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Road vehicles — Vehicle to grid communication interface —

Part 1:
General information and use-case definition

Véhicules routiers — Interface de communication entre véhicule et réseau électrique —

Partie 1: Informations générales et définition de cas d'utilisation

Reference number
ISO 15118-1:2013(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 15118-1 was developed in cooperation with IEC TC 69, *Electric road vehicles and electric industrial trucks*.

ISO 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: Network and application protocol requirements*

— *Part 3: Physical and data link layer requirements*

The following parts are under preparation:

— *Part 4: Network and application protocol conformance test*

— *Part 5: Physical layer and data link layer conformance test*

This corrected version of ISO 15118-1:2013 incorporates the following correction:

— The ISO/IEC double logo was added to the cover page.

Introduction

The pending energy crisis and the necessity to reduce greenhouse gas emissions have 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 CO_2 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 standardization 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 optimization 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 stabilization 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 15118 specifies the communication between Electric Vehicles (EV), including Battery Electric Vehicles and Plug-In Hybrid Electric Vehicles, and the Electric Vehicle Supply Equipment (EVSE). As the communication parts of this generic equipment are the Electric Vehicle Communication Controller (EVCC) and the Supply Equipment Communication Controller (SECC), ISO 15118 describes the communication between these components. Although ISO 15118 is oriented to the charging of electric road vehicles, it is open for other vehicles as well.

This part of ISO 15118 specifies terms and definitions, general requirements and use cases as the basis for the other parts of ISO 15118. It provides a general overview and a common understanding of aspects influencing the charge process, payment and load levelling.

ISO 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 message elements 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) (compare ECE/TRANS/WP.29/78 ev.2). This does not prevent vehicles in other categories from adopting ISO 15118 as well.

NOTE 2 This part of ISO 15118 is destined to orientate the message set of ISO 15118-2. The absence of any particular use case in this part of ISO 15118 does not imply that it shall not put into practice, with the required messages.

NOTE 3 This part of ISO 15118 and ISO 15118-2 are designed to work independent of data transfer medium used. However, this series of documents are made for fitting the specified data link layers in the corresponding documents in this series.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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/TR 8713, *Electrically propelled road vehicles — Vocabulary*

ISO 15118-2, *Road vehicles — Vehicle to grid communication interface — Part 2: Network and application protocol requirements*

ISO 15118-3, *Road Vehicles — Vehicle to grid communication interface — Part 3: Physical and data link layer requirements*

3 Terms and definitions

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

3.1
actor
entity which characterizes a role played by a user or any other system that interacts with the subject

3.2
amount of energy for charging
energy required by the EV until the departure time has been reached or the battery's SOC is at 100 %

Note 1 to entry: This might include the amount of energy the EV consumes for other vehicle features than solely charging the battery.

3.3
authentication
procedure between EVCC and SECC or between USER and EVSE or SA, to prove that the provided information (see identification) is either correct, valid, or it belongs to the EVCC, the USER or the SECC

3.4
authorization
procedure for EVSE to verify if EV is allowed to be charged

3.5
basic signalling
physical signalling according to the pilot function provided by IEC 61851-1, Annex A

3.6
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

3.7
certificate
electronic document which uses a digital signature to bind a public key with an identity

Note 1 to entry: ISO 15118 describes several certificates covering different purposes (e.g. Contract Certificate including the contract ID and OEM Provisioning Certificates)

3.8
charger
power converter that performs the necessary functions for charging a battery

3.9
charging control
function that confirms the maximum charge current which is allowed to be drawn from EVSE based on charging schedule

Note 1 to entry: Actual charge current to the battery should be controlled by BMS. It is not in scope of ISO 15118.

3.10
charging scenario
combination of use case elements to fulfil a specific charging use case

3.11
charging schedule
scheme which contains the power limits for charging the EV for a specific time

Note 1 to entry: The EV should apply the negotiated limits as close as possible, to allow power balancing for the DSO

EXAMPLE The schedule is calculated based on target setting, sales tariff table and grid schedule information, respecting the corresponding current limitations, i.e. using the lowest current value.

3.12
charging session
time between the beginning (connection of the cable) and the end (disconnection of the cable) of a charging process

Note 1 to entry: During a charging session the EV may have none, one, or many periods of charging the battery, doing pre-conditioning or post-conditioning.

3.13
contactor
electrically controlled switch used for switching a power circuit

Note 1 to entry: Unlike a circuit breaker, a contactor is not intended to interrupt a short circuit current.

Note 2 to entry: As far as communication is concerned the contactor occurs as a trigger for the power supply.

3.14
contract ID
contract IDentification of the contract that is used by the SECC or secondary actor to enable charging and related services (including billing)

Note 1 to entry: 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.

3.15
credential
document attesting the permission of the EV to be charged

3.16
demand and prognosis
function that covers the collection of grid and local installation limits which applies to the actual charging process

EXAMPLE Sales tariff table containing a price, CO_2 content and percentage of renewable energy 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.

3.17
Demand Clearing House
DCH
entity for grid negotiation that provides information on the load of the grid

Note 1 to entry: The demand clearing house mediates between two clearing partners: a SECC and the part of the power grid connected to this SECC. Most likely this function will be served by a system operator.

Note 2 to entry: Demand clearing house and meter operator may exchange information with each other as well as with other actors.

EXAMPLE A DCH typically fulfils following tasks:

— 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 (including renewable energies), and predicted charging schedules submitted by EVCCs.

— Consolidate the collected grid information to a “grid profile” and offer it to SECCs/EVCCs.

— Provide charging schedule 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 schedule if the grid profile has changed.

— On the contrary, the SECC will inform the demand clearing house if the EV's charging schedule has changed.

3.18
departure time
point in time when the user intends to unplug the car and/or leave the charging location

3.19
Distribution System Operator
DSO
entity responsible for the voltage stability in the distribution grid (medium- and low-voltage power grid)

Note 1 to entry: 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 to entry: 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).

3.20
E-Mobility Operator
entity with which the customer has a contract for all services related to the EV operation

Note 1 to entry: Typically the E-Mobility Operator will include some of the other actors, like spot operator or Electricity 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 to entry: The E-Mobility Operator validates contract IDs from his customers, which were received either from the E-Mobility Operator Clearing House, other E-Mobility Operators or spot operators he is in relation with.

Note 3 to entry: The E-Mobility Operator issues contract IDs to his customers.

3.21
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.,

— providing SECC with confirmation that an E-Mobility Operator will pay for a given contract ID (authorization of valid contract),

— transferring a Service Detail Record (SDR) after each charging session to correct E-Mobility Operator and Electricity Provider of the identified contract.

