indicate how the system should interact with the user or with another system to achieve a specific goal. In other words, a use case is a sequence of interactions that will take place between a system and its actors, in response to an event that the main actor initiates on the system itself. The definition of use cases is the first step to define how the INCAR platform should be implemented and what actually should be demonstrated during the project. It defines the scope of each INCAR functionality and describes how the platform will interact with users and other systems.

4.1.2 Background information for use case definition

In order to be able to make a detailed description of the use cases, this section provides a brief introduction in the INCAR main functionalities and services.

The objective of this product is to enable EVs to be charged at an EVSE regardless of whether the owner/user of the vehicle has a contract with the provider that operates the charging point or not, and in a transparent manner. This is possible thanks to the standard protocol OCPI [1]. Other solutions like the Hubject platform also cover this objective, but those solutions use proprietary communication protocols, while INCAR aims at offering a standard solution that is open to support different business models for exploitation. Several concepts need to be clarified in order to understand the functionality of this product:

- The charging points are owned and managed by the CPO
- Clients have contracts and pay for the charging service to EMSPs which are in charge of billing
- In the roaming scenario, the process of charging an EV at an EVSE is managed via the exchange of messages defined in the OCPI protocol between the CPO that operates the EVSE and the EMSP of the driver. This message exchange between EMSP and CPO will be performed by INCAR backend.

INCAR will offer new value-added and integrated EV related services such as combined smart parking and charging, monitoring real-time information about publicly accessible EVSE, searching and routing to EVSE as well as reservation of charging spots. These integrated services will allow EV drivers to plan their trip according to the status of their EV batteries, find and book in advance a parking spot with charging point and to be routed to it by means of a free smartphone app.

Besides, with the development of smart city dashboard, the information related with all electromobility elements presented in a city will be also available to the pilot sites. Real-time information includes the current status of parking spots and charging points (available, not available, out of order).

4.1.3 Use case definition methodology

Each use case is defined and documented in a dedicated use case table. The specification of each use case always follows the same format:

- Use Case Title: Identification code and descriptive name/title of the use case.
- Short description: Summary of the use case.
- Stakeholders: Anyone or anything that performs a behaviour (who is using the system). A use case defines the interactions between external stakeholders and the system under consideration to accomplish a goal. The stakeholders can be either natural persons or system stakeholders.
- Pre-conditions: Refer to the state of the system and its environment that is required before the use case can be started. It can be helpful to use preconditions to clarify how the flow of events starts.
- Trigger: This is the event that causes the use case to be initiated.
- Flow of events: The description of the normal, expected path through the use case (“Happy Path”). This is the path taken by most of the users most of the time.
- Expected results: Shows the expected outcomes after the use case execution.

4.1.4 Use case definition template

The use case definition template is represented in table 1. It contains the information described in the previous chapter.

TABLE 1: USE CASE TEMPLATE

Use case tittle	
Short Description	
Stakeholders	
Preconditions	
Trigger	
Flow of events	
Expected results	

4.1.5 Use cases list

In this section, the use cases which cover INCAR functionalities are presented. As it was explained in previous sections, all functional requirements will be available once the task T1.3 ends, which collects all possible scenarios in which INCAR platform will be present. The following use cases have been specified by the whole consortium, designing an initial list which has been increased and modified after several revisions and iterations performed by the project partners.

TABLE 2: USE CASE 1: USER LOGIN

Use case tittle	UC – 001: User login
Short Description	A user of INCAR app for EV drivers logs in
Stakeholders	• EV driver as end-user • EMSP (Electromobility Service Providers) with which the driver has a service contract
Preconditions	• The driver has a contract with one or more EMSPs integrated in INCAR platform • The driver has INCAR app for e-driver installed in his/her mobile device
Trigger	The driver enters the application
Flow of events	• When a user wants to access services which require a login, the INCAR app displays a list with all EMSPs involved in INCAR platform. • The user selects one of the EMSPs with which he or she has a contract. • The application requests user ID and password • The driver provides correct user ID and password
Expected results	• The user is authenticated and gets logged in INCAR app. The app authorises the user to use its services • INCAR app gets access to user tokens of a central identity management system which contain relevant information (name, mail, etc.) • The INCAR functionalities which require a login become available to the user
Exception paths	• If the driver provides wrong user ID or password an error message is displayed in INCAR app

TABLE 3: USE CASE 2: IDENTITY PROVIDER VALIDATES USER CREDENTIALS

Use case tittle	UC – 002: Identity provider validates user credentials
Short Description	INCAR app interacts with the central identity management system in order to authenticate the final user and get necessary data such as OCPI token to perform further operations.
Stakeholders	• EV driver as end-user • EMSP (Electro-mobility Service Providers) with which the driver has a service contract
Preconditions	• The driver has a contract with an EMSP integrated in INCAR platform • Before introducing credentials, the user has selected the EMSP with which has a service contract. • The EMSP has introduced their customers information in identity provider system • The user login form of the identity provider is displayed in INCAR app.
Trigger	The driver introduces his/her credentials in the login form.
Flow of events	• The identity provider validates user credentials • Credentials are correct so the identity provider redirects to INCAR main view
Expected results	• The user is authenticated and INCAR is informed about relevant user information (name, mail, OCPI token, etc.)
Exception paths	• If the driver provides wrong user ID or password an error message is displayed in INCAR app

TABLE 4: USE CASE 3: LOOKING FOR A SUITABLE EVSE

Use case tittle	UC – 003: Looking for a suitable EVSE
Short Description	A driver uses INCAR app to look for a suitable EVSE near the location of interest that is operated by a provider with which he/she has or does not have a service contract
Stakeholders	• EV driver as end-user • CPO (Charging point operator) that offers the charging infrastructure
Preconditions	• The EVSE is operated by a CPO integrated into INCAR • CPOs provide charging station data including static and dynamic data to INCAR backend • INCAR app requests charging station data of all integrated CPOs from INCAR backend
Trigger	The driver uses either the map view of INCAR app to locate look for an EVSE to charge his/her vehicle or the vicinity search to look for closest EV taking into account additional filters
Flow of events	• The driver may indicate any optional filters, such as the kind of connector of his/her EV, the mix of provided energy or which CPOs to be included for the display of charging stations in the map view or vicinity search • The set of EVSEs near the EV driver location is displayed. • The driver may select an EVSE, in order to visualize more information such as availability status of tariffs.
Expected results	• The driver knows which EVSEs are available and suitable for his/her EV in the area of interest and selects one for booking or starting a charging transaction

TABLE 5: USE CASE 4: ROUTING TO SELECTED EVSE

Use case tittle	UC – 004: Routing to selected EVSE
Short Description	A driver uses INCAR app to get the route to a selected EVSE
Stakeholders	• EV driver as end-user • CPO (Charging point operator) that offers the charging infrastructure
Preconditions	• The EVSE is operated by a CPO integrated in INCAR • CPOs provide charging station location as well as static and dynamic data to INCAR backend • INCAR app requests charging station data of all integrated CPOs from INCAR backend • INCAR app has integrated routing services that cover all areas of charging station locations
Trigger	The user selects an EVSE in the map view or vicinity search of INCAR app and clicks on the routing button
Flow of events	• The driver selects and EVSE and requests a routing to this location. • The EV driver can set different trip optimization criteria such as duration or CO2 emissions for the route calculation • The location of the EVSE is translated by INCAR app to destination address for routing • INCAR app calculates the route to EVSE taking into account current traffic situation based on Floating Car Data (FCD) • INCAR app presents the routing results in map view and list of directions
Expected results	• The driver receives directions by INCAR app in order to find the fastest way to selected EVSE

