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BUILDING A FOUNDATION FOR AN ENERGY STATION SERVICE PLATFORM

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ABSTRACT

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Charging of electric vehicles is becoming more and more common. Charging of electric vehicles does not only need a functioning infrastructure but also various information systems to handle data in the process.

The purpose of this thesis was to study how a completely new information system for handling energy information collected in the process of charging electric cars could be built by using existing energy sector information systems. The research problem for this thesis was provided by Empower IM Oy.

The research for this thesis was mainly done by studying the OCPP protocol and design documents of Empower IM's information systems. Some of the information was collected by interviewing specialists and by participating in meetings and presentations.

The end result of this thesis is a data model for ESSP, a study of the OCPP protocol and use cases how the OCPP is used in ESSP functions. The data model describes how the objects of electric vehicle charging are modelled using the EnerIM CIS database.

Keywords: OCPP, Energy Station Service Platform, Data Model, Software program plan

CONTENTS

TERMS AND ABBREVIATIONS

AMR	Automatic Meter Reading
Charge Box	A Charge Box is the control unit within a Charge Point. Charge Box and Charge Point in this document are used interchangeably.
Charge Point	Physical system where an electric vehicle can be charged. A charge Point has one or more connectors
Charging Carrier	Party who collects and processes electric vehicle charging transactions
Central System	Charge Point Management System: the central system that manages charge points and includes the information for authorizing users for using charge points.
Connector	Connector refers to an independently operated and managed electrical outlet on a Charge Point. This usually corresponds to a single physical connector.
EOI	EllaEDM/EnerimCIS Open Interface
ESSP	Energy Station Service Platform
ET	Energy Technology
ETSI	European Telecommunications Standards Institute
EV	Electric Vehicle
EVCC	Electric Vehicle Communication Controller
EVSE	Electric Vehicle Supply Equipment
IETF	Internet Engineering Task Force
IT	Internet Technology
IoE	Internet of Energy
IP	Internet Protocol
M2M	Machine to Machine
RFC	Request for Comments
SC	Supply Chain
SCADA	Supervisory Control and Data Acquisition
SG	Smart Grid
V2G	Vehicle to Grid
EVSE	Electric Vehicle Supply Equipment
EDM	Energy Data Management

CIS	Customer Information System
ESSP	Energy Station Service Platform
OCPP	Open Charge Point Protocol
SOAP	Simple Object Access Protocol. A computer protocol which is used to communicate between different components.
SQL	Structured Query Language
Central System	Underlying system used in (OCPP) communication
HTML	Hyper Text Markup Language
XML	Extensible Markup Language. XML is a standard of the World Web Consortium for the syntax of formal markup language used to display structured data in the form of plain text.
EIA	Energy Industries Association is a society of the most important and prestigious industry lobbying organization, whose opinions are listened to and valued in both national and international decision-making as a public forum in the future

1 INTRODUCTION

An Energy Station Service Platform is an information system that is a link between electric vehicle charging stations and energy market. Its goal is to provide benefits for three parties, energy consumers (electric vehicle users), utility companies and charging station operators. ESSP main functions consist of collecting electric vehicle charging transaction data, storing information of electric vehicles, electric contracts and charging stations and other information needed for logging a charging transaction, forming electric invoices and exchanging of electric information between utility companies.

An ESSP Core system will act as an integration layer from an Electric Vehicle and Charging Station to a Customer information system and an Energy data management system.

1.1 Objectives of the Thesis

The objective of the thesis was to give reader a basic idea what an Energy Station Service Platform is, to study an OCPP protocol and to create a data model for the ESSP core functions. This thesis focuses on the ESSP basic functionality like identifying the vehicle to be charged, the charging transaction start/stop and saving the charging session data to a database. However, other ESSP functionalities are explained as well to facilitate the understanding of the whole system. The developed data model introduces a general logic which could be used in the implementation of highly extensible solutions. This data model is based on a new information service, the ESSP Core and existing information systems called EnerimCIS, EnerIM EDM and EnerIM EMS. The generic model of ESSP is introduced in figure 1.

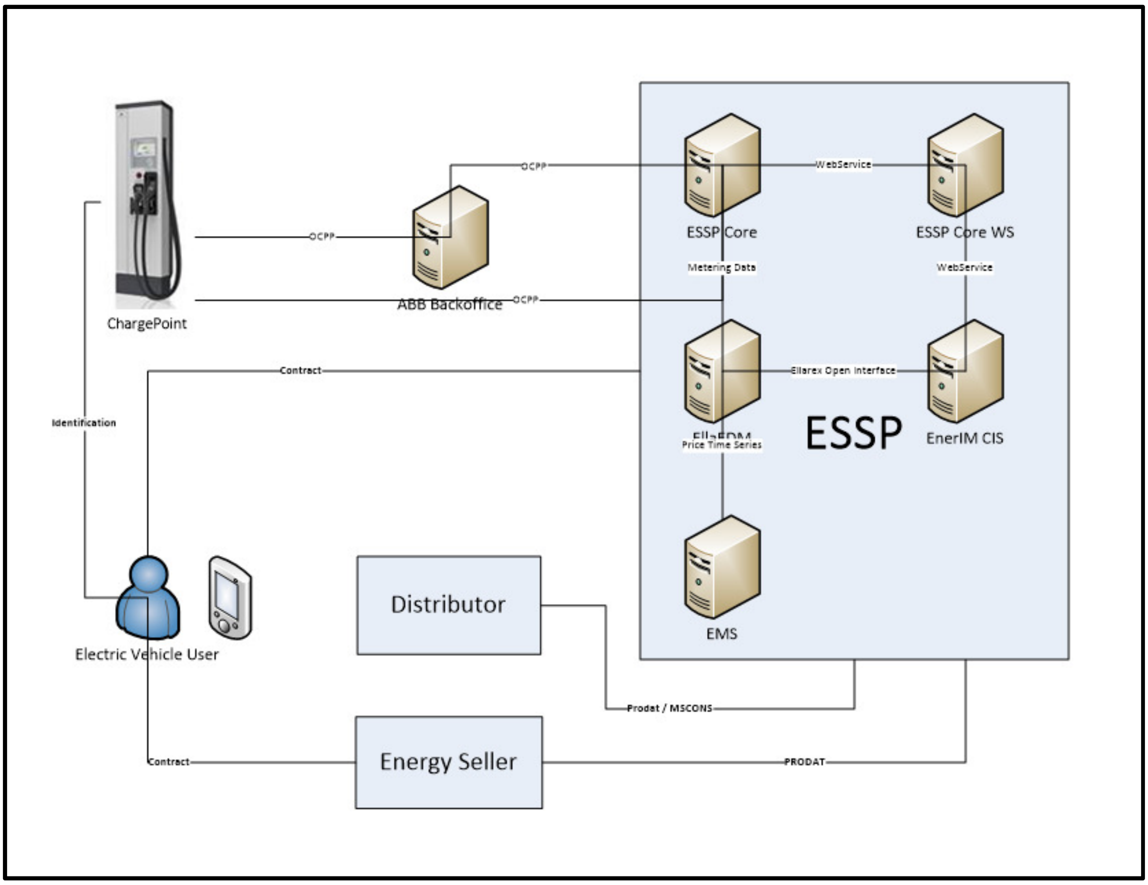

FIGURE 1. Generic model of ESSP and connections to other energy market parties

The protocol, OCPP was defined in order to specify the standardized way of communication between electric vehicle charging points and ESSP. The translation of the protocol made it possible to adjust ESSP to existing solutions and technologies. The ESSP aims to fully utilize all data available to it in order to improve the processes of charging electric vehicles.

1.2 EU Strategy for a Smart Energy – Problem Definition

The Europe 2020 strategy for a smart, sustainable and inclusive growth aims at tackling the social challenges like climate change, energy and resources scarcity, enhancing competiveness and meeting the energy security. This is accomplished by a more efficient use of resources and energy. A target of 60% greenhouse gas emissions reduction from transport by 2050 is trying to be achieved by breaking the oil dependence. The proposal for a directive (a deployment of alternative fuels infrastructure) aims at ensuring the build-up of alternative measures to distribute alternative fuel forms and implementing technical specifications for this infrastructure. [3].

Given the importance of reducing carbon emissions from road transport, and the price and security of oil supply, electric cars may well provide a viable alternative to traditional internal combustion engines using fossil fuels. In order to encourage the electrification of road transport, it is necessary to eliminate potential regulatory hurdles and to encourage standardization activities on both intra- and extra-vehicle technologies. [1]

The situation for electric charging points varies greatly across the EU. The leading countries are Germany, France, the Netherlands, Spain and the UK. Under this proposal a minimum number of recharging points, using a common plug will be required for each member state as shown in Table 1. The aim is to put in place a critical mass of charging points so that companies will mass produce the cars at reasonable prices.

A common EU wide plug is an essential element for the roll out of this fuel. To end uncertainty in the market today, the Commission has announced the use of the "Type 2" plug as the common standard for the whole of Europe. [2]

*TABLE 1. Electric charging Points/vehicles per Member State (*EU clean fuel strategy. Date of retrieval 05.05.2013*)*

Members States	Existing infrastructure (charging points) 2011	Proposed targets of publicly accessible infrastructure by 2020	Member States' plans for nos of electric vehicles for 2020
Austria	489	12000	250000
Belgium	188	21000	-
Bulgaria	1	7000	-
Cyprus	-	2000	-
Czech Republic	23	13000	-
Germany	1937	150000	1000000
Denmark	280	5000	200000
Estonia	2	1000	-
Greece	3	13000	-
Finland	1	7000	-
France	1600	97000	2000000
Hungary	7	7000	-
Ireland	640	2000	350000
Italy	1350	125000	130000 *(by 2015)*
Lithuania	-	4000	-

Luxembourg	7	1000	40000
Latvia	1	2000	-
Malta	-	1000	-
Netherlands	1700	32000	200000
Poland	27	46000	-
Portugal	1350	12000	20000
Romania	1	10000	-
Spain	1356	82000	2500000
Slovakia	3	4000	-
Slovenia	80	3000	14000
Sweden	-	14000	600000
United Kingdom	703	122000	1550000

1) The number of publicly accessible recharging points is 10% of the total number of recharging points

These figures leave us with a need to develop modern information systems that support Charging and billing the users of Electric Vehicles. These systems could potentially lead to various businesses.

2 DEFINITION

The following chapters provide an introduction to technologies, existing data warehouse systems and terms.

2.1 Waterfall Model

The waterfall model or a linear model is the oldest life-cycle model, which was developed in late 1960's. The model is based on the idea that the system is constantly being developed forward. As a result, it is difficult or unnecessary to go back to the previous versions of development. The figure 2 below shows the waterfall model works.

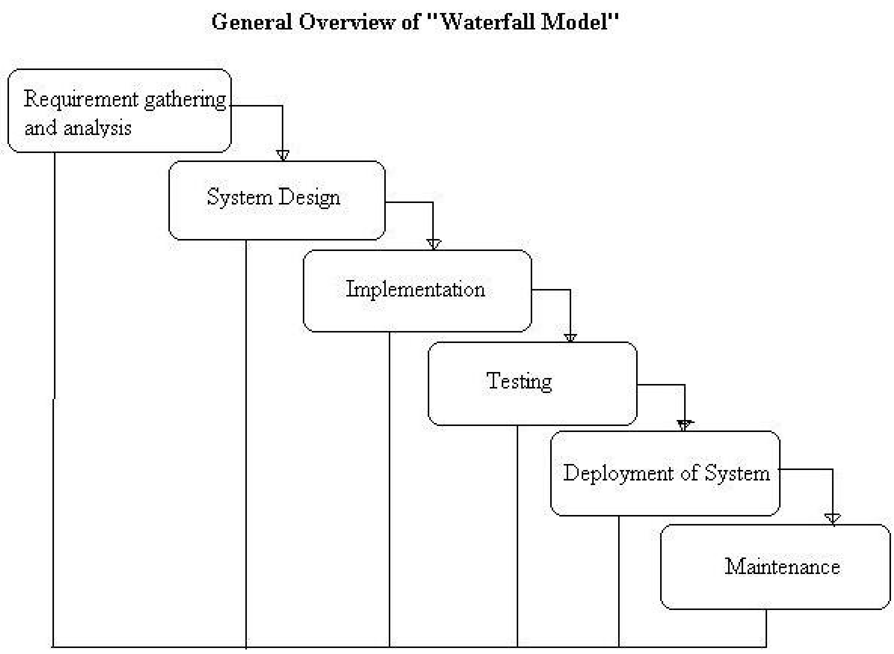

FIGURE 2, Waterfall model (Pohjonen, R. 2002, 40)

In the waterfall model system development phases are gone through step by step as presented above. In a real life the development stages of progress often overlap because when moving to the next stage some deficiencies that need to be corrected may occur.
The most significant shortcoming of the waterfall model is its lack of iteration. [12] Additional problems are caused by the strictness of the requirements as the model does not allow changes in the requirements. The waterfall model is not very customer-oriented since the customer cannot see

the end result of the project until at the relatively late stage of development. These problems can lead to a failure of schedule which is the most common reason of failure in projects build on the waterfall model. [13]

2.2 EnerIM EDM

An Energy Data Management System (EDM) is used for metering and possible clearing of metering data. EllaEDM has been developed as a multi-sectorial and multi-company environment to a work-performing system, which acts as an effective tool for a variety of operational processes, both in distribution, sales, and district heating as the water business. An automatic remote reading (AMR) causes a multiplication of the electric measurement data. At the same time the measurement data management complexity and the need to make use of it grows. The EllaEDM measurement database provides the tools to increase the mass of information and new subscription management interfaces. A calculation module can make necessary calculations quickly and efficiently.
EllaEDM is a system used for large volumes of information and for further processing of data, in particular for the distribution system and for the electricity seller's current and future needs (e.g. tariffs, balance sheet report, vendor deliveries, the equalization calculation of time-series clustering, computing operations, controls).

EllaEDM is scalable to different needs from a single network company to a multi-company environment. EllaEDM is not bound to any quantity so it supports various business functions such as district heating, water and electricity.

EllaEDM supports:

- Different types of measurements (e.g. electricity, district heating, water, gas)
- Multi -company environment
- Software as a solution
- A number of smart metering systems, as well as hand held devices for meter reading
- A flexible connectivity with external systems

EllaEDM includes:

- Basic data for consumption places

- Meter connections for consumption places
- A measurement data management
- A measurement data check and repair
- User-definable calculations
- Tariff information (structures needed for pricing)
- Billing energies, the stresses exerted calculations
- EDIEL message traffic
- Balance sheet report
- Predictive
- Reporting Database

EllaEDM is part of the EnerimCIS (EnerimCIS) product family that covers the basic functions of the energy company's processing of the measurement data. Systems are integrated together by open interfaces and they support processes for network, sales and customer service. In particular, the transition to an automatic meter reading and the growing impact of information flows is taken into account in the overall system integration.