Note 1 to entry: E-Mobility Operator Clearing House, E-Mobility Operator and meter operator may exchange information with each other as well as other actors.

3.22
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 1 to entry: 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

3.23
Electricity Provider
EP
body of secondary actor to provide electricity

3.24
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

3.25
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 1 to entry: Such specific functions could be e.g. controlling input and output channels, encryption, or data transfer between vehicle and SECC.

3.26
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

3.27
Electronic Control Unit
ECU
unit providing information regarding the vehicle

3.28
energy transfer type
element which allows the EV to select its desired energy transfer type in case both the EVSE and EV support multiple charging types and different plugs and sockets according to IEC 62196

3.29
EVSE ID
unique identification of the charging spot

Note 1 to entry: The SECC provides the EVSE ID. This ID includes the EVSE operator ID and the power outlet ID, issued by the EVSE operator.

3.30
EVSE operator
actor for managing and maintaining the charging spot

3.31
External Identification Means
EIM
any external means that enable the user to identify his contract or the car

EXAMPLE NFC, RFID, SMS.

3.32
Fleet Operator
FO
person or legal entity operating several EVs and who may have the contracts with the E-Mobility Operator

3.33
grid schedule
function which sets the power level at a specific time based on the local grid situation

Note 1 to entry: Parameters to calculate grid schedule are e.g. local grid demand and supply situation, actual and forecast.

3.34
High Level Communication
HLC
bi-directional digital communication using protocol and messages and physical and data link layers specified in ISO 15118 series

Note 1 to entry: High Level Communication in ISO 15118 is compliant with the term digital communication in SAE J1772/2836/2847/2931.

3.35
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 to entry: All information from a user (input) or displayed to a user (output) will be performed through an HMI.

Note 2 to entry: The HMI could be implemented as a function of the EV, EVSE, mobile phone, etc.

3.36
identification
procedure for EVCC or USER to provide its identifying information for the purpose of authorization, mostly to provide its capability for payments, such as Contract Certificate, credit card number, etc. and/or procedure for SECC to provide EVSE ID to EVCC

Note 1 to entry: For simplicity reasons, within the ISO 15118 series the term identification includes also the authentication of the provided identifying information, i.e. this information is correct, or it belongs to the EVCC, the USER or the SECC.

3.37
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 1 to entry: This function may be implemented in EV or EVSE.

3.38
Meter Operator
MO
body having the legal responsibility for the installation and maintenance of the Electric Energy Meter (EEM)

3.39
Original Equipment Manufacturer
OEM
producer who manufactures products or components that are purchased by a company and retailed under that purchasing company's brand name

Note 1 to entry: OEM refers to the company that originally manufactured the product.

Note 2 to entry: When referring to automotive parts, OEM designates a replacement part made by the manufacturer of the original part.

3.40
paying unit
PU
device on EVSE side that offers payment methods

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

Note 1 to entry: If the EVCC normally chooses a payment method, then the paying unit indicates to the SECC whether the customer is authorized or not.

3.41
pilot function
any means, electronic or mechanical, that ensures the conditions related to the safety or the transmission of data required for the mode of operation, compliant with IEC 61851-1

3.42
Plug and Charge
PnC
identification mode where the customer just has to plug their vehicle into the EVSE and all aspects of charging are automatically taken care of with no further intervention from the driver

Note 1 to entry: The aspects of charging may include load control, authorization and billing.

3.43
power outlet
socket outlet or, in the case of a fixed cable, connector, that provides power to the EV, typically to be installed with the fixed wiring

3.44
power outlet ID
unique identification of the power outlet to the vehicle

3.45
primary actor
entity involved directly in the charging process

3.46
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

3.47
sales tariff table
function of price related information over time

— Sales tariff table provides input for calculating a charging schedule.

— Sales tariff table shall be issued by a secondary actor, e.g. Electricity Provider or mobility operator.

— Sales tariff table should reflect “supply and demand balance of the Electricity 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 Electricity 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.

3.48
secondary actor
entity involved indirectly in the charging process

Note 1 to entry: Secondary actors may exchange information between each other.

Note 2 to entry: Secondary actors could also be a single entity.

3.49
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)

3.50
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 1 to entry: 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.

3.51
service provider
secondary actor which offers value-added services to customers throughout the EVSE operator

Note 1 to entry: Contract ID may be used for activation.

3.52
Supply Equipment Communication Controller
SECC
entity which implements the communication to one or multiple EVCCs according to ISO 15118-2 and which may be able to interact with secondary actors

Note 1 to entry: Further details regarding possible architectures are given in Annex A.

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

3.53
target setting
function which covers the following user demand-related information:

— departure time;

— amount of energy required for charging or available for discharging;

— charging schedule;

— energy transfer type

3.54
trigger
event that will start or be a condition in the use case

3.55
use case
description of a system's behaviour as it responds to a request that originates from outside that system

Note 1 to entry: 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.

Note 2 to entry: The term charging scenario is used simultaneously to the term use case within this document.

3.56
Value-Added Services
VAS
elements not directly needed for the pure charging of the EV

3.57
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

3.58
Vehicle to Grid
V2G
plug-in electric vehicle interaction with the electric grid, including charging as well as discharging and bi-directional communication interface

Note 1 to entry: The first part of this definition is excerpted from the scope of the V2G Domain Expert Working Group, SGIP, NIST.

3.59
vehicle user
person or legal entity using the vehicle and providing information about driving needs and consequently influencing charging patterns

Note 1 to entry: 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

HLC High Level Communication

HMI Human Machine Interface

LAN Local Area Network

MO Meter Operator

OEM Original Equipment Manufacturer

PLC Power Line Communication

PnC Plug and Charge

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 15118-1 form the basic framework for all use cases descriptions and related documents in the ISO 15118 series. Communication in the context of this standard could be differentiated into two concepts called 'basic signalling' and High Level Communication. ISO 15118-1 and ISO 15118-2 specify High Level Communication. High Level Communication shall be used to enable features like identification, payment, load levelling and value-added services. The relations between these two concepts are specified in ISO 15118-2 and ISO 15118-3. In the context of 'Basic signalling' items such as vehicle states, control pilot handling for safety and initialization of the charging process are defined (see also subclause 3.25).

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 subclause 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 does not have any High Level Communication means;
  - — EV supports High Level Communication;
  - — EV requires High Level Communication.

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

5.2 General considerations

The following general requirements build the basis for defining the use cases elements described in clause 7:

- — The mechanisms defined in ISO 15118-3 shall be used for associating each EVCC to its corresponding SECC.
- — Some data communication between EV and the secondary actor is confidential. Appropriate cryptography has to be applied to protect the data exchanged between the EV and the secondary actor.
- — Communication data shall be protected against 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.

