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Road vehicles — Vehicle to grid communication interface — Part 1: General information and use-case definition

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO/IEC 15118-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

ISO/IEC 15118 consists of the following parts, under the general title *Road vehicles — Vehicle to grid communication interface*:

— *Part 1: General information and use-case definition*

— *Part 2: Technical protocol description and open systems interconnections (OSI) requirements*

— *Part 3 Physical and data link layer requirements*

Introduction

The pending energy crisis and the necessity to reduce greenhouse gas emissions has led vehicle manufacturers to make a very significant effort to reduce the energy consumption of their vehicles. They are presently developing vehicles partly or completely propelled by electric energy. Those vehicles will reduce the dependency on oil, improve global energy efficiency and reduce the total CO2 emissions for road transportation if the electricity is produced from renewable sources. To charge the batteries of such vehicles, specific charging infrastructure is required.

Much of the standardisation work on dimensional and electrical specifications of the charging infrastructure and the vehicle interface is already treated in the relevant ISO or IEC groups. However, the question of information transfer between the vehicle, the local installation and the grid has not been treated sufficiently.

Such communication is beneficial for the optimisation of energy resources and energy production systems as vehicles can recharge at the most economic or most energy-efficient instants. It is also required to develop efficient and convenient payment systems in order to cover the resulting micro-payments. The necessary communication channel may serve in the future to contribute to the stabilisation of the electrical grid as well as to support additional information services required to operate electric vehicles efficiently.

Road vehicles — Vehicle to grid communication interface — Part 1: General information and use-case definition

1 Scope

ISO/IEC 15118 specifies the communication between electric vehicles (EV), (this term includes Battery Electric Vehicles as well as Plug-In Hybrid Electric Vehicles) and the electric vehicle supply equipment (EVSE). The communication parts of this generic equipment are the electric vehicle communication controller (EVCC) and the supply equipment communication controller (SECC). ISO/IEC 15118 is oriented to the charging of electric road vehicles. However, this standard is open for other vehicles as well. The purpose of this part of ISO/IEC 15118 is the description of terms and definitions, general requirements and use cases as the basis for the other parts of ISO/IEC 15118. ISO/IEC 15118-1 provides a general overview and a common understanding of aspects influencing the charge process, payment and load levelling. It furthermore specifies safety issues for charging.

ISO/IEC 15118 does not specify the vehicle internal communication between battery and charging equipment and the communication of the SECC to other actors and equipment (beside some dedicated messages related to the charging). All connections beyond the SECC, and the method of message exchanging are considered to be out of the scope as specific use cases.

NOTE 1 Electric road vehicles specifically are vehicles in categories M (used for carriage of passengers) and N (used for carriage of goods). This does not prevent vehicles in other categories from adopting this standard as well.'

NOTE 2 Vehicle internal communication and communication from the SECC to other actors beside the vehicle may act as triggers in the use cases or as actors in the safety requirements. Related hardware issues such as plugs and cables are out of scope of this standard.

2 Normative references

The following referenced documents are required for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 - *International electrotechnical vocabulary*

IEC 61851-1 - *Electric vehicle conductive charging system — Part 1: General requirements*

ISO 8713 - *Electric road vehicles – Vocabulary*

IEC 62052-11 *Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 11: Metering equipment*

IEC 62053-21 *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

IEC 62053-52 *Electricity metering equipment (AC) - Particular requirements – Part 52: Symbols*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8713 and the following terms and definitions apply.

3.1
Actor
specifies a role played by an user or any other system that interacts with the subject

3.2
Basic Signalling
physical signalling according to the pilot function provided by IEC 61851-1 Annex A.

3.3
Battery Management System (BMS)
electronic device that controls or manages the electric and thermal functions of the battery system and that provides communication between the battery system and other vehicle controllers

3.4
Certificate
certificate which contains the contract id

3.5
Charging control
confirms the maximum charge current that is allowed to be withdrawn from EVSE based on charge schedule

NOTE Actual charge current to the battery should be controlled by BMS. It is not in scope of this standard.

3.6
Charging schedule
maximum charging current vs. time information, which the EV will not exceed while charging the battery. It shall be calculated based on target setting, sales tariff table and grid schedule information, respecting the corresponding current limitations, i.e. using the lowest current value

3.7
Charging session
time between the beginning (connection of the cable) and the end (disconnection of the cable) of a charging process

NOTE During a charging session the EV may have none, one, or many periods of charging the battery, doing pre-conditioning or post-conditioning.

3.8
Contactor
electrically controlled switch used for switching a power circuit

NOTE 1 Unlike a circuit breaker, a contactor is not intended to interrupt a short circuit current.

NOTE 2 As far as communication is concerned the contactor occurs as a trigger for the power supply.

3.9
Contract ID
identification of the contract that is used by the SECC to enable charging and related services (incl. billing)

NOTE The contract ID is associated with the electricity consumer and may be vehicle-specific or customer-specific. The customer can e.g. be the driver, the owner of the vehicle or an E-mobility operator.

3.10
Demand Clearing House (DCH)
entity for grid negotiation that provides information on the load of the grid

NOTE 1 The demand clearing house mediates between two clearing partners – a SECC and the part of the power grid connected to this SECC.

- Collect all necessary information from all parts of the power grid, e.g. current or forecasted load of local transformers, distribution grid, power substation, transmission grid, transmission substation, power plants (incl. renewable energies), and predicted charging profiles submitted by EVCCs.
- Consolidate the collected grid information to a “grid profile” and offer it to SECCs / EVCCs.
- Provide charging profile proposal for the connected EV to the requesting SECC based on the collected grid profile.
- Inform the SECC as to the necessity for an updated charging profile if the grid profile has changed.
- On the contrary, the SECC will inform the demand clearing house if the EV's charging profile has changed.

NOTE 2 Demand clearing house and meter operator may exchange information with each other as well as with other actors.

3.11
Distribution System Operator (DSO)
item responsible for the voltage stability in the distribution grid (medium and low-voltage power grid)

NOTE 1 Electricity distribution is the final stage in the physical delivery of electricity to the delivery point (e.g. end user, EVSE or parking operator).

NOTE 2 A distribution system network carries electricity from the transmission grid and delivers it to consumers. Typically, the network would include medium-voltage power lines, electrical substations and low-voltage distribution wiring networks with associated equipment. Depending on national distribution regulations, the DSO may also be responsible for metering the energy (MO).

3.12
E-Mobility Operator
entity with which the customer has a contract for all services related to the EV operation

NOTE 1 Typically the E-mobility operator will include some of the other actors, like spot operator or energy provider, and has a close relationship with the distribution system operator and meter operator. An OEM or utility could also fulfil such a role.

NOTE 2 The E-mobility operator authenticates contract IDs from his customers received either from the E-Mobility operator clearing house, other E-mobility operators or spot operators he is in relation with.

3.13
E-Mobility Operator ID
unique identification related to the contract between the vehicle user or the vehicle itself and the E-mobility operator, which identifies the issuer of the contract ID

NOTE E-Mobility Operator ID may be used for roaming services

3.14
E-Mobility Operator Clearing House (EMOCH)
entity mediating between two clearing partners to provide validation services for roaming regarding contracts of different E-Mobility Operators for the purpose of:

- collecting all necessary contract information like Contract ID, E-Mobility Operator, communication path to E-Mobility Operator, roaming fees, begin and end date of contract, etc.
- provide SECC with confirmation that an E-Mobility Operator will pay for a given Contract ID (authentication of valid contract) transfer a Service Detail Record (SDR) after each charging session to the electricity provider of the identified contract

NOTE E-Mobility operator clearing house, E-Mobility Operator and meter operator may exchange information with each other as well as other actors.

3.15
Electric Energy Meter (EEM)
equipment for measuring electrical energy by integrating power with respect to time, which complies with IEC 62052-11 and IEC 62053-21, IEC 62053-52 NOTE Some use cases need the amount of electric energy measured by the electric energy meter and communicated through the SECC to the EVCC, while other scenarios do not need a separate electric energy meter. The EV may get this information and use it according to the OEM's intentions

3.16
Electricity Provider (EP)
body of secondary actor to provide electricity

3.17
Electric Vehicle (EV)
any vehicle propelled by an electric motor drawing current from a rechargeable storage battery or from other portable energy storage devices (rechargeable, using energy from a source off the vehicle such as a residential or public electric service), which is manufactured primarily for use on public streets, roads or highways

3.18
Electric Vehicle Charger
power converter that performs the necessary functions for charging a battery

3.19
Electric Vehicle Communication Controller (EVCC)
embedded system, within the vehicle, that implements the communication between the vehicle and the SECC in order to support specific functions

NOTE Such specific functions could be e.g. controlling input and output channels, encryption, or data transfer between vehicle and SECC.

3.20
Electric Vehicle Supply Equipment (EVSE)
conductors, including the phase(s), neutral and protective earth conductors, the EV couplers, attached plugs, and all other accessories, devices, power outlets or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the EV and allowing communication between them as necessary

3.21
Electronic Control Unit (ECU)
unit providing information regarding the vehicle

3.22
EVSE ID
unique identification of the charging spot

3.23
EVSE operator
actor for managing and maintaining the charging spot

3.24
EVSE operator ID
unique identification of the EVSE operator which provides the EV with energy

NOTE SECC provides the EVSE operator ID together with the EVSE ID uniquely identify the spot. The EVSE operator will fix the power outlet ID.

3.25
External Identification Means (EIM)
any external means that enable the user to identify his contract or the car

EXAMPLE NFC, RFID, SMS

3.26
Fleet operator (FO)
a person or legal entity operating several EVs and may have the contracts with the E-Mobility Operator

3.27
Grid Schedule
maximum charging current vs. time information, which is possible at the current outlet based on the local grid situation

NOTE Parameters to calculate grid schedule are e.g. local grid demand and supply situation, actual and forecast.

3.28
High Level Communication
bidirectional digital communication using protocol and messages specified in ISO/IEC 15118-2 and physical and data link layer specified in ISO/IEC 15118-3.

NOTE High-level communication in ISO/IEC 15118 is compliant with the term digital communication in SAE J1772/2836/2847/2931.

3.29
Human Machine Interface (HMI)
interface allowing the vehicle user to receive information relative to the charging process and provide input to the charging system

NOTE 1 All information from a user (input) or displayed to a user (output) will be performed through an HMI.

NOTE 2 The HMI could be implemented as a function of the EV, EVSE, mobile phone etc.

3.30
Interlock
safety function using a mechanical lock, either electrically or manually controlled. This prevents the contacts of a socket outlet or inlet from becoming live before it is properly engaged with a plug, and which either prevents the plug from being withdrawn, while its contacts are live, or makes the contacts dead before separation

3.31
Level selector
function to select the lowest value among the Sales tariff table, Grid schedule and Local physical limit, and feeds to scheduling function

NOTE This function may be implemented in EV or EVSE.

3.32
Meter Operator (MO)
body having the legal responsibility for the installation and maintenance of the electric energy meter

3.33
Original Equipment Manufacturer (OEM)
an original equipment manufacturer, or OEM, manufactures products or components that are purchased by a company and retailed under that purchasing company’s brand name. OEM refers to the company that originally manufactured the product. When referring to automotive parts, OEM designates a replacement part made by the manufacturer of the original part

3.34
Paying Unit (PU)
device on EVSE side that offers payment methods

EXAMPLE payment methods: EIM, cash, credit cards, etc.

NOTE If the EVCC normally chooses a payment method then the paying unit indicates to the SECC whether the customer is authorised or not.

3.35
Payment Data Container
container, which can carry payment definitions and is thus not directly bound to a message structure encapsulating the payment information

3.36
Pilot function
any means, electronic or mechanical, that insures the conditions related to the safety, or the transmission, of data required for the mode of operation, compliant with IEC 61851-1

3.37
Plug and Charge
scenario where the customer just has to plug his vehicle into the EVSE and all aspects of charging are automatically taken care of with no further intervention from the driver, this may include, load control, authentication, authorisation and billing

3.38
Power Outlet
part of a plug and socket outlet intended to be installed with the fixed wiring. All power outlets shall have the pilot function

3.39
Power Outlet ID
unique identification of the power outlet to the vehicle

3.40
Primary actor
role involved directly in the charging process

3.41
Pulse Width Modulation (PWM)
pulse control in which the pulse width or frequency, or both, are modulated within each fundamental period to produce a certain output waveform (IEC 60050; IEV 551-16-30).

3.42
Residual Current Device (RCD)
mechanical switch device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions

NOTE 1 A residual current device can be a combination of various separate elements designed to detect and evaluate the residual current and to make and break current.

NOTE 2 In the following countries, an RCD may be either electrical, electronic, mechanical or a combination thereof: US, JP, UK.

3.43
Sales tariff table
time table of energy price or percentage of green energy and optional current vs. time information

NOTE - Sales tariff table provides input for calculating a charging schedule.

- Sales tariff table shall be issued by a secondary actor, e.g. energy provider or mobility operator.

- Sales tariff table should reflect “supply and demand balance of the energy provider” and “usage of green energy” (e.g. wind mill, photovoltaic).

- Information of the chosen tariff should be included in service detail record.

- Sales tariff table can be updated periodically. It may differ by country or energy provider.

- There may be multiple Sales tariff tables existing for one customer.

- Sales tariff table information should be constructed in such a way that normal fluctuations on the grid side will not lead to an insufficiently charged EV or cost increase.

- The contract-based current limitation might vary over time, e.g. lower value during daytime and higher value during the night.

3.44
Secondary actor
role involved indirectly in the charging process

NOTE 1 Secondary actors may exchange information between each other.

NOTE 2 Secondary actors could also be a single entity.

3.45
Semi online
status, where the SECC or any other device in general has the ability to go online, but being online is not required synchronously to the referring use case(s)

NOTE The SECC may decide to go online, if required.

3.46
Service Detail Record (SDR)
data package of a charge or service related session with all necessary information that an E-Mobility Operator needs for billing or for informing the customer about the session

NOTE Some data may be sent from EVSE. Some data originally owned by E-Mobility Operator Clearing House. Some data may be created at E-Mobility Operator Clearing House. Some records to be sent to E-Mobility Operator for billing or informing their customers.

3.47
Service provider
body of secondary actor to offer value-added services to customers throughout the EVSE operator

NOTE Contract ID may be used for activation.

3.48
Supply Equipment Communication Controller (SECC)
entity which implements the communication to one or multiple EVCCs according to ISO/IEC 15118-2 and which may be able to interact with secondary actors

NOTE 1 Further details regarding possible architectures are given in Annex A.

NOTE 2 Functions of a supply equipment communication controller may control input and output channels, data encryption, or data transfer between vehicle and SECC.

3.49
Trigger
event that will start or be a condition in the use case

3.50
Use case
description of a system's behaviour as it responds to a request that originates from outside that system

NOTE In systems engineering, a use case describes "who" can do "what" with the system in question. The use case technique is used to capture a system's behavioural requirements by detailing scenario-driven threads through functional requirements.

3.51
Value-Added Services (VAS)
elements not directly needed for the pure charging of the EV

3.52
Vehicle coupler
means of enabling the manual connection of a flexible cable to an EV for the purpose of charging the traction batteries consisting of two parts: A vehicle connector and a vehicle inlet

3.53
Vehicle to grid (V2G)
plug-in electric vehicle interaction with the electric grid, including charging as well as discharging (excerpted from 'scope of V2G Domain Expert Working Group', SGIP, NIST) and bi-directional communication interface

3.54
Vehicle user
person or legal entity using the vehicle and providing information about driving needs and consequently influences charging patterns

NOTE Driving needs, such as range and time of availability, are necessary to achieve the most appropriate charging scenario.

4 symbols and abbreviated terms

BMS	Battery Management System
DCH	Demand Clearing House
ECU	Electronic Control Unit
EEM	Electric Energy Meter
EIM	External Identification Means
EMOCH	E-Mobility Operator Clearing House
EP	Electricity Provider
EV	Electric Vehicle
EVCC	Electric Vehicle Communication Controller
EVSE	Electric Vehicle Supply Equipment
FO	Fleet Operator
GW	Gateway
HAN	Home Area Network
HMI	Human Machine Interface
LAN	Local Area network
MO	Meter Operator
OEM	Original Equipment Manufacturer
PLC	Power Line Communication
PU	Paying Unit
PWM	Pulse Width Modulation
RCD	Residual Current Device
SDR	Service Detail Record
SECC	Supply Equipment Communication Controller
USER	Vehicle User
VAS	Value-Added Services
V2G	Vehicle to Grid

5 Requirements

5.1 Communication concept

The requirements of ISO/IEC 15118-1 form the basic framework for all use cases descriptions and related documents in the ISO/IEC 15118 series. Communication is defined by two different concepts called 'basic signalling' and 'high-level communication'. ISO/IEC 15118-1 and ISO/IEC 15118-2 specify 'high-level communication'. The relations between these two concepts are specified in ISO/IEC 15118-3. 'Basic signalling' shall be used to define items such as states and duty cycle for safety and initialisation of charging (see also 3.2).

In case of AC charging, the EV performs the charging control itself. In case of DC charging, the charger located in the EVSE performs the charging control.

Information exchange with high-level communication only occurs if both EV and EVSE are equipped with a high-level communication device.

Several options shall be considered. The interoperability between EVs and EVSEs that implement the different options is described in chapter 7.3:

- On the EVSE side:
    - EVSE does not support high-level communication;
    - EVSE supports high-level communication;
    - EVSE requires high-level communication.
- On the EV side:
    - EV supports high-level communication;
    - EV does not have any communication means.

There are some combinations requiring timeout handling due to the initial mismatch of communication capabilities. This timeout duration ensures that the overall initialisation duration does not exceed a user-acceptable period of time. Timeouts are defined in ISO/IEC 15118 -2 and -3.

5.2 General considerations

A number of general considerations build the use case element construction basis and result in individual requirements. This applies for the following elements and protocol definitions (see ISO/IEC 15118-2):

- High-level communication shall be used to enable features like identification, payment, load levelling and value-added services.
- Association of each EVCC to its corresponding SECC.
- Data communication between EV and the secondary actor is confidential. Appropriate cryptography applies data exchange protection between the EV and the secondary actor.
- Protect sensitive communication from monitoring and manipulation. The protection shall also cover non-fraud such as replay attacks.
- Protect communication data from modification or imitation (hacking).
- Electric energy offered by the spot operator shall either be measured specifically in the EVSE (if separate billing is required) or shall be part of the overall energy consumption.

— Different principles for billing are defined by the E-mobility operator (e.g. per kWh, per km or per hour of usage).

NOTE 1 ISO/IEC 15118-2 describes the security threat scenarios against which protective measures are implemented.

NOTE 2 The electric energy offered may also be included in other fees (e.g. a parking fee).

NOTE 3 National regulations require the usage of a certified meter for the measurement of the supplied energy in kWh.

NOTE 4 There is no direct communication from the EVCC to a smart meter defined within this standard. Meter data will be exchanged between the EVCC and the SECC depending on the Use Case. The communication between SECC and the smart meter is outside the scope of this standard.

5.3 User-specific requirements

5.3.1 Prerequisite

The support of ISO 15118 by EVs shall not prevent charging according to IEC 61851-1 Mode 1.

5.3.2 Reliability, availability, error handling and error reporting

The charging shall

— be completed by a predetermined point in time;

— in the case of any exceptional circumstances, i.e. if the charging schedule cannot be met and the EV cannot be recharged by the announced point in time, a specified error reporting procedure to inform the user should be triggered as soon as possible (see ISO/IEC 15118-2);

If there is a negotiation process for the charging profile e.g. because of the load levelling needs of the electrical grid, the user shall be informed whether the target setting can be fulfilled or not. During the negotiation process for the charging profile, the user shall be informed whether the requested charging conditions can be fulfilled.

In the event that the requested charging schedule can't be fulfilled, a re-negotiation of the charging profile shall be initiated for alternatives.

EV manufacturers or E-mobility operators can choose suitable methods to inform their customers about unexpected differences from the negotiated charging profile.

Any error should be detected and controlled either by the EVSE or the EV. Error handling is performed according to predetermined routines in the EVCC and SECC and as defined in ISO/IEC 15118-2.

5.3.3 Protection of privacy

— Private information and user data shall only be readable by the intended addressees.