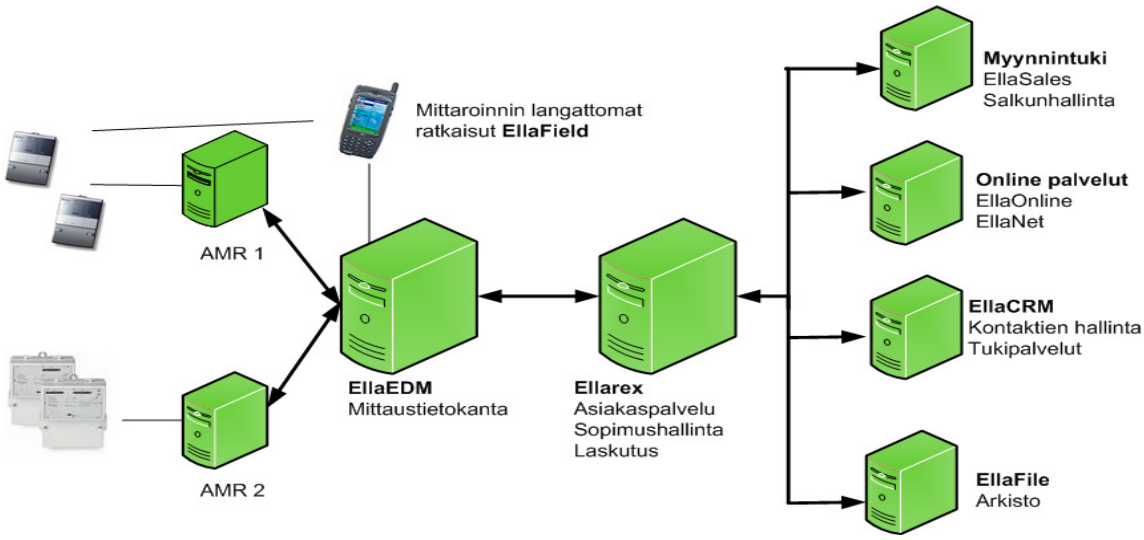

FIGURE 3. EnerIM systems. (Empower IM EllaEDM System description. Internal document. Empower IM Oy.)

EllaEDM is carried out in a modern multi-layer architecture. It is based on a Microsoft .NET technology. The service is divided into different hardware as needed, for example, a database server + an application server + a web server + an Integration Server. EllaEDM system's external connections are implemented through both direct integrations and a Microsoft BizTalk integration platform.

The basic model of the implementation is a standard (EllaEDM EOI) interface from EllaEDM to a BizTalk system integration platform where information presentation and structure can be adapted and directed to different destinations. Similarly, information from external systems is gathered through BizTalk. This model enables that when EllaEDM supports service to one party, the same service can be implemented to other parties as well by taking advantage of BizTalk's features.
EllaEDM EOI interface supports for example consumption place basic data, reading and hour series, disconnections and breaks, as well as ad-hoc reading data. The EllaEDM system integration has been carried out in key markets in remote metering, network information and customer service systems.
EllaEDM is database-independent. Supported database environments include Oracle and PostgreSQL.
ElllaEDM supports sending and receiving of messages through the messaging transmission service, which is based on the Energy Industry Association's In-house example of the structure. The mode of operation is commonly used and it enables for example the centralized routing of messages to different parties and an EDIFACT conversion powerful automatic implementation of the proxy service provider.

2.3 EnerimCIS

An EnerimCIS customer information system enables efficient processes for energy – and water companies. These processes include customer invoicing as well as customer information and energy meter data handling. EnerimCIS is built to meet the requirements of the specific characteristics of the electricity market and it is designed to be easily accessible to users.

The system's key functions are:

- Reliable and efficient mass billing
- Sales process management and reporting
- Product management
- Contacts and contact information processing
- Easy access to customer and consumption place data
- Easy management of contract data
- Interfaces to other Ella family products and 3rd party products
- EDIEL Messaging
- End customer self-service portrait

EnerimCIS is carried out in a client - server architecture. The client executes direct procedure calls to the database using an Oracle client. Client is Microsoft Windows (XP or newer) compatible and it is based on the Microsoft Visual Basic 6.0 technology.
EnerimCIS supports the Oracle 10.2g and 11.2g database. The platform for the database is Microsoft Windows Server 2003 or newer. Most of the business logic is embedded in to the database. This is done by PL/SQL procedures and functions. Some minor parts of the system like file handling are implemented as external DLLs which are executed from the database.
The integration to other systems is done via EnerimCIS Open Interface which writes and reads data in the XML format. [7]

2.4 ABB Back Office

ABB back office communicates with the OCPP Central on behalf of the ABB charge points. A subset of the OCPP version 1.5 is currently in use. ABB EVCI has two types of charge points: a DC fast charger, and an AC wall box. The AC wall box has an OCPP 1.2 interface. The AC wall box will communicate with the OCPP central in ESSP via the ABB back office. The DC fast charger has a proprietary interface to the ABB back office. The ABB back office will emulate the DC fast charger as an OCPP charge point to the OCPP central in ESSP. [14]

2.5 PL/SQL

PL/SQL stands for a Procedural Language extension of SQL. It was developed by Oracle to enhance the capabilities of SQL. PL/SQL is a combination of Procedural features of programming languages and SQL. PL/SQL is available in the Oracle Database version 7 and newer. The IBM DB2 database also supports PL/SQL. PL/SQL was not designed to be used as a standalone language, but instead to be invoked from within a host environment.

The user can run a PL/SQL code from within the database through various interfaces like a SQL developer. Alternatively users can define and execute a PL/SQL code from within an Oracle Developer form or reports. This approach is called client-side PL/SQL. However, it is impossible to create a PL/SQL program that runs all by itself.

Oracle uses a PL/SQL engine to process PL/SQL statements. PL/SQL supports variables, loops, exceptions, arrays and conditions like other programming languages. Implementations after Oracle version 8 have included object-orientated-like features. Another feature of PL/SQL is that a program code can be directly compiled to the database. This enables any number of applications or users to share the same code. PL/SQL also enables the user to create triggers. Triggers are subprograms that are executed automatically in response to specified events. Typically these events are updating, inserting or deleting from a database table.[8]

3 OCPP

An Open Charge Point Protocol is an open standard which describes methods enabling electric vehicles to communicate with a central system. OCPP was initiated by E-laad. (e-laad.nl).

3.1 Technology

OCPP uses a Simple Object Access Protocol. SOAP is a framework which enables sending messages between applications over the Internet. One advantage of SOAP is that the facilities for sending and receiving messages are covered by the standard. This enables a rapid implementation.

The content of a SOAP message is drawn up according to the Extensible Markup Language (XML) standard. The XML language is related to the HTML. In addition to text, XML messages can contain images and an executable source code. One big advantage in XML is that the messages are sent in a legible text.

3.2 OCPP Structure

The OCPP version 1.5 describes 25 operations. 10 of these are initiated by the charge point and 15 by the Central system.
Initiated by the charge point are the following:

- Authorize
- Boot Notification
- Data Transfer
- Diagnostics Status
- Notification
- Firmware Status Notification
- Heartbeat
- Meter Values
- Start Transaction
- Status Notification
- Stop Transaction

Initiated by the central system are the following:

- Cancel Reservation
- Change Availability
- Change Configuration
- Clear Cache
- Data Transfer
- Get Configuration
- Get Diagnostics
- Get Local List Version,
- Remote Start Transaction
- Remote Stop Transaction
- Reserve Now
- Reset
- Send Local List
- Unlock Connector
- Update Firmware

The communication between a charge point and the central system always begins with a request. In the OCPP specification this request is described with operationname.req(). The party receiving this message will always reply with a confirmation. In the OCPP specification a confirmation is described as operationname.conf().

Figure 4 shows the flow for the operation Authorize. For the sake of clarity the message names and the rest of the communication flows in this figure have been removed. The figure shows a charge point sending a message to the central system, Authorization.req() and getting an answer in the Authorization.conf().

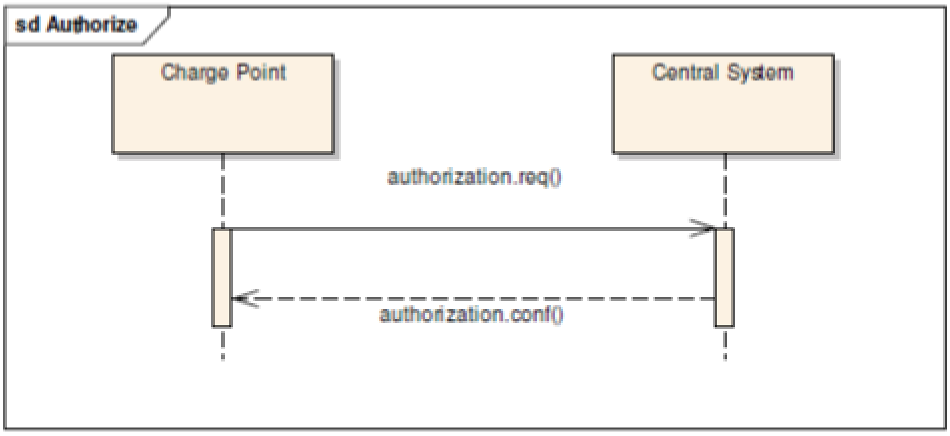

*FIGURE 4. OCPP operation: Authorize. (*Open Charge Point Protocol - Interface description between Charge Point and Central System. Date of retrieval 06.06.2013*)*

3.3 OCPP Functional Description

In the following a functional description of the data exchanged between a charge point and the central system during various operations is described.

3.3.1 Starting up a Charge Point

The charge point sends a message to the central system containing details of the configuration, brand and type. This happens once the charge point has been turned on and started.
The central system will then check to see if the charge point is known to the system. If the charge point is known to the central system, it will send a reply stating whether or not the charge point has been accepted. The accepted answer also includes the time and date of the central system and the heartbeat interval.

3.3.2 Heartbeat

When the charge point receives a confirmation from the central system that it is connected, it will send a heartbeat to the central system. This heartbeat has the interval which was designated by the central system after the contact was first made. The heartbeat informs the central system that the charge point is still available to do operations. A response to a heartbeat from the charge point is the central system's current time and date.

3.3.3 Starting Transaction

When charging an electric car, the first thing is to authorize the charge action. When a charge pass (an ID card) is inputted to the charge point, a message is send to the central system. This message contains data identifying the person who is charging the electric car. The central system responds to this message by stating the validity, expiry date and possible parent-ID. (a parent –ID is acceptable when the pass belongs to a particular group i.e. a company card). If the received ID data passes the central system's checks, the charge point may proceed with charging.

A charge point has the option of maintaining a local list of ID cards used and accepted by the central system. This is because the charge point has to be able to accept charge actions even when no connection can be made with the central system.

In the OCPP version 1.5 the local list has been extended and modified into an authorized list. The authorization list includes the same functionality as the local list, with a difference that it is now possible to manage the authorization list from the central system. The central system can request, replace, synchronize and add or remove specific IDs from the list.

3.3.4 Stopping Transaction

When the user wants to stop the charge action they need to identify themselves using the ID card at the charging point. After the identification has been done the charge point sends a request to the central system to stop charging. This request message includes the final meter reading, transaction identifier (number), Card ID and the current time. The central system will then indicate if the user is authorized to stop the charging transaction.

3.3.5 Firmware Update

When the central system has firmware updates ready for distribution, it will send a message to the charge point. This message contains the location where the update can be downloaded, the time and date when the update needs to be collected, the number of attempts and the interval

between download attempts. The charge point answers to this message by sending a confirmation to the central system that the message has been received.
At the set time and date the charging point downloads and installs the update. During the installation process the charge point informs the central system of the current status and also if the update has been successfully downloaded and if the installation has succeeded.

3.3.6 Dealing with Errors

When a technical error or failure occurs in the charge point, it will try to send a message to the central system. Possible indicated errors are relating to

- the plug lock
- a too high temperature
- the mode 3 communication
- the reading of a KWh meter
- resetting
- magnetic switch for enabling the charging voltage

3.3.7 Diagnostics

The central system can ask the diagnostic data from the charge point. After such request, the charge point uploads a file with the diagnostic data to the central system.

3.3.8 Reserving

The OCPP version 1.5 includes the option of reserving a charge point. When reserving a slot, the central system sends a message to the charging station containing the reservation time, the ID card and a reservation ID. The charge point responds with a message containing information if the reservation succeeded, was refused, or if it was not possible. The reservation will be refused when the charge point is in use, broken down or not available.
The central system has the capability of cancelling a reservation which has been made earlier. When this happens the central system sends a message to the charge point. This message contains the reservation ID. If the charge point identifies this reservation, it will then send a reply stating that the request has been accepted. If the reservation ID is unknown to the charge point, it will respond with a message that the request has been refused.

3.3.9 Change Configuration

The Change configuration enables the central system to modify different charge point settings. These settings are: Heartbeat interval, connector time-out, the number of reset attempts, charge point name and reading interval for the energy meter. It is also possible from the central system to start and stop a charging action, to unlock the cable, to restart the charge point and modify its status.

4 PRACTICAL PART

The following chapters describe the design work of the Energy Station Service Platform.

4.1 Introduction

The project started with a very little of existing knowledge, since charging carrier business at the moment is still in its infancy. One of the big open questions is which of the energy market operators would be the user of the ESSP. This lead to a solution where a platform should be designed so that it could easily be configured to work in various setups and situations.

ESSP was designed to be built from three main components. Two these were the existing data warehouse systems, EnerimCIS and EnerIM EDM. The third was ESSP Core which handles data flows from Energy Stations by using the OCPP protocol. The ESSP Core and EnerimCIS communicate via a webservice. Using the existing systems as a part of the new service was justified because these systems already provided processes that were similar to the ones used in gathering the electric vehicle charging information and turning this information into electric invoices.

Figure 5 describes the general environment of the ESSP Project. This master's thesis focuses on the parts surrounded with a dotted line.

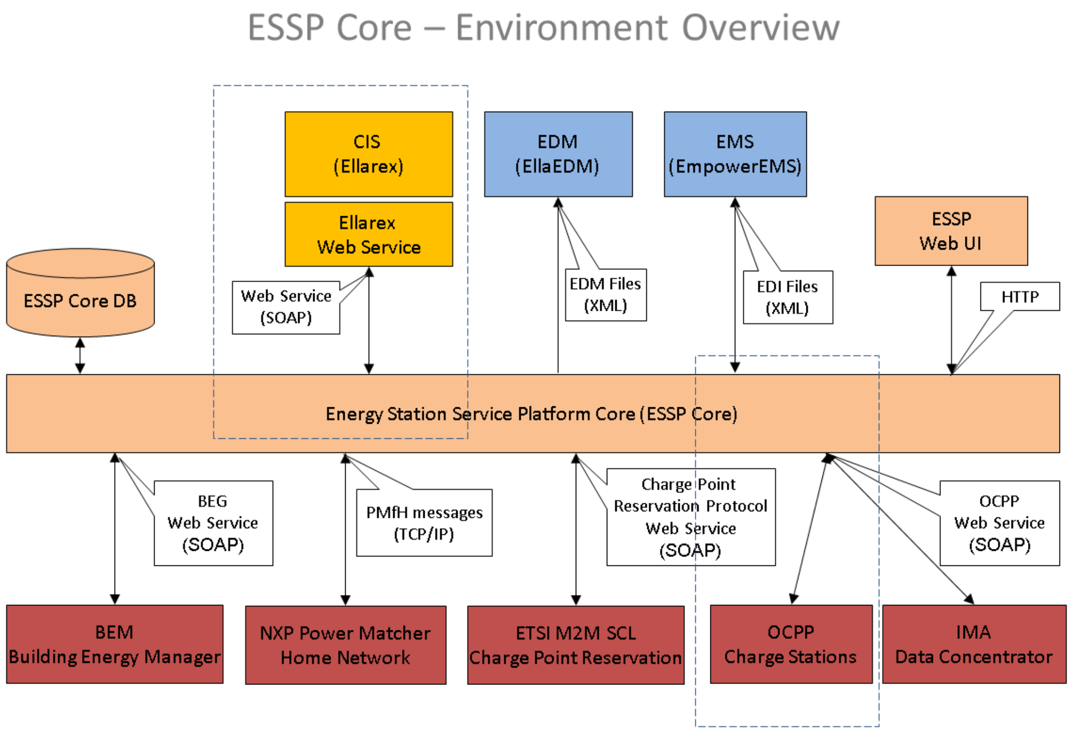

Figure5. ESSP Core – Environment Overview

The first steps in this thesis closely resemble the first three steps of the waterfall model. The following chapters describe the requirements of gathering and analysis, system design and the first steps of implementation.