The billing principles, e.g. per hour, are defined by the E-Mobility Operator and will be included in the contractual agreement between Operator and customer.

NOTE 1 ISO 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 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 15118-2);

If there is a negotiation process for the charging schedule e.g. because of the load levelling needs of the electrical grid, the protocol shall implement methods to indicate whether the target setting values could be fulfilled or not.

In the event that the requested charging schedule can't be fulfilled, a re-negotiation of the charging schedule 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 schedule.

Any error should be detected and controlled either by the EVSE or the EV. Error handling is performed according to ISO 15118 and IEC 61851-1.

5.3.2 Protection of privacy

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

Private information shall be transferred only when necessary.

5.4 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 and electrical wiring) have higher priority than the requested charging schedule.

To store certificates or other user-/customer-specific information related to the charging process in the EV, the following requirements shall be fulfilled (for additional information see Annex B):

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) 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.

   — 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.

   — Installing of an OEM provisioning certificate at production time is possible.

   — EVs may be used for more than 20 years.

   — Maintenance of an EV at independent workshops should be possible.

5.5 Utility-specific requirements

5.5.1 Power limiting for grid control or local energy control

The SECC shall inform the EVCC of the maximum available power level to optimize 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 in case the charging spot does not support High Level Communication (see Table 2 for details).

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

5.5.2 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.

The SECC shall indicate to the EVCC the maximum nominal current that can be supplied to the EV. The current indication shall correspond to the current that can be supplied without overloading the local installation.

If the EV permanently exceeds the limits indicated by the EVSE during the charging process, the EVSE shall interrupt the charging process using predefined routines of ISO 15118-2 and, in case of an emergency, basic signalling routines.

5.5.3 Authorization of charging services

The EVSE identifies itself to the EV and performs authorization to check if the EV is allowed to be charged. Typically, EVSE allows charging if EV or USER provides the mechanism for payment. For this purpose, EVCC may present Contract Certificate, or USER present some credit card/debit card, or deposit some cash at EVSE.

In case of authorization using Contract Certificate, 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 USER presenting payment relevant information at the EVSE such an exchange of information is not applicable.

EXAMPLES Parking information (to integrate charge into parking fees), EIM, debit/credit card, cash, mobile payment.

5.5.4 Retrofitting

In order to allow the upgrading of existing charging stations (EVSEs) by adding a component, the High Level Communication systems shall be defined in a way that an upgrade of existing infrastructure in compliance with ISO 15118 is possible.

Furthermore, in case the new component does not fully integrate the existing components in the EVSE (separated Control Pilot / SECC architecture), the newly installed SECC shall know and process the physical limits of the EVSE as well.

6 Actors

6.1 General

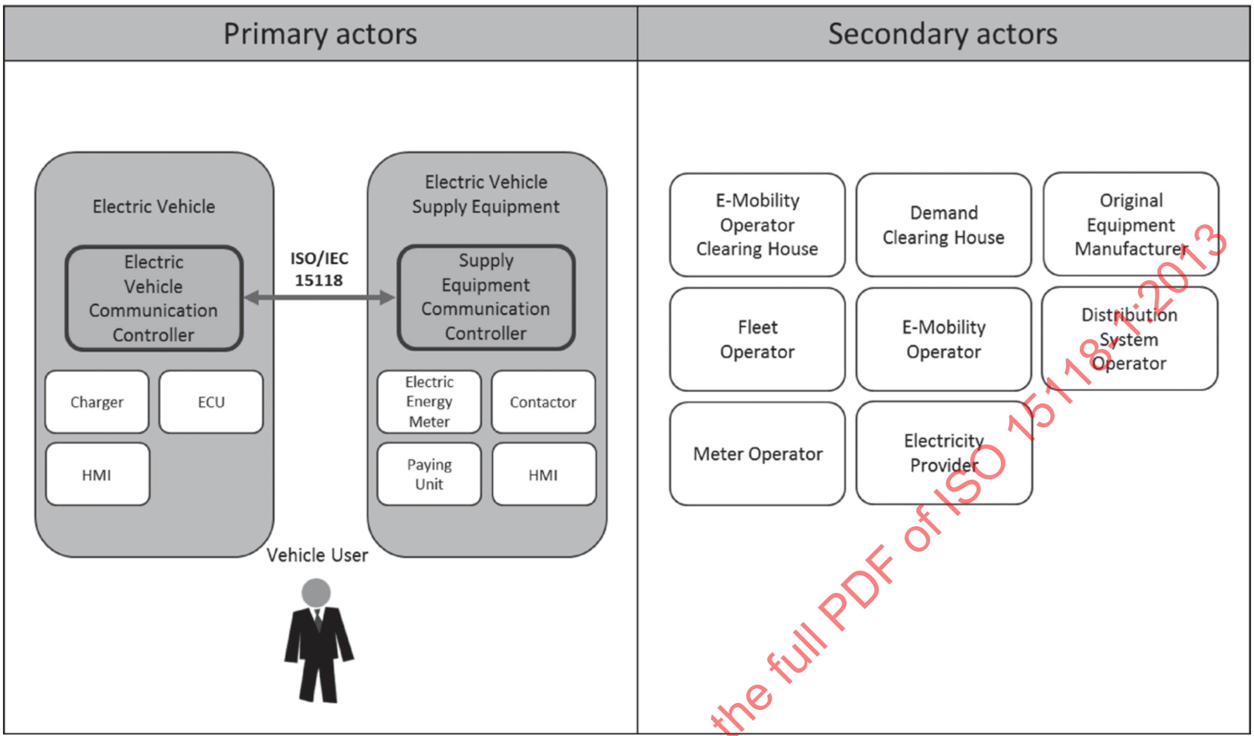


Figure 1 — Overview with examples of participating actors in the overall scenario

Figure 1 shows all primary and secondary actors as well as their trigger functions that may be involved directly or indirectly in the charging procedure of ISO 15118. The use case element descriptions in clause 7 will incorporate, where applicable, those actors and functions.

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.

The vehicle user (USER) plays an important role in the full context of charging EVs using the charging infrastructure. For implementing EVSE's it is crucial to understand this role and the interactions between the charging system and the vehicle USER. However, this standard is not intended to establish requirements relative to USER behaviour. Whenever the term 'USER' is used in this standard as the subject of a requirement this is rather meant to provide guidance for the implementer of the standard how a USER can behave and how a user should be guided by any means than defining the exact behaviour of the USER.

Although this standard does not specify the protocol between the primary actors and a secondary actor, there are messages defined in ISO 15118-2, which include elements to exchange data between these 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 described in ISO 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. Electricity Provider or Distribution System Operator.