— Private information shall be transferred only when necessary.

5.3.4 OEM-specific requirements

A charging schedule is calculated either by a secondary actor, the EVSE or the EV, based on information from the user, charging spot and energy grid and is transferred back to the grid to allow the planning of other EVs.

EVCC and SECC shall provide the possibility to adapt the charging schedule from either side if required.

NOTE 1 It is possible to divide the charging schedule into different phases like charging postponement, charging process interruption and charging in progress.

NOTE 2 Electrical or physical limits of the installation (EVSE & electrical wiring) have higher priority than the requested charging profile.

To store certificates or other user/ customer specific information related to the charging process in the EV, the following requirements shall be fulfilled:

a) It shall be possible over the lifetime of the EV to change customer-specific information under the following circumstances:

   - at EV production;
   - at EV delivery to customer resp. start of EV usage;
   - when energy contract is changed by the customer;
   - when certificate expires;
   - if EVCC or the component which stores the user/ customer-specific data will be replaced in a workshop;
   - when vehicle is discarded;
   - when vehicle is stolen.

b) in case of selling the EV by the customer, the following requirements and process boundary conditions need to be fulfilled by any type of customer-related data:

   - limited storage and processing capacity available at a control unit for EV-specific data or certificates;
   - initial writing of such data should be (almost only) possible at EV production time;
   - since the production of the EV may happen months before delivery to a customer, no data specific to the future customer nor contract can be written at production time;
   - EVs may be used for more than 20 years;
   - independent workshops shall be able to maintain an EV.

5.4 Utility-specific requirements

5.4.1 Power limiting for grid control or local energy control

The SECC shall inform the EV of the maximum available power level to optimise local grid energy usage. The EVCC shall also signal the maximum power level required to the SECC.

The support of ISO 15118 by EVs shall not prevent the usage of basic signalling if the charging spot does not require high level communication.

NOTE For optimised grid usage, an EVCC may offer information about the estimated required energy and the available time. This information allows scheduling for an optimal charging profile, as well as the possibility of re-scheduling.

5.4.2 Power limiting for supply protection

The SECC shall indicate to the EVCC the maximum nominal current that can be provided to the EV. The current indication shall correspond to the current that can be provided without overloading the local installation taking into account all active charging processes.

5.4.3 Current limiting for EVSE protection

The maximum nominal current provided by the EVSE shall not exceed the ratings of the spot, the supply rating and the ratings of the attached cable assembly.

Charging without any maximum charging current data communicated as defined in ISO/IEC 15118 is also possible through basic signalling, up to the maximum level available at the charging spot.

The EVSE shall interrupt the charging process using basic signalling routines and predefined routines of ISO/IEC 15118-2 if the drawn energy is exceeding the power ratings of the EVSE or the used cable.

Furthermore, the EVCC shall indicate the actual power limitations indicated by the EVSE using basic signalling to the SECC, if available.

5.4.4 Authorisation of charging services

The protocol shall allow the exchange of contract-relevant information between EVCC and SECC.

The validation of the contract-relevant information shall be achieved by an indication of acceptance or non-acceptance between the vehicle, the EVSE and, if needed, the user. It shall be managed in a way that misuses are prevented.

In case of an identification at the EVSE such an exchange of information is not applicable.

EXAMPLE Integration into parking fees, EIM, debit/credit card, cash, mobile payment.

5.4.5 Retrofitting

In order to allow the upgrading of existing charging stations, the high-level communication systems shall be defined in a way that an upgrade of existing infrastructure in compliance with ISO/IEC 15118 is possible.

6 Actors

6.1 General

Figure 1 shows all primary and secondary actors that may be involved directly or indirectly in the charging procedure of ISO/IEC 15118.

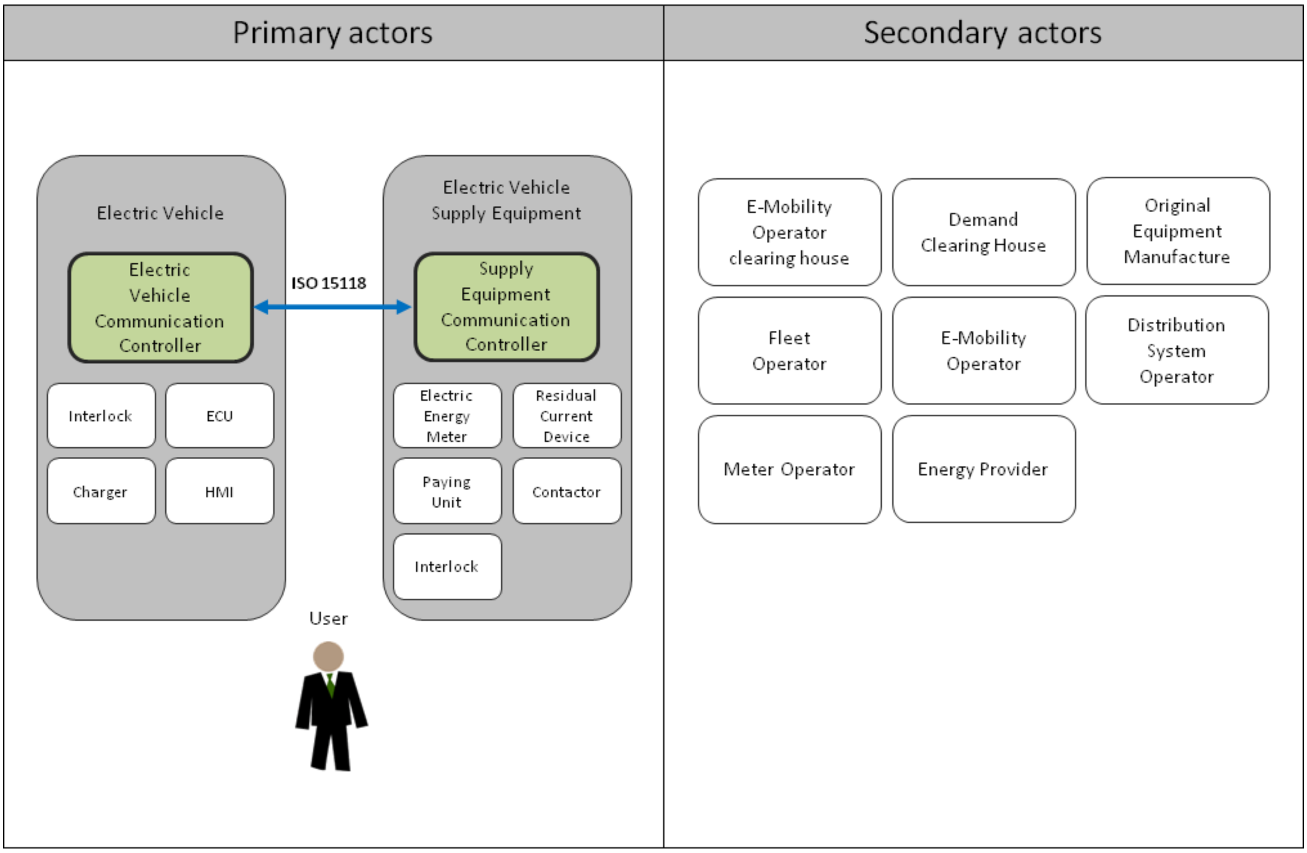


Figure 1 - Overview with examples of participating actors in the overall scenario

Primary actors are directly involved in the charging process. The information flow between EVCC and the SECC shall be specified according to all layers of the Open Systems Interconnection (OSI) reference model in accordance with ISO 7498.

ISO/IEC 15118 specifies the communication between SECC and the secondary actors on a message level. Annex A provides some examples of possible architectures with the secondary actors.

NOTE 1 Secondary actors may be involved in the charging process due to supplying information to the EVCC needed for the charging process. Depending on the use case element, they may be involved but a specific relation is not de-scribed in ISO/IEC 15118. Due to country-specific characteristics, the supply of information to the SECC may be done by centralised actors such as financial and demand clearing house and meter operator, or directly by secondary actors i.e. energy provider or distribution system operator.

NOTE 2 Not all primary actors are necessarily located within the EVSE.

6.2 Actors and roles (primary)

The physical signalling and communication for ISO/IEC 15118 shall be defined between the primary actors EVCC and SECC. Figure 2 shows the other primary actor that may be involved in the charging process as triggers or as sources of information for the charging.

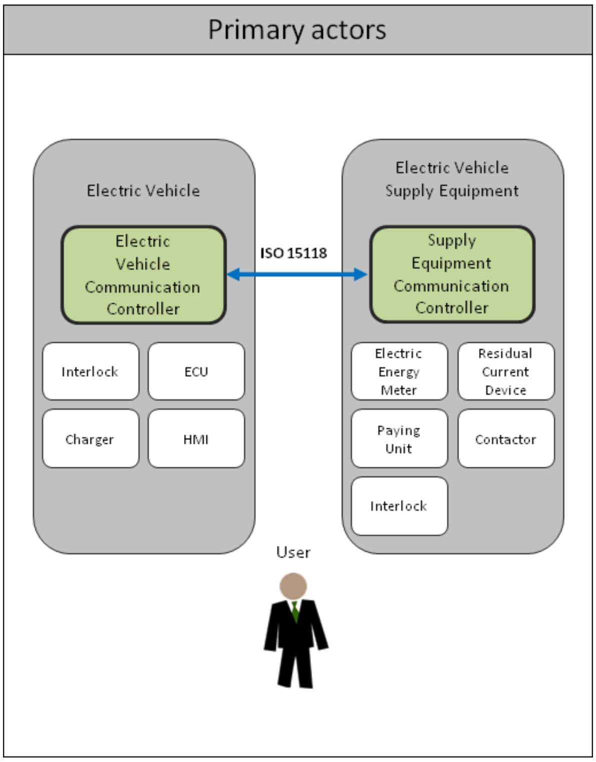


Figure 2 - Overview of primary actors

Table 1 - Primary actors and their function

Primary actor	Refer to
Contactor	Start of the charging process in accordance with 7.3 End of the charging process in accordance with 7.9
Electric Vehicle	Start of the charging process in accordance with 7.3
ECU	Interlock Start of the charging process in accordance with 7.3 Charging in accordance with 7.7
Electric Vehicle Supply Equipment	Start of the charging process in accordance with 7.3
Interlock	Start of the charging process in accordance with 7.3
Charger	Start of the charging process in accordance with 7.3 Charging in accordance with 7.7 End of the charging process in accordance with 7.9
Human Machine Interface	Identification and authentication in accordance with 7.5 Payment in accordance with 7.6
Electric Energy Meter	End of the charging process in accordance with 7.9
Paying Unit	Payment in accordance with 7.6
Residual Current Device	**Start of the charging process in accordance with 7.3**

The following list contains the primary actors and their trigger function for the use cases:

- EV: detecting device, e.g. plug-in detector
- EVSE detecting device, e.g. plug-in detector
- ECU: mechanical interlock,
- Charger: start/stop of the charging process,
- HMI: payment or activations of a charging process,
- EEM: a specific amount of energy supplied,
- PU: for payment accepted,
- Interlock: to set the start and the end of the charging process,
- RCD: a fault scenario e.g. power cord fault.

6.3 Actors and roles (secondary)

Figure 3 shows an overview of secondary actors, which may be involved in the charging process as, described in the elementary use cases (see clause 7).

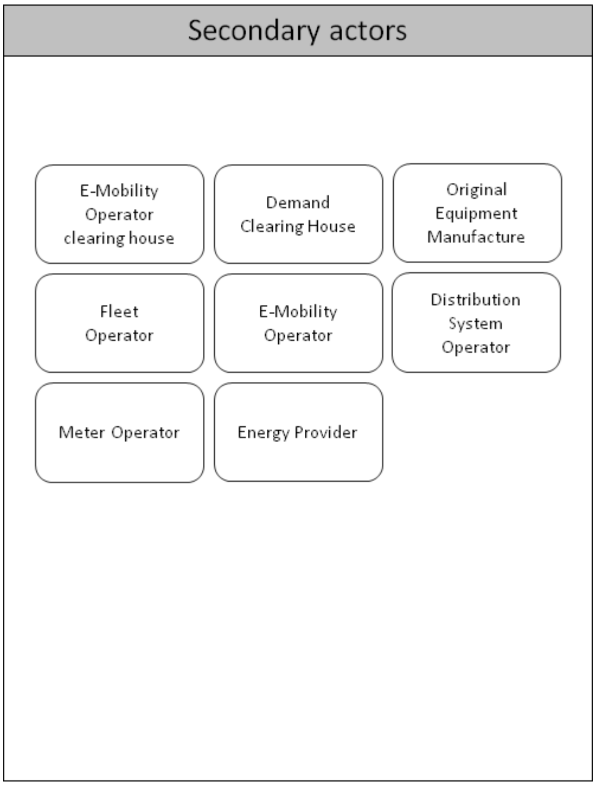


Figure 3 – Overview of secondary actors

7 Use case elements

7.1 General

This clause classifies the elementary use cases for the communication system between EVCC and SECC. The communication to accomplish the identified use cases is defined in ISO/IEC 15118-2 and -3. If neither EV nor EVSE have any high-level communication device, basic signalling applies.

The charging process is separated into eight functional groups to allow the classification of the elementary use cases (see Figure 4). For each functional group, several elementary use cases are possible. Each use case should be a combination of elementary use cases.

All possible elementary use cases are mentioned in the document:

a) Start of the charging process: initiation of the process between vehicle and EVSE after the physical plug-In of the vehicle. It sets the basis for the ongoing charging process e.g. availability of PWM, high-level communication etc.;

b) Communication setup: establishes the association and relevant connection between EVCC and SECC;

c) Certificate Handling: everything related to certificates;

d) Identification, Authentication and Authorization identification and authentication: methods for identification, authentication and authorization;

e) Target setting and charging scheduling: information needed from the EV as well as from SECC and the secondary actor to start the charging process and charging;

f) Charging controlling and re-scheduling: elements during the charging process;

g) Value-added services: elements not directly needed for pure charging of electric vehicles;

h) End-of-charging process: Describes the trigger for signalling the end of the charging process.

Variations of use case implementations exist, depending on the EVSE, the electric vehicle or the business case used for the charging process. Figure 4 provides an overview of all use case elements grouped by function.

NOTE 1 Variations of use case implementation exist. See Annex E for examples of possible charging scenarios.

NOTE 2 The groups do not specify the order in which the use case elements will be implemented, or which elements are required or optional.

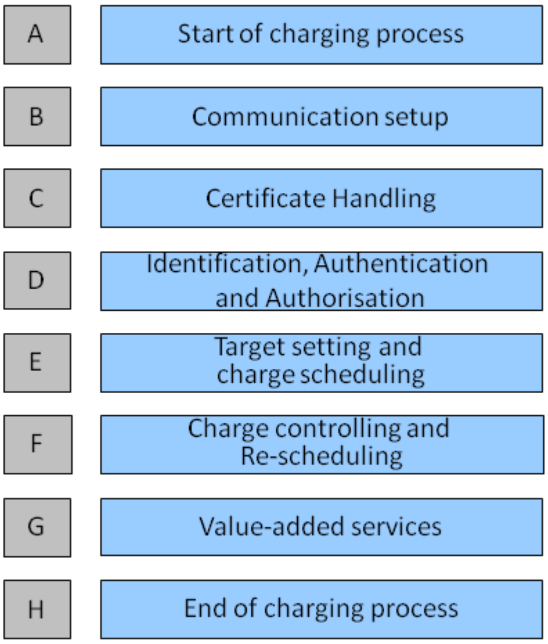


Figure 4 — Use case function groups

Table 2 - Overview of elements of use cases

No.	Use case element name / grouping
A1	Start of charging process with forced high-level communication
A2	Start of charging process with concurrent IEC61851-1 and high-level communication
B1	EVCC/SECC communication setup
C1	Certificate update
C2	Certificate installation
D1	Authentication from EV with local Authorisation
D2	Authentication from EV with Authorisation from secondary actors
D3	Identification at EVSE
D4	Identification at the EVSE with validation from the secondary actor
E1	AC charging with load levelling based on high-level communication
E2	Optimised charging with scheduling from the secondary actor
E3	Optimised charging with scheduling at EV
E4	DC charging with load levelling based on high-level communication
E5	Resume to authorised charging schedule
F0	Charging loop
F1	Charging loop with metering information exchange
F2	Charging loop with interrupt from the SECC
F3	Charging loop with interrupt from the EVCC or user
F4	Reactive power compensation
F5	Vehicle to grid support
G1	Value-added services
G2	Charging details
H1	**End of charging process**

7.2 Start of charging process [A]

The following two cases occur if an EVSE implements high-level communication:

- A1) High-level communication required by EVSE, PWM signal (according to IEC 61851-1) at 5 %, EVSE will not provide power to EVs that do not support high-level communication, unless in that case an authorisation by any other means took place.

- A2) High-level communication optional, EVSE will provide power even to those EVs that do not support high-level communication.

Table 2 shows the different combinations of EVSEs and EVs that do, or do not, support high-level communication and how these cases are treated.

Table 3 — Combinations of EV and EVSE communication capabilities

EVSE	EV	Case treated
ISO 15118 not implemented	ISO 15118 not implemented	Charging according IEC 61851-1 – outside scope of ISO/IEC 15118
ISO 15118 implemented, high-level communication optional	ISO 15118 not implemented	Failure end condition of use case element A2 on EVSE side, charging using Basic Signalling. No establishment of high-level communication on data link layer
ISO 15118 implemented, high-level communication required	ISO 15118 not implemented	Failure end condition of use case element A1 on EVSE side. If the EVSE operator implements it as a fall-back solution, for example where an authorisation is done by any other means, charging using Basic Signalling is possible.
ISO 15118 implemented, high-level communication optional	ISO 15118 implemented	See use case element A2
ISO 15118 implemented, high-level communication required	ISO 15118 implemented	See use case element A1
ISO 15118 not implemented	ISO 15118 implemented	Failure end condition of use case elements A1 and A2 on EV side. Charging using Basic Signalling is possible.

NOTE Activity and sequence diagram about message flow and interaction are described in ISO/IEC 15118-2. An activity and timing diagram about the interconnection between IEC 61851-1 and ISO/IEC 15118 is described in ISO/IEC 15118-3.