4.2 Requirements

The ESSP software project was started by studying the list of minimum functional requirements the platform needed to have. This list was provided by an ARTEMIS project. The list is referred to Appendix 2-6.

Appendix 2 - ESSP Device capabilities: requirements for devices, Charging Stations used in ESSP

Appendix 3 - Interfaces to other systems: requirements for common data structures, network interfaces and interfaces to other systems

Appendix 4 - ESSP Core: requirements for data structures that ESSP core must have.

Appendix 5 - Ancillary services: requirements for ancillary services in ESSP. Mainly these are functions that report / input ESSP data

Appendix 6 - Security and Privacy: requirements how the data in the system should be secured and how real life security threads like stolen Electric Vehicle should be reported to ESSP.

The pre-work was continued by adding columns to this list. These extra columns described data classes, possible database for data needs, OCPP operations and OCPP messages used in the process.

The list was filled with information of how existing data warehouses (databases) could be used instead of creating new ones. Also equivalent OCPP messages were listed and referenced to OCPP operations. ESSP Core Data classes, OCPP Operations and OCPP Messages were also cross-referenced to keep list easy to read.

4.3 ESSP General Architecture

The ESSP Core system includes three services: Charging Services, Reservation Services and Price Calculation. These services will use the ESSP Core database, if needed for the service. Communication to EV and CS includes three separate communication layers: OCPP communication, Charge Point Reservation Communication and PMfH Communication. OCPP and Charge Point Reservation are using the SOAP Web Service. PMfH is TCP/IP messages. As mentioned earlier this study is focused on OCPP.
Communication to CIS, EDM and EMS includes three communication layers: CIS Communication, EDM Communication and EMS Communication. CIS is using the SOAP Web Service. EDM is using XML-files and MSCONS. EMS is using XML-files.

4.4 Functionalities

The next part of the design work was studying the OCPP and defining the basic functionalities of ESSP. The following chapters provide an introduction to functionalities of the system and shortly describe its environment, too.

4.4.1 Electric Vehicle Authorization

An electric vehicle must be authenticated before the start of the approved charge. The user of an electric vehicle authorizes him / herself for example by inputting a PIN code or an identification card. The authorization status for the requested identifier is then returned from the central station. If the identifier is allowed for, the charging status is *Accepted*. If the identifier is not allowed for, the charging status is *Blocked, Expired or Invalid.* Blocked is returned if an electric vehicle has been for example reported stolen in the central system. Expired is returned if an electric vehicle user has no valid contracts in the central system. Invalid may be returned if the requested identifier is not registered to the central station. By allowing the status, also an expiration date is returned. This date indicates the last date when customers' contract is valid in the customer information system.

Function: GetAuthorization

Authorization must succeed even when the charging station is not in communication with the central system for example during a temporary communication failure. The local authorization is maintained on the charging station. A new version of list can be uploaded periodically from the central station or the charging station can request an update for local list. The update type of list is differential or full.

Function: GetAuthorizationListUpdate

4.4.2 Charge Station data

Charge stations are registered in the EnerimCIS device registry. When a new charge station is installed to infrastructure, it must be registered to ESSP, too. A charge station registration is done by inputting a Charge Station Identifier and other extra information like address and GPS coordinates.

When modifications to the charge station configuration are made, it checks if it is present in the EnerimCIS device registry. The registration status is *Accepted,* if the Charge station is found in the registry. Otherwise the status is *Rejected.*

Function: RegisterChargeStation

Function: CheckChargeStation

The charge station information can be updated to the EnerimCIS registry. This can happen for instance if connectors are added or removed from the charge station. New information can also be read from the central station to the charge station.

Function: UpdateChargeStationData

Function: ReadChargeStationData

4.4.3 Charge Station Status Info

The central station needs to be able to control the charge station's status. For instance, the whole station can be switched of for maintenance. The charge station's alive-information can be modified and checked. If too long time from last heartbeat is passed, then the charge station is not alive and all connectors' status must be set to Unavailable.

Function: SetChargeStationStatus

Function: SetChargeStationAlive

Function: UpdateNotAliveChargeStations

There needs to be functionality in the core system to reserve connectors.
A charge station's connector is set to a reserved mode in the central system when an electric vehicle is connected to the connector.

Function: SetConnectorStatus

4.4.4 Energy Charging Transaction Data

The energy consumed when charging an electric vehicle is registered as transaction in the ESSP core. This transaction is then processed and passed to EnerimCIS as consumption and to EllaEDM as hour series. The following describes the functions needed in process of handling energy charging transaction data.

A new energy transaction is created in the ESSP core. This transaction is identified with an identifier (Electric vehicle identifier) received from the charging station with the OCPP and connector identifier. The transaction is ended when charging stops.

One identifier is allowed for charging but not for multiple transactions. The function needs to check If a charging transaction is already activated. The return value is an ongoing transaction

identifier if a transaction exists, otherwise rejected. ESSP also actively searches active transactions within charge stations and compares them to the transactions listed in ESSP.
Function: CreateTransaction
Function: CloseTransaction
Function: CheckTransactions
Function: FindActiveTransactions

Hour series data has to have a variable identifying Electric vehicle in EllaEDM. This variable is part of electric vehicle information in EnerimCIS. The variable is received from CIS by ESSP when the function is saving hour series to EllaEDM. Whenever meter values are received from active charging sessions, they are sampled as hour series. These hour series are identified with a transaction identifier.
Sampled meter values are:
Function: ReadEDMVariableInfo
Function: AddMeterValues

Charging session data is written to the ESSP core database. An authorized identifier and all needed values are in the transaction data. Charging session energy, start time, end time and charging station identifier are written to the EnerimCIS database.
Function: WriteChargingSession

For an active transaction, unwritten sampled metering time series are written to EllaEDM. For a completed transaction, unwritten time series values are written to EllaEDM. If time series values are yet not sampled, the time series values are first calculated from transaction data.
Function: WriteChargingMeterValues

4.5 General Data Structures

The ESSP Core has an internal database for fast access data, like Charge Station attributes and status information. The internal database also includes data for charging transaction.
Charge Station base attributes and EV authentication data will be in the CIS database. The energy consumption data from EV charging sessions will be in the EDM database (and EMS data-

base). Price calculation parameters and the calculated price will be in the EMS database. An access to these external systems will be done by using the native services for each system.

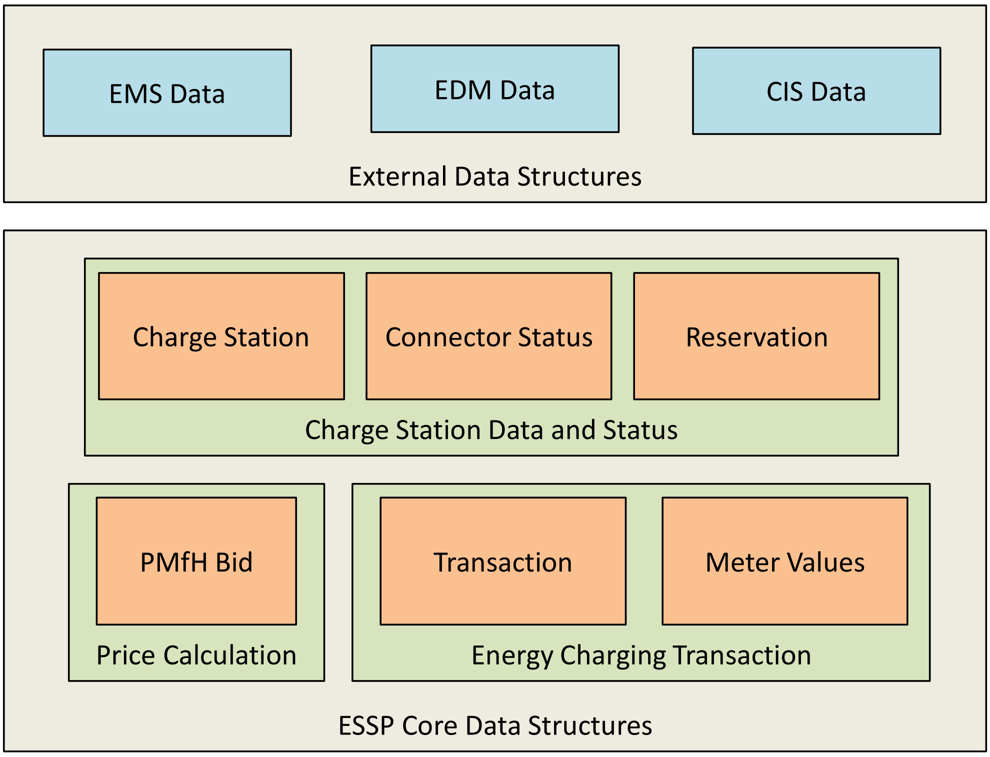

Figure 6. Overview of ESSP general data structures

4.6 CIS Data Structures

The basic components of the Charge Carrier Service consist of rechargeable cars, charging stations, car users, i.e. people who charge cars and energies of charging session.

These components and information close to them need to be modelled to the data structures in the ESSP information system. This was the next step in building a foundation to ESSP.

Mostly these basic data structures already exist in EnerimCIS. The work was started by creating an excel sheet. The columns of the sheet are described in the table 2.

TABLE 2. Columns of the CIS structures appendix.

Column	Column description
ESSP Data Class	Main data class of data structure. Comparable to real-life object
ESSP Data Item	Smaller part of data structure

Description	Describes ESSP Data Item
CID Data Class	Main data class in Customer Information System
CIS Data Item	Smaller part of CIS Data Item
Description	Describes CIS Data Item. Ie. what data is presenting in CIS
EnerimCIS Data Table	Database table in CIS
EnerimCIS Data Item	Database table column
New Item	Indicates if the item is needed to be added to CIS

The table containing these basic data structures is listed as Appendix 1 – ESSP CIS structures. The table is constructed by studying EnerimCIS database table descriptions and comparing them to the requirements of an ESSP data model.

The concepts of the EnerimCIS system are modelled in such a way that they imitate real life things. Naming conventions are directly under the terms of the electricity sales as recommended by Finnish Energy Industries (Energiatelollisuus ry). [9], [10], [11].

4.7 Data Model

EnerimCIS was chosen as a part of ESSP since it has a basic functionality and data model that can be used in ESSP with only little alterations. An EnerimCIS database is used to store rarely updated data like Electric vehicle information and contract information. The ESSP Core database is for rapidly updated data like metering information and transaction handling. The following chapter explains the data structures that are essential to ESSP.
The colors in the following pictures are selected so that yellow represents a real life object, blue is an abstract object that is used to connect two or more real life objects. White object refines a real life object and green is a new object to be added to the data model. One box in the picture represents an object or a database table in EnerimCIS. The first row is objects description, the second row is database object name and rows after that describe the object.

4.7.1 Electric Vehicle

The Electric Vehicle in ESSP consists of four basic EnerimCIS objects, Equipment, Consumption Place, Contract and Customer. These normal components of the consumer energy market are shown in figure 7.

An Equipment is connection point to the Charge Station. The Equipment is needed to gather and record charging transactions to ESSP. The Equipment consists of counters and their properties like quantity of energy, measured. The Equipment is connected to a Metering Place which is a connecting point of equipment and Consumption Place.

A Consumption Place (Contract Object in EnerimCIS) models the essence of Electric Vehicle. In the normal use case, the consumer energy market, the consumption place is fixed to one location, ie. it is part of only one distribution network. Since an electric vehicle in real world can be charged anywhere in the grid, an electric vehicle or a ”moving consumption place” has to be modelled so that it can be part of multiple junctions. Junction is the connection point to an energy grid. An Electric vehicle is identified by a contract objects external identification. External identification is a sting and type code identifying an electric vehicle for example a license plate number.

A Contract connects the Electric Vehicle owner or user to The Consumption Place. The Contract holds a contracts charging schedule, it defines when and by which rules an Electric Vehicle is allowed to be charged.

A Customer is the user of an Electric Vehicle and an owner of the contract. The Customer has information like name, address, invoicing address, type of customer (organization / person).

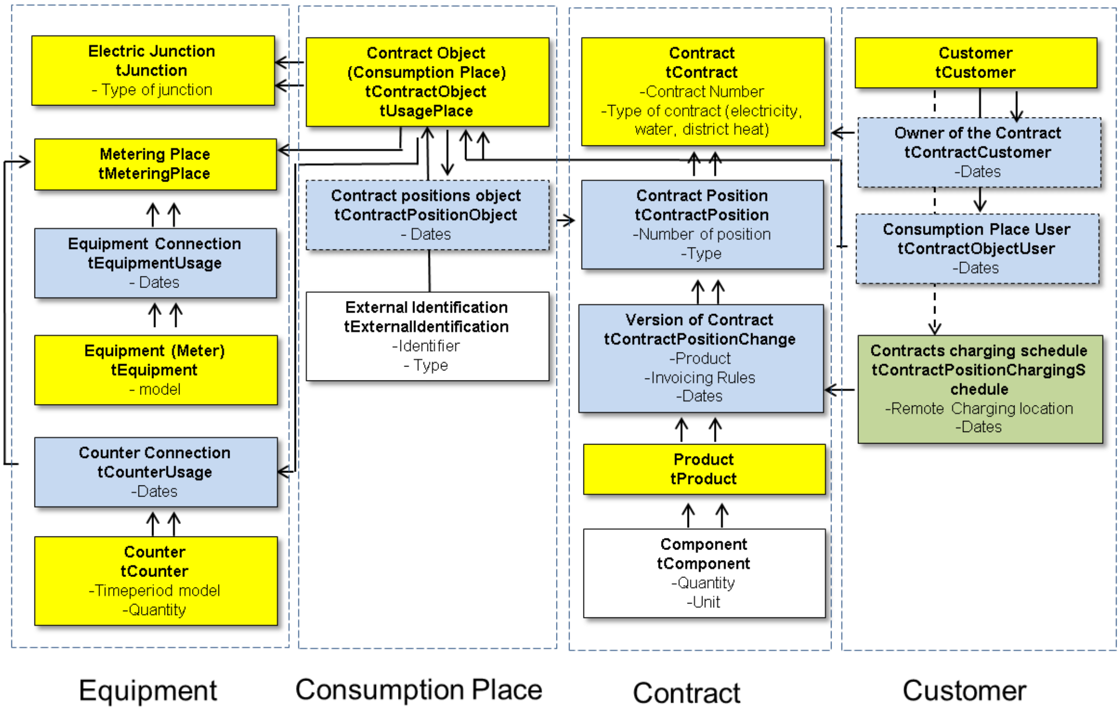

FIGURE 7. Electric Vehicle modeled with EnerimCIS data structures

4.7.2 Electric Vehicle Energy

Electric Vehicle charging transactions are transformed to meter readings and hour series in the ESSP Core. Meter readings are inputted to EnerimCIS for invoicing purposes. Meter readings are targeted to a customer by an electric vehicle identifier (a consumption place identifier). The basic requirements set to this project specify that the electric car user must have information of where each charging transaction occurred. Therefore a new item, a Charge station Identifier is added to energy input data.