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

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 15118-2 and ISO 15118-3. 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 2). For each functional group, several elementary use cases are possible. Each use case should be a combination of elementary use cases (see Annex C).

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 on-going 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 and Authorization: methods for identification 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 needed for pure charging of electric vehicles;

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

Variations of use case implementations exist, depending on the EVSE, the EV or the business case used for the charging process. Figure 2 provides an overview of all use case elements grouped by function. Examples are listed in Annex C

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

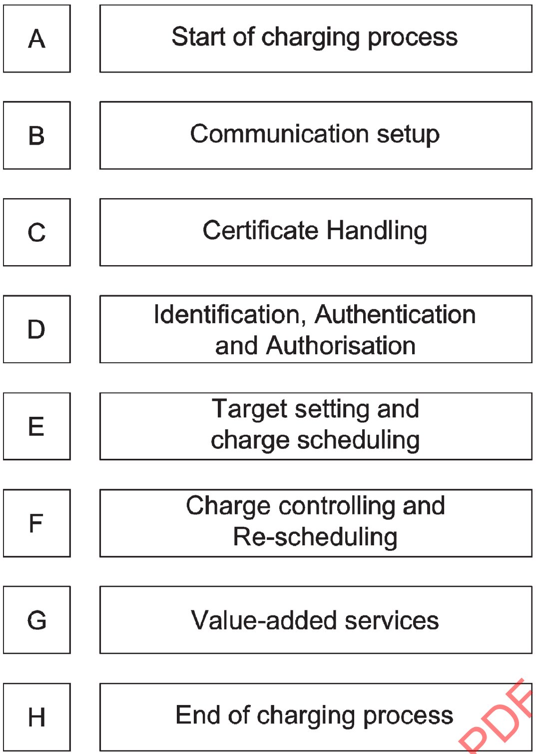


Figure 2 — Use case elements function groups

Table 1 — Overview of elements of use cases

No.	Use case element name / grouping
A1	Begin of charging process with forced High Level Communication
A2	Begin of charging process with concurrent IEC 61851-1 and High Level Communication
B1	EVCC/SECC communication setup
C1	Certificate update
C2	Certificate installation
D1	Authorization using Contract Certificates performed at the EVSE
D2	Authorization using Contract Certificates performed with help of SA
D3	Authorization at EVSE using external credentials performed at the EVSE
D4	Authorization at EVSE using external credentials performed with help of SA
E1	AC charging with load levelling based on High Level Communication
E2	Optimized charging with scheduling to secondary actor
E3	Optimized charging with scheduling at EV
E4	DC charging with load levelling based on High Level Communication
E5	Resume to Authorized Charge 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

Table 1 *(continued)*

No.	Use case element name / grouping
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;

— 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 2 — Combinations of EV and EVSE communication capabilities

	EV ISO 15118 **not implemented**	**EV** ISO 15118 **implemented, not required**	**EV** ISO 15118 **implemented and required**
EVSE ISO 15118 **not implemented**	Charging according basic signalling – not inside the scope of ISO 15118.	Failure end condition of use case element A1/A2 on EV side. No establishment of HLC. Charging according basic signalling – not inside the scope of ISO 15118.	Charging is not possible
EVSE ISO 15118 **implemented, not required**	Failure end condition of use case element A1/A2 on EVSE side. No establishment of HLC. Charging according basic signalling – not inside the scope of ISO 15118.	See use case element A1/A2	See use case element A1
EVSE ISO 15118 **implemented and required**	Failure end condition of use case element A1 on EVSE side. Charging is not possible.	See use case element A1	See use case element A1

Not Implemented = Functionality is not available

Implemented, not required = Functionality is available; usage applies, if counterpart has functionality implemented as well.

Implemented, required = Functionality is available, usage enforced. If functionality is not available at counterpart charging is not possible.

NOTE Sequence diagrams about message flow and interaction are described in ISO 15118-2. A timing diagram about the interconnection between IEC 61851-1 and ISO 15118 is described in ISO 15118-3.

7.2.1 Start of charging process with forced High Level Communication

Table 3 — Start of charging process with forced High Level Communication

No.	Type	Description
1	Use case element name	Start AC/DC of charging process with forced High Level Communication (ISO 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 require High Level Communication and mode 3/ mode 4 charging. 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 15118-3) — Communication setup (use case function group 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 15118-2 and ISO 15118-3
6	Requirements	— Successful set-up of High Level Communication at the data link layer — Timing for the initialization process shall be according to ISO 15118-3 — Triggers: — for EVSE: EV is connected properly to the EVSE — for EV: Plug present and PWM duty cycle indicating High Level Communication required according to IEC 61851-1
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 or failure of PWM signal — No correct association of SECC and EVCC or timeout in the binding process occurs.

7.2.2 Start of charging process with concurrent IEC 61851-1 and High Level Communication

Table 4 — Start of charging process with concurrent IEC 61851-1 and High Level Communication

No.	Type	Description
1	Use case element name	Start of AC 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 basic signalling (IEC 61851–1) from the EVSE and high-level communication working concurrently and mode 3 charging. NOTE Charging spot operator may offer a fall-back solution if High Level Communication fails by enabling charging according to IEC 61851–1 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 15118-3) — Communication set-up (use case function group 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 15118-2 and ISO 15118-3
6	Requirements	— Successful set up of High Level Communication at the data link layer — Timing for the initialization process shall be according to ISO 15118-3 — Triggers: — For EVSE: EV is connected properly to the EVSE — For EV: Plug present shall be according IEC 61851-1
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 — No correct association of SECC and EVCC or timeout in the binding process occurs.

7.3 Communication set-up [B]

7.3.1 EVCC/SECC communication set-up

Table 5 — 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 15118-2. The timing of this binding shall be in line with the requirements given by ISO 15118-2 EVCC and SECC shall exchange information about the supported ISO 15118-2 protocol versions and use the latest common protocol version.
7	End conditions	<u>Success end conditions:</u> — 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 15118-2 protocol version. <u>Failure end conditions:</u> — Negotiation of the ISO 15118-2 protocol version failed.

7.4 Certificate handling [C]

7.4.1 Certificate update

Table 6 — Certificate update

No.	Type	Description
1	Use case element name	Certificate update
2	Use case element ID	C1
3	Objectives	Replace the valid or expired certificate in the EV with a new and valid certificate from the secondary actor.

Table 6 *(continued)*

No.	Type	Description
4	Description	This use case covers the update of a valid 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 Whether an expired certificate is subject to be updated depends on the business decision of SA NOTE 3 If there is no permission from the SA to update the certificate, 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. Trigger: — EVCC / SECC detects that the certificate of the EV has — Limited remaining lifetime.
7	End conditions	Success end conditions: — 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 7 — 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 (OEM Provisioning 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 OEM Provisioning Certificate (or its ID) to — the clearing house / all known clearing houses. — 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 (OEM Provisioning 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 OEM Provisioning 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.