7.2.1 Start of charging process with forced high-level communication

Table 4 — Start of charging process with forced high-level communication

No.	Type	Description
1	Use case element name	Start of charging process with forced high-level communication (ISO/IEC 15118 in compliance with IEC 61851-1)
2	Use case element ID	A1
3	Objectives	Establishing of high-level communication
4	Description	This use case covers the initial PWM signalling (IEC 61851-1) from the EVSE, with a 5 % duty cycle in order to force high-level communication and mode 3 charging. NOTE Charging spot owner may offer a fall-back solution if high-level communication fails by enabling charging according IEC61851-1 with authorisation by any other means. The actors involved are: ▪ Primary actors: EV, EVSE EVCC, SECC. Scenario description: ▪ Connect the cable between the EV and EVSE ▪ EVSE indicates the PWM duty cycle ▪ EV interprets the PWM duty cycle ▪ EVCC and SECC establish the physical and data link layers connection (The detailed sequence is defined in ISO/IEC 15118-3) Communication setup (B) is able to start
5	Prerequisites	▪ The EV shall be connected physically to the EVSE ▪ The EV and EVSE require pilot function and basic signalling in accordance with IEC 61851-1 ▪ The EV and EVSE shall have a higher level communication device in accordance with ISO/IEC 15118-2 and ISO/IEC 15118-3
6	Requirements	▪ Successful set-up of high-level communication at the data link layer ▪ Timing for the initialisation process shall be according to ISO/IEC 15118-3 ▪ Triggers: o for EVSE: EV is connected properly to the EVSE o for EV: Plug present and PWM duty cycle indicating high-level communication required according to IEC61851-1
7	End conditions	Success end conditions: ▪ Successful set-up of high-level communication at the data link layer Failure end conditions: ▪ No establishment of high-level communication at the data link layer or failure of PWM signal

7.2.2 Start of charging process with concurrent IEC 61851-1 and high-level communication

Table 5 — Start of charging process with concurrent IEC 61851-1 and high-level communication

No.	Type	Description
1	Use case element name	Start of charging process with concurrent IEC 61851-1 and high-level communication)
2	Use case element ID	A2
3	Objectives	Establish high-level communication concurrently with IEC 61851-1 mode 3 charging
4	Description	This use case covers the initial PWM signalling (IEC 61851-1 mode 3) from the EVSE and high-level communication working concurrently. NOTE Charging spot operator may offer a fall-back solution if high-level communication fails by enabling charging according to IEC61851-1 with authorisation by any other means. The actors involved are: ▪ Primary actors: EV, EVSE EVCC, SECC. Scenario description: ▪ Connect the cable between the EV and EVSE ▪ EVSE sets a valid duty cycle in the range of 10-96% (this indicates that high-level communication is not required) ▪ EV interprets the PWM duty cycle which is in the range 9 - 97 %. ▪ EVCC and SECC establish the physical and data link layers connection (The detailed sequence is defined in ISO/IEC 15118-3) ▪ Communication set-up (B) is able to start
5	Prerequisites	▪ The EV shall be connected physically to the EVSE ▪ The EV and EVSE require basic signalling ▪ The EV and EVSE shall have a higher level communication device in accordance with ISO/IEC 15118-2 and ISO/IEC 15118-3
6	Requirements	▪ Successful set up of high-level communication at the data link layer ▪ Timing for the initialisation process shall be according to ISO/IEC 15118-3 ▪ Triggers: o For EVSE: EV is connected properly to the EVSE o For EV: Plug present shall be according IEC61851-1
7	End conditions	<u>Success end conditions:</u> ▪ Successful set-up of high-level communication at the data link layer <u>Failure end conditions:</u> ▪ No establishment of high-level communication at the data link layer ▪ Failure of PWM signal

7.3 Communication set-up [B]

7.3.1 EVCC/SECC communication set-up

Table 6 — EVCC/SECC communication set-up

No.	Type	Description
1	Use case element name	EVCC/SECC communication set-up
2	Use case element ID	B1
3	Objectives	The goal of this use case element is to establish a communication link between EVCC and SECC and correct association.
4	Description	The primary actors are the SECC and the EVCC. There is no information exchange between the EVCC and the SECC at application layer. The actors involved are: ▪ Primary actors: EVCC, SECC.
5	Prerequisites	▪ Plug in process according use case elements A1 or A2 shall be established successfully
6	Requirements	▪ The SECC and EVCC shall be capable of being associated one-to-one. ▪ The EVCC shall be bound to the SECC by the protocol described in ISO/IEC 15118-2. The timing of this binding shall be in line with the requirements given by ISO/IEC 15118-2 and -3. ▪ EVCC and SECC shall exchange information about the supported ISO/IEC 15118-2 protocol versions and use the latest common protocol version. NOTE The protocol version of either SECC or EVCC may not be the latest version. In this case, the "common" latest protocol version will be used for communication between EVCC and SECC.
7	End conditions	Success end conditions: ▪ SECC and the EVCC are associated and bound correctly, i.e. EVCC is able to send the first request to SECC on application layer according to the negotiated ISO/IEC 15118-2 protocol version. Failure end conditions: ▪ No correct association of SECC and EVCC or timeout in the binding process occurs. ▪ Negotiation of the ISO/IEC 15118-2 protocol version failed.

7.4 Certificate handling [C]

7.4.1 Certificate update

Table 7 — Certificate update

No.	Type	Description
1	Use case element name	Certificate update
2	Use case element ID	C1
3	Objectives	Replace the expired certificate in the EV with a new and valid certificate from the secondary actor.
4	Description	This use case covers the update of an expired certificate in the EV. Therefore, the EVCC is initiating a certificate update process using the established high-level communication with the SECC to retrieve a new certificate from the issuing secondary actor. Note 1: There may be alternative communication paths to do a certificate update. However, these are outside the scope of this standard. Note 2: If a certificate has already expired, Use Case Element C2 might apply. The certificate update process from SECC to secondary actor and back is outside the scope of this standard. The actors involved are: ▪ Primary actors: EVCC, SECC. ▪ Secondary actors: EMOCH, FO, E-Mobility Operator Scenario description: ▪ EVCC requests a certificate update by SECC, providing information about the secondary actor who has issued the certificate. ▪ SECC enables a communication link to the secondary actor or provide the certificates to be updated as a local copy. ▪ SECC requests a certificate update for EVCC from secondary actor containing EVCC specific information. ▪ Issuing entity provides a new certificate to the requesting SECC. ▪ SECC forwards the new certificate to EVCC.
5	Prerequisites	▪ Communication set-up according use case element B1 shall be established successfully. ▪ EV (i.e. EVCC) possesses a valid certificate for an energy contract (Contract Certificate). ▪ Semi-online connection between SECC and secondary actor shall be possible or certificates to be updated shall be available on SECC.

6	Requirements	EVCC shall support the certificate update process.
		SECC shall support the certificate update process.
		SECC shall be able to trigger an EVCC update process.
		Trigger:
		▪ EVCC / SECC detects that the certificate of the EV has either
		    o Limited remaining lifetime.
		    o Has expired but still accepted by the secondary actor.

7	End conditions	<u>Success end conditions:</u>

		• Valid certificate (Contract Certificate) from the secondary actor shall be stored in the EVCC. Failure end conditions: • Certificate update failed due to communication issue. • Certificate update failed due to rejection by secondary actor.

7.4.2 Certificate installation

Table 8 — Certificate installation

No.	Type	Description
1	Use case element name	Certificate installation
2	Use case element ID	C2
3	Objectives	Installation of a new certificate from the secondary actor in the EV.
4	Description	This use case covers the installation of a certificate (Contract Certificate) into the EV if no such certificate is available yet / it has expired / is invalid. Therefore, the EVCC is initiating a certificate installation process using the established high-level communication with the SECC to retrieve a certificate from the issuing secondary actor. The EV is identified by using a certificate (Bootstrap Certificate) that was installed by the OEM earlier (e.g. at EV production). Note: There may be alternative communication paths for doing a certificate installation. However, these are outside the scope of this standard. The certificate installation / transfer process from SECC to the secondary actor and back is outside the scope of this standard. The actors involved are: ▪ Primary actors: EVCC, SECC. ▪ Secondary actors: EMOCH, FO, E-Mobility Operator Scenario description: ▪ EVCC requests a certificate installation by SECC. ▪ SECC enables a communication link to the secondary actor or provides the certificates to be installed as local copy. ▪ For this purpose, the SECC has to identify the secondary actor which has a contract with the owner of the EV. Therefore, it has to send the Bootstrap Certificate (or its ID) to o the clearing house / all known clearing houses. o the preferred secondary actor / all known secondary actors. The corresponding contract may be identified by the secondary actor, for instance, via the certificate ID of the Bootstrap Certificate. This ID is transferred from the customer to the secondary actor at contract creation. (First, the OEM has to transfer this ID to the customer e.g. at EV delivery). ▪ SECC requests a certificate installation for EVCC from the secondary actor found containing EVCC specific information (Bootstrap Certificate). ▪ Issuing entity shall provide a certificate and the corresponding private key to the requesting SECC. At least the private key has to be encrypted using the old EVCC Bootstrap Certificate. ▪ SECC shall forward the new certificate and the corresponding (encrypted) private key to EVCC.
5	Prerequisites	▪ Communication set-up according to use case element B1 shall be established successfully. ▪ No Contract Certificate resp. no valid Contract Certificate is available in the EV. ▪ A Bootstrap Certificate created by the OEM is available in the EV. ▪ Online connection between SECC and secondary actor shall be possible or certificates to be updated shall be available on SECC.
6	Requirements	SECC supports certificate installation process. SECC shall enable a communication link to the secondary actor or provide the certificates being installed as local copy.

		Trigger: EVCC detects resp. SECC signals that the certificate of the EV either ▪ Does not exist in the EV. ▪ Has expired. ▪ Is invalid. ▪ This use case may also be applied to update a certificate that is still valid but only has a limited lifetime (instead of applying C5).
7	End conditions	Success end conditions: • Valid certificate (Contract Certificate) from secondary actor shall be stored in the EVCC. • The Bootstrap Certificate (created by the OEM) is still available in the EV. Failure end conditions: • Certificate update failed due to communication issue. • Certificate update failed due to rejection by the secondary actor. • Certificate update failed because no secondary actor with a matching contract can be found.

7.5 Identification, authentication and authorisation [D]

7.5.1 Overview of identification and authentication cases

Depending on the EVSE infrastructure and the capabilities of the EV, the methods of identifying a user differs. Figure 5 classifies the possible scenarios. For ISO/IEC 15118 only the cases with high-level communication between EVCC and the SECC are normative and therefore only elementary use cases D1 and D2 apply. Other alternatives for identification are listed in the informative section.

Figure 5 may be taken as the graphical overview of the possible identification means and their location.

Table 9 — Overview of use case elements

High-Level communication	**EVSE Offline / Semi-online**	**EVSE Always online**
With high-level communication (normative)	D1	D2
Without high-level communication (informative)	**D3**	**D4**

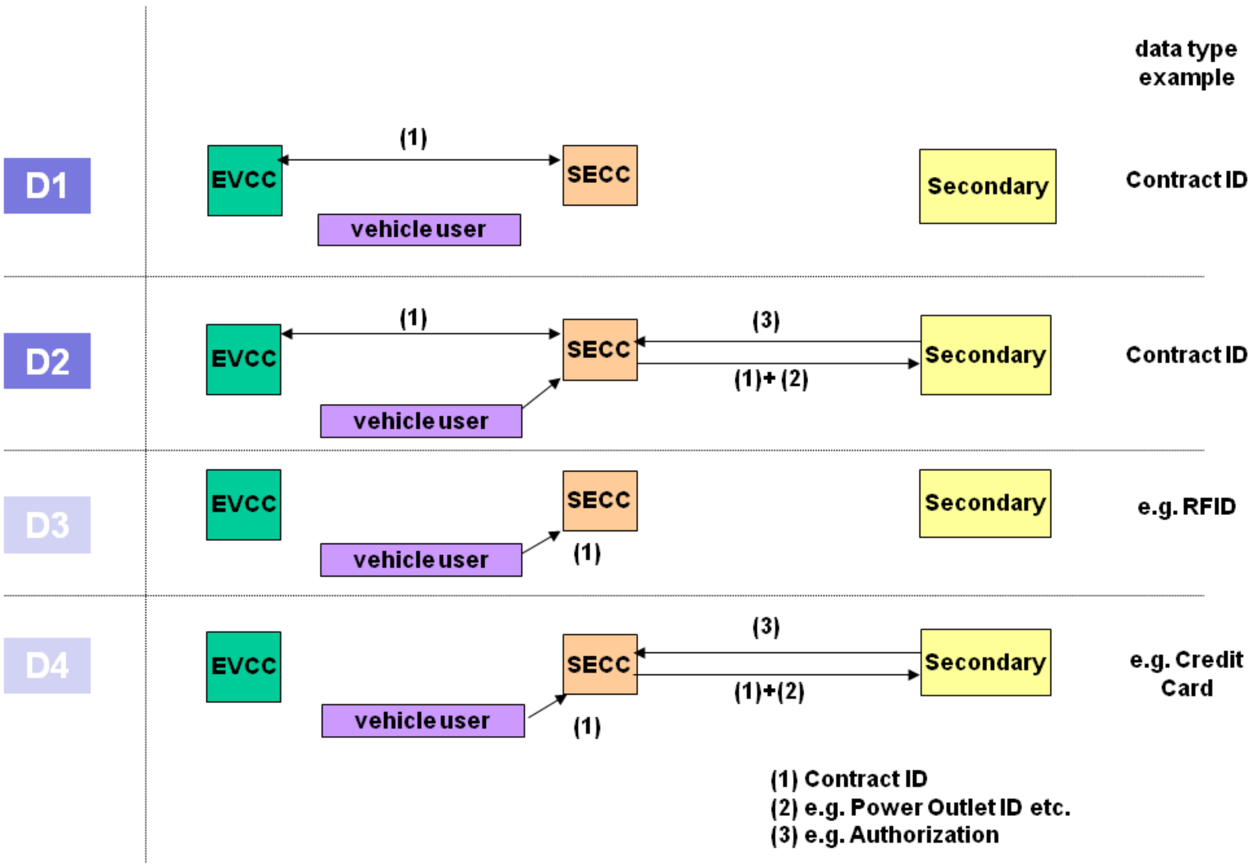


Figure 5 : Graphical overview of scenarios for identification

7.5.2 Authorisation

Depending on the EVSE design, many authorisation methods are thinkable in the future. However, all authorisation methods could be categorised by means of authorisation location and authentication.

Authorisation covers all methods for services rendered to the client. It includes the payment for electricity supplied to the vehicle and the authorisation to receive a requested value-added service. Payment for electricity concerns relatively small amounts, other services (e.g. car rental) may concern larger amounts and may require supplementary security.

No authorisation for the charging process is required if the authorisation to receive electricity is done by a third party.

EXAMPLE At a car park where parking fees could include the energy consumption of the vehicle or charging at domestic household socket.

With authorisation, the vehicle user shall be identified in any way to start the charging process. Outside the EV, i.e. a phone call or EIM may be used at the paying unit (EVSE) for authentication. Inside the vehicle, a unique authentication code is transmitted between EVCC and SECC to identify the vehicle user.

With this clustering of the authorisation methods they can be classified into four types: authorisation with or without authentication, as well as authorisation inside or outside the EV.

Table 10 — Clustering of authorisation methods

Authorisation	**Outside EV (within CS or CS environment)**	**Inside EV**
Without authentication	- Cash - Money card - Pre-paid - Other	
With authentication	**- Credit card - RFID card - Bank account - SMS payment - Smartphone - Other**	**- Contract ID - Payment data container**

These authorisation options are an indicator of possible implementations in the field. For ISO/IEC 15118 only those options are listed as a use case element, which require informational exchange on message level between EVCC and SECC.

7.5.3 Authentication from EV with local Authorisation

Table 11 — Authentication from EV with local Authorisation

No.	Type	Description
1	Use case element name	Authentication from EV with local Authorisation
2	Use case element ID	D1
3	Objectives	Authenticate and authorise the validity of the contract by using the ISO/IEC 15118-2 message set
4	Description	This use case covers the authentication process from the EV. The identification should be made with an ID as stipulated in ISO/IEC 15118-2. The actors involved are: ▪ Primary actors: EVCC, EV SECC, EVSE, HMI. ▪ Secondary actors: EMOCH, E-Mobility Operator Scenario description: ▪ USER connects the car with the station and activates the service offering the ID. This could also be done automatically. ▪ SECC and EVCC exchange their IDs (e.g. Contract ID) ▪ The SECC may decide to forward the IDs from the EVCC associating its own IDs to the secondary actors ▪ Service should start after successful authorization of the IDs
5	Prerequisites	▪ Communication set-up according to use case element B1 shall be established successfully ▪ All required credentials shall be stored in the SECC in case the SECC does not establish online connections synchronously to the charging event.
6	Requirements	▪ Reply or acceptance of the verification of the IDs at the local infrastructure or from the secondary actors shall be done within a specific time. ▪ SECC shall exchange its IDs (Spot Operator ID and Power Outlet ID) to the EVCC ▪ EVCC shall exchange its IDs (Provider ID and Contract ID) to the SECC ▪ Trigger: o Start of the identification process from the EVCC ▪ USER may need to activate the payment within a specific time after connecting the EV to the EVSE. Activation is only necessary for payment by a payment data container. This timing is stipulated in ISO/IEC 15118-2. ▪ Reply or acceptance of the payment (ID) shall be done within a specific time. This timing is stipulated in ISO/IEC 15118-2.
7	End conditions	Success end conditions: • Authentication and authorisation process is successful, a session ID is defined and the required service (charging or value added) starts. Failure end conditions: ▪ Authentication process fails. ▪ The required service does not start. ▪ User might be informed about the reason for failure (i.e. contract has expired, contract has been blocked – stolen car, stolen contract, procedure to be restarted, identification server not available).

7.5.4 Authentication from EV with authorisation from the secondary actors

Table 12 — Authentication from EV with authorisation from the secondary actors

No.	Type	Description
1	Use case element name	Authentication from EV with authorisation from secondary actors
2	Use case element ID	D2
3	Objectives	Authenticate and authorise the validity of the contract with a validation from a secondary actor by using the ISO/IEC 15118-2 message set.
4	Description	▪ This use case covers the authentication process from the EV. The identification should be made with an ID as stipulated in ISO/IEC 15118-2. The actors involved are: ▪ Primary actors: EV, EVCC, EVSE, SECC, HMI ▪ Secondary actors: EMOCH, E-Mobility Operator Scenario Description: ▪ USER connects the car to the station and activates the service offering the ID. This could also be done automatically. ▪ SECC and EVCC exchange their IDs (e.g. Contract ID). Those are forwarded to the secondary actor for validation. ▪ The secondary actor replies with an agreement or non-agreement ▪ Service starts after successful authorisation of the IDs
5	Prerequisites	▪ Communication set-up according use case element B1 shall be established successfully ▪ Online connection between SECC and secondary actors is required.
6	Requirements	▪ If the identification is not launched automatically, the USER has to activate the identification through the HMI (in the car) within a specific time after connecting the EV to the EVSE. ▪ SECC shall exchange its IDs (Spot Operator ID and Power Outlet ID) to the EVCC. ▪ EVCC shall exchange its IDs (Provider ID and Contract ID) to the SECC. ▪ SECC shall forward the IDs (Provider ID and Contract ID from the EVCC associating its own IDs (Spot Operator ID and Power Outlet ID) to the secondary actors. ▪ Reply or acceptance of the verification of the IDs from the secondary actors shall be done within a specific time. ▪ Trigger: o Initialisation of the identification process from the EVCC ▪ USER may need to activate the payment within a specific time after connecting the EV to the EVSE. Activation is only necessary for payment by a payment data container. This timing is defined in ISO/IEC 15118-2. Reply or acceptance of the payment (ID) shall be done within a specific time. This timing is stipulated in ISO/IEC 15118-2.
7	End conditions	Success end conditions: Authentication and authorisation process is successful, a session ID is defined and the required service (charging or value added) starts. Failure end conditions: ▪ Authentication process fails, no authorisation given by the secondary actor. • The required service does not start.

		▪ User might be informed about the reason for failure (i.e. contract has expired, contract has been blocked, stolen car or contract, procedure to be restarted, identification server not available).

7.5.5 Identification at EVSE

Table 13 — Identification at EVSE

No.	Type	Description
1	Use case element name	Identification at EVSE.
2	Use case element ID	D3.
3	Objectives	Identification of the user at EVSE.
4	Description	User identifies himself at the EVSE by using one of the identification methods offered. NOTE Depending on the identification type, the EVSE operator may not have the possibility to authenticate the ID and therefore might not authorise the service. The SECC may decide to forward the IDs (Provider ID and Contract ID) associating its own IDs (Spot Operator ID and Power Outlet ID) to the secondary actors. Service should start after successful verification of the Ids. The actors involved are: ▪ Primary actors: USER, EVSE, HMI, SECC. ▪ Secondary actors: EMOCH, E-Mobility Operator.
5	Prerequisites	▪ Communication set-up according to use case element B1 shall be established successfully.
6	Requirements	▪ USER shall activate the identification within a specific time after connecting the EV to the EVSE or the EVSE shall have an HMI or any other method to authorise the restart of the identification process. ▪ USER shall, for example, use an HMI to type in the identification code or any other identification method offered at the EVSE. ▪ USER shall plug in and activate the identification method. ▪ SECC shall evaluate the identification and, if accepted, proceed with the communication flow. ▪ Trigger: o EV and EVSE are required to be in STATE B (IEC 61851-1). o Identification shall be made at the EVSE and activated by the USER.
7	End conditions	<u>Success end conditions:</u> Identification process is successful, a session ID is defined and the required service (charging or value-added) starts . <u>Failure end conditions:</u> • Identification process fails. • The required service does not start. • User might be informed about the reason for failure (i.e. identification means has expired, contract has been blocked – stolen car, stolen contract, procedure to be restarted, identification means out of order).