The Energy input specific data is specified in an energy input amount. This information consists of a start- and end date (+ time), a reading date and an amount. This is shown in figure 8.

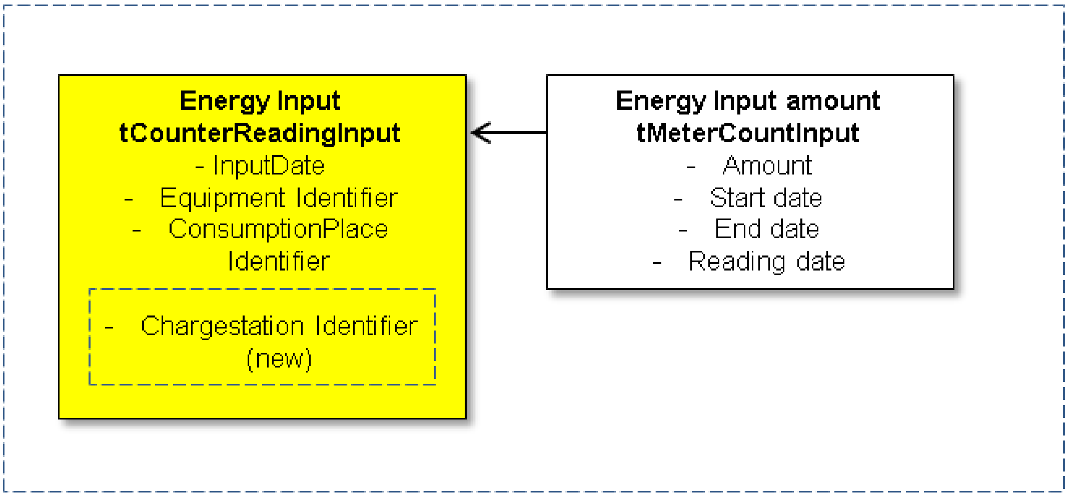

FIGURE 8. Electric Vehicle Energy record modelled with EnerimCIS data structures

4.7.3 Charge Station

The Charge Station is modelled in EnerimCIS by using the existing data structures. The Charging Point consists of Equipment and its counters. The Counter represents the connector and equipment charge box. The Equipment has a model information. The Model has general information about equipment, like manufacturing date and type code. The Charge Station is connected to an electric junction via a metering place. These data structures have additional information like location coordinates and an address.

Under the current rules in EnerimCIS only one counter per tariff (time period model) is allowed to connect to the equipment. Some restrictions (constraints) and business logic in the database need to be modified. The Charge station is modelled in figure 9.

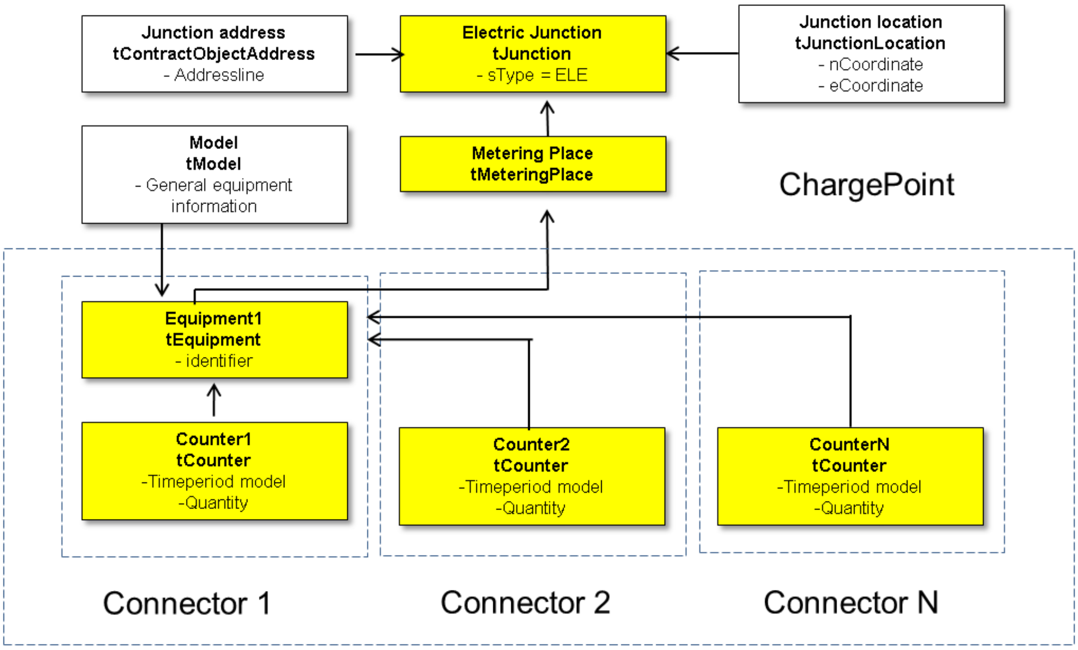

FIGURE 9. Charge Station modelled with EnerimCIS data structures

4.7.4 Electric Vehicle User

The data model of an Electric vehicle user is basically same as the customer data model in EnerimCIS. The Customer is an Electric Vehicle User. It has a unique identifier, a customer number. The Customer has a type, a person or an organization. The Customer general information is Name, Address and Social security code.

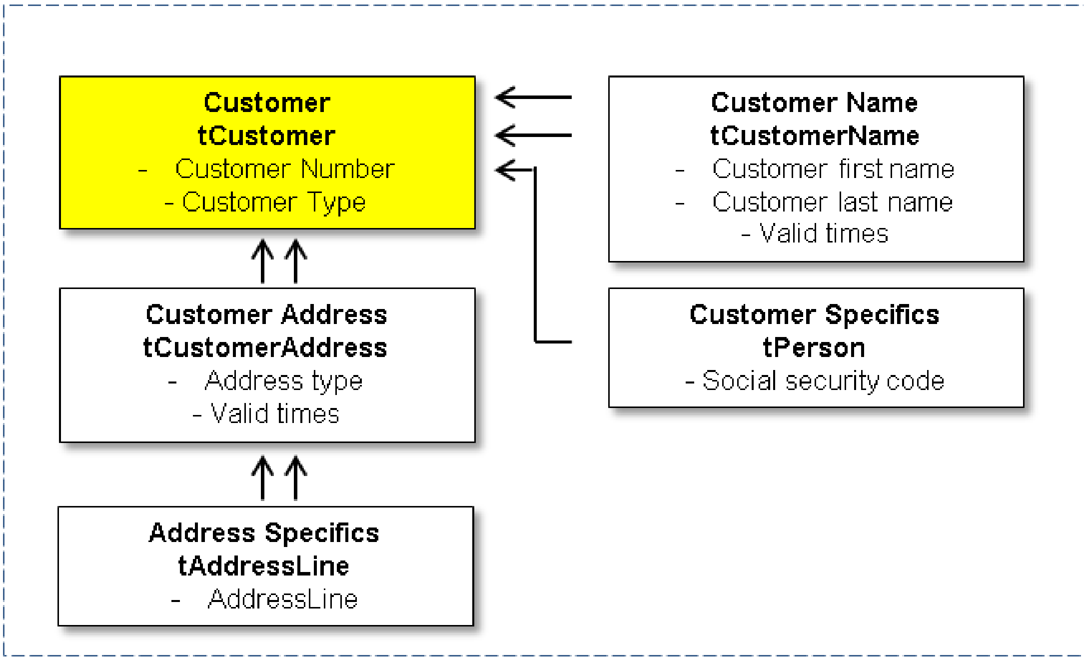

FIGURE 10. Charge Station modelled with EnerimCIS data structures

4.7.5 General Ingoicing Structure in CIS

The Contract in EnerimCIS is an agreement about the conditions under which the customer is invoiced. The Contract can have one to many positions. The Position defines the contract object and related terms, such as the duration of the contract, invoicing information and product. The Product has one or more components. The Product or sometimes component holds the pricing information of the contract.

The Position connects a contract object to the contract. The Contract object models the invoiced consumption place or in this study an electric vehicle. The Contract object is connected to an electric junction which is a physical connection point to an electric grid. The Metering place models the place where an electric meter is connected to the consumption place.

An Invoicing contract is part of the contract. It describes invoicing rules like invoicing group, terms of invoicing and invoicing method (e.g. paper invoice, electric invoice). The Invoicing contract is versioned like the contract by contract positions.

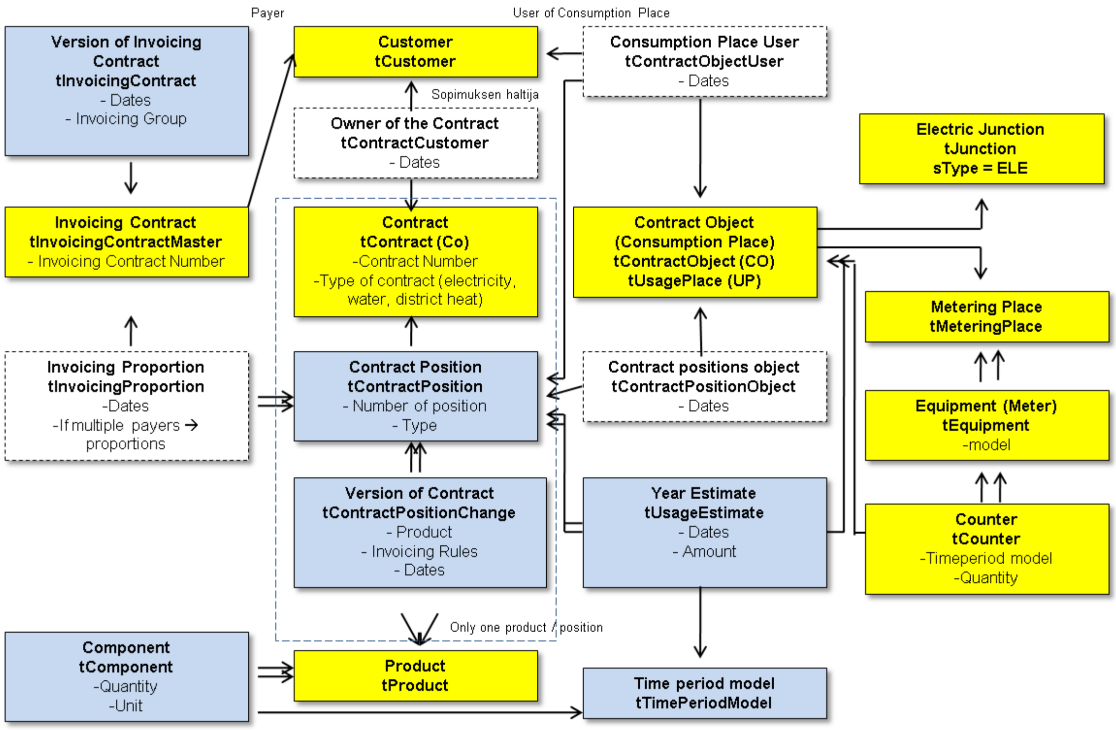

FIGURE 11. Basic contract structure in EnerimCIS

4.8 OCPP Communication

The ESSP Core is communicating with Charge Stations by an OCPP protocol via SOAP Web Service. The OCPP communication layer will be implemented by the OCPP 1.5 version.

The OCPP communication layer has two modules: a client module and a server module. The functions in the client module are used in a service application to send OCPP requests to the OCPP partner. The server module creates an OCPP web service and calls back the request handler functions in the service application when receiving an OCPP request from the OCPP partner. An OCPP client function is a communication layer function, which is called when the service application needs to send an OCPP message to the OCPP partner. The client function gets the data to the OCPP message as input parameters from the service application. The client function returns response data from the OCPP partner as output parameters.

TABLE 3. OCPP Communication layer, Client Functions

Client Function	OCPP Message	Response

OCPP_ChangeConfiguration(ChargeStationId, ConfigList)	Change Configuration	Status
OCPP_RemoteStartTransaction(ChargeStationId, ConnectorID, Identifier)	Remote Start Transaction	Status
OCPP_RemoteStopTransaction(ChargeStationId, TransactionId)	Remote Stop Transaction	Status
OCPP_ReserveNow(ChargeStationId, ConnectorID, ExpiryDate, Identifier, ReservationID)	Reserve Now	ReservationStatus
OCPP_CancelReservation(ChargeStationId, ReservationID)	Cancel Reservation	CancelationStatus
OCPP_GetLocalListVersion(ChargeStationId)	GetLocal List Version	ListVersion
OCPP_SendLocalList(ChargeStationId, ListVersion, AuthorisationList, UpdateType)	Send Local List	UpdateStatus

An OCPP callback function is a service application function, which is called when the OCPP message is received. The callback function gets the data from the OCPP message as input parameters. The function returns response to the OCPP message initiator as output parameters.

TABLE 4, OCPP Communication layer, Callback functions

OCPP Message	**Callback Function**	**Response to initiator**
Boot Notification	OCPP_BootNotification(ChargeStationId, Model, Vendor)	CurrentTime, HeartbeatInterval, RegistrationStatus
Authorize	OCPP_Authorize(ChargeStationId, Identifier)	AuthorizationStatus
Start Transaction	OCPP_StartTransaction(ChargeStationId, Connector, Identifier, StartValue, StartTime)	AuthorizationStatus , TransactionId

OCPP Message	Callback Function	Response to initiator
Meter Values	OCPP_MeterValues(ChargeStationId, Connector, TransactionId, MeterValues)	None
Stop Transaction	OCPP_StopTransaction(ChargeStationId, Identifier, StopValue, StopTime, TransactionId)	AuthorizationStatus
Heartbeat	OCPP_Heartbeat(ChargeStationId)	CurrentTime
Status Notification	OCPP_StatusNotification(ChargeStationId, Connector, ErrorCode, Status)	None

An OCPP Charging Service component is responsible for serving the Charge Stations (CS) with the ESSP data and storing the charging information from the CS during and after the charging session.

The component creates a SOAP Web Service port and starts to serve the OCPP requests from the charging stations. This is serving the charge stations during the startup, error events and EV charging sessions.

Logically the service is divided into 2 modules: status information and a charging session. This component is using the OCPP Communication layer.