Table 7 *(continued)*

No.	Type	Description
6	Requirements	SECC supports certificate installation process. SECC shall enable a communication link to the secondary actor or provide the Contract Certificate being installed as local copy. Trigger: EVCC detects resp. SECC signals that the certificate of the EV either — 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 C1).
7	End conditions	<u>Success end conditions:</u> — 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. <u>Failure end conditions:</u> — 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 and Authorization [D]

7.5.1 Overview

The EVSE identifies itself to the EV and performs authorization to check if the EV is allowed to be charged. Typically, the EVSE allows charging if an EV or USER provides the mechanism for payment. For this purpose, EVCC may present Contract Certificate, or USER present some credit card/debit card, or deposit some cash at EVSE.

Depending on the EVSE infrastructure and the capabilities of the EV, the methods of authorizing a user differ. Figure 3 classifies the possible scenarios, in general there are two major groups: Plug and Charge (PnC) where Contract Certificates are used and external identification (EIM) where identification/authorization is performed without using Contract Certificates. Although ISO 15118 does not specify requirements for the implementation of external identification methods (EIM – D3 and D4)) the message sets defined in ISO 15118-2 support both identification types. In case of EIM, ISO 15118-3 outlines the necessary synchronisation requirements between High Level Communication and Basic Signalling.

Figure 3 may be taken as the graphical overview of the possible identification/authorization means and their location.

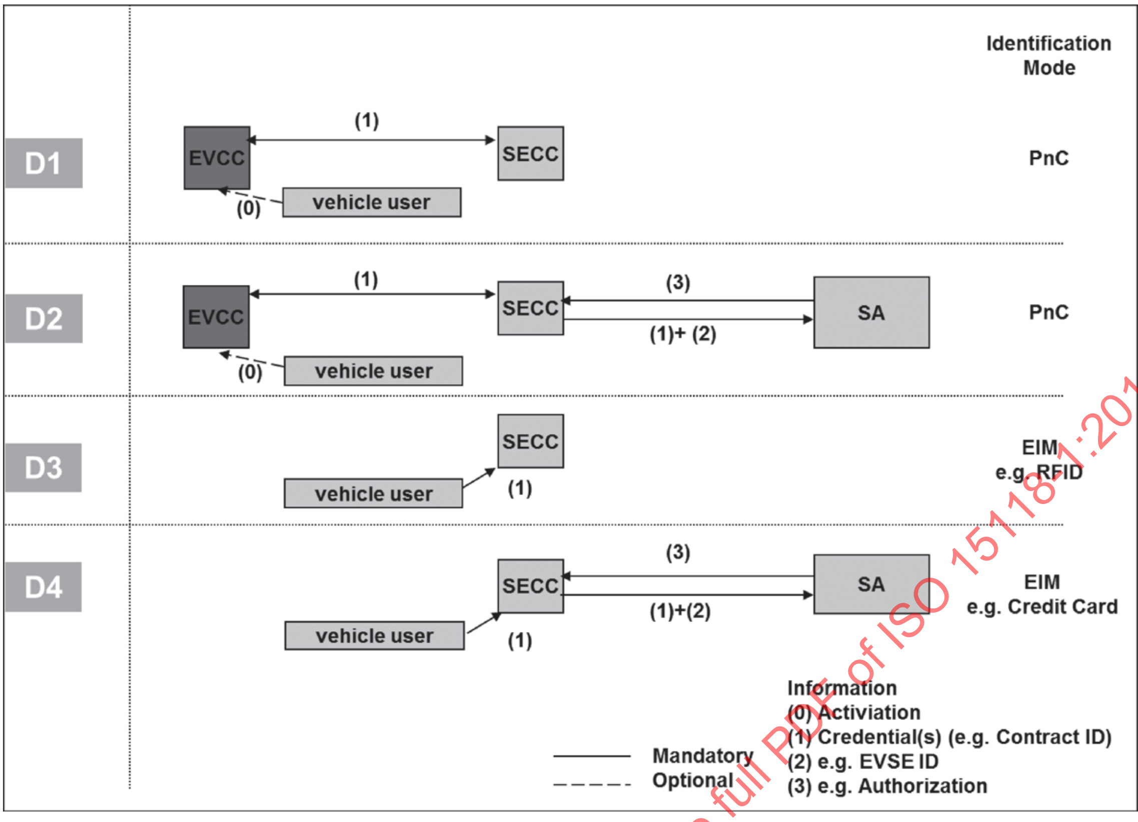


Figure 3 — Graphical overview of scenarios for identification

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

No authorization for the charging process is required if the authorization 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.

7.5.2 Authorization using Contract Certificates performed at the EVSE

Table 8 — Authorization using Contract Certificates performed at the EVSE

No.	Type	Description
1	Use case element name	Authorization using Contract Certificates performed at the EVSE
2	Use case element ID	D1
3	Objectives	Verify the validity of the contract by using the 15118-2 message set at the EVSE
4	Description	This use case covers the authorization process using contract certificate at the EVSE. The identification should be made with an ID(Contract Certificate) as stipulated in ISO 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 (contract ID and EVSE 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 verification of the IDs
5	Prerequisites	— Communication set-up according to use case element B1 shall be established successfully All required information for authorization shall be stored in the SECC in case the SECC does not establish online connections synchronously to the charging event.
6	Requirements	— If the authorization is not automatically launched, the USER has to activate the authorization through the HMI (in the car) within a specific time after connecting the EV to the EVSE. — SECC shall exchange its IDs (EVSE ID) to the EVCC — EVCC shall exchange its IDs (contract ID) to the SECC — Trigger: — Initialization of the authorization process from the EVCC — Reply or acceptance of the payment (ID) shall be done within a specific time. This timing is stipulated in ISO 15118-2.
7	End conditions	Success end conditions: — Authorization process is successful, a session ID is defined and the required service (charging or value added) starts. Failure end conditions: — Authorization 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, authorization server not available).