7.5.6 Identification at the EVSE with validation from the secondary actor

Table 14 — Identification at the EVSE with validation from the secondary actor

No.	Type	Description
1	Use case element name	Identification at the EVSE with validation from the secondary actor.
2	Use case element ID	D4.
3	Objectives	Identification with validation from the secondary actor.
4	Description	This use case covers the process of how identification should be validated by a secondary actor. User identifies himself at the EVSE by using one of the identification methods offered. NOTE Depending on the identification type, the EVSE operator may not have the possibility to authenticate the ID and therefore might not authorise the service. The actors involved are: ▪ Primary actors: USER, EVSE, SECC, HMI. ▪ Secondary actors: EMOCH, E-Mobility Operator. Scenario description: ▪ SECC forwards the IDs (Spot Operator ID, Power Outlet ID, provider ID and Contract ID) to the secondary actor for validation. ▪ The secondary actor replies with an agreement or non-agreement. ▪ Service Starts after successful verification of the IDs.
5	Prerequisites	▪ Communication set-up according use case element B1 shall be established successfully ▪ Online connection between SECC and secondary actors is required.
6	Requirements	▪ USER shall activate the identification within a specific time after connecting the EV to the EVSE or the EVSE shall have an HMI to authorise the restart of the identification process. ▪ USER shall use the identification method at EVSE (e.g. HMI). ▪ EVCC shall send the ID to the secondary actor for validation. ▪ Trigger: o EV and EVSE are required to be in STATE B (IEC 61851-1). o Identification shall be made at the EVSE and activated by the USER.
7	End conditions	Success end conditions: Identification process is successful, a session ID is defined and the required service (charging or value-added) starts. Failure end conditions: ▪ Identification process fails. ▪ The identification performed by the USER at the EVSE is not validated by the secondary actor. ▪ The required service does not start. ▪ User might be informed about the reason for failure (i.e. contract has expired, contract has been blocked, stolen car or contract, procedure to be restarted, identification server not available).

7.6 Target setting and charging scheduling [E]

7.6.1 AC charging with charging current limitation based on high-level communication

Table 15 — AC charging with charging current limitation based on high-level communication

No.	Type	Description
1	Use case element name	AC charging with charging current limitation based on high-level communication.
2	Use case element ID	E1
3	Objectives	This use case covers only charging within local charging infrastructures. Dynamically Adjustment of the maximum AC current to be drawn by the EV within the limits of the local installation.
4	Description	The SECC and EVCC exchange information about the AC current limits using high-level communication. The SECC communicates the maximum power that can be drawn from the outlet, in order to protect the EVSE, to the EVCC. Note: The high-level information shall not contradict the safety requirements stipulated in IEC 61851-1. Simple load levelling can be in a car park or at home, where not all AC power outlets can deliver full AC current and, therefore, need to dynamically adjust the maximum AC current that the EV can draw. The actors involved are: ▪ Primary actors: USER, EVSE, SECC
5	Prerequisites	▪ If authorisation according use case elements D is applied, it shall be established successfully.
6	Requirements	▪ EVCC shall ask for the maximum AC current limit from the SECC. ▪ SECC shall reply with the maximum allowed AC current per phase. ▪ EV shall not exceed the AC current limit. ▪ Trigger: o Charging authorisation shall be completed and EV shall be ready to retrieve energy.
7	End conditions	Success end conditions: ▪ EVSE delivers AC current within the max. local installation limits. . ▪ EV charges within the given local limits of EVSE. Failure end conditions: ▪ EVSE does not deliver AC power due to contactor failure.

7.6.2 Optimised charging with scheduling from the secondary actor

Table 16 — Optimised charging with scheduling from the secondary actor

No.	Type	Description
1	Use case element name	Optimised charging with scheduling from the secondary actor
2	Use case element ID	E2
3	Objectives	Dynamic adjustment of the maximum power to be drawn by the EV. Prognosis of the power drawn by the EV which can be dynamically adjusted.
4	Description	This use case covers the AC charging process with information about local installation, grid schedule and sales tariff table. With this, the EVSE can dynamically react to changes in the supply chain to reduce peak demand or oversupply situations. Additionally, the behavior of the vehicle while charging becomes transparent to secondary actors in order to enhance electricity supply scheduling. The secondary actor needs to propose a charging schedule to the SECC, based on actual information about the local installation, grid schedule and sales tariff table. It is necessary that EVCC, SECC and secondary actor have each the possibility to trigger a re-scheduling of the charging profile. The Involved actors are: ▪ Primary actors: EV, EVCC EVSE, SECC ▪ Secondary actors: DCH, E-Mobility Operator Scenario descriptions: ▪ USER inputs “Target set” at EV” ▪ EV calculates the required amount of energy needed for the charging (Wh) and the departure time to meet the target. ▪ EVCC sends the calculated value and the charging capability of EV to the SECC, which might forward it to a secondary actor. ▪ A secondary actor collects “Demand and prognosis”. (e.g. Local physical limits from EVSE, grid schedule from DCH, Sales tariff table from EP or e-Mobility Operator) ▪ Note: This action might be performed prior to the charging event and could therefore been sent to the SECC. ▪ A secondary actor or the SECC executes “Level selector” to provide input for charging schedule ▪ A secondary actor or the SECC calculates “Charging schedule” ▪ EVSE picks up the current limitation of “Charging schedule” for “Charging Control”. ▪ SECC send the current limitation to “EVCC”. ▪ EV will start charging according to the current limitation
5	Prerequisites	▪ If authorization according use case elements D is applied, it shall be established successfully.” ▪ SECC shall be able to forward information from / to the secondary actor ▪ Consideration of local installation limits shall be available

6	Requirements	▪ The USER shall input the requirements for ‘when the EV should be charged to a given state’ to secondary actors, for this to be included in the schedule ▪ Trigger: ○ Authorisation of charging has been completed and EV is ready to re-trieve energy or ○ Charging loop is established and one of the interrupts occurs or ○ EV is in a charging pause, e.g. state B according to IEC 61851-1, and SECC has the necessity to renegotiate the charging schedule.
7	End conditions	Success end conditions: ▪ EV will start charging according to the negotiated schedule. Failure end conditions: ▪ Wh calculator does not calculate the required amount of charging (Wh) to meet the target. ▪ A secondary actor does not collect “Target set” and “Demand and prognosis” information. ▪ A secondary actor does not calculate “Charging schedule”. ▪ EV will not start charging.

7.6.3 Optimized charging with scheduling at EV

Table 17 — Optimized charging with scheduling at EV

No.	Type	Description
1	Use case element name	Optimized charging with scheduling at EV
2	Use case element ID	E3
3	Objectives	Dynamically adjustment of the maximum power to be drawn by the EV. Prognosis of the power drawn by the EV which can dynamically adjusted.

<table>
<tr><td>4</td><td>Description</td><td>This use case covers the AC charging process with information about local installation, grid schedule and sales tariff table. With this the EV can react on changes in the supply chain to reduce peak demand or oversupply situations. Additionally the behaviour of the vehicle while charging becomes transparent to secondary actors in order to enhance electricity supply scheduling.

The secondary actor needs to provide a grid schedule and sales tariff table to the SECC. The SECC forwards this information, together with the local limitations, to the EVCC.

It is necessary that the EVCC, SECC and secondary actor each have the possibility to trigger a re-scheduling of the charging profile.

The actors involved are:
Primary actors: EV, EVCC EVSE, SECC.
Secondary actors: DCH, E-Mobility Operator.
Scenario descriptions:
USER inputs “Target set” at EV”.
EV calculates the required amount of energy required for the charging (Wh) and the departure time to meet the target.
EVCC sends the calculated value and the charging capability of EV to the SECC, which might forward it to a secondary actor.
A secondary actor collects “Demand and prognosis”. (e.g. grid schedule from DCH, Sales tariff table from EP or e-Mobility Operator) and forwards this information to the SECC.
Note: This action might be performed prior to the charging event and could therefore be sent to the SECC.
The SECC provides grid schedule, sales tariff table and local physical limits to the EVCC.
The EV executes “Level selector” to provide input for the charging schedule.
The EV calculates “Charging schedule” and shall send the schedule to the SECC for commitment.
EV picks up the current limitation of “Charging Schedule” for “Charging Control”.
EV will start charging according to the current limitation.</td></tr>
<tr><td>5</td><td>Prerequisites</td><td>If authorisation according use case elements D is applied, it shall be established successfully.
SECC shall be able to forward information from / to the secondary actor.
Consideration of local installation limits shall be available.</td></tr>
<tr><td>6</td><td>Requirements</td><td>The USER shall input the requirements for ‘when the EV should be charged to a given state’ to the secondary actors to include this in the schedule.
Trigger:
Authorisation of charging has been completed and EV is ready to retrieve energy.
Charging loop is established and one of the interruptions occurs or,
EV is in a charging pause, e.g. state B according to IEC 61851-1, and SECC needs to renegotiate the charging schedule.</td></tr>
</table>

7	End conditions	Success end conditions: ▪ EV will start charging according to the negotiated schedule. Failure end conditions: ▪ Wh calculator does not calculate the required charging amount (Wh) to meet the target. ▪ EV does not collect / receive “Target set” and “Demand and prognosis” information. ▪ EV does not calculate “Charging schedule”. ▪ EV will not start charging.

7.6.4 DC charging with load levelling based on high-level communication

Table 18 — DC charging with load levelling based on high-level communication

No.	Type	Description
1	Use case element name	DC charging with load levelling based on high-level communication.
2	Use case element ID	E4
3	Objectives	Charging without considering complex grid situations and secondary actors. Dynamic adjustment of the max. DC power to be drawn by the EV within the limits of the local installation.
4	Description	The EVSE and EV will exchange information about the DC power limits using high-level communication. The EVSE will communicate the max. DC power that can be drawn from the outlet in order to protect the supply equipment to the EV. The EV and the EVSE exchange control information for the battery management system. The actors involved are: ▪ Primary actors: EV, EVCC EVSE, SECC.
5	Prerequisites	▪ If authorisation according use case elements D is applied, it shall be established successfully. ▪ Mode 4 charging (according to IEC 61851-1) shall be selected.
6	Requirements	▪ EV shall ask for the max. DC power, voltage and current limits from the EVSE. ▪ EVSE shall reply with the limits. ▪ EV shall provide information about demanded voltage and current. ▪ Loop charging will begin.
7	End conditions	Success end conditions: ▪ The EVSE shall deliver DC power within the max. local limits of installation. ▪ EV shall be charged within the given local limits of EVSE. ▪ EVSE shall deliver power until the user disconnects. Failure end conditions: ▪ The EVSE will not deliver DC power, due to contactor failure. ▪ Negotiation between EV and EVSE failed. ▪ No power delivery from EVSE to EV.

7.6.5 Resume to authorised charging schedule

Table 19 — Resume to authorised charging schedule

No.	Type	Description
1	Use case name	Resume to authorised charging schedule
2	Use case element ID	E5
3	Objectives	Restart sleeping charging schedule.
4	Description	This use case covers the resume process to once authorised and sleeping charging sched-ule. The actors involved are: ▪ Primary actors: EV, EVCC EVSE, SECC Scenario descriptions: ▪ Optimising charging schedule often makes pause or went-to-sleep status within its schedule. In case of a sleep status, EVCC and SECC are, in general, neither able to communicate to each other nor can be woken up by the counterpart. This depends on the . communication technology used. Therefore, ISO/IEC 15118-3 provides means and concepts as to how the communication can be re-established from sleep mode, either from the EV or EVSE side, depending on the physical layer used and IEC 61851-1 based concepts and requirements. ▪ The wake-up trigger could be initiated either on the EV or EVSE side. The entity which receives this initial trigger needs to be able to wake up the counterpart according to ISO/IEC 15118-3. ▪ High-level communication will be re-established and identification, authentication and authorisation will be done again. ▪ EVCC and/or SECC will recognise/receive information about the suspended charging schedule from the internal memory or e-Mobility operator to share it between them. If both accept this suspended charging schedule, it will be resumed from the interrupted point.
5	Prerequisites	▪ Optimised charging schedule is already authorised in use cases E2 or E3. ▪ Charging schedule is paused according use case element H1. ▪ EV and EVSE indicate sleep mode according to ISO/IEC 15118-3.
6	Requirements	▪ Either EV or EVSE gets an initial wake-up trigger at the restart time of the charging schedule. a. If EVSE gets the initial wake-up trigger, it shall wake up the EV/EVCC according to ISO/IEC 15118-3. b. If EV gets the initial wake-up trigger, it shall wake up the EVSE/SECC according to ISO/IEC 15118-3 ▪ HLC shall be re-established and identification, authentication, authorisation shall be ended successfully. ▪ E2 shall be executed and lead to the same charging schedule as the original agreed if the boundary conditions remain unchanged. ▪ Charging process shall be re-started from the resume point.

7	End conditions	Success end conditions: ▪ Information of former suspended charging session is accepted by both the SECC and EVCC and they agree to resume it. ▪ EVCC goes back to the suspended point of the charging schedule and restarts charging Failure end conditions: ▪ Wake up of counterpart was unsuccessful. ▪ Information of former session is not accepted by either the SECC, EVCC or both. a. Negotiation of the charging schedule leads to different results and charging can be resumed according to changed schedule. b. It is not possible to resume the charging process because one of the required intermediate use case elements leads to a failure end condition.

7.7 Charging controlling and re-scheduling [F]

7.7.1 Charging loop

Table 20 — Charging loop

No.	Type	Description
1	Use case element name	Charging loop
2	Use case element ID	F0
3	Objectives	Continue charging process until success conditions reached and enable billing of transferred energy.
4	Description	This use case covers the basic loop charging. The following information needs to be exchanged between the actors: The actors involved are: ▪ Primary actors: EV, EVCC EVSE, SECC. The following information needs to be exchanged between the actors: From EVCC to SECC: EV status (as stipulated in ISO/IEC 15118-2). From SECC to EVCC: EVSE status (e.g. maximum current, as stipulated in ISO/IEC 15118-2).
5	Prerequisites	▪ Target setting or charging scheduling according to use case elements E1 or E2 shall be successfully established. ▪ Charging loop shall be active.
6	Requirements	▪ EVCC shall send SECC the current status in a specified time frame according ISO/IEC 15118-2. ▪ SECC shall reply with no interrupt flag.
7	End conditions	<u>Success end conditions:</u> ▪ Charging loop continues. <u>Failure end conditions:</u> ▪ Charging loop will be stopped.

7.7.2 Charging loop with metering information exchange

Table 21 — Charging loop with metering information exchange

No.	Type	Description
1	Use case element name	Charging loop with metering information exchange
2	Use case element ID	F1
3	Objectives	Continue charging process until success conditions reached and enable billing of transferred energy.
4	Description	This use case covers the basic loop charging with meter readout. For reliable billing of transferred energy, the utility must be able to prove that a specific amount of measured energy was delivered to a specific EV / customer. It is therefore mandatory that the transferred energy is confirmed by the EV/ customer. With respect to the communication between EVCC and SECC, one possibility is that the vehicle signs the meter information from the SECC to confirm the reception of this meter. The vehicle may perform a plausibility check between the EVSE measured energy amount and the received energy amount to validate if there is an unexpected high-energy loss during the charging process. The actors involved are: ▪ Primary actors: EV, EVCC EVSE, SECC. The following information needs to be exchanged between the actors: From EVCC to SECC: EV status (as stipulated in ISO/IEC 15118-2), signed meter reading. From SECC to EVCC: EVSE status (as stipulated in ISO/IEC 15118-2), meter reading.
5	Prerequisites	▪ Target setting or charging scheduling according to use case elements E1 or E2 shall be established successfully. ▪ Charging loop shall be active.
6	Requirements	▪ EVCC shall send SECC the current status in a specified time frame according to ISO/IEC 15118-2. ▪ SECC shall reply with no interrupt flag. ▪ SECC shall send a meter readout to EVCC for signing. ▪ SECC shall send the signed meter readout to the MO.
7	End conditions	<u>Success end conditions:</u> ▪ EVCC receives the metering information and performs plausibility check. ▪ SECC receives the plausibility check of the metering information. ▪ Charging loop continues. <u>Failure end conditions:</u> ▪ Validation of the information fails, e.g. the delivered energy amount is different from the received energy amount. ▪ SECC has not received signed meter reading for certain period or for a pre-specified amount of energy. ▪ EVSE stops power delivery because validation not received from the EVCC. ▪ Charging loop will be stopped.

7.7.3 Charging loop with interrupt from SECC

Table 22 — Charging loop with interrupt from SECC

No.	Type	Description
1	Use case element name	Charging loop with interrupt from the SEC
2	Use case element ID	F2
3	Objectives	Continue charging process until the SECC interrupts the charging loop.
4	Description	The EVCC is the 'client' and always requests information from the SECC. If an SECC wants to interrupt the charging loop, for example with an updated charging schedule or new set-point for the load levelling, then this use case will describe the process. The actors involved are: ▪ Primary actors: EV, EVCC EVSE, SECC. The following information needs to be exchanged between the actors: From EVCC to SECC: EV status (as stipulated in ISO/IEC 15118-2). From SECC to EVCC: EVSE status (as stipulated in ISO/IEC 15118-2), SECC interrupt, new departure time.
5	Prerequisites	▪ Target setting or charging scheduling according to use case elements of E shall be established successfully. ▪ Charging loop shall be active.
6	Requirements	▪ SECC shall send EVCC the current status in a specified time frame according to ISO/IEC 15118-2. ▪ Charging process interrupt flag set by SECC / secondary actor. ▪ The EVCC shall initialise the charging set-up process again.
7	End conditions	Success end conditions: ▪ Charging loop interrupt occurred and either charging set-up or end-of-charging process starts. Failure end conditions: ▪ Charging process will not start again.

7.7.4 Charging loop with interrupt from the EVCC or user

Table 23 — Charging loop with interrupt from the EVCC or user

No.	Type	Description
1	Use case element name	Charging loop with interrupt from the EVCC or user
2	Use case element ID	F3
3	Objectives	Possibility for the EVCC or user to interrupt the charging loop
4	Description	EVCC or user interrupts charging process when e.g. charging schedule changes or unpre-dictable event in the EV occurs or user returns and wants to leave. The actors involved are: ▪ Primary actors: EV, EVCC EVSE, SECC, USER. This use case covers the basic charging loop with interrupt from the EVCC or user. ▪ EVCC shall send an EV status in a specified time frame according ISO/IEC 15118-2. ▪ SECC shall reply with an EVSE status in a specified time frame according to ISO/IEC 15118-2. ▪ EV will continue either with charging setup process or with end of charging pro-cess. The following information needs to be exchanged between the actors: From EVCC to SECC: EV status (as stipulated in ISO/IEC 15118-2), EVCC Interrupt, new departure time. From SECC to EVCC: EVSE status (as stipulated in ISO/IEC 15118-2).
5	Prerequisites	▪ Target setting or charging scheduling according to use case elements of E shall be established successfully. ▪ Charging loop shall be active.
6	Requirements	▪ EVCC shall send SECC the current status in a specified time frame according ISO/IEC 15118-2. ▪ SECC shall reply in a specified time frame according ISO/IEC 15118-2. ▪ EV or user shall re-schedule or terminate the charging process.
7	End conditions	Success end conditions: ▪ Charging loop interrupt occurred and either charging set-up or end-of-charging process starts. Failure end conditions: ▪ Charging process does not start again.

7.7.5 Reactive power compensation

Table 24 — Reactive power compensation

No.	Type	Description
1	Use case element name	Reactive power compensation
2	Use case element ID	F4
3	Objectives	EV supports the EVSE in reducing reactive power in the grid.
4	Description	This use case element covers the exchange of information regarding the possibility of reactive power compensation from the EV side and the demanded reactive power compensation from the EVSE or grid side. The actors involved are: ▪ Primary actors: EV, EVCC EVSE, SECC. Scenario description: ▪ EVCC is indicating that reactive power compensation is possible. ▪ EVCC provides information as to what kind of reactive power compensation can be supported. ▪ SECC requests reactive power compensation with an appropriate reactive power compensation value. ▪ EVCC confirms the adjusted reactive power compensation value. The following information needs to be exchanged between the actors: From EVCC to SECC: Flag indicating that reactive power compensation is supported, supported reactive power compensation values, actual used reactive power compensation value. From SECC to EVCC: flag indicating that reactive power compensation is necessary, necessary reactive power compensation value.
5	Prerequisites	▪ Target setting or charging scheduling according to use case elements of E shall be established successfully. ▪ Charging loop shall be active. ▪ EV is able to support reactive power compensation.
6	Requirements	▪ SECC indicates to the EVCC that reactive power compensation is necessary.
7	End conditions	Success end conditions: ▪ Charging is done with appropriate reactive power compensation value Failure end conditions: ▪ Charging is done with incorrect reactive power compensation value.