This component is serving the following OCPP functions:

- Boot Notification
- Authorize
- Start Transaction
- Meter Values
- Stop Transaction
- Heartbeat
- Status Notification

This component is calling one OCPP function, Change Configuration.

4.8.1 Charge Station Communication – Use Case

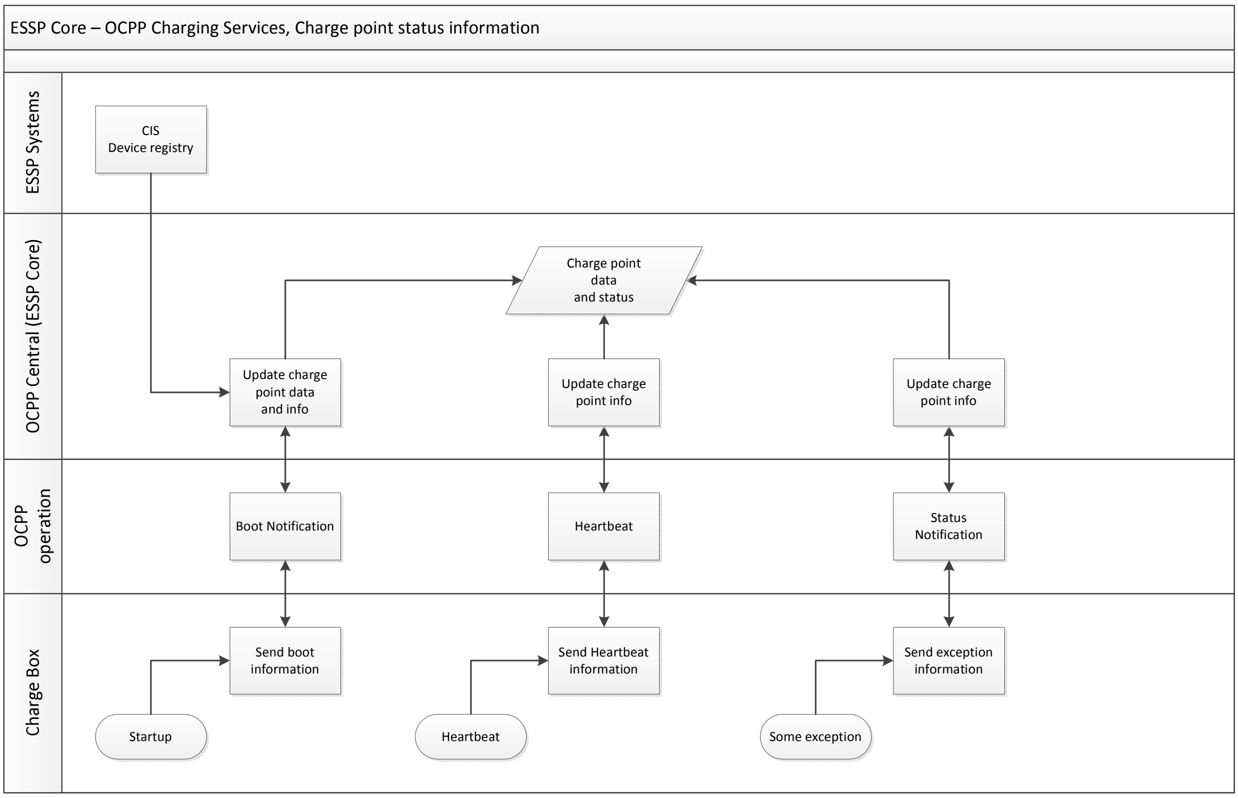

FIGURE 12. ESSP Core OCPP, Charge Station Status Information

Figure 12 shows the basic use cases of charge station status as a flowchart. The CIS device registry and charge station data model is explained in the preceding paragraphs.

The Use cases for Charge station status information are

- CS requests a permission to start with the boot notification
- CS informs being alive with the heartbeat
- CS informs status changes with status notifications

The Charge point reservation has functions to

- Authenticate the CS against CIS device registry
- Copy or update local CS data from CIS device registry
- Update CS SOPA Web address
- Set meter value parameters in CS with change configuration request
- Update the CS status

The Charge station cannot be started if CS is not found from the CIS registry

4.8.2 Electric Vehicle Charging Session Functionality – Use Case

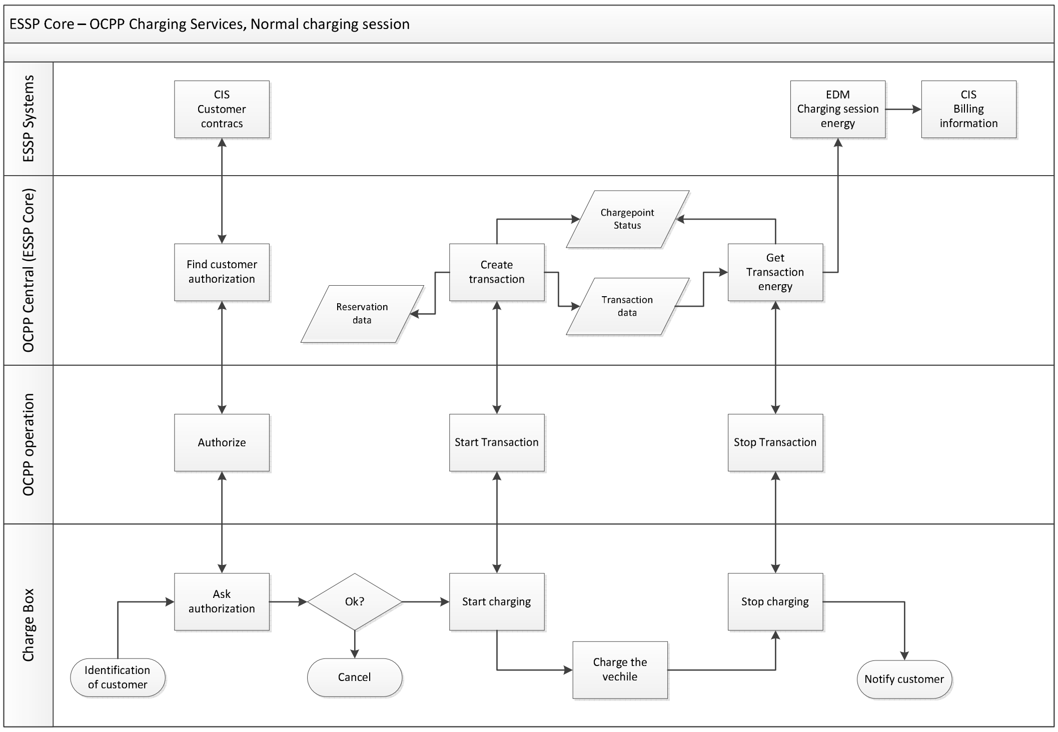

FIGURE 13. ESSP Core OCPP, EV Charging Session

Figure 13 shows the basic use cases of charging an electric vehicle.

The Use cases for charging an electric vehicle are:

- CS requests an authorization for the EV
- CS informs that charging has been started
- CS might send sampled meter values
- CS informs that charging has been stopped

Charge point reservation has functions to:

- Authenticate the EV identifier
- Save charging transaction startup data
- Save sampled meter values
- Create and send the charging session data from transaction startup and stop to CIS
- Create the time series data from session data and sampled values and send time series data to EDM
- Update the CS status

The charging session cannot be started if the EV identifier is not authorized to charge.

4.8.3 Free Charge Point Functionality – Use Case

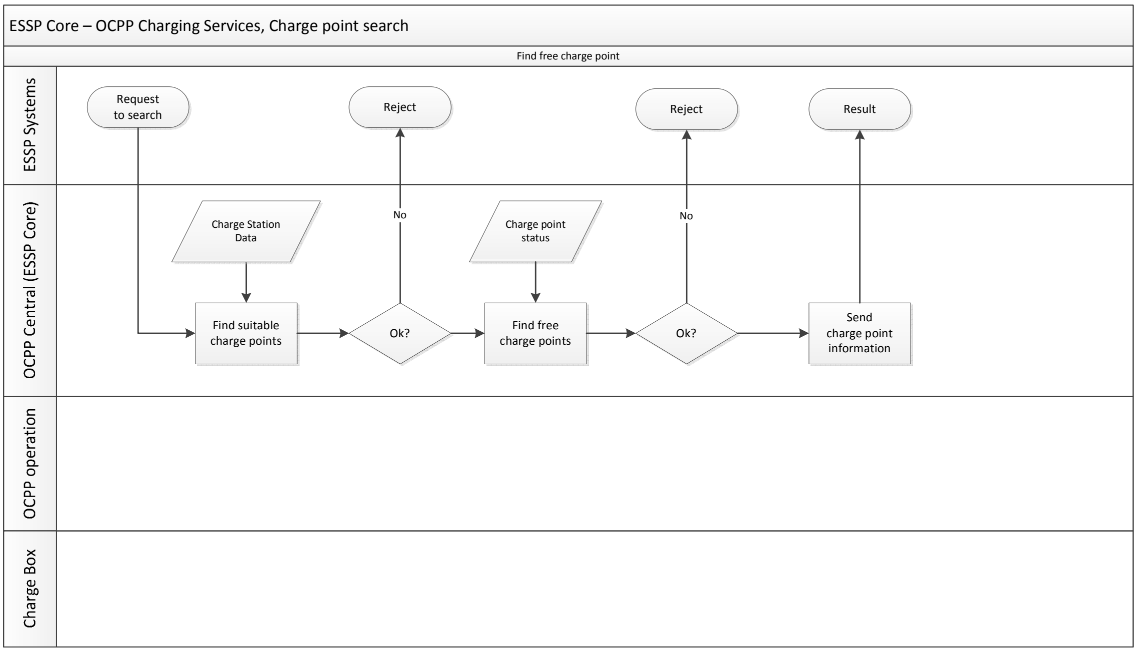

FIGURE 14. ESSP Core Reservation Service, Charge Point Search

Figure 14 shows the basic use case for finding suitable and free charge points for reservation as a flow chart.

The Use cases for charge point search are:

- EV sends charge point filter information in the charge point query message to find out suitable charge stations
- Service returns list of free sockets information for charge stations that fit to the filtering

The Charge point search has functions to:

- Search for charge stations that fit to the filtering
- Search free sockets for the matched charge stations
- Return a list of free sockets information

4.8.4 Charge Point Reservation Functionality – Use Case

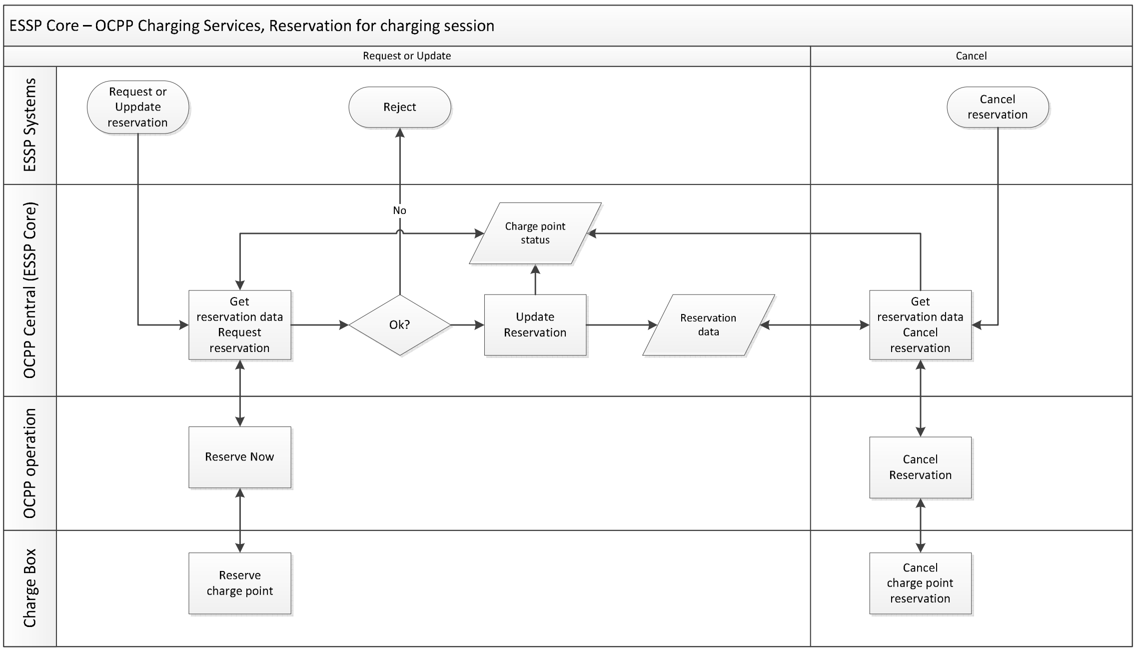

FIGURE 15. ESSP Core Reservation Service, Charge Point Reservation

Figure 15 shows the basic functionality for reserving the charge stations and canceling reservations.

The Use cases for reserving charge stations are:

- The EV sends its own identifier and the selected charge point identification to reserve the charge point
- The Service returns a reservation identifier if the reservation was successful

The Charge point reservation has functions to:

- Authenticate the EV identifier
- Search active reservations for the EV. The number of reservations for one EV is limited
- Make the charge point reservation with a Reserve now –operation

The Reservation cannot be activated if:

- The EV identifier is not authorized to charge.
- There is already too many active reservations for the EV

- The charging stations refuses to make the reservation

The Use cases for canceling reservations are:

- The EV sends its own identifier and the reservation identifier
- The Service returns ok if the cancellation was successful

The Cancel Reservation has functions to:

- Authenticate the EV identifier
- Search the reservation for the reservation identifier
- Cancel the charge point reservation with the Cancel Reservation operation

The reservation cannot be cancelled if:

- The EV identifier is not authorized
- There are no active reservations for the reservation identifier
- The charging station refuses to cancel the reservation

4.8.5 Remote Start and Stop – Use Case

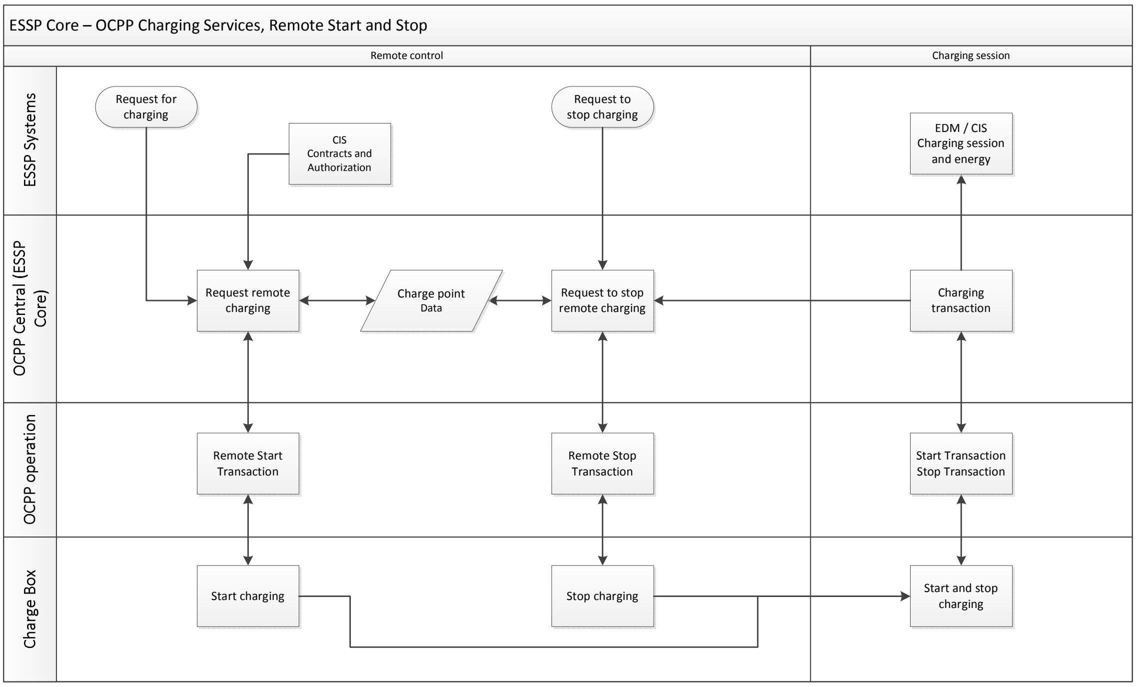

Figure 16, ESSP Core Charging Service, Remote Start and Stop

Figure 16 shows the basic functionality for remotely starting and stopping charging sessions.