7.5.3 Authorization using Contract Certificates performed with help of SA

Table 9 — Authorization using Contract Certificates performed with help of SA

No.	Type	Description
1	Use case element name	Authorization using Contract Certificates performed with help of SA
2	Use case element ID	D2
3	Objectives	Verify the validity of the contract with a validation from a secondary actor by using the ISO 15118-2 message set.
4	Description	— This use case covers the authorization process using Contract Certificate with help of SA. The identification should be made with an ID(Contract Certificate) as stipulated in ISO 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 (contract ID and EVSE). Those are forwarded to the secondary actor for validation. — The secondary actor replies with an agreement or non-agreement — Service starts after successful authorization of the IDs
5	Prerequisites	— Communication set-up according to use case element B1 shall be established successfully — Online connection between SECC and secondary actors is required.
6	Requirements	— If the authorization is not automatically launched, the USER has to activate the authorization through the HMI (in the car) within a specific time after connecting the EV to the EVSE. — SECC shall exchange its IDs (EVSE ID) to the EVCC. — EVCC shall exchange its IDs (contract ID) to the SECC. — SECC shall forward the IDs (contract ID from the EVCC associating its own IDs (EVSE ID) to the secondary actors. — Trigger: — Initialization of the authorization process from the EVCC Reply or acceptance of the payment (ID) shall be done within a specific time. This timing is stipulated in ISO 15118-2.
7	End conditions	Success end conditions: — Authorization process is successful, a session ID is defined and the required service (charging or value added) starts. Failure end conditions: — Authorization process fails, no authorization 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, authorization server not available).

7.5.4 Authorization at EVSE using external credentials performed at the EVSE

Table 10 — Authorization at EVSE using external credentials performed at the EVSE

No.	Type	Description
1	Use case element name	Authorization at EVSE using External Credentials performed at the EVSE
2	Use case element ID	D3
3	Objectives	Authorization at EVSE with credentials, which are external to the vehicle
4	Description	USER identifies himself/herself 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 IDs and therefore might not authorize the service. The SECC may decide to forward the IDs (contract ID) associating its own IDs (EVSE 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 authorization within a specific time after connecting the EV to the EVSE or the EVSE shall have an HMI or any other method to authorize the restart of the authorization process. — USER shall, for example, use an HMI to type in the identification code or any other authorization method offered at the EVSE. — SECC shall evaluate the authorization and, if accepted, proceed with the communication flow. — Trigger: — authorization shall be made at the EVSE and activated by the USER.
7	End conditions	Success end conditions: — Authorization process is successful, a session ID is defined and the required service (charging or value-added) starts. Failure end conditions: — Authorization 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).

7.5.5 Authorization at EVSE using external credentials performed with help of SA

Table 11 — Authorization at EVSE using external credentials performed with help of SA

No.	Type	Description
1	Use case element name	Authorization at EVSE using external credentials performed with help of SA
2	Use case element ID	D4
3	Objectives	Authorization at EVSE with credentials, which are external to the vehicle, with help of a secondary actor
4	Description	This use case covers the process of how identification should be validated by a secondary actor. USER identifies himself/herself 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 IDs and therefore might not authorize the service. The actors involved are: — Primary actors: USER, EVSE, SECC, HMI. — Secondary actors: EMOCH, E-Mobility Operator. Scenario description: — SECC forwards the IDs (EVSE 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 to use case element B1 shall be established successfully — Online connection between SECC and secondary actors is required.
6	Requirements	— USER shall activate the authorization within a specific time after connecting the EV to the EVSE or the EVSE shall have an HMI to authorize the restart of the identification process. — USER shall use the identification method at EVSE (e.g. HMI). — The SECC shall send the identification to the secondary actor for validation — Trigger: — Authorization shall be made at the EVSE and activated by the USER.
7	End conditions	Success end conditions: — Authorization process is successful, a session ID is defined and the required service (charging or value-added) starts. Failure end conditions: — Authorization 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 load levelling based on High Level Communication

Table 12 — AC charging with load levelling based on High Level Communication

No.	Type	Description
1	Use case element name	AC charging with load levelling based on High Level Communication
2	Use case element ID	E1
3	Objectives	This use case covers only charging within local charging infrastructures. Dynamic 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. EXAMPLE 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 authorization 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: — Charging authorization shall be completed and EV shall be ready to retrieve energy.
7	End conditions	<u>Success end conditions:</u> — EVSE delivers AC current within the max. local installation limits. — EV charges within the given local limits of EVSE. <u>Failure end conditions:</u> — EVSE does not deliver AC power due to contactor failure.

7.6.2 Optimized charging with scheduling from the secondary actor

Table 13 — Optimized charging with scheduling from the secondary actor

No.	Type	Description
1	Use case element name	Optimized 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.

Table 13 *(continued)*

No.	Type	Description
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 behaviour 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 (e.g. power limits, local power generation), 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 schedule. 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 in order to fully charge (Wh) the battery for the user-provided departure time. — EVCC sends the required energy amount, departure time and charging capability of the 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, local power generation, 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 be 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 to 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

Table 13 *(continued)*

No.	Type	Description
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: — Authorization of charging has been completed and EV is ready to retrieve 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 14 — 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	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.

Table 14 *(continued)*

No.	Type	Description
4	Description	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 propose a charging schedule to the SECC, based on actual information about the local installation (e.g. power limits, local power generation), grid schedule and sales tariff table. It is necessary that the EVCC, SECC and secondary actor each have the possibility to trigger a re-scheduling of the charging schedule. 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 been 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.
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.

Table 14 *(continued)*

No.	Type	Description
6	Requirements	— 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: — Authorization 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.
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 15 — 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 authorization 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 be able to 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 authorized charging schedule

Table 16 — Resume to authorized charging schedule

No.	Type	Description
1	Use case name	Resume to authorized charging schedule
2	Use case element ID	E5
3	Objectives	Restart sleeping charging schedule.

Table 16 *(continued)*

No.	Type	Description
4	Description	This use case covers the resume process to once authorized and sleeping charging schedule. The actors involved are: — Primary actors: EV, EVCC, EVSE, SECC Scenario descriptions: — Optimizing 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 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 15118-3. — High Level Communication will be re-established and identification and authorization resumed securely — 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	— Optimized charging schedule is already authorized in use cases E2 or E3. — Charging schedule is paused according use case element H1. — EV and EVSE indicate sleep mode according to ISO 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 15118-3. b. If EV gets the initial wake-up trigger, it shall wake up the EVSE/SECC according to ISO 15118-3 — HLC shall be re-established and identification, authentication, authorization 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 17 — 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. From EVCC to SECC: EV status (as stipulated in ISO 15118-2). From SECC to EVCC: EVSE status (e.g. maximum current, as stipulated in ISO 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 15118-2. — SECC shall reply with no interrupt flag.
7	End conditions	Success end conditions: — Charging loop continues. Failure end conditions: — Charging loop will be stopped.