7.7.6 Vehicle to grid support

Table 25 — Vehicle to grid support

No.	Type	Description
1	Use case element name	Vehicle to grid support.
2	Use case element ID	F5
3	Objectives	EV can supply energy back to the grid.
4	Description	This use case element covers the exchange of information regarding the principle and actual possibility of supporting vehicle to grid energy flow. Therefore, the EV needs the possibility to indicate that it can technically support vehicle to grid energy flow. Additionally, it needs the possibility to provide information as to how much energy is available for vehicle to grid operation, and with which power this operation can be supported. The actors involved are: ▪ Primary actors: EV, EVCC EVSE, SECC. ▪ Secondary actors: EP, EMOCH. Scenario description: ▪ EVCC shall indicate that it can support vehicle to grid operation from a technical point of view. ▪ EVCC shall provide information at which power vehicle to grid operation can be supported. ▪ EVCC shall provide information as to how much energy is available for vehicle to grid operation, therefore the vehicle takes into account that the user goal of a charged vehicle at a given time can still be reached. ▪ SECC shall indicate that it supports vehicle to grid operation. ▪ SECC shall provide grid schedule together with sales tariff table information or a proposed charging schedule, including a vehicle to grid tariff / segment, to indicate that the EP, EMOCH requests vehicle to grid operation. ▪ EV shall use / reject the offered vehicle to grid tariff / segment according to use case element E3. The following information needs to be exchanged between the actors: From the EVCC to SECC: Flag indicating that vehicle to grid operation is technically possible from the EV side, maximum supported vehicle to grid power value, available vehicle to grid energy or maximum duration of vehicle to grid energy flow at maximum power value. From the SECC to EVCC: Flag indicating that vehicle to grid operation is technically possible from the SECC side.
5	Prerequisites	▪ Target setting or charging scheduling according to use case elements of E shall be established successfully. ▪ Charging loop shall be active. ▪ EVSE shall support vehicle to grid operation. ▪ Secondary actor shall have the possibility to request vehicle to grid energy flow from the EVCC / SECC.
6	Requirements	SECC indicates to the EVCC that vehicle to grid energy flow is requested.

7	Post-conditions	Success end conditions: ▪ EV supplies energy back to the grid. Failure end conditions: ▪ EV does not supply energy back to the grid.

7.8 Value added services [G]

7.8.1 Value Added services

Table 26 — Value Added services

No.	Type	Description
1	Use case name	Value-added services
2	Use case element ID	G1
3	Objectives	Value-added service (VAS) information exchange between the EVCC and SECC
4	Description	Optional services that may connect to the local network domain (EVSE) or the internet using optional protocols. Protocols on different communication layers may be used e.g. DHCP, HTTP, SOAP, HTML" Scenario description: ▪ OEM or user requests VAS. ▪ SECC requests service from the EVCC. ▪ SECC routes information.
5	Prerequisites	▪ Authorisation according to use case elements D1 or D2 shall be established successfully. ▪ SECC should be online. ▪ EV and EVSE are capable of enabling value-added services in general.
6	Requirements	EVSE shall offer the value-added service. Trigger: ▪ User has to request information.
7	End conditions	Success end conditions: ▪ USER or secondary actor receives the requested information. Failure end conditions: ▪ USER or secondary actor does not receive the requested information.

7.8.2 Charging details

Table 27 — Charging details

No.	Type	Description
1	Use case element name	Charging details
2	Use case element ID	G2
3	Objectives	Information supply of current charging process to the vehicle user or secondary actor
4	Description	This use case covers the exchange of information regarding the current charging process to the SECC. Parameters like battery status and state of charging could be provided for the SECC. The SECC or secondary actor, aware of the status of its charging process, delivers information to the vehicle user. The actors involved are: ▪ Primary actors: EV, EVCC EVSE, SECC, HMI. Scenario Description: ▪ Service detail record requested. ▪ SECC requests record from EVCC. ▪ EVCC sends record to SECC after request is accepted. ▪ SECC provides information for the secondary actor or HMI. The following information needs to be exchanged between the actors: From the EVCC to SECC: EV charging details according to the requested list. It needs to be indicated if the requested information is not available from the EV side. From the SECC to EVCC: Authorisation to request charging details, list of requested charging details.
5	Prerequisites	▪ Target setting or charging scheduling according to use case elements of E shall be established successfully. ▪ Charging loop shall be active. ▪ EV is capable of delivering charging details.
6	Requirements	USER/HMI or secondary actor has requested information.
7	End conditions	<u>Success end conditions:</u> ▪ USER or secondary actor will receive the requested information. <u>Failure end conditions:</u> ▪ USER or secondary actor will not receive the requested information.

7.9 End of charging process [H]

The EVCC should end the charging process by sending a request to the SECC and the SECC should respond by switching off the power, sending the final meter reading and releasing the locking feature (if implemented). This may only be necessary if the charging process is still in progress when the user initiates the end of the process.

If the system is equipped with a locking feature, the lock shall not be released before reaching "Ending charging process, except in the case of irregular unplugging".

NOTE 1 In case an unexpected disconnection or error on the EV-EVSE connection occurs, which affect electrical safety issues, the procedures of IEC 61851-1 apply.

NOTE 2 In case of a blackout on the electric grid, the EV should stop the charging and switch from state C to B. EVCC should terminate the communication, either due to a timeout in the communication or due to an EV internal trigger. The EV should keep the connector locked on the EV side, if possible. When the power supply is back again, use case element A1 or A2 applies.

7.9.1 End of charging process

Table 28 — End of charging process

No.	Type	Description
1	Use case name	End of charging process.
2	Use case element ID	H1
3	Objectives	Closing down the charging process in a safe and secure way whilst exchanging all relevant information required for subsequent procedures
4	Description	This use case covers the basic ending charging process. The actors involved are: ▪ Primary actors: EV, EVCC EVSE, SECC, USER. Basic elementary use case description: ▪ User returns to the EV / EVSE and initiates ending charging process a. If the user is indicating this on the EV side, the EVCC will tell the SECC that the charging process will end. b. If the user is indicating this on the EVSE side, e.g. using authentication by alternative means, the SECC will tell the EVCC that the charging process will end. ▪ EV switches to state B according to IEC 61851-1. ▪ EVSE opens main switches according to IEC 61851-1. a. If a meter is present, the EVCC requests the last meter readout before the charging process ends. b. EVSE replies with a meter readout. c. EVCC signs the meter readout and asks the SECC to release the connector. ▪ The SDR is generated on the EVSE side. This may be transferred to the EVCC or to authorised secondary actors. ▪ If applicable, the EVSE releases the connector on the EVSE, or waits until state A, according to IEC 61851-1, is recognised. Between the EVCC and SECC the information end charging process is exchanged. Between the SECC and EVCC the meter reading and connector unlocked information is exchanged. NOTE 1 The exact sequence and nature of each step depends on the preceding use cases.
5	Prerequisites	▪ Charging controlling and re-scheduling according to use case elements F2 or F3 shall be established successfully. or ▪ End of charging according to conditions specified in ISO/IEC 15118-2.
6	Requirements	Trigger: ▪ Charging loop shall be completed. ▪ User / EVSE / EV initiates end-of-charging process.
7	End conditions	Success end conditions: ▪ The billing procedure is terminated normally. Failure end conditions: ▪ The procedure is not terminated normally and information is lost. ▪ The EVSE will not deliver power, due to contactor failure.

Annex A (informative)

Charging infrastructure architecture

A.1 Introduction

A.1.1 General information

For setting up an intelligent charging infrastructure, the topology of power distribution, control pilot handling, distribution of control logic, contactors and PLC modems can be divided into three major subgroups.

As a basis for further discussions and documents, this annex summarises these topologies, and discusses their typical application, requirements, advantages and challenges.

A.1.2 Assumptions

This annex assumes that all the topologies described use an individual control pilot wire between the EVSE and the EV, according to SAE J1772 and IEC 61851-1, Annex A.

The PLC connection will not focus on a specific technology. However, for each topology attention needs to be given to the signal travel paths and the dimensions of the commonly used physical media.

Any individual network node, within a common physical medium, is part of the same collision domain, which means sharing the whole bandwidth with all other network nodes in the same collision domain.

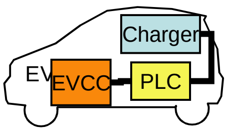
Whenever the term ‘electric vehicle’ is used, an electric vehicle with integrated PLC communication is assumed, e.g. EVCC and PLC.

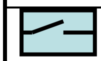
The systems will be compatible with existing and future HANs and LANs.

A.1.3 Abbreviations and Symbols

The table below specifies symbols with its associated description.

Table A.1 — Abbreviations and Symbols

Symbol	Description
	EV with integrated application layer implementation, PLC interface and AC charger
GW	Application layer gateway terminates application layer protocol and interfaces to other application layer protocol.
EVCC	Electric vehicle communication controller, e.g. instance which is implementing the application layer according to ISO/IEC 15118-2

SECC	Supply equipment communication controller, e.g. instance which is implementing the application layer according to ISO/IEC 15118-2
Secondary actor	Application layer implementation on secondary actor side, to interface with the application layer implementation of the gateway.
SECC Intelligent control unit	Supply equipment communication controller integrated in a detached intelligent control unit, which provides secondary actor data.
Router	Router separates IP subnets. If dashed lines are used it is optional.
PLC Bridge	PLC to HAN, LAN or other physical layer converter. Bridge performs MAC addressing.
Filter	Optional filter device to eliminate / reduce electromagnetic emissions, see ISO/IEC 15118-3 for details. This may break the PLC communication.
Pilot control	Entity performing the control pilot handling according to IEC 61851-1.
	Contactor to switch charging power to the charging coupler.
	PLC bypass and PWM filter device.
	Control pilot and PLC communication line if PLC is used ‘in line’.
	Optional control flow between the EVSE controller and ISO/IEC 15118 related entities.
	Power distribution and PLC communication line if PLC is used via mains.
	Local transmission media between PLC bridge and SECC, or GW, may be inside a circuit board if PLC chip and SECC or GW are on the same circuit board. May be a HAN if the PLC bridge is connected to SECC using a HAN installation.
	This line identifies the communication counterparts on the same application layer, e.g. an application layer session is established between the two entities. An application layer gateway divides such a communication path into two sides, one using an application layer 1 and another using an application layer 2.

A.1.4 Network characteristics

There are two communication paths:

— EVCC ⬄ SECC

— SECC ⬄ Secondary actor

Although the SECC to secondary actor communication is outside the ISO/IEC 15118 specification, some ISO/IEC 15118 messages require this communication, and thus the ISO/IEC 15118 specification will specify some requirements to assure the interoperability between the EVCC and the secondary actor.

Depending on the system architecture, these communication paths involve different components for establishing and maintaining communication. The drawings are intended for outlining the most general cases. If all of the components shown are separately present in a specific implementation, it is up to the OEM and EVSE supplier.

Communication between the EVCC and SECC can be divided into two set-ups, depending if the SECC is "local" (Figure A.1) to the EVCC or "remote" (Figure A.2).

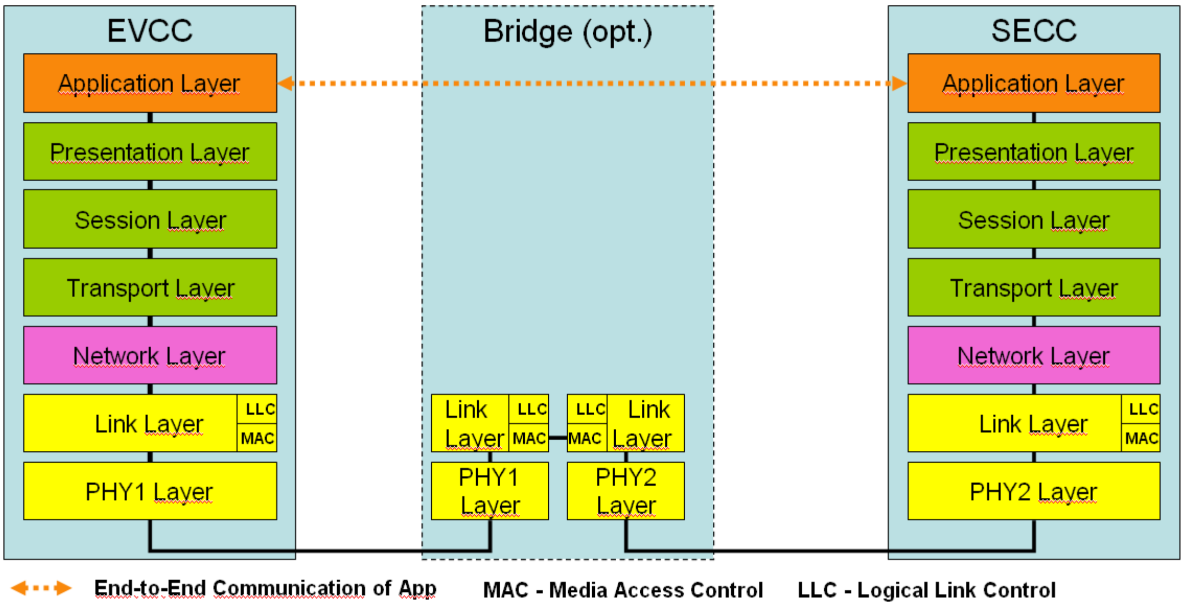


Figure A.1 —EVCC to SECC communication in a "local" setup

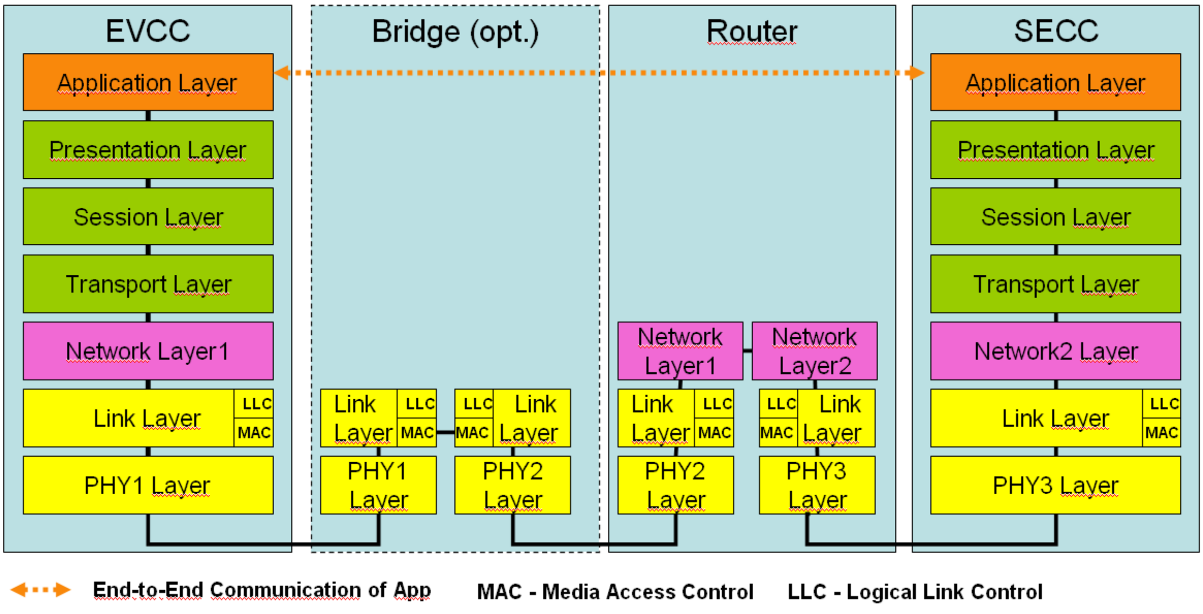


Figure A.2 —EVCC to SECC communication in a "remote" setup

Depending on the installation architecture, multiple “bridges”, routers might be necessary.

Figure A.3 shows the general case, requiring an application gateway for communication to the network / application layer.

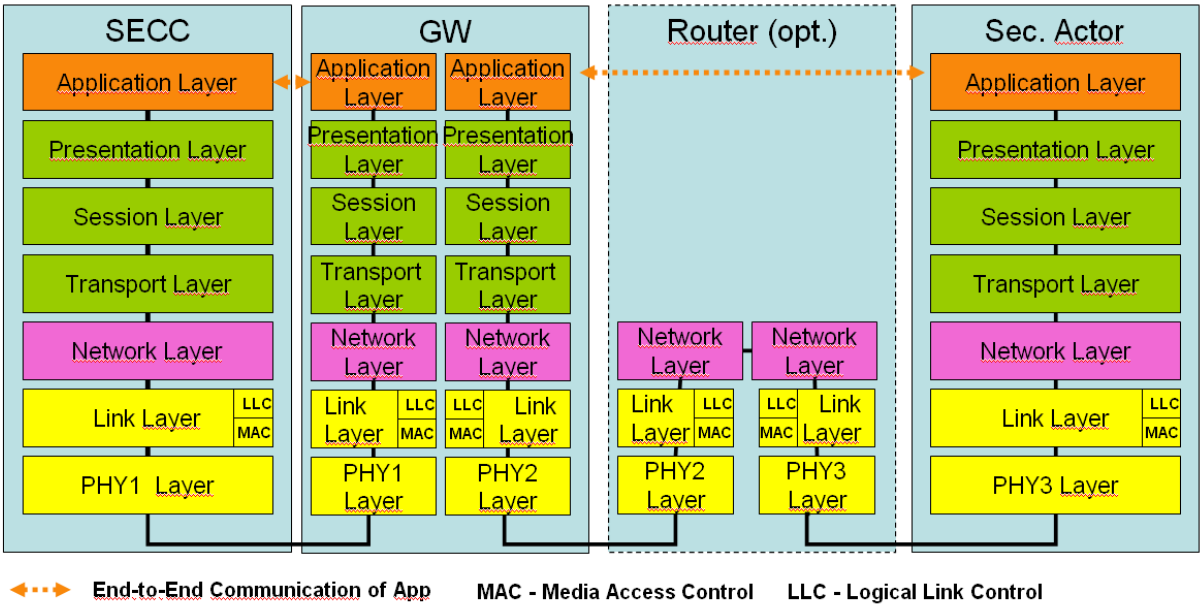


Figure A.3 —SECC communicates with the secondary actor using an application gateway

A.2 Variations of the SECC and EVCC setups

Typical SECC and EVCC set-ups can be divided into:

— 1:1 communication relationship between a SECC and an EVCC over all OSI layers.

— 1:n communication relationship between one SECC and multiple EVCCs.

  — SECC manages multiple EVCCs, knowing which EVCC is connected to which outlet.

  — SECC manages multiple EVCCs, knowing which EVCC is connected to which cluster of outlets. The SECC may be local or remote (communication done on an IP address basis).

These set-ups can be summarised as shown in Figure A.5.

Figure A.5 illustrates system architectures that are supported by ISO/IEC 15118-2 and ISO/IEC 15118-3.

— Option1: The combination of Figure A 1. and A 3

— Option2: The combination of Figure A 2. and A 3

In any case, each power outlet has its own PWM controller, for monitoring earth continuity (see IEC 61851-1).