The Use cases for remote start functionality are:

- User enters the EV identification on the remote control web page
- User hits the search-button to ensure that there is no charging session active on the EV
- User enters the charge station and socket information
- User hits the start-button to remotely start charging session

The Remote Start has functions to:

- Authenticate the EV identifier
- Search an active charging session for the EV
- Start the charging session with Remote Start Transaction operation

The remote start cannot be activated if:

- The EV identifier is not authorized to charge
- There is already a charging session active
- The charging station refuses to start a charging transaction

The Use cases for the remote stop functionality are:

- The User enters the EV identification on the remote control web page
- The User hits the search-button to ensure that there is a charging session active on the EV
- The User hits the stop-button to remotely stop charging session

The Remote Stop has functions to:

- Authenticate the EV identifier
- Search active charging session for the EV
- Stop the charging session with the Remote Stop Transaction operation

The remote stop cannot be activated if:

- The EV identifier is not authorized to charge
- There is no charging session active
- The charging station refuses to stop the charging transaction

4.9 EnerimCIS Web Service

EnerimCIS functionalities and data structures will be accessed using the SOAP Web Service. The CIS communication layer has only a client module. The functions in the client module are used in a service application to send request messages to the CIS system. Initiating a web service function runs a PL/SQL procedure in the EnerimCIS database. The ESSP Core is an initiator for all the operations. CIS operations are listed in table 6. CIS web service is called from the ESSP Core as explained in figure 5. Web service functions are explained in the following chapters.

TABLE 5. CIS operations

Operation	Description
CheckChargeStation	Check that the Charge Station is found from CIS registry
ReadChargeStationData	Read the Charge Station information from CIS
GetAuthorization	Get authorization for the Electric Vehicle identifier
GetAuthorizationListUpdate	Get update to offline authorization list
FindContractBasedChargings	Get list of chargings to be started
WriteChargedEnergy	Write the charged energy data to CIS

4.10 CheckChargeStation

The function checks if the charge station is present in the CIS device registry. The registration status is accepted if the CS is found from CIS and related data is ok. Otherwise the status is rejected.

TABLE 6. CheckChageStation function parameters

Input data	**Type**	**Description**
ChargeBoxIdentity	String	Identifies the CS received from OCPP
Output data	**Type**	**Description**
RegistrationStatus	Enum	If CS can be found and CS data structures are ok, Then Accepted. If CS can not be found or is not allowed to start transaction then Rejected

The EnerimCIS data structure and tables involved in the function are explained in Figure 9.

The Registration status can be rejected if,

- The Charge station is not found from CIS registry
- The Charge station is marked disconnected from grid in CIS
- The Charge station is marked with status “in maintenance” in CIS
- The Charge station unit of measurement is incorrect

4.11 ReadChargeStationData

Detailed Charge Station info is send to the ESSP Core from the CIS device registry. Information contains the charge station location coordinates, address and unit of energy measured.

TABLE 7. ReadChargeStationData function parameters

Input data	Type	Description
ChargeBoxIdentity	String	Identifies the CS received from OCPP
Output data	**Type**	**Description**
CsData	Structure	Contains the charge station data from CIS.

The EnerimCIS data structure and tables involved in the function are explained in Figure 9. Function output data is null if the charge station is not found from the CIS registry. The ESSP core should be designed so that in process of reading the charge station data, a check charge station – function is first initiated. If that returns rejected then the read charge station data function is not initiated.

4.12 GetAuthorization

The Function checks if an Electric Vehicle is authorized to start a charging transaction by the EV identifier. The charging might be allowed or disallowed according to the EV contract. The function returns the authorization status. If the identifier is allowed for charging: Allowed, otherwise: Blocked, Expired, Invalid.

TABLE 8. GetAuthorization function parameters

Input data	Type	Description
Identifier	String	Identifier received from OCPP
Output data	**Type**	**Description**
AuthStatus	Enum	Accepted, Blocked, Expired, Invalid.

The Electric Vehicle data structure and database tables in EnerimCIS are explained in figure 7. The general contract structure and database tables in EnerimCIS are explained in figure 11.

The Electric Vehicle charging transaction can be allowed when:

- The Customer has agreed to the billing terms of ESSP's administrator, a Charging Station Operator
- The Electric Vehicle is not reported stolen
- The Customer has active electric contract
- The Electric Vehicle is not reported disconnected in EnerimCIS (for instance the user has unpaid invoices)

4.13 GetAuthorizationListUpdate

The Charge station needs to be able to start a charging transaction even if a connection to the ESSP core is broken. Therefore the ESSP core has a functionality that keeps a list of authorized EV identifiers. The list is automatically maintained in EnerimCIS by database triggers. The function enables to get update to Charge Station list version or a full authorization list from the current authorization version. The update type is Differential of Full.

TABLE 9. GetAuthorizationListUpdate function parameters

Input data	**Type**	**Description**
ListVersion	Integer	The version Number of Charge Station authorization list.
Output data	**Type**	**Description**
AuthorizationList	(String, Enum, DateTime)[]	List of EV identifier, Authorization Status and Expiration dates
UpdateType	Enum	Is list full list of identifiers or update to existing list
ListVersion	Integer	Version of the list

The Electric Vehicle data structure and database tables in EnerimCIS are explained in figure 7. The General contract structure and database tables in EnerimCIS are explained in figure 11.

An authorization list is a list of Electric vehicles identified by an EnerIIM CIS Consumption Places external identification. The list also contains the authorization status of an electric vehicle and the expiration date of contract bound to the electric vehicle.

4.14 FindContractBasedChargings

The charging of an electric vehicle can be started automatically at any given time. Charging times are listed in the electric vehicle contract in EnerimCIS. For example if a user has a home charging station, a user can leave an electric vehicle plugged to the charge station for the night. The contract has an automatic charging schedule for the night time tariff. In the night time the price of electricity is usually cheaper.

TABLE 10. FindContractBasedChargings function parameters

Input data	**Type**	**Description**
BeginTime	DateTime	Begin time of the schedule range
EndTime	DateTime	End time of the schedule range
Output data	**Type**	**Description**
EVIdentifier	String	Identifies the electric vehicle
ChargeStationIdentifier	String	Identifies the the charge station for charging transaction
ChargeStationConnector	Integer	Identifies the connector inside the charge station
StartTime	DateTIme	Time when charging transaction should be started
EndTime	DateTIme	Time when charging transaction should be stopped

The Electric Vehicle data structure and database tables in EnerimCIS are explained in figure 7. The general contract structure and database tables in EnerimCIS are explained in figure 11.
The ESSP Core checks the EV contracts in EnerimCIS periodically and starts charging sessions if needed. The function can be scheduled for example to be run four times a day.

4.15 WriteChargedEnergy

The Energy recorded in the charging transaction is inputted to EnerimCIS for invoicing purposes. An Electricity invoice is formed by the normal business logic in EnerimCIS.

TABLE 11. WriteChargedEnergy function parameter

Input data	**Type**	**Description**

EVIdentifier	String	Identifies the Electric Vehicle
ChargeStationIdentifier	String	Identifies the charge station for charging transaction. Identifier is needed to inform invoiced customer where the charging transaction were made
ChargeStationConnectorID	Integer	Indentifies the connector inside the charge station
SessionEnergy	Integer	How much energy was consumed in transacion (kW)
StartTime	DateTIme	The time when charging transaction was started
EndTime	DateTime	The time when charging transaction was ended
Output data	**Type**	**Description**
InputStatus	Boolean	Was transaction inputted to EnerimCIS database successfully

The EnerimCIS data structure and tables involved in the function are explained in Figure 8.

5 CONCLUSIONS

The scope of the thesis was very broad. Therefore, the aim was not to go into details of every aspect. Guidelines were drawn but some details should be specified, too.
The thesis fulfilled its objectives. The design work provides a foundation for Energy Station Service Platform data models and use cases for OCPP communication.

One of the big challenges during the work was mentally letting go of the existing rules that have been created into the information systems used in this work. By breaking and changing these rules, necessary data models and processes were outlined for the use of an Energy Station Service Platform.
Energy distribution has remained virtually unchanged for past decades. It is a recognized fact that changes and innovative solutions have to be made in the process of turning the existing energy infrastructure into future smart grids. One big challenge was to understand the needs and complexity of data flows between smart grid information systems.

The existing information systems can and should be used to develop new products and services. The information gained during the realization of this thesis can be used on its own or to create a completely new data information system.

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APPENDICES

Appendix 1 – ESSP CIS structures

Appendix 2 – ESSP Requirements – Device capabilities

Appendix 3 – ESSP Requirements – Interfaces to other systems

Appendix 4 – ESSP Requirements – ESSP Core

Appendix 5 – ESSP Requirements – Ancillary Services

Appendix 6 – ESSP Requirements – Security and Privacy

Appendix 1 – ESSP CIS structures

ESSP Data Class	ESSP Data Item	Description	CIS Data Class	CIS Data Item	Description	EnerimCIS Data Table	EnerimCIS Data Item	New Item
Electric Vehicle (EV)								
	EV_Identifier	EV identifier (string of 20 characters). Received from OCPP operation or other systems to authorize operations. Must be unique among	CIS_ConsumptionPlace		ConsumptionPlace is used to access the EV data and the EV customer contract in ESSP. The ConsumptionPlace is connected to CIS_Equipment, Contract and Customer. The type of the	tUsagePlace		

		all the Electric Vehicles in the system.			CIS_Consumption Place instance is EV. CIS_Consumption Place identifies the EV type and identification (registration number).			
				ConsumptionPlace identifier / ConsumptionPlace External Identification	EV_Identifier is an external identifier string in ConsumptionPlace containing the ESSP EV_Identifier value. It is used to identify the correct ConsumptionPlace to access the EV data and contract.	tExternalSystem-Identification	sExternalIdentification with nTypeCodeID	
				ChargingAllowed	Charging Allowed	tContrac-	nReasonCodeID	

					identifier indicates that the EV has rights to charge.	tObjectConnection		
				VechicleStolen	VehicleStolen indicates if the EV has been stolen or not.	tContrac-tObjectConnection	nReasonCodeID	
				NetworkCompany	An energy network company. A company in which the network area of the charging station is located	tJunctionSup-plyArea	nDeliveryCustomerID	
				SellingCompany	An energy Selling company. A company where the EV end user buys electricity from	tUsagePlaceSeller	nSellerCustomerID	
			CIS_Equipment	Equipment	Equipment is used to collect metering data and to con-	tEquipment		

					nect the metering data to the contract.			
				EquipmentType	For EV type <equipment> the <equipmenttype> is enumeration of the "EV".	tModel	nEquipmentTypeCodeID	
				EquipmentIdentifier	EquipmentIdentifier contains an identification string, like a registration number.	tEquipment	sEquipmentNumber	
			CIS_Contract		The Contract is used to define authorization and charging parameters for the EV. The contract also connects the EV to	tContract		

					the Customer and Billing. The right to charge can be allowed or disallowed. Charging can be allowed or disallowed during daytime. Charging can be remotely started during daytime.			
				ContractValidFrom	Validity dates of the charging contract.	tContractPosition-Change	dValidFrom	
				ChargingAl-lowedSchedule	Dates when charging is allowed/disallowed.	tChargingSchedule	dChargingAl-lowedFrom / To	x
				RemoteCharg-ingSchedule	Times of day when charging will be		dChargingStartTime	x

					started remotely.			
				RemoteCharg-ingLocation		tChargingSchedule	nLocationID	x
				InvoicingType	Billing types, an enumeration.	tContractPosition-Change	nEstimateInvoic-ingTypeCodeID	
			CIS_Customer		The customer identifies the own-er of an EV and the billing target for the charged ener-gy.	tCustomer		
Electric Vehicle Energy (EE)								
	EE_Load_En ergy	Energy loaded in one charg-ing session.	CIS_Energy	EnergyInput	Energy is input into CIS for Billing the end customer.	tCounterReadingIn-put	nAmount	

	EE_Load_StartTime	The Charge session starting time.		ConsumptionStart	The starting time of the charging session	tMeterCountInput	dReadingPeriodStart	
	EE_Load_StopTime	The Charge session stopping time.		ConsumptionStop	The stopping time of the charging session	tMeterCountInput	dReadingPeriodEnd	
	EE_Load_Station	Charge station identification (a string of characters), CS.Identifier.		LoadStationIdentifier	Identifies the location where the charging was made	tCounterReadingInput	nLocationIdentifier	x
Charge Station (CS)								

	CS_Identifier	A CS identifier (a string of characters). Received from the OCPP operation SOAP header or other systems to access the CS data. CS is used to describe both the Charge Point andCharge Box. Must be unique among all the Charge Stations in the system.	CIS_MeteringPlace		MeteringPlace is used to access the CS data in ESSP. MeteringPlace contains the CS status. MeteringPlace contains also the CS communication data, like the SOAP address. The MeteringPlace is connected to Equipment. The type of the Equipment instance is CS. Equipment identifies the CS type and contains data	tUsagePlace		

					elements for CS.			
				Metering-PlaceIdentification	<tunniste> is an external identifier string in Metering-Place containing the ESSP CS_Identifier val-ue. It is used to identify the correct MeteringPlace to access the CS da-ta.	tMeteringPlace	sMeteringPlace	
				MeteringPlace Address	MeteringPlace Ad-dress contains the street address of the CS.	tContrac-tObjectAddress	sAddressLine	

			CIS_Equipment		Equipment contains the CS information, like identification (serial number) and CS type information. Equipment may also contain CS behaviour data, like a hertbeat interval and a MeasurementValues operation capability.	tEquipment		
				EquipmentType	For CS type Equipment the EquipmentType is enumeration of "CS".	tModel	nEquipmentTypeCodeID	
				EquipmentIdentifi-	EquipmentIdentifi-	tEquipment	sEquipmentNumber	

				er	er contains an identification string, like a serial number.		with sSerialNumber	
				EquipmentUnit	Ie. kWh	tCounterUsage	nQuantityCodeID	
Electric Vehicle User (EU)								
			CIS_Customer		An Electric Vehicle User is a person who charges the Electric Vehicle. The Electric vehicle user can be an EV Charging Contract owner or a different person	tCustomer		
				Address	A Customer ad-	tCustomerAddress	sAddressLine	

					dress			
				Name	An Electric Vehicle User's name	tCustomerName	sName	
				Social security number	A Social security number of the EV user	tPerson	sSocSec	

Appendix 2 – ESSP Requirements – ESSP Device Capabilities

Requirement	Comment
1.1.1 ESSP Device Capabilities and Properties	
1.1.1.1 REQ-1.1.1 Device Connectivity	
Related use case: None	
Requirement type: Functional	
Priority: High	
Description: ESSP Devices shall be able to communicate with the ESSP Core directly with an Internet Protocol (IP) based connection or through a gateway to an IP network.	the ESSP core supports the OCPP protocol when it is possible
1.1.1.2 REQ-1.1.2 Collecting Components Status	
Related use case: D1.02 / 5.6.5	
Requirement type: Functional	
Priority: Medium	
Description: The charging station components shall be able to report its internal status.	The ESSP core supports the OCPP protocol when it is

	possible
1.1.1.3 REQ-1.1.3 Report Charging Status	
Related use case: D1.02 / 5.6.3	
Requirement type: Functional	
Priority: Medium	
Description: The charging station components shall be able to report the charging information.	OCPP start / stop transactions
1.1.2 Device Security	
1.1.2.1 REQ-1.2.1 Storing Credentials Securely	
Related use case: Storing of credentials and other sensitive information.	
Requirement type: Design constraint	
Priority: High	
Description: Devices shall hold their keys, certificates and other credentials used in security services in a secure and tamper resistant storage.	