TABLE 6: USE CASE 5: BOOKING AN EVSE

Use case tittle	UC – 005: Booking an EVSE
Short Description	A driver books an EVSE that is operated by a CPO integrated in INCAR
Stakeholders	• EV driver as end-user • CPO (Charging point operator) that offers the charging infrastructure • EMSP (Electro-mobility Service Providers) with which the driver has a service contract
Preconditions	• The driver has a contract with an EMSP integrated in INCAR platform • The EVSE is operated by a CPO integrated in INCAR • The CPO must allow EVSE reservation • CPO and EMSP have a roaming contract • The driver has logged in INCAR app and has been authenticated and authorized to use the service
Trigger	The user has selected an EVSE and decides to book it
Flow of events	• The driver uses the app to select a convenient EVSE to book • The driver confirms the booking • INCAR interacts with the CPO of the EVSE and the EMSP of the user (sending the required information about the user, the EVSE and the transaction) and manages the booking
Expected results	• The new status of the EVSE, reserved, is displayed in INCAR app (for all users) • The status of the reservation is displayed in INCAR app (for the user that made it) • The INCAR application and backend shall not allow making any booking nor starting any transaction in the EVSE until the booking expires

TABLE 7: USE CASE 6: STARTING AN EV CHARGING TRANSACTION USING INCAR APP

Use case tittle	UC – 006: Starting an EV charging transaction using INCAR app
Short Description	A driver starts a charging transaction at an EVSE that is operated by a CPO integrated in INCAR by using the INCAR app
Stakeholders	• EV driver as end-user • CPO (Charging point operator) that offers the charging infrastructure • EMSP (Electro-mobility Service Providers) with which the driver has a service contract
Preconditions	• The driver has a contract with an EMSP integrated in INCAR platform • CPO and EMSP have a roaming contract • The EVSE is operated by a CPO integrated in INCAR
Trigger	The driver has connected the EV to the EVSE and wants to start a transaction
Flow of events	• If the driver has previously booked an EVSE, he/she uses the app to display his/her currently active booking(s) and activates the option to start the charging transaction • Otherwise, the user selects the EVSE in the app and activates the option to start the charging transaction • The driver confirms the starting of the transaction • INCAR interacts with the CPO of the EVSE and the EMSP of the user (sending the required information about the user, the EVSE and the transaction) and manages the transaction start. • If the CPO provides updates about the charging progress (kWh, time, cost etc.), this information will be displayed in INCAR app during charging process.
Expected results	• The charging transaction is registered in the EMSP, CPO and INCAR platform and the EVSE initiates the charging process. • The new status of the transaction is displayed in INCAR app.

TABLE 8: USE CASE 7: ENDING AN EV CHARGING TRANSACTION USING INCAR APP

Use case tittle	UC – 007: Ending a EV charging transaction using INCAR app
Short Description	A driver ends a charging transaction at an EVSE that is operated by a CPO integrated in INCAR
Stakeholders	• EV driver as end-user • CPO (Charging point operator) that offers the charging infrastructure • EMSP (Electro-mobility Service Providers) with which the driver has a service contract
Preconditions	• The driver has a contract with an EMSP integrated in INCAR platform • The EVSE is operated by a CPO integrated in INCAR • CPO and EMSP have a roaming contract • The user has previously started a charging transaction at an EVSE
Trigger	The driver wants to end the active transaction and disconnect the EV from the EVSE
Flow of events	• The driver uses the app to display the active transaction and clicks the button to end it • INCAR interacts with the CPO of the EVSE and the EMSP of the user by means of the OCPI protocol, and manages the transaction end.
Expected results	• The end charging transaction is registered in the EMSP, CPO and INCAR platform, and the EVSE ends the charging process • Relevant information for statistics services and smart mobility dashboard will be stored and analysed (e.g. power supplied, time spent, etc.) • The new status of the transaction is displayed in INCAR app • At the end of each charging session, the CPO sends the EMSP/INCAR accounting service the charging detail information which contains all relevant data about the charging session. • The transaction summary is shown in the list of transactions in INCAR app

TABLE 9: USE CASE 8: DISPLAY REAL-TIME INFORMATION IN THE SMART E-MOBILITY DASHBOARD

Use case tittle	UC – 008: Display real-time information in the Smart E-Mobility Dashboard
Short Description	The user has access to information in real-time and status of the different elements of the electromobility in the city
Stakeholders	• An analyst or decision-maker of the city council or any other organization that needs to evaluate the performance of the electromobility in the city
Preconditions	• The city EVSEs are operated by CPOs integrated in INCAR
Trigger	The user wishes to display information
Flow of events	• The elements of the electromobility in the city (e.g. EVSEs) that have a geographical position are displayed in a map. • The user clicks an element in the map and details about it are displayed.
Expected results	• Details about selected element are displayed • Set of real-time information that could be provided: EVSE status (idle, booked, charging, out of order), amount of drivers who are charging their EVs, information about EV and its state of charge when available, the power that EVSEs are providing, progress bar about charging transaction (reporting time and power), CO_2 equivalent emissions in current transactions, tariff description, EVSE owner (CPO), Smart charging support (y/n), etc.

TABLE 10: USE CASE 9: DISPLAY HISTORIC INFORMATION IN THE SMART E-MOBILITY DASHBOARD

Use case tittle	UC – 009: Display historic information in the Smart E-Mobility Dashboard
Short Description	The user displays historic data about metrics or status of the different elements of the electromobility in the city
Stakeholders	• An analyst or decision-maker of the city council or any other organization that needs to evaluate the performance of the electromobility in the city
Preconditions	• The INCAR services are running and have been storing data for a period of time in the databases of INCAR backend, about the status of the different elements and the values of different performance evaluation metrics of the electromobility.
Trigger	The user wishes to display historic information
Flow of events	• The user, by means of the menus of the application, selects the information of interest (KPI) • The user selects if the information will be shown for each electromobility element (e.g. charging station), or in a global way considering all elements existing in the city. • The user selects the period of time for the representation of historic metrics data.
Expected results	• The KPI(s) values are displayed based in the user search parameters. • Set of relevant KPIs could be: energy and max/mean power provided, CO2 equivalent emissions in transactions, amount of transactions, set of users (EV drivers), time spent on charging processes

TABLE 11: USE CASE 10: PLATFORM JOINS TO INCAR

Use case tittle	UC – 010: Platform joins to INCAR
Short Description	A platform, composed of one or many EMSPs and/or CPOs, joins to INCAR
Stakeholders	• EMSP which is not registered in INCAR platform • CPO which is not registered in INCAR platform
Preconditions	• The EMSP/CPO implements OCPI 2.2 • Roaming agreements are signed between all CPOs and EMSPs already integrated in INCAR with all CPOs and EMSPs of joining platform
Trigger	The EMSP/CPO platform wishes to join INCAR platform
Flow of events	• EMSP/CPO sends different kind of data required in registration process to INCAR platform. • INCAR sends different kind of data required in registration process to EMSP/CPO platform.
Expected results	• The platform joins to INCAR platform and it is allowed to connect with INCAR backend.