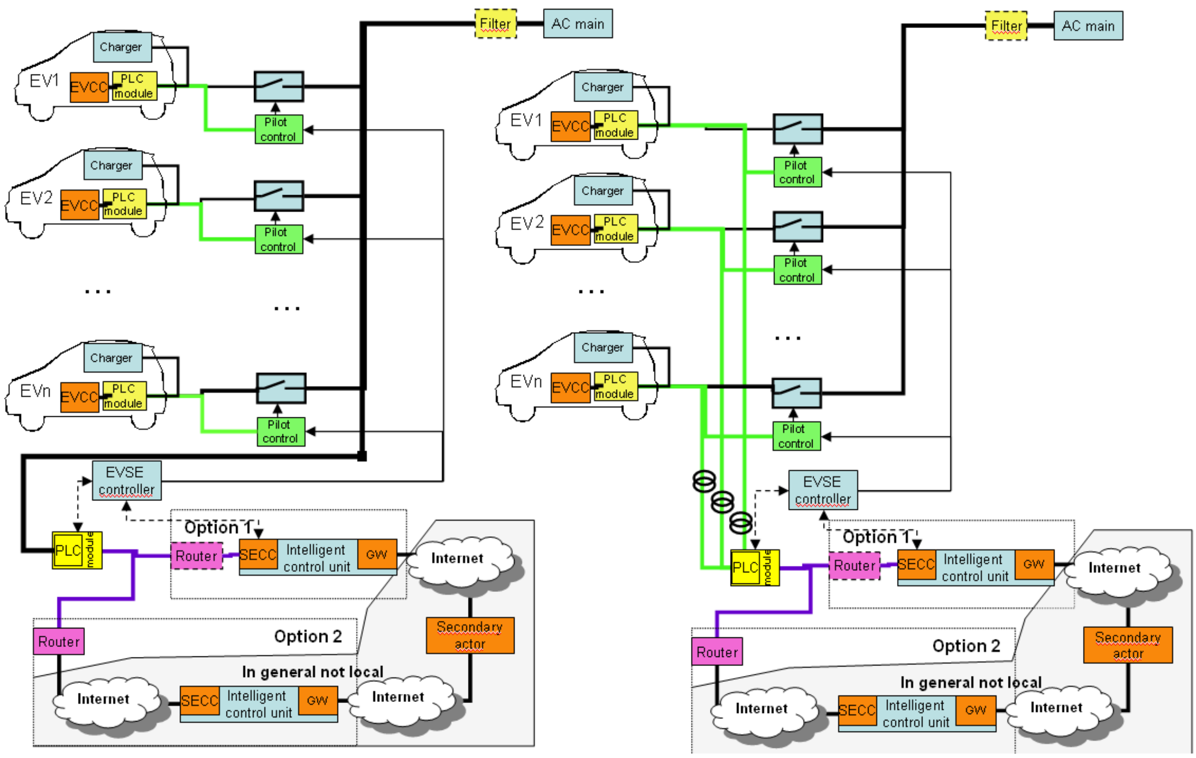


Figure A. 4 —General communication architecture set-up

The characteristics and possibilities of these communication set-ups are defined below:

— The control pilot handling is described in IEC 61851-1. Depending on the infrastructure set-up, each duty cycle may either indicate high-level communication required or indicate the actual maximum power rating of the outlet.

— The PLC devices need to be sufficiently close to each other, see ISO/IEC 15118-3 document for detailed requirements. Depending on PLC technology, additional elements may be necessary (not shown here), see ISO/IEC 15118-3.

— The association on physical and data link layer is always done based on the MAC addresses of the connected devices, with local bridge(s)/device(s), see ISO/IEC 15118-3 for details and limitations. Alternatives:

  - One PLC bridge/device per power outlet.
  - One PLC bridge/device for multiple outlets.
- Alternatives regarding the number of SECCs per physical outlet.
  - One SECC per physical power outlet, see Figure A.5 option 1 with only one outlet.
  - One SECC for multiple physical power outlets that is handling the communication to all EVCCs connected to these power outlets, see Figure A.5 option 1 with multiple outlets.
  - Router that moderates the communication from one or multiple physically connected EVCCs to one SECC which may not be part of the local installation, see Figure A.5 option 1 with router or option 2 with one or multiple outlets.
- Alternatives regarding interaction of the EVSE controller, PLC module and SECC.
  - If the EVSE controller has the possibility to interact with the PLC module, it is possible to ensure that the PLC module on the infrastructure side is associated with the correct PLC module on the EV side, see option 1 and 2 with implemented control flow between the EVSE controller and the PLC module. Details are specified in ISO/IEC 15118-3.
  - If the SECC needs to know which EVCC is connected to which physical outlet, the SECC might need the possibility to interact with the EVSE controller to get additional information from the specific EVSE, see option 1 with implemented control flow between the EVSE controller and SECC.
  - If it is not necessary to identify exactly to which outlet the EV is connected, the PLC module might not need to interact with the EVSE controller.
  - End-to-end communication on application layer between SECC and each connected EVCC is possible in all cases.
- SECC may require an application gateway to exchange information with a secondary actor. The entity implementing this secondary actor is generally located elsewhere compared to the SECC entity, see grey highlighted box in Figure A.4. The definition of this application gateway is not part of ISO/IEC 15118.
- Optional EVCC IP communication to HAN through PLC module and router or SECC.

A.3 Location of identification, authorisation and billing related elements

Identification and authorisation covers the necessary information flow and interaction between the user, EV, EVSE and secondary actor to get the permission to retrieve energy from the EVSE or to do value-added services using the communication link between the EV and EVSE.

There are two general possibilities for identification and authorisation prior to starting the charging process.

- Identification / authorisation and billing using the ISO/IEC 15118 communication link.
- Identification / authorisation and billing on the EVSE side independently from ISO/IEC 15118 communication.

Identification / authorisation on the EVSE side are outside the scope of ISO/IEC 15118 communications and therefore not outlined in detail. Table A.2 shows the case where all billing-related data are handled on the EVSE side only, independently from ISO/IEC 15118. In principle, combinations of the two general approaches are possible. For each individual charging process, the relevant ISO/IEC 15118 features need to be negotiated between the EVCC and SECC.

Identification, authorisation and billing can be separated into three steps.

- Determine customer ID.
- Authentication / authorisation of counterpart.
- Billing relevant data exchange.

“Determine customer ID” covers the functionality required to select an ID and to be authorised to use the ID. This includes the necessary security aspects to avoid misuse of an ID and to ensure privacy.

“Authentication and authorisation” covers the functionality required to verify that the counterpart is trustworthy and that the customer is authorised to receive a service.

“Billing relevant data exchange” covers the functionality required to exchange charging process or value-added service related data that are mandatory for billing purposes.

Table A.2 - Identification, authorisation and billing using ISO/IEC 15118

Stage	**Function**	**Location and example of equipment**		
		EV/PHV	**Charging Spot**	**Secondary Actor**
Determine customer ID	Customer ID (having), e.g. certificate (Use case element C1 / C2)	Customer ID/Certificate handling device, i.e. card reader, on-board memory		
	Customer ID (knowing) – optional	HMI to enter a PIN		
	Authorise the exchange of ID/certificates	If PIN fits the customer ID/certificate handling device		
Authentication / authorisation of counterpart	Exchange of ID/certificates (Use case element C1 / C2)	EVCC provides customer ID/certificate to SECC	SECC provides ID/certificate to EVCC	
	Authentication of customer / EVSE (Use case element D2)	Check if SECC ID/certificate is authentic	Check if Customer ID/certificate is authentic, this may be done locally at SECC or at secondary actor. This depends on the set-up of SECC / EVSE	Provide certificate revocation list or service to verify a customer ID/certificate
	Approval of charging by checking the ability to pay (Use case element		Check if EVCC is authorised to	Provide certificate revocation list or ser-

	D2)		charge	vice to verify authorisation
Billing based on exchanged and committed status information, like energy consumption, time present, etc	Exchange of status data while charging (Use case element F1)	Receive status data, optional.	Provide status data	
	Validate / commit status data (Use case element F1)	Commit status data with a signature issued by EVCC, optional.	Store a charging detail record (CDR) for billing, containing the signature of EVCC if available.	
	Provide CDR to secondary actor		Transmit CDR to secondary actor	Store CDR for billing

Table A.3 - Identification, authorisation and billing independent from ISO/IEC 15118, for information only

Stage	Function	Location and example of equipment		
		EV/PHV	**Charging Spot**	**Secondary Actor**
Determine customer ID	Customer ID (having), e.g. certificate		Certificate handling device, i.e. Card reader	
	Customer ID (knowing) - optional		HMI to enter a PIN	
	Authorise the exchange of certificates		Check if PIN fits the certificate handling device.	
Authentication of counterpart	Exchange of certificates		Identification of the outlet, i.e. HMI to select the outlet.	
	Authentication of customer		Check if Customer certificate is authentic	Provide certificate revocation list
Billing relevant data handling	Populate transferred energy		HMI to display the transferred energy	
	Validation of received energy by customer		HMI to commit the transferred energy by user ◊ Charging Detail Record (CDR)	

	Provide CDR to secondary actor		Transmit CDR to secondary actor	Store the committed energy for billing.

A.4 Location of charging process related elements

The charging process can be split into different elements, in general. These are:

- Target Setting
- Demand and Prognosis
- Scheduling
- Charging control

'Target Setting' covers all kind of user demand-related information such as:

- When shall the charging process be finished
- How much energy is needed
- Charging preferences like fast charging, cheapest charging, least CO2 charging, etc.
- Energy provider

'Demand and Prognosis' covers the collection of grid and local installation limits which applies to the actual charging process, e.g.

- Sales tariff table containing a price, efficiency or CO2 content information vs. time-based on grid, energy production, energy demand and customer contract information, along with an optional contract-based current limitation.
- Grid schedule containing a current vs. time limitation at the specific EVSE due to local installation and local electricity demand situation.

'Scheduling' covers the compilation of 'Target Setting' and 'Demand and Prognosis' information when necessary to create a charging schedule, i.e. charging current vs. time prognosis, for the current charging process.

- Calculate a charging plan to meet customer requirements, which respects current limitations from the sales tariff table, grid schedule and local installation.
- The result of the calculation is a timetable of maximum charging current allowed to be withdrawn from the EVSE.
- Schedule may be changed according to the real time situation.
- Schedule shall respect tariff limitations, grid limitations, local infrastructure limitations and EV limitations. Level selector does the combination of tariff limitations, grid limitations and local infrastructure limitations.

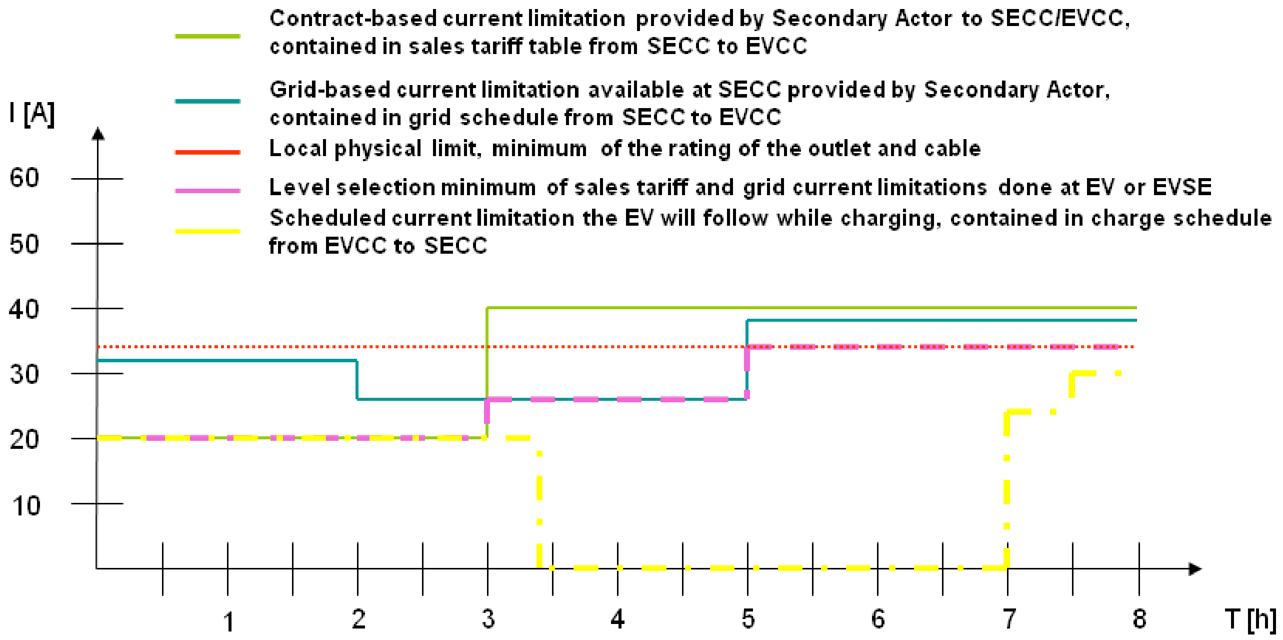


Figure A.5 — Charging process flow chart

'Charging Control' covers the control of the charging process according to 'Scheduling' results

NOTE Actual charging current to the battery should be controlled by BMS. It is outside the scope of the standard.

'BMS' charges the battery under the current limitations provided by 'Charging Control'

The cooperation between these elements is shown in Figure A.6.

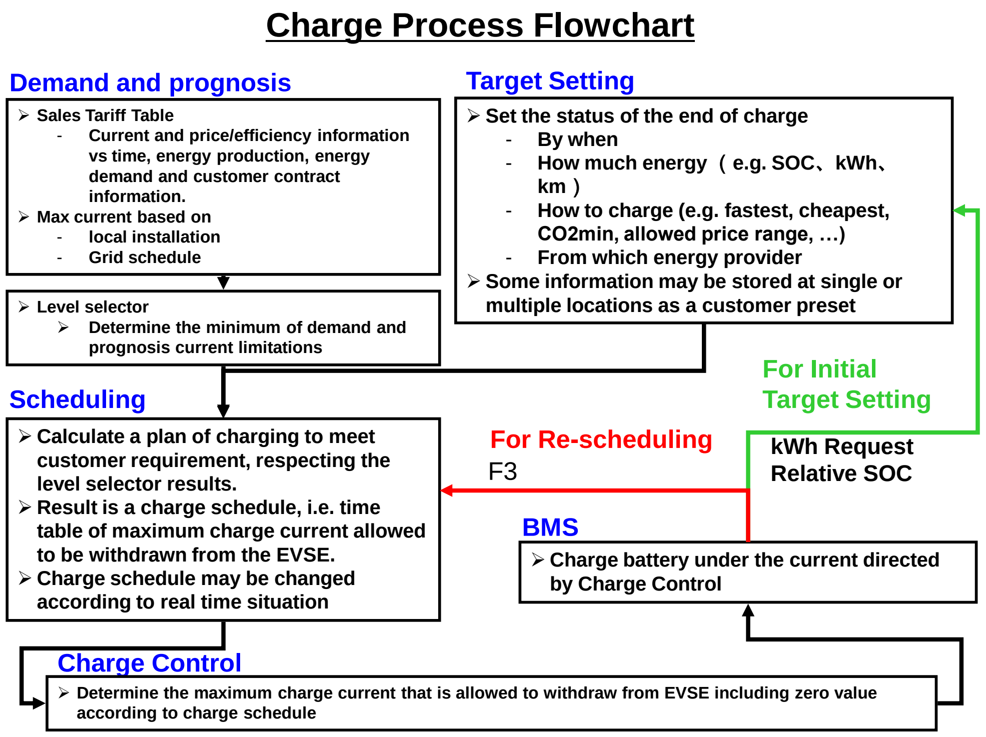


Figure A.6 —Charging process flow chart

In the case of AC and DC charging it seems obvious that the BMS is located in the EV and 'Demand and Prognosis' is a task of a secondary actor, which might be located within the EVSE. The remaining elements in the charging process flow chart can either be located in the EV, the EVSE or at a secondary actor. Depending on the decision for a specific system, additional equipment for user interaction, data transfer, availability of a communication link to a secondary actor, etc. arise. See Table A.4 for details.

Table A.4 — Additional equipment required if scheduling and charging control is mainly located on the infrastructure side

Stage	Function	Location and example of equipment			
		EV/PHV	**Charging Spot**	**Secondary Actor1**	**Secondary Actor2**
Target Setting	Setting of the status of the end of charging	Switch / button etc.			
	Setting of the required amount of energy needed for the charging and charging capability of the EV	Calculated by BMS (Wh calculator)	SECC may forward. This depends on the set-up of the SECC / EVSE	Database to store the target setting data for further processing.	
Demand and Prognosis	Development of the sales tariff table			Database to store the sales tariff table for	Energy provider or E-Mobility oper-

				scheduling	ator
	Determination of the grid schedule			Database at DCH or charging spot opera-tor,	
	Determination of local limita-tion		Controller providing the outlet rating and the cable rating		
	Level selector			Controller using the database and charg-ing spot in-formation	
Scheduling	Schedule calculation accord-ing to "Target set" and "Demand & Prognosis" info.		Database to store the charg-ing sched-ule	Schedule calculator result sent to charging spot	
	EV or user confirm the charg-ing schedule (Optional)	Charging schedule confirmation			
Charging Control	Inform the maximum charging current at that time. Pick up from charging schedule.	Controller to follow the cur-rent limitation	Controller to follow the charg-ing sched-ule and inform the EV about the current limitation		
	Renegotiation due to envi-ronmental condition changes (t°, ..) (optional)	EVCC Return to 'target set-ting'			
	Renegotiation due to changed environmental con-dition on EVSE or the sec-ondary actor side (optional)		Return to Target Setting or Demand and Prog-nosis	Return to Target Set-ting or De-mand and Prognosis	

Table A.4 — Additional equipment required if scheduling and charging control is mainly located on the EV side

Stage	**Function**	**Location and example of equipment**			
		EV/PHV	**Charging Spot**	**Secondary Actor1**	**Secondary Actor2**
Target Setting	Setting of the status of the end of charging	Switch / button etc.			
	Setting the required amount of charging and charging capability of the EV	Calculated by BMS (Wh calculator)	SECC may forward. This depends on the set-up of the SECC / EVSE		
Demand and Prognosis	Development of the Sales tariff table		SECC forward sales tariff table to EVCC		Energy Provider or E-Mobility operator
	Determination of the grid schedule		SECC forward grid schedule to EVCC	Database at DCH or charging spot operator	
	Determination of local limitation	Controller providing the cable rating	Controller providing the outlet rating . SECC forward this information to EVCC		
	Level selector	Controller determines the minimum of all current limitation information provided by SECC			
Scheduling	Schedule calculation according to "Target Setting" and "Demand & Prognosis" info.	Controller to calculate a charging schedule			

	EV or user provides the charging schedule to the SECC.	EVCC provides charging schedule to SECC	Charging schedule confirmation		
Charging Control	Inform the maximum charging current at that time. Pick up from charging schedule.	Controller to follow the current limitation			
	Renegotiation due to environmental condition changes (t°, ..) (optional)	EVCC return to 'target setting'			
	Renegotiation due to changed environmental condition on EVSE or the secondary actor side (optional)		Return to Target Setting or Demand and Prognosis	Return to Target Setting or Demand and Prognosis	

Annex B
(informative)

Security

B.1 Analysis of target use cases

B.1.1 General

The following scenarios are described as part of the use case matrix in sub-clause 7.1. These use cases serve as a starting point for the derivation of security requirements later on. The focus for the analysis of the use cases is placed on the communication relations, as well as the data exchanged between the communicating parties.

Use cases in scope of the security concept mapped to the Security Requirements are described in Table B.1

The following goals of applying cryptographics to communication are an extract from the Handbook of Applied Cryptography, by A. Menezes, P. van Oorschot, and S. Vanstone, CRC Press, 1996 and are repeated here for easier understanding of the cryptographic measures. For further information, see www.cacr.math.uwaterloo.ca/hac

1. **Confidentiality** is a service used to keep the content of information from all but those authorised to have it. Secrecy is a term synonymous with confidentiality and privacy. There are numerous approaches to providing confidentiality, ranging from physical protection to mathematical algorithms, which render data unintelligible.
2. **Data integrity** is a service that addresses the unauthorised alteration of data. To assure data integrity, one must have the ability to detect data manipulation by unauthorised parties. Data manipulation includes such things as insertion, deletion, and substitution.
3. **Authentication** is a service related to identification. This function applies to both entities and information itself. Two parties entering into a communication should identify each other. Information delivered over a channel should be authenticated as to origin, date of origin, data content, time sent, etc. For these reasons, this aspect of cryptography is usually subdivided into two major classes: entity authentication and data origin authentication. Data origin authentication implicitly provides data integrity (for if a message is modified, the source has changed).
4. **Non-repudiation** is a service that prevents an entity from denying previous commitments or actions. When disputes arise due to an entity denying that certain actions were taken, a means to resolve the situation is required. For example, one entity may authorise the purchase of property by another entity and later deny such authorisation was granted. A procedure involving a trusted third party is needed to resolve the dispute. "Accountability" as used in B.1 is equivalent to the term “non-repudiation”.