Appendix 3 – ESSP Requirements – ESSP Interfaces to Other Systems

Requirement	**Com-ment**	**Data class**	**Data-base**		**OCPP**

1.1 Communication and Interfaces to Other Systems					
1.1.1 Communication Properties					
1.1.1.1 REQ-2.1.1 IP Connectivity		n/a			Ok
Related use case: None					
Requirement type: Functional					
Priority: High					
Description: All ESSP core related communication shall be based on IP. Any non-IP communication technology can be supported through a gateway to the ESSP Core.					
1.1.1.2 REQ-2.1.2 Wireless Communication from an EV		n/a			n/a
Related use case: D1.02 / 5.7.1					
Requirement type: Functional					
Priority: Low					
Description: An EV shall be able to communicate with secondary actors using both wide area and local area wireless communication.					
1.1.1.3 REQ-2.1.3 Batch or Real-time Communication between EV, Charging Station and Billing Operator		Charging session Information (REQ-3.2.6	El-laEDM		Batch communication is not supported

		Charging records), Energy consump-tion (REQ-3.2.6 Charging records)			
Related use case: D1.02 / 5.6.4					
Requirement type: Functional					
Priority: Low					
Description: The data of EV charging transactions shall be possible to be sent or collected on certain intervals for invoicing and reporting purposes.					
1.1.1.4 REQ-2.1.4 ETSI M2M Interfaces Compatibility		n/a			n/a
Related use case: None					
Requirement type: Design constraint					
Priority: Low					
Description: It should be possible to connect ETSI M2M-compatible devices to the ESSP.					
1.1.1.5 REQ-2.1.5 Pairing of EVSE and a User Mobile Device		n/a ?			n/a

Related use case: None					
Requirement type: Functional					
Priority: Low					
Description: An EV end user shall be able to select a device to which EVSE status information is sent. It can be done for example by pairing a user's mobile device and EVSE. Charging related information is then sent to the user mobile device, for example to select charging schedule or get a notification when the battery is full (enough).			EnerIM CIS		
1.1.2 Security					
1.1.2.1 REQ-2.2.1 Message Encryption		n/a			SOAP / SSL
Related to use cases: Where communication is required between two or more ESSP devices and/or services.					
Requirement type: Design constraint					
Priority: High					
Description: The protocol used between communicating entities must offer confidentiality: It must provide means to ensure that a sent message is only readable by allowed entities selected by the sender.					
1.1.2.2 REQ-2.2.2 Message Authentication and Integrity		n/a			SOAP
Related to use cases: Where communication is required between two or more ESSP devices and/or services.					

Requirement type: Design constraint					
Priority: High					
Description: The protocol used between communicating entities must offer integrity of messages: It must provide means to ensure confidence that a received message has not been intentionally or accidentally corrupted or tampered with.					
1.1.2.3 REQ-2.2.3 Replay Attack Protection		n/a			SOAP / SSL
Related to use cases: Where communication is required between two or more ESSP devices and/or services.					
Requirement type: Design constraint					
Priority: High					
Description: The protocol used between communicating entities must offer countermeasures against replay attacks: It must provide means to ensure confidence that an adversary has not been recorded and playing back a received message.					
1.1.2.4 REQ-2.2.4 Possibility to Select if Security Services are used		n/a			n/a
Related to use cases: Where communication is required between two or more ESSP devices and/or services.					
Requirement type: Design constraint					
Priority: High					

Description: Entities in ESSP conceptual model [IoE-D1.02] have different amount of resources, They work in different domains, and might be under different amounts of loads. It must be possible for each entity to ensure all the time that the communication is secure, but still do it whenever the entity wants to do it. From this we get the next requirement: The protocol used between communicating entities must allow any entity to use the means to ensure non-corruption, non-playback, and privacy, but the protocol must not require that all entities use these means at all times.					
1.1.3 Interfacing with Devices and Systems from the Energy Domain		Energy marketing data	EllaEDM, Ener-im EMS, Ener-imCIS		n/a
1.1.3.1 REQ-2.3.1 Information Exchange with Utility Systems					
Related use case: None					
Requirement type: Functional					
Priority: Medium					
Description: There should be an interface between ESSP and Utility companies' systems. Data exchanged in the interface can be for example current and upcoming grid balancing information, meter values from AMR and smart metering systems and proprietary SCADA systems. Also some value added service might use information of larger scale energy storage facilities. The interfaces should be open and standard interfaces that can be accessed using IP based protocols.					

Appendix 4 – ESSP Requirements – ESSP Core

Requirement		Data class	Data-base		OCPP Operations	Initiator	OCPP Messages
1.1 ESSP Core							
1.1.1 Service Enablers							
1.1.1.1 REQ-3.1.1 Service development support		n/a			n/a		
Related use case: None							
Requirement type: Functional							
Priority: Medium							
Description: Energy Station Service Platform shall enable ancillary service development.							
1.1.1.2 REQ-3.1.2 ESSP Core data access		n/a			n/a		
Related use case: None							
Requirement type: Functional							
Priority: Medium							
Description: Access to ESSP data must be done in a secure way through the authentication and authorization process.							

At least data from Electric Vehicles, Users, Stolen Vehicles as well as Charging Station information would be useful from a service developer's point of view. In addition, some services might need information about charging sessions and for example failure logs. Also, some services can require information about energy storages. The information access might be limited only for certain actions for example only for information read and not for writing and modification. It is noteworthy that service developers are responsible for the data privacy and the end user shall not be able to access or see other end-users' information without permission.							
1.1.1.3 REQ-3.1.3 Device Inventory		Device Register (Vechile, charging station)	Enerim CIS		n/a		
Related use case: None							
Requirement type: Functional							
Priority: Medium							
Description: The ESSP Core shall have a registered device database. It should be possible to search the database using different keys like a device identification, location or status.							

1.1.2 Data Storage							
1.1.2.1 REQ-3.2.1 Information Protection		n/a			n/a		
Related use case: None							
Requirement type: Functional							
Priority: High							
Description: Access to ESSP stored data shall be limited and the data shall be protected. The data access rights can be of different types such as read, write, modify, and delete. The data access must be protected through authentication and authorization process.							
1.1.2.2 REQ-3.2.2 User Information		Customer Information, User Information	Enerim CIS		4.1 Authorize, 4.8 Start Transaction	Station	Authorize.conf, StartTransaction.conf
					5.13 Send Local List	Central	SendLocalList.req
Related use case: None							
Requirement type: Functional							
Priority: Medium							

Description: User information shall be able to be read, modified, created and deleted. User information can vary, although user information such as identification, name, contact information, and user EVs are usually common information. Other than that, other information can also be stored for example customer contract information and user preferences. The access to user information must be protected through an authentication and authorization process.							
1.1.2.3 REQ-3.2.3 EV information		Vechile Information, Customer (and User) Information	Enerim CIS		n/a		
Related use case: None							
Requirement type: Functional							
Priority: Medium							

Description: Electric Vehicle information shall be able to be read, modified, created and deleted. EV information can vary, although information such as a model, identification, and the owner of EV (relation to a user information record) are usually common information. In addition to that, EV might have several users whose relation should be stored to EV information. The access to EV information must be protected through authentication and authorization process.							
1.1.2.4 REQ-3.2.4 Stolen EVs		Vehicle Blacklist	Enerim CIS		n/a		
Related use case: None							
Requirement type: Functional							
Priority: Low							
Description: Stolen vehicles shall be able to be blacklisted. For this it should be possible to add vehicle identifications to a blacklist, remove vehicles from the list, and provide an access to search a vehicle identification from the blacklist. The access to the blacklist must be protected through an authentication and authorization process. Especially, any outsider should not be able to remove or add vehicle identifications to the blacklist. Naturally, providing this kind of service must be done in such a way that related security and privacy directives and regulations are followed.							
1.1.2.5 REQ-3.2.5 Charging Station Information		Charging station	Enerim CIS		4.2 Boot Notifica-	Sta- tion	BootNotifica- tion.req

		Information			tion		
Related use case: None							
Requirement type: Functional							
Priority: Medium							
Description: There should be an interface to charging stations. Using that interface it should be possible to add new charging station information, remove existing records, and modify charging station information if needed. The access to charging station information must be protected through an authentication and authorization process.							
1.1.2.6 REQ-3.2.6 Charging Records		Charging session Information, Energy consumption in session	EllaEDM, Enerim CIS		4.8 Start Transaction, 4.10 Stop Transaction	Station	StartTransaction.req, StopTransaction.req
Related use case: None							
Requirement type: Functional							
Priority: Medium							

Description: Information of each charging session shall be stored. The charging session information can vary. However, usually a charging session record contains at least the charging station identification, user and/or EV identification, amount of consumed energy and timestamp when this session happened. Charging session records can be used for customer billing, thus the data can be very sensible. The data access must be protected through authentication and authorization process.							
1.1.2.7 REQ-3.2.7 Energy Storage Information		Energy storage Information	El-laEDM Enerim CIS		n/a		
Related use case: None							
Requirement type: Functional							
Priority: Low							
Description: Information about energy storages may be integrated into the Energy Station Service Platform for monitoring and maintaining purposes.							
1.1.2.8 REQ-3.2.8 Failure logs		Failure Log	Event-log		4.9 Status Notification	Station	StatusNotification.req
Related use case: D1.02 / 5.6.5							
Requirement type: Functional							

Priority: Medium							
Description: Failures related to the Energy Station Service Platform should be monitored and failure information should be available. Failures can be related to the ESSP devices, ESSP usage such as intrusion detection, some internal errors or something else.							
1.1.2.9 REQ-3.2.9 Charging Station Information Database		Same as REQ-3.2.5 Charging station infor-mation					
Related use case: None							
Requirement type: Functional							
Priority: Medium							
Description: Information about all charging stations shall be logged. Searching charging stations can be based on different kinds of search criteria for example the location of the charging station, the model of the charging station, status of the charging station, or the identification of the charging station.							
1.1.3 Infrastructure							

1.1.3.1 REQ-3.3.1 Unique ID for Each Device		Vechile infor-mation ID	Ener-imCIS		n/a		
Related use case: None							
Requirement type: Functional							
Priority: High							
Description: All devices which are integrated to the Energy Station Service Platform shall be uniquely identified.							
1.1.3.2 REQ-3.3.2 Communication with Devices		Device ?	Enerim CIS		n/a		
Related use case: None							
Requirement type: Functional							
Priority: Medium							
Description: A registered ESSP device should be able to be connected if supported by the device.							
1.1.3.3 REQ-3.3.3 Register or Unregister a Device into ESSP		Device Register	Enerim CIS		n/a		
Related use case: None							
Requirement type: Functional							
Priority: Medium							

Description: Devices may be integrated into the Energy Station Service Platform. It should be possible to remove the integrated device from the Energy Station Service Platform. The Energy Station Service Platform should provide a possibility to register or unregister devices.							
1.1.3.4 REQ-3.3.4 Device Type Identification		Device Type	Enerim CIS		n/a		
Related use case: None							
Requirement type: Functional							
Priority: Medium							
Description: All devices should be identified by the device type, for example EV, Charging Station, and Energy Storage.							
1.1.3.5 REQ-3.3.5 Receive Charging Records		Energy metering data	EllaEDM, Enerim CIS		4.7 Meter Values, 4.10 Stop Transaction	Station	MeterValues.req, StopTransaction.req
Related use case: D1.02 / 5.6.4							
Requirement type: Functional							
Priority: Medium							

Description: The ESSP Core shall be able to receive Charging Records from Charging Stations.							
1.1.3.6 REQ-3.3.6 Receive Logs from Devices		Same as REQ-3.2.8 Failure logs			n/a		
Related use case: D1.02 / 5.6.3							
Requirement type: Functional							
Priority: Medium							
Description: The ESSP Core shall be able to receive logs from different devices. Logging information can vary, although usually at least failures are logged.							
1.1.3.7 REQ-3.3.7 Notification of Invalidated Credentials		Customer infor-mation Creden-tials	Enerim CIS		n/a		
Related use case: D1.02 / 5.6.2							
Requirement type: Functional							
Priority: Medium							

Description: The ESSP Core shall be able to accept a notification regarding the use of invalidated credentials.							
1.1.3.8 REQ-3.3.8 Collecting Offline Records		Same as REQ-3.2.6 Charging records			n/a		
Related use case: D1.02 / 5.6.4							
Requirement type: Functional							
Priority: Medium							
Description: The ESSP Core shall be able to collect an off-line log of events.							