TABLE 12: USE CASE 11: SEARCHING FOR ACCOUNTING INFORMATION

Use case tittle	UC – 011: Searching accounting information
Short Description	Displaying accounting information to platforms involved in INCAR.
Stakeholders	• EMSPs which is integrated in INCAR platform • CPO which is integrated in INCAR platform
Preconditions	• EMSP and CPO have been previously joined in INCAR platform • A charging transaction which EV driver is EMSP customer has ended • A charging transaction which has been performed in a CPO location has ended
Trigger	CPO/EMSP logs in INCAR accounting web
Flow of events	• INCAR accounting web validate platform credentials • EMSP/CPO access accounting web • Search parameters such as date are offered to the user in order to filter billing records.
Expected results	Relevant billing information related to the partner who has logged in is displayed.

4.1.6 Use case conclusions

The definition of use cases is the first step to define how the INCAR platform should be implemented and what should be demonstrated during the project. The use cases intend to cover most of the possible situations that INCAR will provide. It defines the scope of each INCAR functionality and describes how the platform will interact with other platforms and with final users. The use cases definition is the first, initial step in specifying the INCAR solution, it sets the basis for the definition and service design.

4.2 Platform architecture and services design

The purpose of this section is to document the methodology employed for the design of the architecture of INCAR platform. From this methodology, the functional blocks have been identified and classified, as well as the system components and backend services, with their respective diagrams and descriptions.

The first step for the definition of the INCAR architecture was to adopt a common understanding of the concept of architecture and all the aspects to be considered. In order to facilitate this, the well-known and widely used "4+1 architectural view model" [2] approach was considered a suitable tool. It was originally proposed by Philippe Kruchten and has been selected for INCAR for its use of views for describing the systems from the point of view of multiple stakeholders.

The purpose of using this model within INCAR is to facilitate a common understanding of the work to be done by all involved partners and to ensure correct identifications of all the aspects of the systems and the issues to be solved.

The model, which is represented in the Figure 5, proposes 4 views for the description of the system:

- Logical view: The logical view is concerned with the functionality that the system provides to end-users and the decomposition of structural elements or abstractions.
- Process view**:** The purpose of the process view is to start to capture both the flow of process and services information exchange (e.g. REST API calls, messaging via a bus) and the sequence and timing of these inter-process communications.
- Development view**:** The development view illustrates a system from a programmer's perspective and is concerned with software management. This view is also known as the implementation view.
- Physical view: The physical view depicts the system from a system engineer's point of view. It is concerned with the topology of software components on the physical layer as well as the physical connections between these components. This view is also known as the deployment view.
- Scenarios**:** The description of an architecture is illustrated using a small set of use cases, or scenarios, which become a fifth view. The scenarios describe sequences of interactions between objects and between processes. They are used to identify architectural elements and to illustrate and validate the architecture design. They also serve as a starting point for tests of an architecture prototype. This view is also known as the use case view

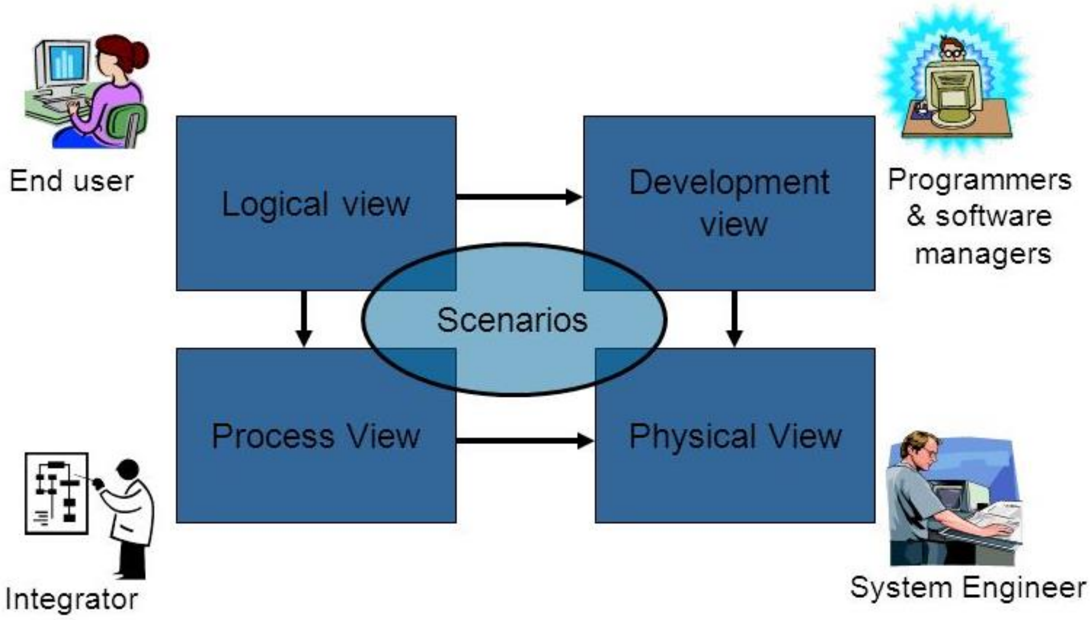


FIGURE 5: ARCHITECTURAL VIEW MODEL

Within INCAR, the scenarios view was already provided and described in the previous use case section. The logical, process, development and physical view will be explained in the next sections.

4.3 Logical view

This view includes the different functionals components and blocks in which the system has been classified.

According to the DoA of the project, INCAR should have at least these components:

- Backend (integrated services): Platform that integrates and manages all the services offered, including the exchange of data among CPOs and EMSPs for interoperability purposes.
- Frontend for individual EV drivers: Mobile app that provides real-time information (location of charging points, their current status, availability of associated parking slots, different tariffs, etc.), trip planning and routing to available EVSE, reservation of parking slots and associated charging points, interoperability to access the EVSE, instant satisfaction feedback from users.

- Frontend for professional EV drivers: Customised mobile app with advanced features, such as integration with load and unload areas and taxi stops, reservation of EVSE with up to 3 days in advance, reservation of associated taxi stops and load and unload areas, information on access restrictions to urban areas, traffic situation (incidents status included), etc.
- Smart e-mobility dashboard for the city management: Dashboard that allows cities to monitor and access real-time information regarding all smart electromobility information and services available in the city. This dashboard could be integrated in a pre-existing urban ICT platform or implemented by its own, depending on the city maturity.

With the aim of improving modularity, extensibility and scalability, after the analysis of the DoA specifications and use cases the architecture of INCAR was finally organized in three layers, as it is shown in the Figure 6:

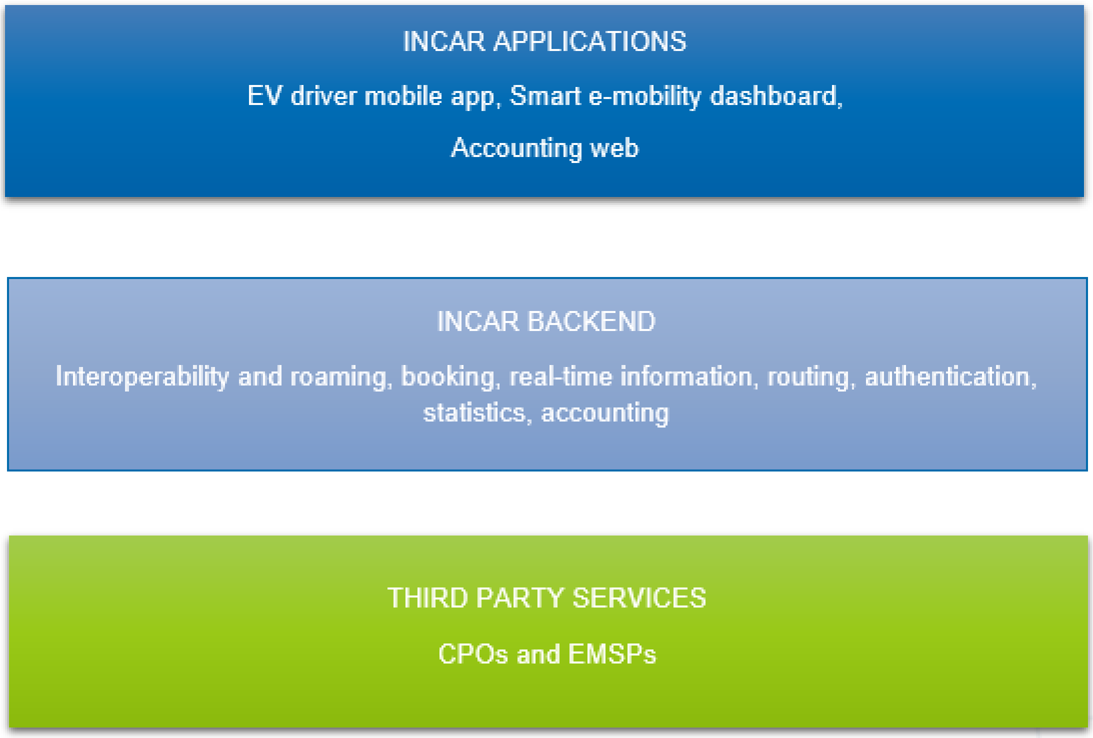


FIGURE 6: PLATFORM LAYERS

- Applications: the actual pieces of software serving as human-machine interface of the INCAR platform, each one specialized in a particular set of use cases. Applications can be apps for mobile devices or web applications.
- Backend: each of the functional blocks included in INCAR, designed and developed to offer a specialized interface to the applications and to the rest of services of the backend. Services shall run continuously in the hosting platform and be ready to receive requests form the client of their functionality.
- Third-party services: continuous iteration with external platforms such as CPOs and EMSPs shall be necessary in order to perform any functionality to be offered to final users by means of INCAR services.

4.3.1 Functional blocks

This section presents a classification of the functional blocks to be covered by the different services and serves as the starting point for the classification of the functionalities of the service modules.

4.3.1.1 Interoperability and roaming services

The functionalities related to the recharge of electric vehicles are:

- Provide static information about EVSEs such as geocoordinates, available plug types and amperage
- Provide real-time information of EVSEs such as availability or price.
- Reservation of EVSEs.
- Management of the start and the end of transactions and monitoring of their status and evolution.
- Control and recording of energy consumption per transaction and in time.

With this set of functionalities, EV drivers will have transparent access for using the EV charging infrastructure of CPOs integrated into the platform, regardless of whether the EMSP of the user offers an application with such functionality.

It is important to clarify that interoperability and roaming issues will be executed by means of the OCPI 2.2 protocol implementation. This protocol version defines how the market role called Hub (in this case INCAR interoperability and roaming services) would act as a communication intermediary between different EMSPs and CPOs. When the development of OCPI was started, it was designed for peer-to-peer communication between CPO and EMSP. This has advantages, but also disadvantages. Having to set up and maintain OCPI connections to a lot of parties requires more effort than doing it for only a couple of connections. By communication via one or more Hubs, the amount of OCPI connections is reduced, while still being able to offer roaming to a lot of different parties and customers. OCPI protocol also specifies all kinds of data that must be taken into account in roaming and charging situations, and explains when and how this information will be exchanged between the different actors involved in interoperability scenarios.

If there was not any platform that could centralise communications between the different actors involved in the charging process, it shall be necessary to manage a high number of connections and develop several end-user applications, as it is shown in the Figure 7:

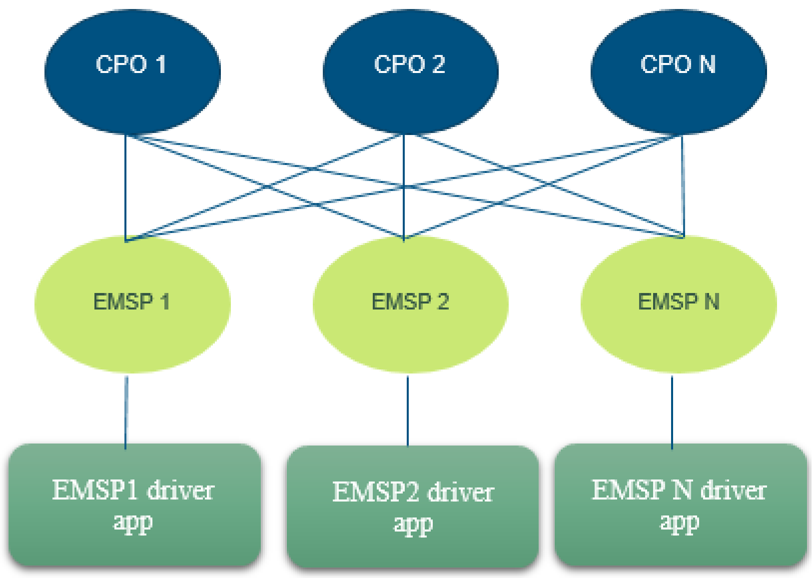


FIGURE 7: INTEROPERABILITY SCENARIO WITHOUT CENTRALIZING COMMUNICATIONS

With the INCAR approach, the roaming use case scenario complexity is reduced (Figure 8):

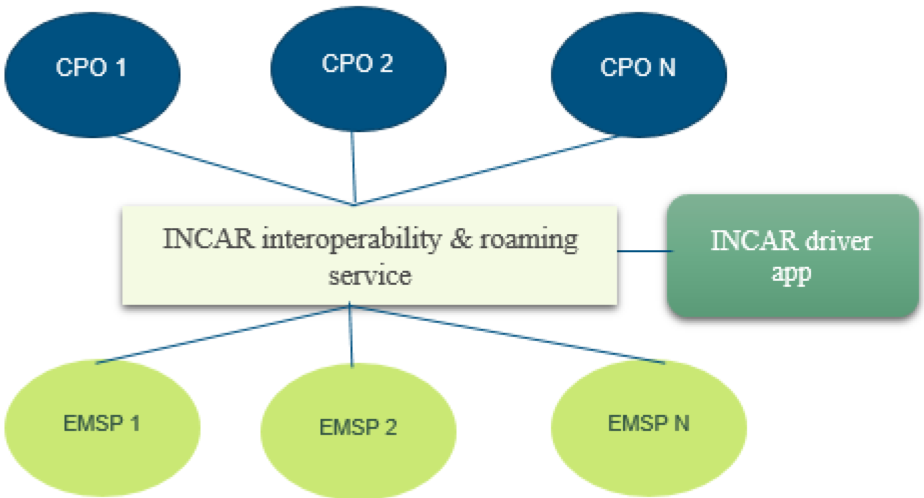


FIGURE 8: INTEROPERABILITY SCENARIO CENTRALIZING COMMUNICATIONS

The Hub can be considered the main entity to be developed regarding roaming services as it is specifically conceived to centralise and facilitate connections between EMSPs and CPOs. However, it functionalities are not just limited to solve interoperability issues. All related services such as accounting, routing or electromobility dashboards are based on the information provided and reported to EMSPs and CPOs, therefore the platform Hub is intended to participate as a main actor in the whole set of INCAR services. Besides, it will have an essential role in the smart charging operations. The reason is that a set of smart charging inputs that are needed by the product SMAC in order to calculate the optimal charging profile will be informed by the Hub, and once this charging profile is defined, it will be reported to CPOs system by the Hub.