An additional goal regarding the data communication is defined below.

1. **Reliability / Availability** is the property of a service of being available and working reliably. Degradation of availability and/or communication reliability potentially compromises an offered service.

Table B.1 — Use case elements and their security requirements

		Accountability	Authenticity	Confidentiality & Privacy	Integrity	Reliability & Availability
A	Beginn of Charging Process					
A1	Plug-in process with forced high level communication					
A2	Plug-in process with concurrent IEC61851 and high level communication					
B	Communication setup					
B1	EVCC/SECC communication setup					
C	Certificate Handling					
C1	Certificate update		x	x	x	x
C2	Certificate installation		x	x	x	x
D	Identification, Authentication & Authorization					
D1	Authentication from EV with local Authorization		x	x	x	x
D2	Authentication from EV with Authorization from secondary Actor		x	x	x	x
D3	Identification at EVSE		x		x	x
D4	Identification at EVSE with validation from secondary actor		x		x	x
E	Target setting and charge scheduling					
E1	AC charging with load levelling based on high-level communication		x		x	x
E2	Optimized charging with schedule to secondary actor		x	x	x	x
E3	Optimized charging with scheduling at EV		x	x	x	x
E4	DC charging with load levelling based on high-level communication		x		x	x
E5	Resume to Authorised Charge Schedule		x		x	x
F	Charge controlling and Re-scheduling					
F0	Charging loop		x		x	x
F1	Charging loop with metering information exchange	x	x	x	x	x
F2	Charging loop with interrupt from the SECC		x	x	x	x
F3	Charging loop with interrupt from the EVCC or user		x	x	x	x
F4	Reactive power compensation		x	x	x	x
F5	Vehicle to grid support	x	x	x	x	x
G	Value added services					
G1	Value added services					
G2	Charging details		x	x	x	
H	Plug-out process					
H1	End of charging process				x	x

NOTE Use case **C1** only has confidentiality requirements if the exchange of new private keys is included. Use case **G1** has security requirements in general, but outside the scope of the V2G CI specification.

These use cases are to be analysed below to determine the communication peers, as well as the communicated data. Moreover, this communication needs to be investigated to determine its criticality to the service provided. This information is one basis for the derivation of security requirements.

B.1.2 Entities

B.1.2.1 General

The use cases described above involve the entities described in the following two clauses.

B.1.2.2 Customer related

Table B.2 — Description of entities

Entity	Description
Contract	An agreement between the customer and a mobility operator for providing charging services. The contract is identified by a contract ID.

B.1.2.3 E-mobility operators

Table B.3 — Description of organisational parties

Organization	Description
	Reference to clause 6
Mobility Operator	The organisation to which a customer has a contract for providing EV charging services. Mobility operator might be the EVSE operator, an energy provider or a 3rd party.

B.1.3 Trust relationships

The following table breaks down the information flow EV, EVSE and SA (secondary actor).

Table B.4 — Communication relations and exchanged data between involved peers

No.	Peer 1	Peer 2	Communication type, exchange data
1	EV	EVSE/ EVSE Operator	Charging control data, contract, EVSE-ID, physical limits (safety monitoring), meter information, charge plan, safety monitoring data
2	EV	Clearing house	Charging information, billing information (indirect), tariff information
3	EV	VAS	Value added service related communication
4	EVSE	EVSE operator	Contracts, limits, meter information, charge plan
			SW-Updates
5	EVSE	Clearing house	Contracts, limits, meter information, charge plan, billing record
6	EVSE	E-Mobility Operator	Contract, charge control
7	EVSE	Energy provider	

To realise the use cases stated in the introduction of this security annex assumptions regarding the trust relations need to be investigated to ensure trust cryptographic credentials are typically used and thus influence the security requirements, security architecture and the selection of security measures (algorithms, mechanisms, etc.).

The trust relations depend considerably on service relations between the different peers and therefore on the data exchanged between the involved parties as presented in Table B.3.

In addition, Table B.4 provides information about certain assumptions regarding the different peers in relation with their security relevant interactions and/or functions.

Table B.5 — Trust and architecture assumptions

No	Peer	Assumptions
1	Vehicle	– Has means to identify and authenticate itself towards other peers, e.g., by using a Contract ID and cryptographic key material
2	EVSE / EVSE Operator	– EVSE delivers correct meter information during the charging cycle – EVSE may control the charging process – The vehicle, clearing house and mobility operator may need to transfer information such as tariff information through the EVSE without the EVSE having access to the information. – EVSE has means to authenticate towards other peers – EVSE will not be provided with billing information from the clearing house or the vehicle (billing in this context is related to personal customer data) – Crosstalk between PLC connections is not addressed (rather an issue for physical measures)
3	SA (Clearing House)	– Clearing house processes the billing correctly – Clearing house has means to authenticate towards other peers
4	SA (VAS Provider)	– VAS provisioning is orthogonal to the electricity charging and the associated billing
5	All	– All parties have means to communicate with each other.

B.1.4 Threats for transmission information

The analysis of exchanged data targets the determination of criticality of the data and thus their influence on the service provisioning. It also addresses potential data protection required for the different data types. For general background information about security techniques refer to ISO/IEC 15408-1.

Table B..6 — Communication relations and exchanged data between peers

No	Data / Service	Priority Class	Threatened Property			
			Integrity	Confidentiality	Non-Repudiation	Availability
1	Charging control data, physical limits charging plan, safety monitoring data		X			X
2	Billing information		X	(X) (if personalised)	X	
3	Tariff information		X	X	(X) (if personal-ised)	X
4	SW updates		(X) (OEM specific)	(X) (OEM specific)		
5	VAS communication		X (depending on VAS, outside the scope of vehicle to EVSE com-munication)			
6	Identity information relat-ed to physical compo-nents (e.g., EVSE- Id)		X			X
7	Identity information relat-ed to persons (e.g., Con-tract Id)		X	X		
8	Charging Service					X

Annex C
(informative)

Charging schedule with load management areas

This annex describes the principle idea of load management areas in ISO/IEC 15118. For details on the corresponding data elements in the messages, refer to the ISO/IEC 15118-2 document.

The charging schedule provided from the EV to EVSE or a secondary actor is good for a prognosis of energy consumption of the EV in the next hours. However, if there is the need to change the vehicle charging schedule , there is at first no information as to what alternatives would be feasible for the EV.

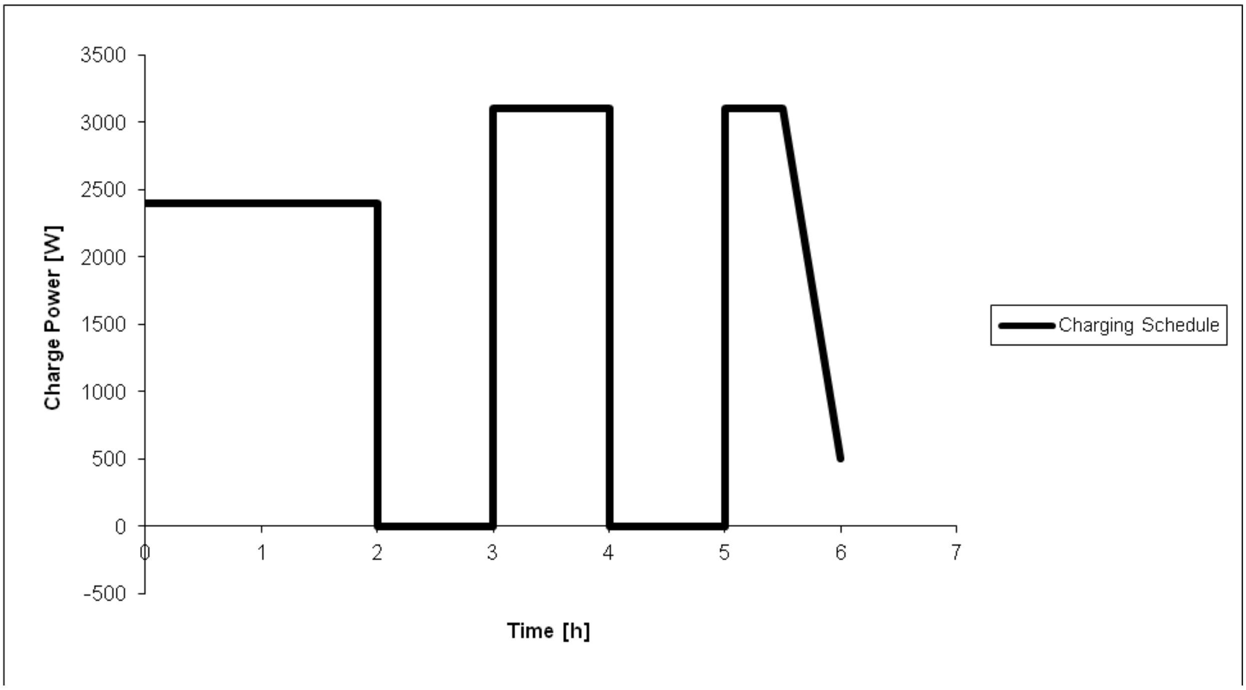


Figure C.1 — Example for charging schedule

It is, therefore, beneficial to extend the charging schedule by the following three pieces of additional information:

- Maximum possible charging load the EV could realise,
- Minimum possible charging load supported by EV, which is not zero,
- Maximum duration of a charging delay.

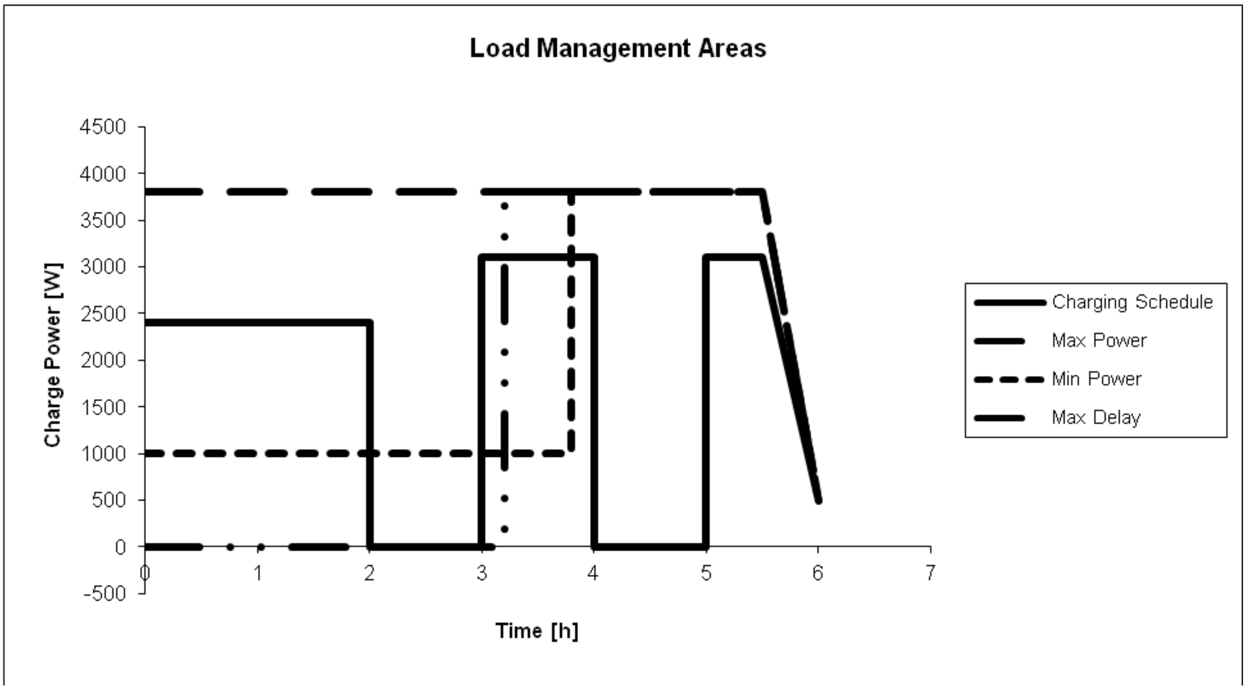


Figure C.2 — Example for extended charging schedule

In the example shown in Figure C.2 the EV provides the following information:

— EV could charge with 3.680 W at max – dashed line “Max Power”.

— Minimum reasonable charging power of the EV is 1.000 W. If the EV were to start charging at this level it would need to charge with maximum power after approximately 4 h to meet the charging goal after 6 h – dashed line “Min Power”.

— EV could delay the charging process for a maximum of 3 h 15 min and needs to charge with full power to meet the charging goal, afterwards – dashed line “Max Delay”.

— Based on the ”Max Delay” curve EVSE or a secondary actor can determine that the charging duration with full power will last 2 hours 45 min.

With this additional information the EVSE or a secondary actor, know the capabilities of the EV.

In addition, the EV can define phases where no load management is possible, e.g. pre-conditioning of battery, pre-condition of cabin, no charging pause due to cold ambient conditions etc. In this case, the minimum values will be set to the maximum values.

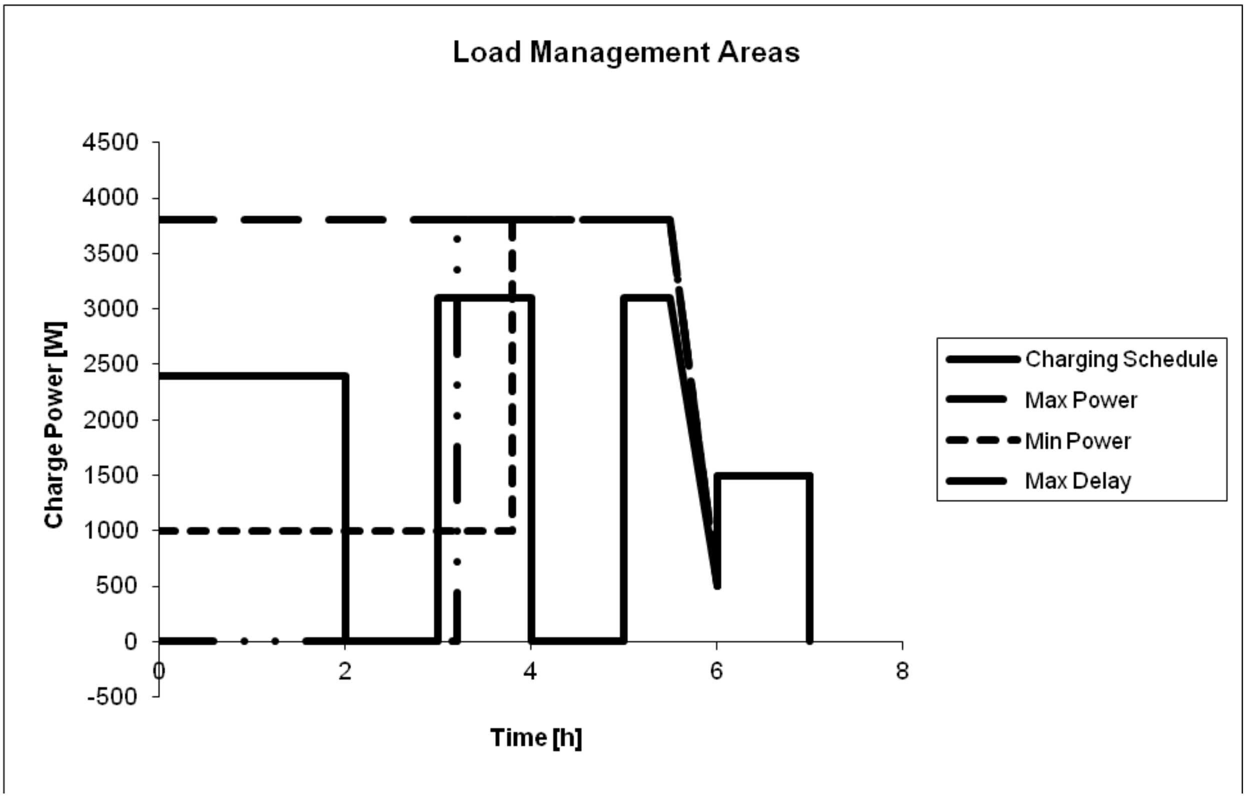


Figure C.3 — Example with cabin pre-conditioning after charging

In the example shown in Figure D.3 the USER has scheduled cabin pre-conditioning prior to the departure time. Therefore in the last hour when the EV is connected to the EVSE there are no load management possibilities and therefore all curves are the same.

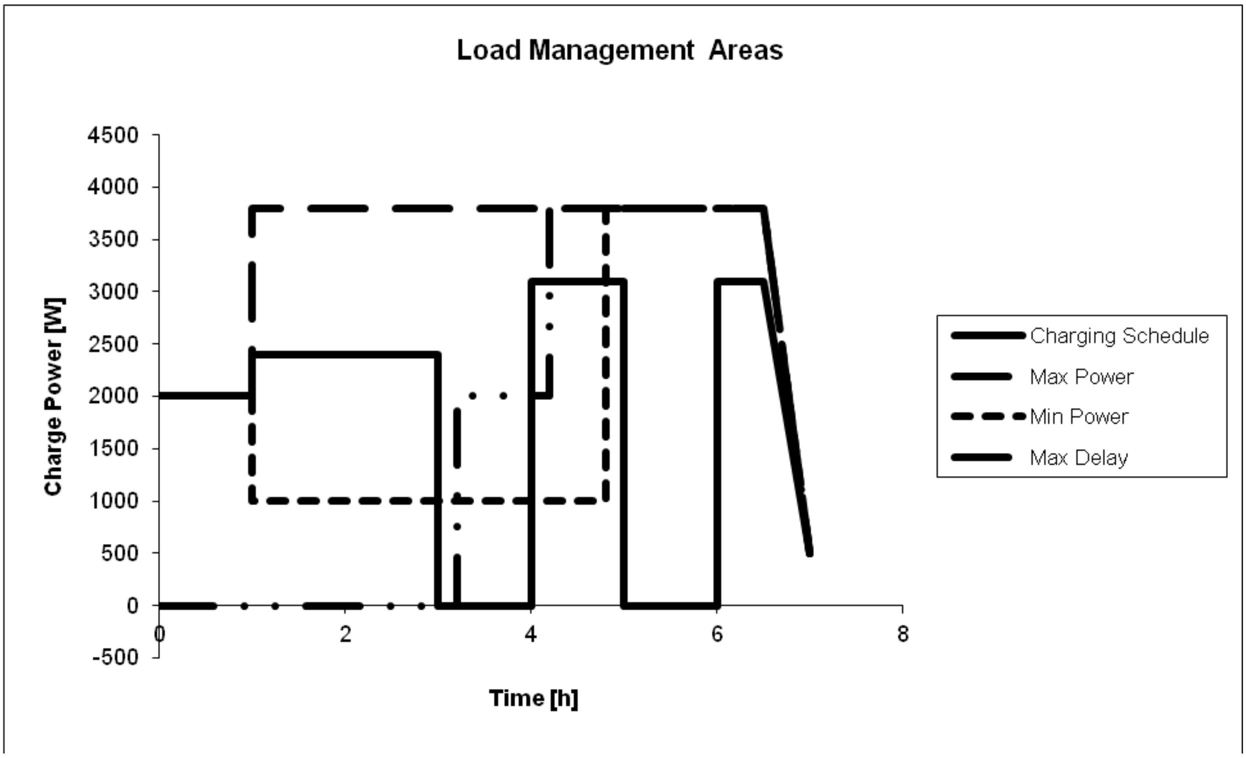


Figure C.4 - Example with battery pre-conditioning prior to charging

In the example shown in Figure C.4 the EV battery wants battery pre-conditioning prior to starting charging. Therefore, in the first hour before the EV starts to charge the battery, the energy, which will be drawn is fixed at 2 kW. In this case there is still the possibility to start with a charging pause. Then the battery pre-conditioning will take place after the charging pause and before the EV starts to charge with maximum power. This is indicated in the example by the jumps of “Max Delay” at 3.2 hours to a value of 2 kW and an additional jump at 4.3 hours to 3.8 kW.