7.7.2 Charging loop with metering information exchange

Table 18 — 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 charging loop with meter readout. For reliable billing of transferred energy, the utility must be able to prove that energy was delivered to a specific EV / customer. It is therefore mandatory for an EV to confirm that energy was retrieved at a certain time and at a certain EVSE. 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 the meter record. 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 15118-2), signed meter reading. From SECC to EVCC: EVSE status (as stipulated in ISO 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 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	Success end conditions: — EVCC receives the metering information and performs plausibility check. — SECC receives the plausibility check of the metering information. — Charging loop continues. Failure end conditions: — 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 19 — Charging loop with interrupt from SECC

No.	Type	Description
1	Use case element name	Charging loop with interrupt from the SECC
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 15118-2). From SECC to EVCC: EVSE status (as stipulated in ISO 15118-2), SECC interrupt, new departure time provided by the USER. NOTE In case of a new departure time set by the USER and transmitted by the SECC, the corresponding SA needs to take care of a secured way of transmission.
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 15118-2. — Charging process interrupt flag set by SECC / secondary actor. — The EVCC shall initialize the charging set-up process again.
7	End conditions	<u>Success end conditions:</u> — Charging loop interrupt occurred and either charging set-up or end-of-charging process starts. <u>Failure end conditions:</u> — Charging loop doesn't start again.

7.7.4 Charging loop with interrupt from the EVCC or USER

Table 20 — 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 unpredictable 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 to ISO 15118-2. — SECC shall reply with an EVSE status in a specified time frame according to ISO 15118-2. — EV will continue either with charging setup process or with end of charging process. The following information needs to be exchanged between the actors: From EVCC to SECC: EV status (as stipulated in ISO 15118-2), EVCC Interrupt, new departure time. From SECC to EVCC: EVSE status (as stipulated in ISO 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 to ISO 15118-2. — SECC shall reply in a specified time frame according to ISO 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 21 — 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 requested.
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 22 — 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.

Table 22 *(continued)*

No.	Type	Description
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: DSO, DCH, 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 DSO, DCH, 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	End conditions	<u>Success end conditions:</u> — EV supplies energy back to the grid. <u>Failure end conditions:</u> — EV does not supply energy back to the grid.

7.8 Value Added Services [G]

7.8.1 Value Added Services

Table 23 — 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 IP protocols. In addition to the function of pure charging of electric vehicles, which are described in the various use case elements, additional value added services to maximize the customer convenience may arise in future applications and environments. EXAMPLE Pre-booking of a public charging spot, Spots availability along the journey, required energy for next usage Scenario description: — OEM or user requests VAS. — SECC requests service from the EVCC. — SECC routes information.
5	Prerequisites	— If required a suitable authorization method needs to be applied prior to using VAS. — 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 24 — 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: Authorization 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	Success end conditions: — USER or secondary actor receives the requested information. Failure end conditions: — USER or secondary actor does not receive the requested information.

7.9 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 and releasing the locking feature (if implemented). All or single steps of this shutdown sequence may only be necessary if the charge process is still in progress when the user initiates the end of the process.

If the system is equipped with a locking feature and it has been activated at least once during the current charging session, it shall not be deactivated before the state transition from ‘B’ to ‘A’ according to IEC 61851-1 occurs.

NOTE 1 If the physical connection between EV-EVSE is impaired by an unexpected disconnect or other error, impacting the electrical safety of the charging system, the procedures of IEC 61851–1 apply.

7.9.1 End of charging process

Table 25 — End of charging process

No.	Type	Description
1	Use case name	Ending 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 initiate ending the charge process — Usually the USER requests the end of the charging process on EV side and the EVCC will tell the SECC that the charging process will end. — For specific scenarios where the USER is indicating this on EVSE side, e.g. using authentication by alternative means the SECC will request the EVCC to end the charging process. NOTE 1 For indicating the end of a charging session the SECC would use the value Stop Charging in the EVSE Notification Type according to ISO 15118-2 — EV switches to state B according to IEC 61851-1. — EVSE opens main switches according to IEC 61851-1. — The SDR is generated on the EVSE side. This may be transferred to authorized secondary actors. — If applicable, the EVSE releases the connector on the EVSE as soon as it detects state A according to IEC 61851-1. Between the EVCC and SECC the information end charging process is exchanged. NOTE 2 The exact sequence and nature of each step depends on the preceding use cases.
5	Prerequisites	— Charge controlling and re-scheduling according use case elements F2 or F3 shall be established successfully or End of charging according conditions defined in ISO 15118-2
6	Requirements	Trigger: — Charging loop shall be completed — USER / EVSE / EV initiates end of charge 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 summarizes 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

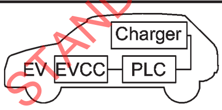
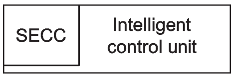
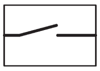
Symbol	Description
	EV with integrated application layer implementation, PLC interface and AC charger.
GW	Application layer gateway terminates application layer protocol and interfaces to other application layer protocol.
EVCC	Electric vehicle communication controller, e.g. instance which is implementing the application layer according to ISO 15118-2.
SECC	Supply equipment communication controller, e.g. instance which is implementing the application layer according to ISO 15118-2.
Secondary actor	Application layer implementation on secondary actor side, to interface with the application layer implementation of the gateway.

Table A.1 *(continued)*

Symbol	Description
	Supply equipment communication controller integrated in a detached intelligent control unit, which provides secondary actor data.
	Router separates IP subnets. If dashed lines are used it is optional.
	PLC to HAN, LAN or other physical layer converter. Bridge performs MAC addressing.
	Optional filter device to eliminate / reduce electromagnetic emissions, see ISO 15118-3 for details. This may break the PLC communication.
	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 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