4.3.1.2 Accounting service

Due to the end-users of the platform are the costumers of the EMPSs, the responsibility of the billing of each charging transaction corresponds to the EMSP, according to the tariffs and contractual conditions of the customers. Meanwhile, CPOs shall manage the direct interaction with the EVSEs infrastructure for the charging of the vehicles and shall periodically generate an invoice to the EMPSs with the aggregation of the costs of the charging transactions in the period.

INCAR will centralize and redirect all kind of information between EMSPs and CPOs, including billing data generated by CPOs. But in this case, when the platform would be notified about an end of charging transaction, and his corresponding billing information, the relevant accounting data will not just be redirected from CPO to EMSP. It also will be stored by INCAR accounting service in a safe way by means of BigchainDB [3] technology.

Although this service will not participate directly in the payment process, any EMSP and CPO will be able to search the billing information of the transactions which their customers have participated (for EMSPs) and which their EVSEs have performed the EV charging (for CPOs).

BigchainDB is attributed as a blockchain database because it contains blockchain features and database properties:

- Immutability: another prominent feature of BigchainDB is that once data is stored on its database, nobody can change or erase it. Or, even if someone manages to corrupt it, it will not be achievable without great difficulties. Additionally, if somehow someone manages to change or erase any data, it will become detectable. So, we can say that the data storage in the BigchainDB's network is practically immutable. BigchainDB's design embraces several strategies to make data storage practically immutable.
    - There are no BigchainDB-provided APIs, which makes alteration or change in stored data almost impossible.
    - Every node in the network possesses a complete copy of all data in a standalone MongoDB database. There is no global MongoDB database. So,

even if some nodes get corrupted, others will continue to work while having a copy of all data.

  - It uses cryptography mechanisms to encrypt and sign all transactions. Changing the transaction detail once stored will require to change the signature, which is also detectable.

- Owner-controlled assets**:** similar to other blockchain platforms, BigchainDB also provisions for owner-controlled assets. It means that only the individual having ownership of an asset can transfer it to others, not even a node operator can do it. In other blockchains, there is only one single built-in asset such as a digital asset or cryptocurrency. However, BigchainDB provisions external users to create several assets. But, they can´t create assets that someone has already created.
- Fast transactions**:** one of the prominent features of BigchainDB is its ability to execute several transactions per second. One design goal of BigchainDB has always been the ability to process a large number of transactions each second.

4.3.1.3 Authentication service

As it has been mentioned previously, EV drivers shall have a contract with an EMSP if they want to use all related charging services. Consequently, end-users of offered services will be the customers of EMSPs which are involved in the INCAR platform. Once an EMSP would be registered on the platform, almost all services and processes related to the final user actions would be performed by INCAR instead of EMSP system. Despite, there is a relevant part of functionalities offered to the final user which both, EMSPs and INCAR backend would have to participate: authentication process.

A graphic user interface of the mobile app will be a login form, with the aim of identifying the EV driver who will make use of INCAR services. The reason why the platform backend will not be able to run this process in an individual way is because customers´ information will be stored neither managed by INCAR, as some data is considered confidential information which shall not be notified to the platform. This storage and management task will be performed by the EMSP with which the EV driver has a contract. Due to the lack of relevant customers data such as credentials in INCAR systems, there will be necessary an authentication service which could validate and identify the final user while respecting their privacy.

These authentication issues will be covered and solved by a Keycloak [4] server instance. Keycloak is an open-source identity and access management solution aimed at applications and services. When the user wants to access any part of the application which requires to be authenticated, the app redirects a user's browser from the application to the Keycloak authentication server where they enter their credentials. This is important because users are completely isolated from applications and applications never see a user's credentials. Applications instead are given an identity token that is cryptographically signed. These tokens can have identity information like username, address, email, and other profile data. These tokens can also be used to make secure invocations on REST-based services.

Realms are the way Keycloak manages sets of users, credentials, roles, groups, and configuration metadata. Realms are completely isolated from one another, in the sense of how data is stored and managed within Keycloak. Keycloak comes with a Master realm out of the box, but this realm is meant to be used solely for administration purposes.

4.3.1.4 Routing service

The routing service aims at guiding the user to the EVSE at which he or she wants to perform a charging process. The routing service therefore firstly needs to request all charging stations of INCAR over OCPI in its Points of Interest (POI) module and, secondly, cover and support all areas where EVSEs integrated in INCAR are located. The routing service also includes a corresponding grid to perform the routing on.

Different modes of transport are supported by the routing service such as car, walk and bike routing; However, the main focus of the routing service will be the car routing as EV drivers are the main target group of INCAR services and applications.

The routing services can process different input parameters that the end-users can set in the INCAR app. These are departure and destination addresses, departure time, arrival time, modes of transport to be considered, and chosen optimization criteria (duration, costs, CO_2 emissions). Multiple routing results are returned by the service based on chosen parameters and ordered by optimization criteria. A corresponding geocoding subservice translates departure and destination addresses into geocoordinates for the routing or uses current GPS location as a starting point for the route. If the user clicks on one of the suggested routes, he or she will see detailed instructions in a directions list view as well as in the map view of the INCAR app.

The routing service can be connected modularly to different local routing services, if available, for walk, bike, car or public transport for specific areas.

The car routing furthermore takes into account the current traffic situation based on Floating Car Data (FCD) generated by GPS-enabled mobile devices or on-board computers installed in cars.

4.3.1.5 Smart e-mobility dashboards

This service aims at feeding the smart e-mobility dashboard with relevant information about the status of the electromobility in the city. All information exchanged between EMSPs and CPOs connected with INCAR will be stored, analyzed, processed and reported to pilot sites dashboards. Could be considered relevant metrics:

- Real-time information about status of EVSEs, connectors and locations.
- Detailed charging transactions such as power supplied, CO_2 equivalent emissions, time spent on charging processes.
- Bookings information such as counting, average duration or frequency.

- Drivers who are charging their EVs.

4.4 Process view

The purpose of the process view is to start to show the services, their workflow and how they communicate either internally, with end-user devices or with third party services.

The design of INCAR applications, webs and services, under the process view perspective, follows the schema defined in section 4.3The set of services, apps and relationship between them can be appreciated in the Figure 9:

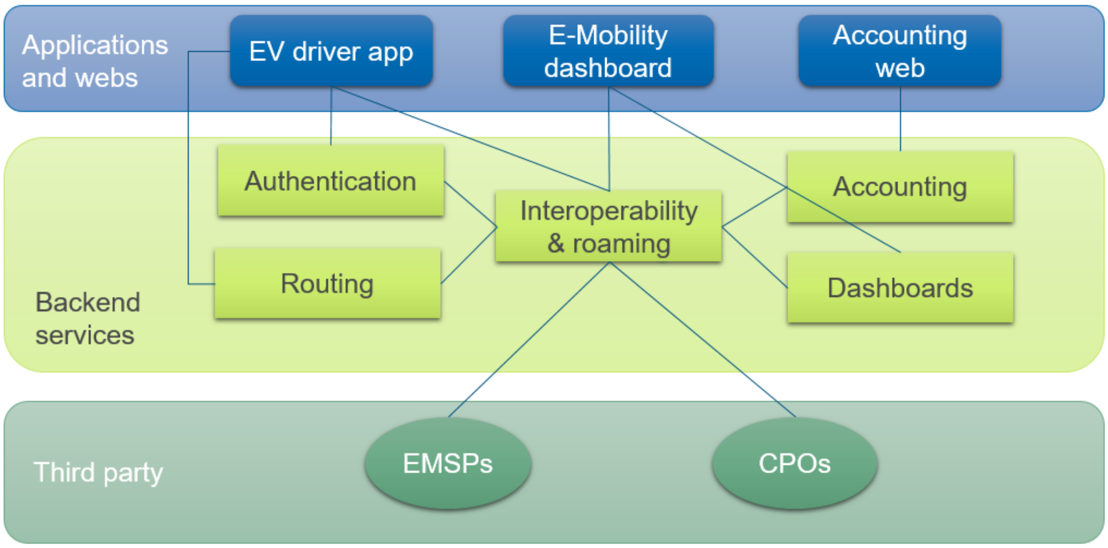


FIGURE 9: PLATFORM COMPONENTS

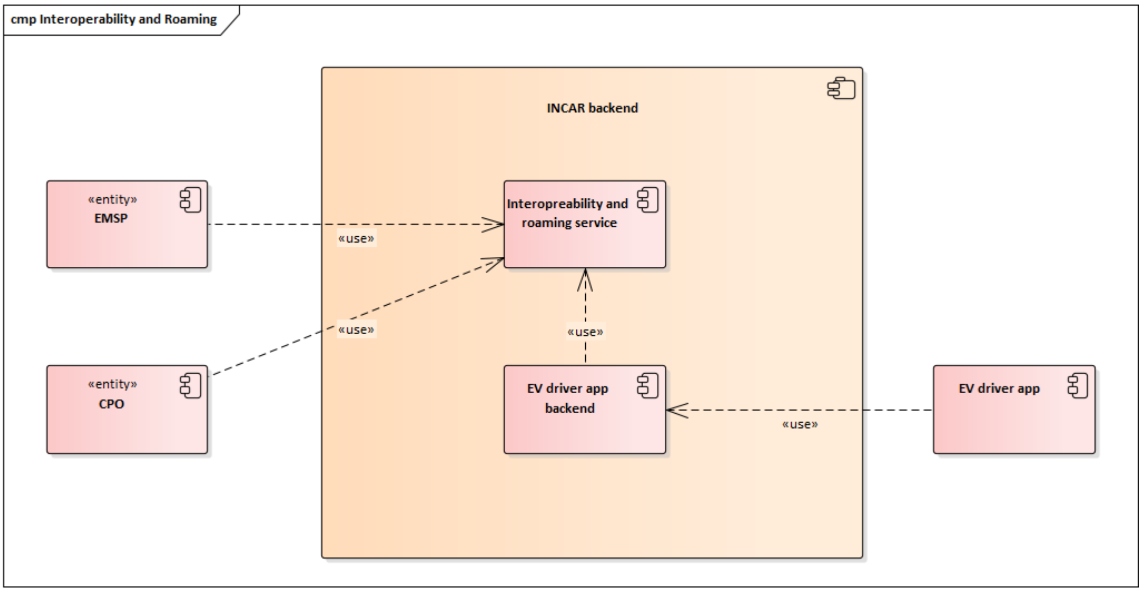
The process view covers the identification of INCAR services and components and which of these components need to be connected and communicated with each other. The detailed specification of each end-user device as well as third party services and INCAR backend services, including their different interfaces, operations, input and output data could be defined once the results and conclusions from T1.3 and T1.2 will be available.

The list of services to be implemented is equivalent to the functional blocks explained in section 4.3.1.

4.4.1 Interoperability and roaming service

With the implementation of OCPI 2.2 protocol, every time any partner involved in the platform (EMSPs and CPOs) would perform any update in the electromobility elements status, INCAR platform will be notified. Immediately, the interoperability and roaming component, which manages the received information, will store this information in the system database. From specific data included in the EMSP/CPO request, the interoperability service will be notified about if the requesting system wants to send this updated information to the whole set of platforms involved in INCAR, or just to a single partner, and the backend service will redirect the information according to this data.

The EV driver app can be considered the end-user device for this service. Their graphic user interfaces will display the information managed by the roaming component such as the EVSEs data (location, availability, etc.). Apart from offering the electromobility elements information, the driver app will perform any of the operations that are conceived in charging scenarios like booking charging points, cancel reservations and start or stop charging transactions. For this set of



functionalities offered to the final user, it would be necessary communication between roaming services and mobile app backend.

FIGURE 10: INTEROPERABILITY AND ROAMING COMPONENT DIAGRAM

4.4.2 Accounting service

The accounting services will interact with the EV driver app, the accounting web and the interoperability and roaming services. With the mobile app, each user could get the billing information of their own ended transactions. The accounting web will let the partners who joined to INCAR platform (EMSPs and CPOs) to search the accounting data of the whole set of charging transactions which have performed (for CPOs) or which their customers have participated (for EMSPs).

The accounting service will be fed by the charge detail records (CDRs) which is the only billing-relevant object defined in OCPI protocol. Data which conforms CDR objects will be created by CPO and sent to INCAR backend, where will be processed and stored by means of this service in the BigchainDB instance.

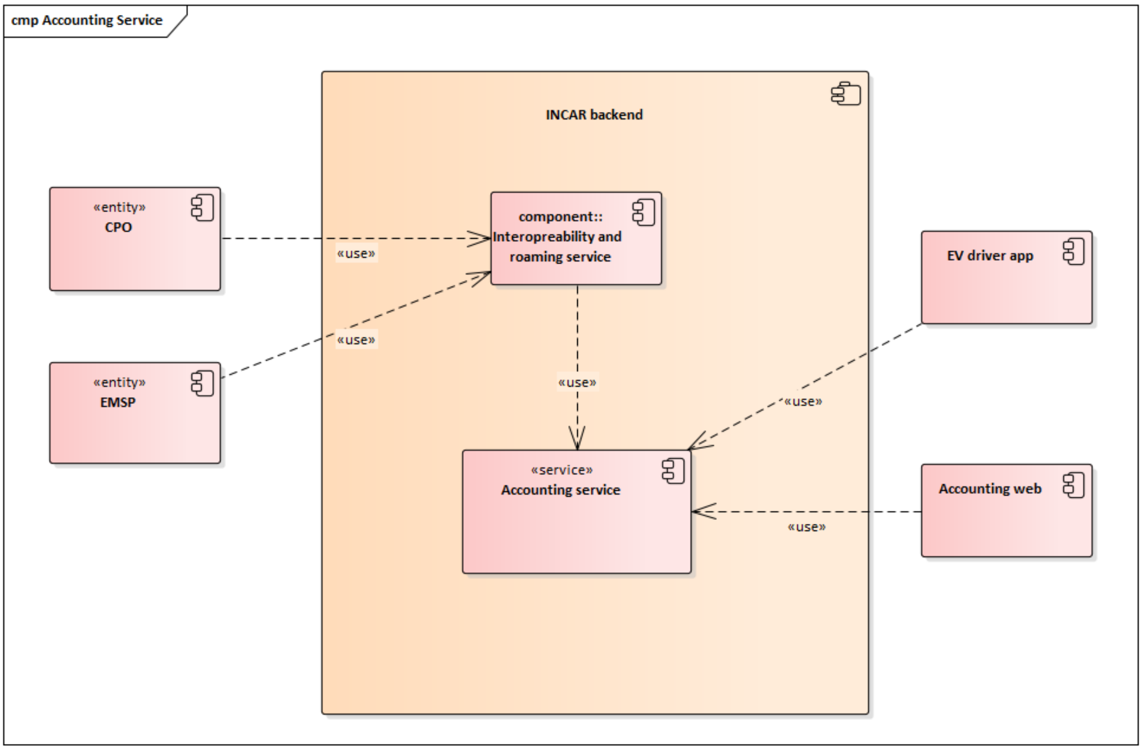


FIGURE 11: ACCOUNTING COMPONENT DIAGRAM

4.4.3 Authentication service

As depicted by the next diagram, the authentication service can be separated into two subcomponents: a graphic user interface (GUI) and the backend service.