Annex D
(informative)

Examples of charging scenarios derived from the use case elements

D.1 General

This Annex is intended to show the way in which the use case elements defined in Clause 7 can be used to construct specific scenarios. Each of these scenarios offers several ways and each of these is a use case derived from the elements described in Clause 7. The aim is not to include all possible communication use cases of in this document. However, this Annex presents some typical scenarios that show the use of the different use case elements. The scenarios are used as tests to verify the completeness of the elementary use cases.

D.2 Fleet operation/ car park

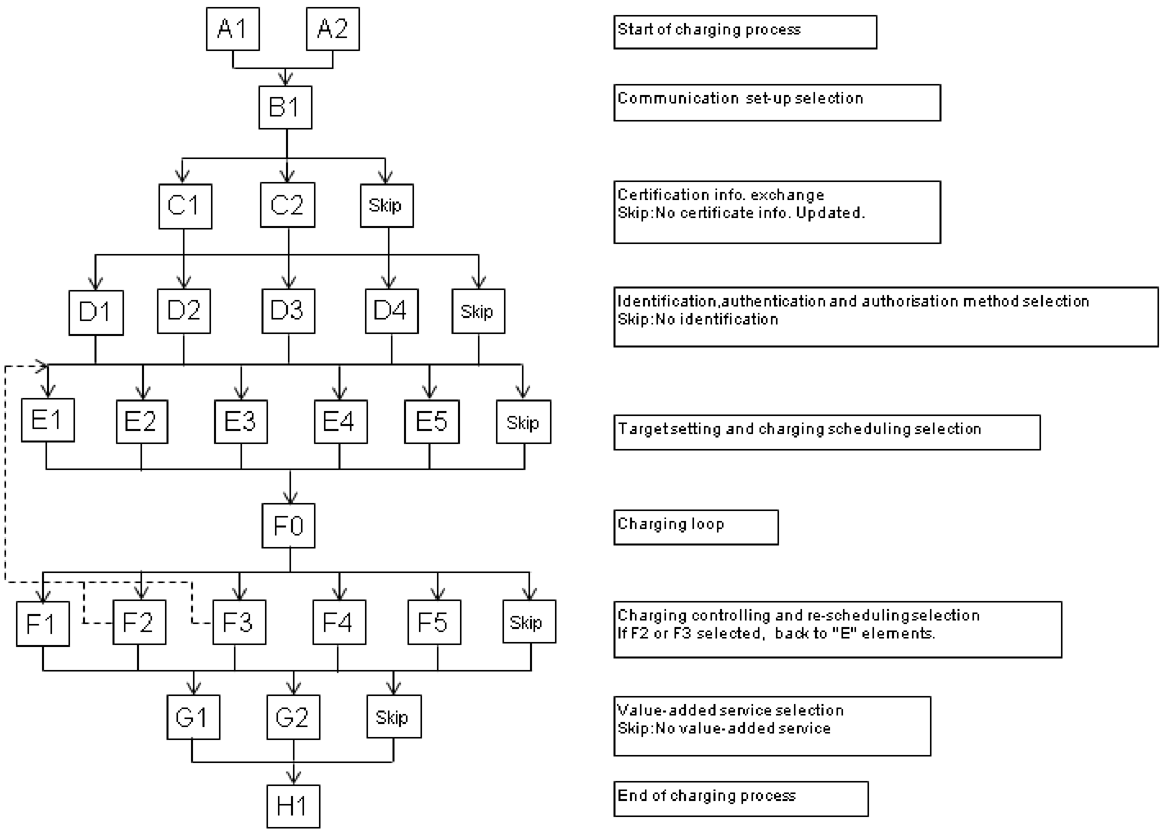


Figure D.1 — Graphical overview of fleet operation/ car park

The use case of fleet operation might be one of the first use cases in the initial phase of electric mobility. Knowing that there might be highly varied realisations of such, this use case describes several possibilities to supply a fleet operation sufficiently.

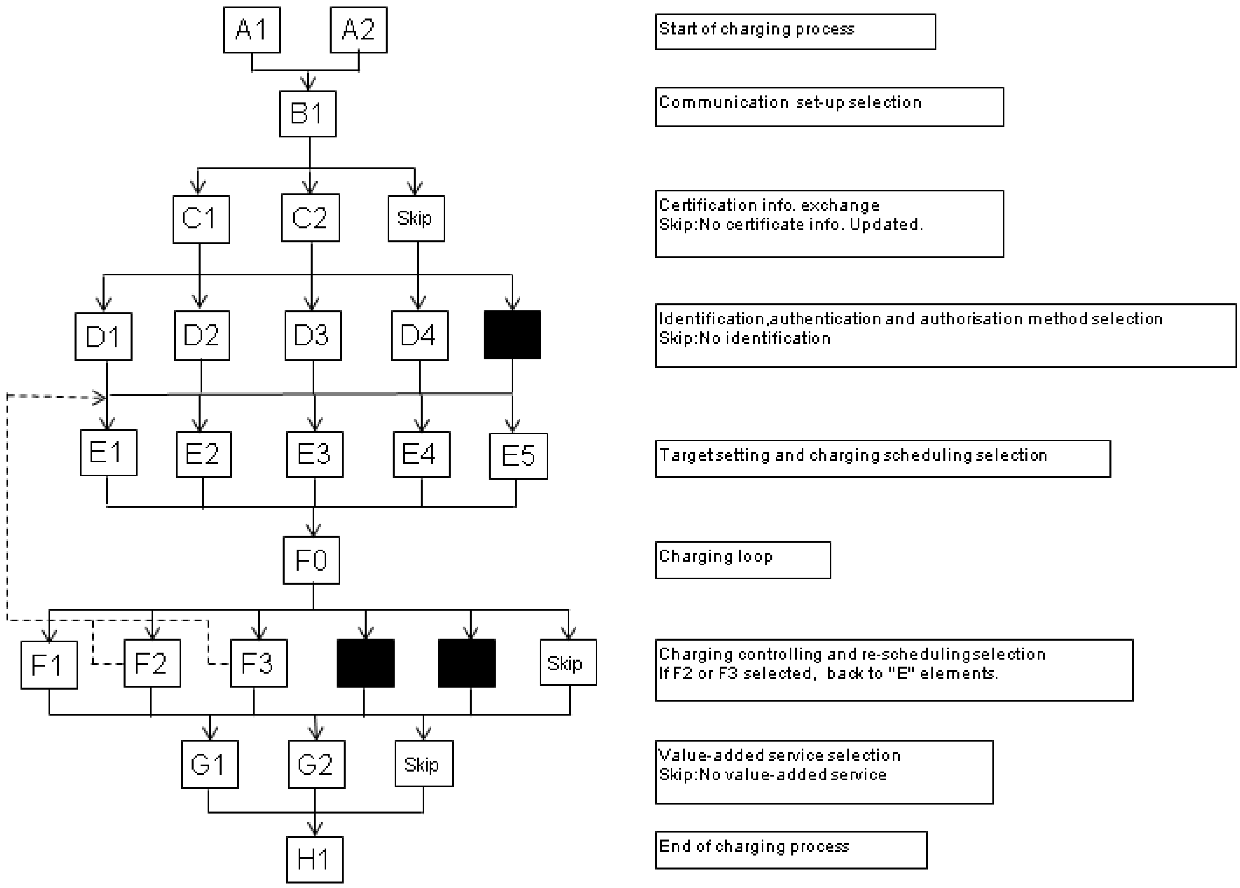
Generally speaking, fleet operation will involve a number of vehicles with limits known by the local energy controller.

NOTE For car park situations a very similar scenario applies. Therefore the following sequence is written for a fleet operator but could easily be exchanged to a car park operator.

Succession of use case elements:

- Start of the charging process with optional either required ISO/IEC 15118 (A1) or concurrent IEC 61851-1 and ISO/IEC 15118 (A2)
- (B1) Association and binding is required
- If certificates are used for the authentication process (D1, D2) the certificate elements (C1, C2) should be supported as well for smooth operation.
- One of the identification, authentication and authorisation use case elements (D1-D4) might be chosen. If no identification is necessary, this sequence shall be skipped. If the customer is billed for the usage of the energy the according element (F1) needs to be supported in addition to the basic charging loop element (F0)
- Depending on the chosen way of load levelling (local installation / respecting grid conditions) use case elements (E1; local) or (E2; grid conditions) apply. Derived from this decision the interrupt conditions (F2) and (F3) need to be integrated
- If the fleet operator wants to meter the energy consumption of each car and get some additional information about the charging he needs to include (F1)+(G2)
- NOTE F4 and F5 Use Cases may apply in the case of a fleet operator. Whether this is applicable to car park situations (especially F5), is not clear. In case of fleet operation the value-added service element (G1) could be used to download actual car routes directly into the vehicle from the management system of the fleet operator
- Finally, the ending of the charging process should be done by using (H1)

D.3 Public charging at kerb side



NOTE All blacked out items do not seem to be applicable within this scenario.

Figure D.2 — Graphical overview of public charging at kerb side

The scenario description is as follows:

— Start of the charging process with optional either required ISO/IEC 15118 (A1) or concurrent IEC 61851-1 and ISO/IEC 15118 (A2)

— (B1) Association and binding is required

— If certificates are used for the authentication process (D1, D2) the certificate elements (C1, C2) should be supported as well for smooth operation.

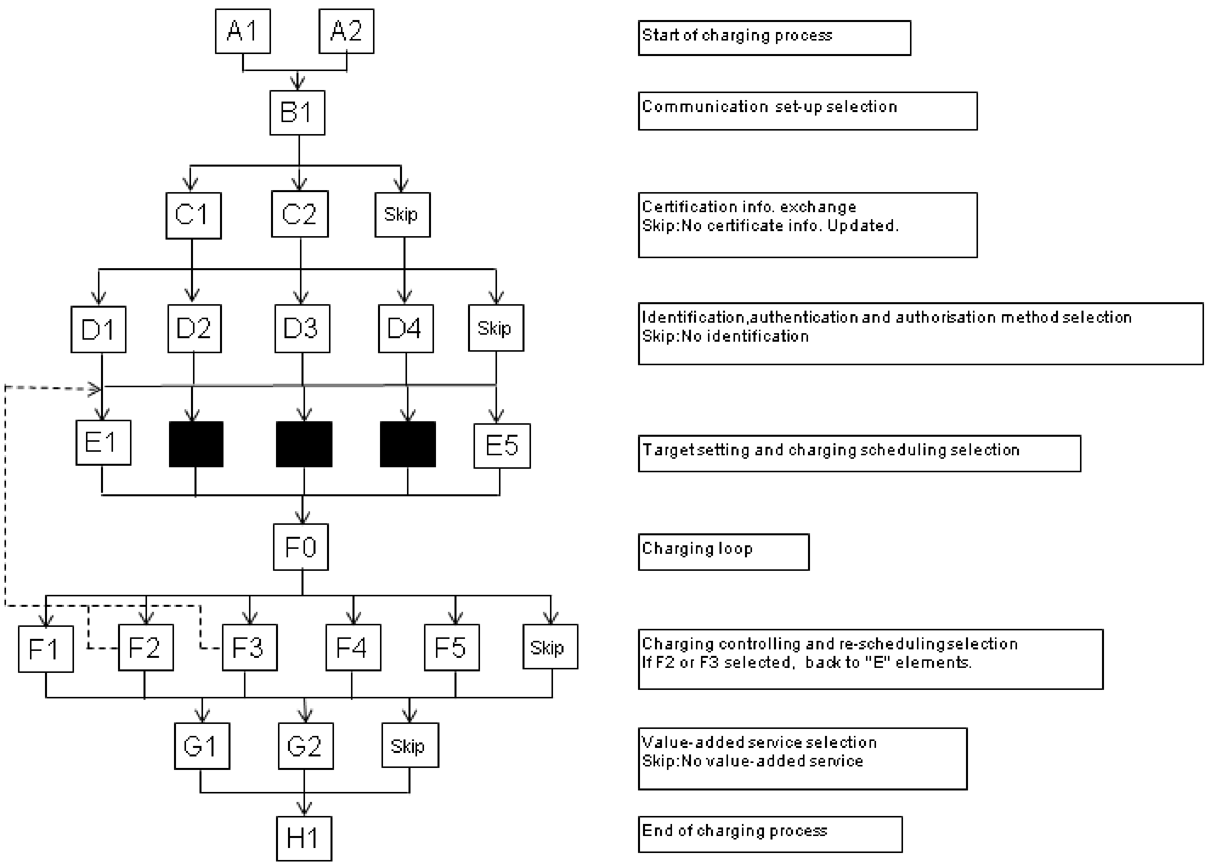
— One of the identification, authentication and authorisation use case elements (D1-D4) shall be chosen. If the customer is billed for the usage of the energy the according element (F1) needs to be supported in addition to the basic charging loop element (F0)

— Depending on the chosen way of load levelling (local installation / respecting grid conditions) use case elements (E1; local) or (E2; grid conditions) apply. Derived from this decision the interrupt conditions (F2) and (F3) need to be integrated

— If enabled, broadband services (G1) might be integrated

— Finally, the ending of the charging process should be done by using (H1)

D.4 Private charging



NOTE All blacked out items do not seem to be applicable within this scenario.

Figure D.3 — Graphical overview of private charging

The scenario description is as follows:

— Start of the charging process with optional either required ISO/IEC 15118 (A1) or concurrent IEC 61851-1 and ISO/IEC 15118 (A2)

— (B1) Association and binding is required

— If certificates are used for the authentication process (D1, D2) the certificate elements (C1, C2) should be supported as well for smooth operation.

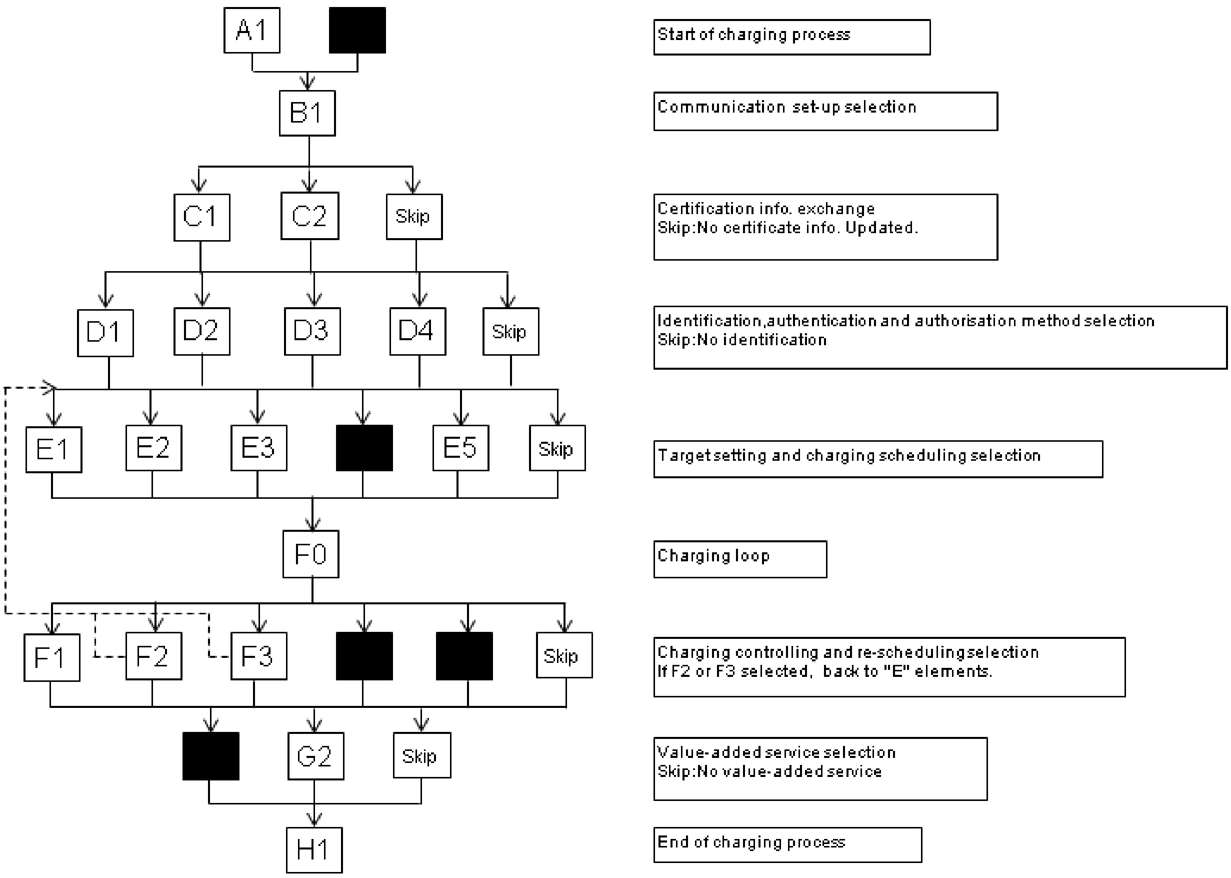
— One of the identification, authentication and authorisation use case elements (D1-D4) might be chosen, in case the charging station is shared with others. If no identification is necessary, this sequence shall be skipped. If the customer is billed for the usage of the energy the according element (F1) needs to be supported in addition to the basic charging loop element (F0)

— (E1) charging with simple load levelling at EVSE side may be chosen to limit connectivity costs or such function is enhanced to the user’s smart grid controller. Derived from this decision the interrupt conditions (F2) and (F3) need to be integrated

— NOTE The use case elements E2-E4 are not needed to fulfil the objective of this scenario, however there might be some cases in where they could apply (e.g. in regulatory framework).

- If a separate meter for the station is installed, the functions (F1)+(G2) are required to perform a valid billing. In the case of an “external” meter in the installation (G2) could be introduced to increase the convenience level of the customer
- The elements for reactive power compensation (F4) and vehicle to grid support (F5) may apply in the private charging scenario, depending on the capabilities of the installation (and each V2G entity)
- If enabled, broadband services (G1) might be integrated
- Finally, the ending of the charging process should be done by using (H1) that does not need data termination

D.5 Mobility application using a specific fleet and information transmitted between EV and EVSE



NOTE All blacked out items do not seem to be applicable within this scenario.

Figure D.4 — Graphical overview of mobility application using a specific fleet and information transmitted between EV and EVSE

Mobility applications may generally be composed of a relatively homogeneous fleet of vehicles. This example is constructed for a fleet of identical vehicles with payment of the complete service. Fleets probably have independent GPRS / GPS data transfer to communicate with a central management. The client identifies himself by any contract relevant information, e.g. Contract ID, EIM or similar. The logic of mobility applications are the inverse of charging by a vehicle owner. In a case where the identification is done by external means (e.g. EIM) the vehicle client will identify himself when he takes the vehicle and so stops the charging. He will end his rental when he returns the vehicle. If the customer needs to pay for km or for energy, or both, it is up to the operator.

When the vehicle is returned

- Start of the charging process with required ISO/IEC 15118 (A1)
- (B1) Association and binding is required
- If certificates are used for the authentication process (D1, D2) the certificate elements (C1, C2) should be supported as well for smooth operation.

- One of the identification, authentication and authorisation use case elements (D1-D4) might be chosen. If there is no identification necessary, this sequence shall be skipped. If the customer is billed for the usage of the energy the according element (F1) needs to be supported in addition to the basic charging loop element (F0)
- Depending on the chosen way of load levelling (local installation / respecting grid conditions) use case elements (E1; local) or (E2; grid conditions) apply. Derived from this decision the interrupt conditions (F2) and (F3) need to be integrated
- To meter the energy consumption of each car and get some additional information about the charging the use case elements (F1) and (G2) are required
- The elements for reactive power compensation (F4) might apply
- If enabled, broadband services (G1) might be integrated
- (G2) is required to do a mapping between the used identification method and the consumption if an energy-based billing is chosen. If not, (G2) shall be skipped.

When the vehicle is taken out for hire

- Client identification at the payment post, or by EIM key opening beside the ‘normal’ possibility of accessing the car with the ignition key (which then might cause an end of charging process)
- Data transfer between vehicle and charge post. If the G1 use case element is used for this communication it might be necessary to re-establish the communication according to the B1 element
- Ending of the charging process should be done by using (H1) that does not need data termination
- Unplugging releases the vehicle for driving

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