Appendix 5 – ESSP Requirements – Ancillary Services

Requirement		**ESSP Core Data class**	**Data-base**		**OCPP Opera-tions**	**Initia-tor**	**OCPP Messages**
1.1 Ancillary Services							
1.1.1 User Management and Privacy							

1.1.1.1 REQ-4.1.1 EV End User Registration		End user Register (REQ-3.2.2 User information)	Enerim CIS		n/a		
Related use case: D1.02 / 5.1.1							
Requirement type: Functional							
Priority: Medium							
Description: The Registration of users shall be possible.							
1.1.1.2 REQ-4.1.2 EV Registration		Vehicle Information (REQ-3.2.3 EV information)	Enerim CIS		n/a		
Related use case: D1.02 / 5.1.1							
Requirement type: Functional							
Priority: Medium							

Description: The Registration of EVs shall be possible. Registered EVs can be connected to registered users.							
1.1.1.3 REQ-4.1.3 Freeze an End User Account		Same as REQ-4.1.1 EV end user registration			4.1 Authorize, 4.8 Start Transaction	Station	Authorize.conf, StartTransaction.conf
					5.13 Send Local List	Central	SendLocalList.req
Related use case: D1.02 / 5.1.1							
Requirement type: Functional							
Priority: Medium							
Description: The Freezing of the user accounts shall be possible. In addition to that, the end user shall be able to freeze his/her account for example in case that an electric vehicle has been stolen.							
1.1.1.4 REQ-4.1.4 Notification of Frozen Account		Same as REQ-4.1.1 EV end user			n/a		

		registra-tion					
Related use case: D1.02 / 5.1.1							
Requirement type: Functional							
Priority: Medium							
Description: An end user shall be notified when his account has been frozen.							
1.1.1.5 REQ-4.1.5 Termination of a User Account		Same as REQ-4.1.1 EV end user registra-tion			Same as REQ-4.1.3 Freeze end user account		
Related use case: D1.02 / 5.1.1							
Requirement type: Functional							
Priority: Medium							
Description: The Termination of a user account shall be possible.							
1.1.1.6 REQ-4.1.6 Notification of a Terminated User Account		Same as REQ-4.1.1 EV end user			n/a		

		registra-tion					
Related use case: D1.02 / 5.1.1							
Requirement type: Functional							
Priority: Medium							
Description: An end user shall be notified when his / her account has been terminated.							
1.1.1.7 REQ-4.1.7 EV End User Notification		n/a			n/a		
Related use case: D1.02 / 5.1.1							
Requirement type: Functional							
Priority: Medium							
Description: An EV end user shall be notified if the charging session is interrupted or failed during the charging process.							
1.1.2 Billing and Payment							
1.1.2.1 REQ-4.2.1 Monitor Energy Usage		Energy consump-tion (REQ-3.2.6	El-laEDM		n/a		

		Charging records)					
Related use case: D1.02 / 5.3.1							
Requirement type: Functional							
Priority: Medium							
Description: An EV end user shall be able to monitor the amount of energy what he / she has used.							
1.1.2.2 REQ-4.2.2 Monitor Charging Costs		Energy consump-tion Costs (REQ-3.2.6 Charging records)	El-laEDM, Enerim CIS		n/a		
Related use case: D1.02 / 5.3.1							
Requirement type: Functional							
Priority: Medium							
Description: An EV end user shall be able to monitor costs of EV charging events.							
1.1.2.3 REQ-4.2.3 Create a Bill of EV Charging		Energy consump-	El-laEDM,		n/a		

		tion Costs (REQ-3.2.6 Charging records)	Enerim CIS				
Related use case: D1.02 / 5.3.1							
Requirement type: Functional							
Priority: Low							
Description: It shall be possible to create bills to customers based on their energy usage in certain time period.							
1.1.2.4 REQ-4.2.4 EV Charging Station reveals its Location		Charging session Infor-mation (REQ-3.2.6 Charging records), Charging station	El-laEDM, Enerim CIS		Same as REQ-3.2.5 Charging station infor-mation		

		Infor-mation (REQ-3.2.5 Charging station infor-mation)					
Related use case: D1.02 / 5.3.2							
Requirement type: Functional							
Priority: High							
Description: An EV end user should be able to see in which charging station the specific charge session is made. The information can be used in verifying billing items.							
1.1.3 Dynamic Charging Control and Vehicle-to-Grid Integration							
1.1.3.1 REQ-4.3.1 Trip Planning for the Next EV Usage		n/a			n/a		
Related use case: D1.02 / 5.4.2							
Requirement type: Functional							
Priority: Medium							

Description: An EV end user should be able to plan for a trip so that the EV will be charged and ready to go when the trip is scheduled to start. For the plan, for example departure time and distance are included.							
1.1.3.2 REQ-4.3.2 Receiving a Charging Schedule		n/a			n/a		
Related use case: D1.02 / 5.4.1							
Requirement type: Functional							
Priority: Medium							
Description: An EV end user should be able to receive a charging schedule proposal which takes into consideration the user's plans and usage preferences.							
1.1.3.3 REQ-4.3.3 Physical Limitations for the Charging Schedule		Receiving a charging schedule is not implemented, how to put constraints to a sched-	Enerim CIS		n/a		

		ule? Vehicle Infor-mation (REQ-3.2.3 EV infor-mation), Charging station Infor-mation (REQ-3.2.5 Charging station infor-mation)					
Related use case: None							

Requirement type: Design constraint							
Priority: High							
Description: The physical limitations of delivering energy to an EV shall be taken into account when a charging schedule is planned.							
1.1.3.4 REQ-4.3.4 Changing a Planned EV Trip		Trip planning is not implemented, how to change a plan?			n/a		
Related use case: D1.02 / 5.4.3							
Requirement type: Functional							
Priority: Medium							
Description: An EV end user should be able to change the already planned trip with new information.							
1.1.3.5 REQ-4.3.5 Provide Updated Charging Schedule		n/a			n/a		
Related use case: None							
Requirement type: Functional							
Priority: Medium							

Description: The system should propose an EV end user a new, re-calculated charging schedule based on the changed information.							
1.1.3.6 REQ-4.3.6 Follow agreed Charging Schedule		Receiving a charging schedule is not implemented, how to follow a schedule?			n/a		
Related use case: D1.02 / 5.4.1, 5.4.2							
Requirement type: Functional							
Priority: Medium							
Description: The ESSP needs to make sure that all agreed charging schedules are to be followed unless the schedule has been changed by the user. However, there might be exceptions to this behaviour in force major type of situations like for example energy grid blackouts or exceptionally high demand peaks for electricity.							

1.1.3.7 REQ-4.3.7 Sell Energy from an EV back to the Grid		Receiving a charging schedule is not implemented, how to get information from a schedule? Customer Information (REQ-3.2.2 User information),	EllaEDM, Enerim CIS		n/a		

		Energy Con-sumption (REQ-3.2.6 Charging records)					
Related use case: None							
Requirement type: Functional							
Priority: Low							
Description: An EV end user may be able to sell energy from the EV back to the energy grid when feasible. The option may be indicated in the usage profile or by selecting this option when making a one-time charging schedule agreement.							
1.1.3.8 REQ-4.3.8 Notification of charged EV		Trip planning is not implemented, how to get infor-			n/a		

		mation about a planned trip?					
Related use case: D1.02 / 5.4.3							
Requirement type: Functional							
Priority: Medium							
Description: An EV end user should get a notification once the EV has been charged enough for the next planned trip.							
1.1.3.9 REQ-4.3.9 A Remote checking of EV's Battery Status		n/a ? There is no battery status messag-es in OCCP.			n/a		
Related use case: D1.02 / 5.7.2							
Requirement type: Functional							
Priority: Low							

Description: An EV end user shall be able to monitor the EV’s battery charging status using for example a mobile device.							
1.1.4 Device Operation and Management							
1.1.4.1 REQ-4.4.1 Remote Monitoring and Maintenance of EVSE Equipment		Charging station Status information (REQ-3.2.5 Charging station information)	Enerim CIS		4.2 Boot Notification, 4.9 Status Notification, 4.6 Heartbeat	Station	BootNotification.req, StatusNotification.req , Heartbeat.req

					5.2 Change Availability, 5.6 Get Configuration, 5.3 Change Configuration, 5.7 Get Diagnostics, 5.15 Update Firmware, 5.12 Reset	Central	ChangeAvailability.req, GetConfiguration.conf, ChangeConfiguration.req, GetDiagnostics.conf, DiagnosticsStatusNotification.req, UpdateFirmware.req, FirmwareStatusNotification.req, Reset.req
Related use case: D1.02 / 5.5.1							

Requirement type: Functional							
Priority: Low							
Description: A service operator or a utility should be able to monitor its fleet of charging stations. If, for example, there is a problem with a specific part of some charging station, a notification should be sent of it to start maintenance procedures. It should be possible to configure and manage run-time conditions of the charging station and its components.							
1.1.4.2 REQ-4.4.2 Data Concentrator Update Request		n/a			n/a		
Related use case: D1.02 / 5.5.2							
Requirement type: Functional							
Priority: Low							
Description: The data concentrator shall be able to send/receive an update request to/from a back office server.							
1.1.4.3 REQ-4.4.3 Charging Command Issuing		Charging station Information (REQ-3.2.5 Charging	Enerim CIS		5.9 Remote Start Transaction, 5.10 Remote Stop Transac-	Central	RemoteStartTransaction.req, RemoteStopTransaction.req

		station infor- mation)			tion		
Related use case: D1.02 / 5.4.1							
Requirement type: Functional							
Priority: Low							
Description: The back office server shall issue a charging command that is catch- able by the data concentrator.							
1.1.4.4 REQ-4.4.4 Monitoring Energy Usage		Charging station Infor- mation (REQ- 3.2.5 Charging station infor- mation), Charging session	El- laEDM, Enerim CIS		n/a		

		Infor- mation (REQ- 3.2.6 Charging records)					
Related use case: D1.02 / 5.5.1							
Requirement type: Functional							
Priority: Low							
Description: The infrastructure provider shall be able to remotely monitor energy usage of the charging station.							
1.1.5 Presence							
1.1.5.1 REQ-4.5.1 Access to Presence Information		n/a			n/a		
Related use case: All use cases in which the presence information of devices and/or services is available.							
Requirement type: Functional							
Priority: Medium							

Description: The user controlling a presentity of ESSP entities must be able to control which other entities can update, observe or have a subscription to that presentity's presence information, and what presence information a particular entity will see for that presentity.							
1.1.5.2 REQ-4.5.2 Relation of Access Control and Presence Information		n/a			n/a		
Related use case: All use cases in which presence information of devices and/or services is available.							
Requirement type: Functional							
Priority: Medium							
Description: The Access control must be independent of presence: the presence service must be able to make access control decisions even when the presentity is out of contact.							

Appendix 6 – ESSP Requirements – Security and Privacy

Requirement		**ESSP Core Data class**	**Database**		**OCPP Operations**	**Initiator**	**OCPP Messages**
1.1 Security and Privacy							
1.1.1 Authentication and Authorization							

1.1.1.1 REQ-5.1.1 EV End User Identification		End user Register (REQ-3.2.2 User information)	Enerim CIS		Same as REQ-3.2.2 User information		
Related use case: D1.02 / 5.2.1							
Requirement type: Functional							
Priority: High							
Description: A service provider should be able to identify the end user in case that a post-paid billing option is used. The end user identification and validation must be done before the EV charging can be started. The EV end user identification shall be able to be performed through various channels.							
1.1.1.2 REQ-5.1.2 EV Identification		Vechile Information (REQ-3.2.3 EV information)	Enerim CIS		Same as REQ-3.2.2 User information		

Related use case: D1.02 / 5.2.1							
Requirement type: Functional							
Priority: Medium							
Description: A service provider should be able to identify a connected EV for billing and information services. The identification should be done before the charging session has been started.							
1.1.1.3 REQ-5.1.3 Authorize an EV Charging		Customer Infor-mation (REQ-3.2.2 Us-er infor-mation), Vechile Infor-mation (REQ-3.2.3 EV infor-mation)	Enerim CIS		Same as REQ-3.2.2 User infor-mation		

Related use case: D1.02 / 5.2.2							
Requirement type: Functional							
Priority: Medium							
Description: A service provider shall be able to authorize the identified EV end user and/or EV before charging can be started. The Authorization may support post-paid, prepaid and hybrid billing models.							
1.1.1.4 REQ-5.1.4 Not Enough Credits for Charging		Customer Infor-mation (REQ-3.2.2 User infor-mation)	Enerim CIS		Same as REQ-3.2.2 User infor-mation		
Related use case: D1.02 / 5.2.2							
Requirement type: Functional							
Priority: Medium							
Description: A service provider shall be able to prevent EV charging if the end user does not have enough credits on his/her account. In that case the authorization process shall fail.							

1.1.1.5 REQ-5.1.5 The Authentication of EV & EVSE		Vechile Infor-mation (REQ-3.2.3 EV infor-mation), Charging station Infor-mation (REQ-3.2.5 Charging station infor-mation)	Enerim CIS		Same as REQ-3.2.2 User infor-mation		
Related use case: D1.02 / 5.2.3							
Requirement type: Functional							
Priority: Medium							

Description: A service provider should be able to require the authentication of EV and EVSE before the charging process can be started.							
1.1.1.6 REQ-5.1.6 Public User IDs		n/a	Enerim CIS		n/a		
Related use case: D1.02 / 5.2.3							
Requirement type: Functional							
Priority: Low							
Description: An EV end user should be able to charge an EV using a public ID for example when using a company car.							
1.1.1.7 REQ-5.1.7 Anonymous Charging		n/a			n/a		
Related use case: D1.02 / 5.2.3							
Requirement type: Functional							
Priority: Low							
Description: An EV end user should be able to charge the EV anonymously with certain payment methods to retain his/hers privacy.							
1.1.1.8 REQ-5.1.8 Rogue and/or Unknown EVSE Prevention		Charging station Infor-mation (REQ-	Enerim CIS		4.8 Start Transac-tion	Sta-tion	StartTransac-tion.conf

		3.2.5 Charging station infor-mation)					
Related use case: D1.02 / 5.2.3							
Requirement type: Functional							
Priority: Medium							
Description: An EV end user should get a warning if the EVSE cannot be identified.							
1.1.1.9 REQ-5.1.9 Stolen EV Database		Vehicle Infor-mation (REQ-3.2.3 EV infor-mation)	Enerim CIS		4.8 Start Transac-tion	Sta-tion	StartTransac-tion.conf
Related use case: D1.02 / 5.2.3							
Requirement type: Functional							
Priority: Low							

Description: An EV end user shall be able to prevent the charging of my EV if the EV has been stolen. In addition, the location of the stolen vehicle should be able to be tracked.							
1.1.1.10 REQ-5.1.10 Prevention of Malicious Use		n/a			n/a		
Related use case: D1.02 / 5.2.4							
Requirement type: Functional							
Priority: High							
Description: Man-in-the-middle attacks between the EV and the EVSE shall not be possible.							
1.1.1.11 REQ-5.1.11 Temporary Vehicle Identification		n/a			n/a		
Related use case: D1.02 / 5.7.1							
Requirement type: Functional							
Priority: Low							
Description: EV shall support temporary identification allocated by a trusted service provider.							
1.1.1.12 REQ-5.1.12 All EV Communication Access Verified by a User		n/a			n/a		
Related use case: None							
Requirement type: Functional							
Priority: Low							

Description: An EV end user shall be able to verify an ancillary communication access to the EV. The verification can be done by the EV user by secondary means. For example the EV sends an access request to the user's mobile and then the user verifies that the access is allowed by sending a response. The triggered communication can be either outgoing or incoming traffic according to the user's preferences.							
1.1.2 Verification							
1.1.2.1 REQ-5.2.1 Verification of EVSE Equipment		Charging station Infor-mation (REQ-3.2.5 Charging station infor-mation)	Enerim CIS		??		
Related use case: D1.02 / 5.2.4							
Requirement type: Functional							
Priority: Low							

Description: An EV end user may be warned if the EVSE does not meet the set standards. For example, when the energy metering system has not been calibrated at all or too much time has passed since the latest calibration.						