The EMSP operator will be the responsible to interact with the authentication service frontend. He/she will have an admin account in order to manage their customers information. It will be necessary that, for each EV driver, the operator includes data required for interoperability operations such as the id OCPI token assigned to the user, as well as useful information for the customization of the driver app frontend.

Once the information is stored in the authentication service backend, the authentication process could be performed using the EV driver app. A login form will be displayed where the final user will introduce their credentials. The mobile app will communicate with the authentication service backend in order to validate the username and password. If they are correct the application will show the INCAR app content and the authentication service will inform about relevant data which the EMSP operator introduced previously, such as user full name or OCPI token.

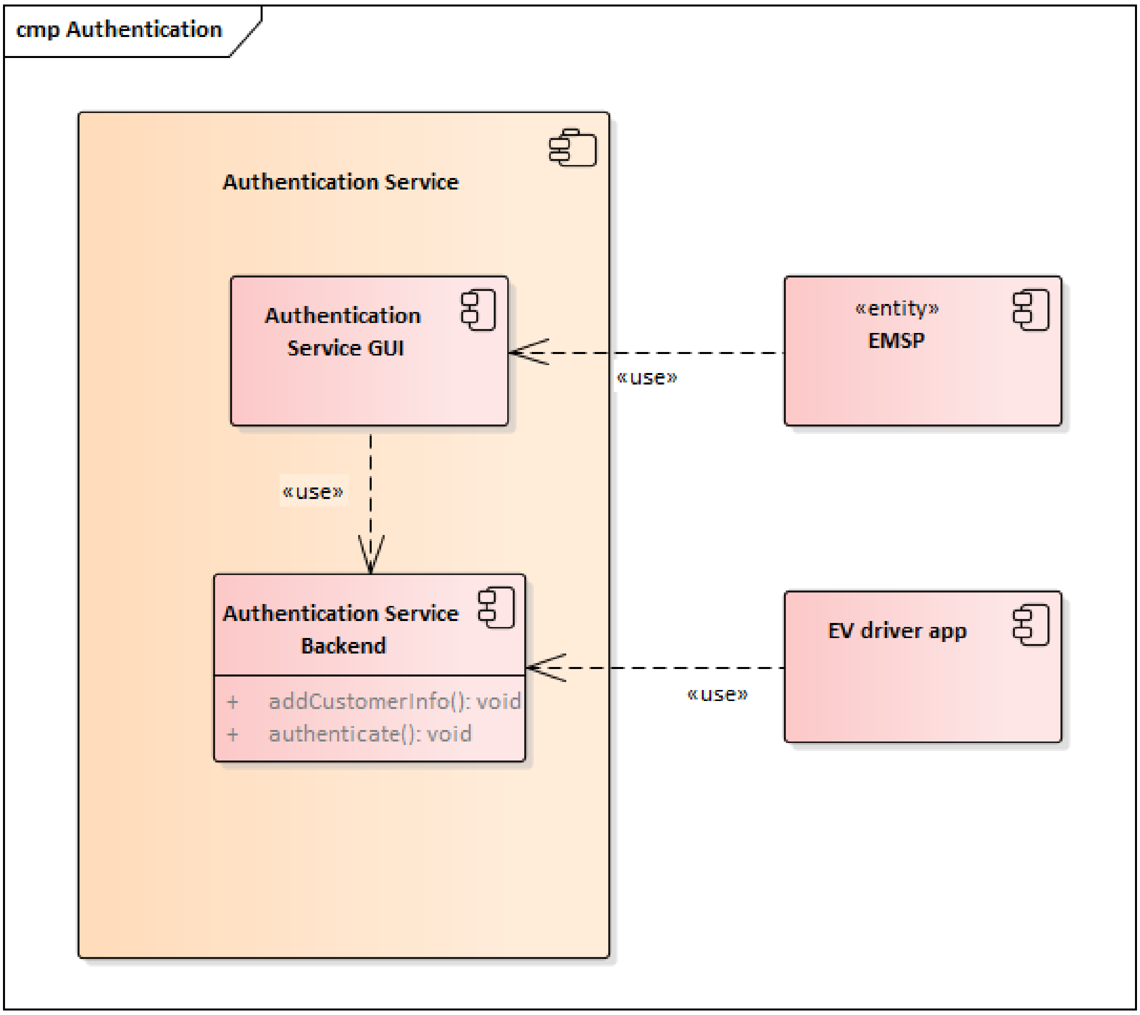


FIGURE 12: AUTHENTICATION COMPONENT DIAGRAM

4.4.4 Routing service

The routing service consists of two main modules: The Points of Interest module and the multimodal routing module. The Points of Interest module requests the charging stations over OCPI from the INCAR backend. The transferred data includes static information about each EVSE such as location, address, operator, plug types etc. as well as dynamic information such as the current tarif or occupancy status.

This charging station data is then transferred together with other points of interests such as public transport stops or parking spaces to the EV driver app so that they can be displayed in the map view of the app.

If the user selects one of the EVSEs and to get a routing in the INCAR app, the app sends a request to the multimodal routing service. This request includes the departure and destination address (derived from EVSE location), departure or arrival time, chosen transport modes and configured optimization criteria.

The multimodal routing service requests modal routes of its internal or external subrouters. The results are combined and ordered and then returned to the EV driver app where they are presented to the user. After the user has selected one of the suggested routes, further details as well as the exact route are shown in the map view of the app.

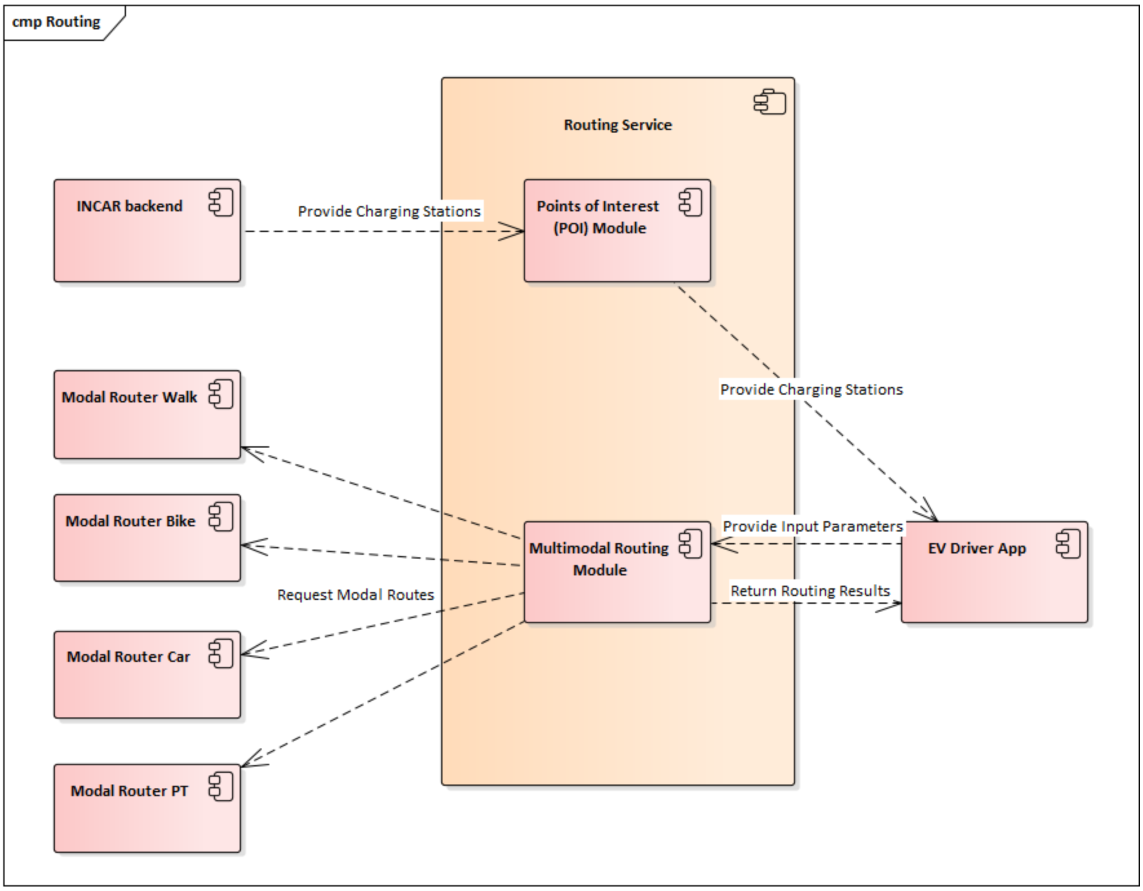


FIGURE 13: ROUTING SERVICE

4.4.5 Smart Mobility Dashboard services

The Smart Mobility Dashboard will have two components:

- Measurements recording service: this service will analyze all the information that has been previously stored in INCAR by means of other components of platform backend such as interoperability and roaming services. Based on the defined KPIs, all the data considered of interest will be processed to be stored in the platform database.

- Dashboard web server: will offer data processed and stored by measurement service to the end-user, composing the user interface of the dashboard application.

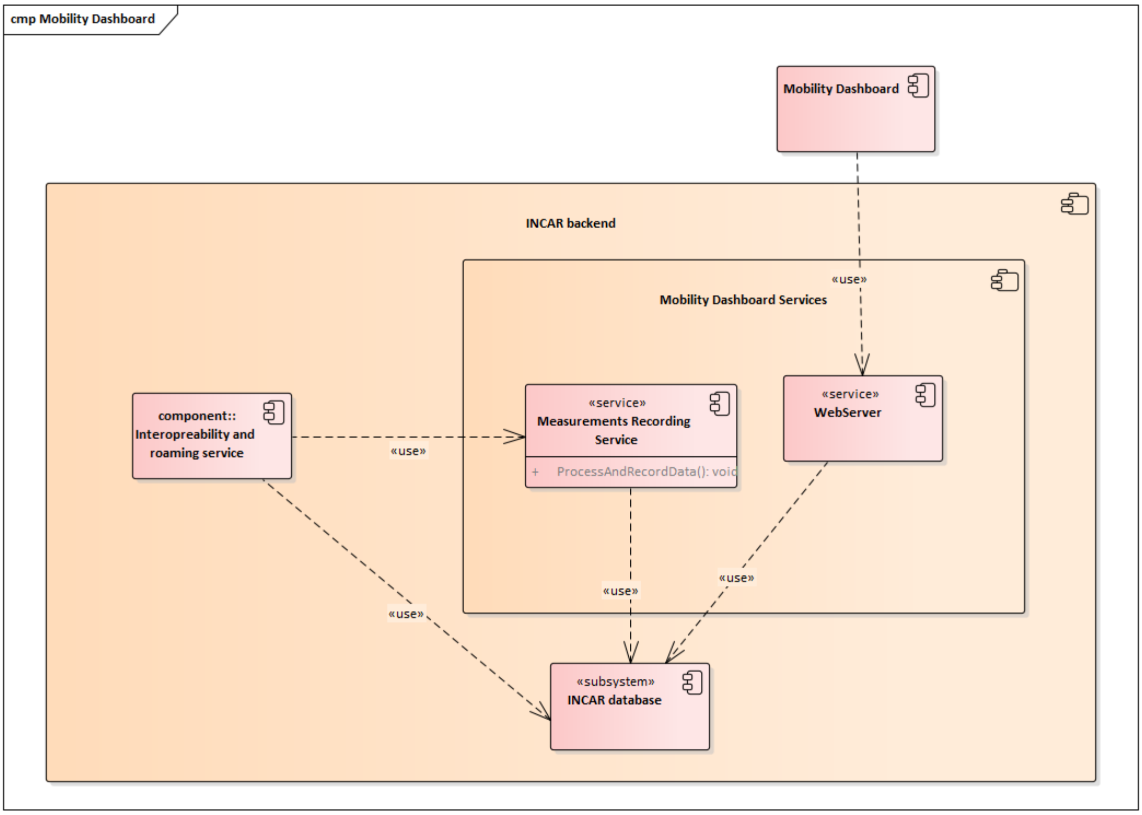


FIGURE 14: MOBILITY DASHBOARD COMPONENT DIAGRAM

4.5 Deployment and implementation view

Most technical decisions about the detailed design and implementation of the applications and services have been postponed to be solved within task T3.3.

However, some decisions were taken during the initial stages of the work within this deliverable.

- The interfaces of the backend services shall be implemented as RESTful services, thus relying on HTTP protocol.
- The data exchanged within these services (except for simple primitive data that might be directly included in the URL of the requests) shall be JSON.

The RESTful architectural style for the INCAR services was chosen due to its flexibility, simplicity and efficiency and the broad availability of software libraries and frameworks for the implementation in different platforms, from servers to mobile devices. This style does not add excessive overhead to the communications layer what is crucial for the communication with applications running in mobile devices. It neither imposes strict restrictions on the formal definitions of interfaces that would reduce flexibility for the evolution of the software components and increase the risk of compatibility problems.

5 Conclusions

Task T3.1 has achieved its goals regarding the design of an interoperability framework and platform by means of the definition of two tools: INFRA and INCAR.

The design of INFRA reflects the four focal fields (layers) of interoperability and provides the different stakeholders with an overview and guidance on the conditions under which it can be achieved. It consists of a top-down process of four main steps including functional and non-functional interoperability requirements for the interoperability platform itself and the further technical products of the project. This methodological approach, in conjunction with the results of the corresponding task T1.3 on technical and legal requirements, will provide the foundation for the implementation of the interoperability framework in task T3.2.

Regarding INCAR specification, T3.1 has used the '4+1 architectural view model' as a conceptual framework in order to define the system functions using the current list of use cases as the starting point, as well the different final user devices, the third-party services that need to communicate with the platform and the set of identified backend services with their respective components. This specification with the conclusions of connected tasks T1.2 and T1.3 will be the main basis for the development of the interoperability platform in task T3.3.

6 References and acronyms

6.1 References

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6.2 Acronyms

Acronym	Meaning
INCAR	Interoperability, Charging and Parking Platform
INFRA	Interoperability Framework
UC	Use case
WP	Work Package
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
OCPI	Open Charge Point Interface
CPO	Charge Point Operator
EMSP	Electro Mobility Service Provider
KPI	Key Performance Indicator
DoA	Description of Action
CDR	Charge Detail Record
GUI	Graphic User Interface