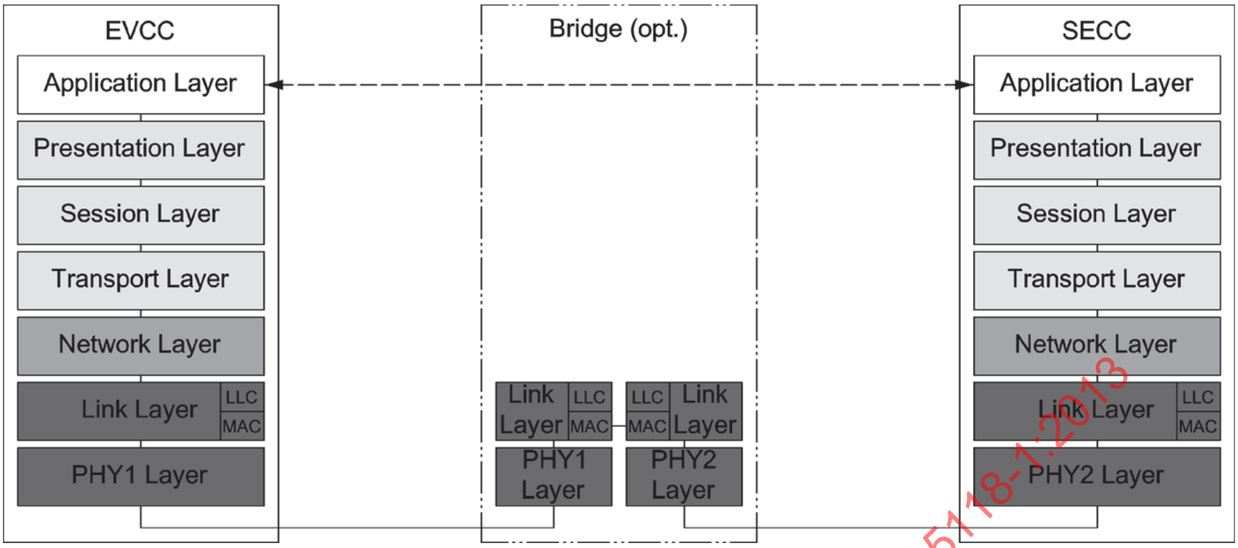
— SECC ↔ Secondary actor

NOTE Communication between EVCC and SA is out of the scope of this standard

Although the SECC to secondary actor communication is outside the ISO 15118 specification, some ISO 15118 messages require this communication, and thus the ISO 15118 specification will specify some requirements to ensure 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.

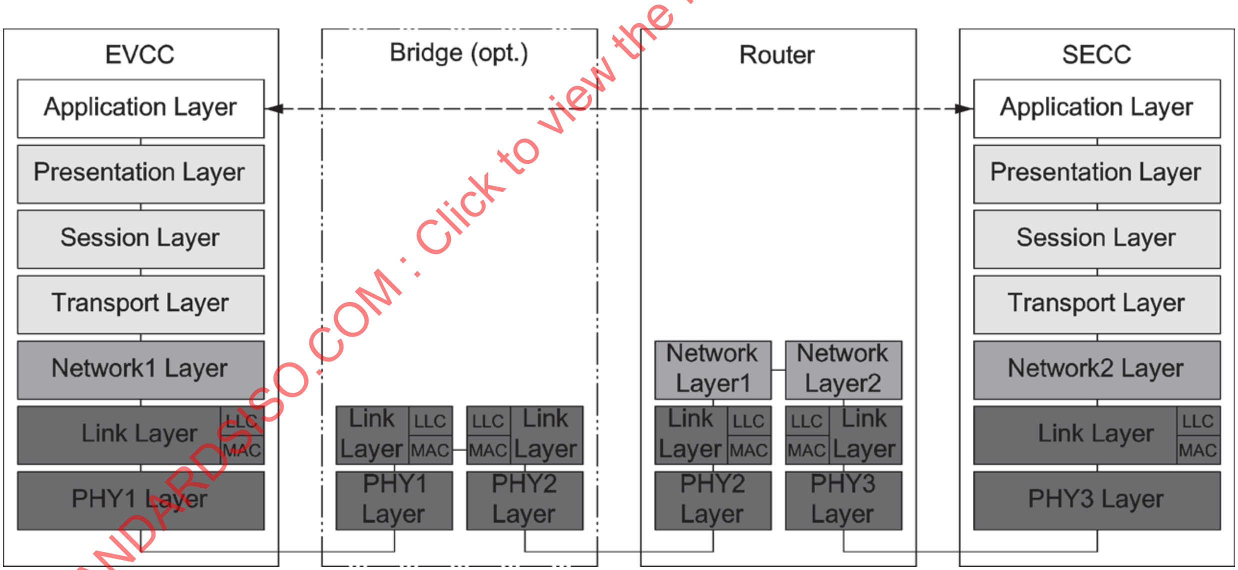
Communication between the EVCC and SECC can be divided into two set-ups, depending if the SECC is "local" (Figure A.1) to the EVCC or "remote" (Figure A.2).



Key

←– –→	End-to-end communication of application
MAC	Media Access Control
LLC	Logical Link Connection

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



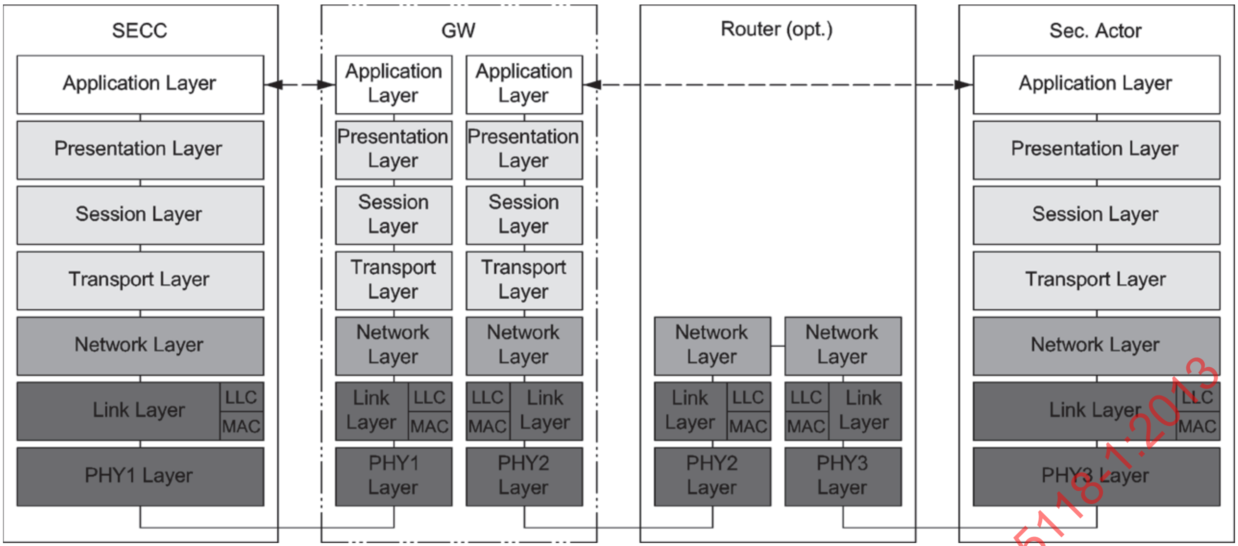
Key

←– –→	End-to-end communication of application
MAC	Media Access Control
LLC	Logical Link Connection

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.



Key

←– – –→	End-to-end communication of application
MAC	Media Access Control
LLC	Logical Link Connection

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 summarized as shown in Figure A.4.

Figure A.4 illustrates system architectures that are supported by ISO 15118-2 and ISO 15118-3.

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

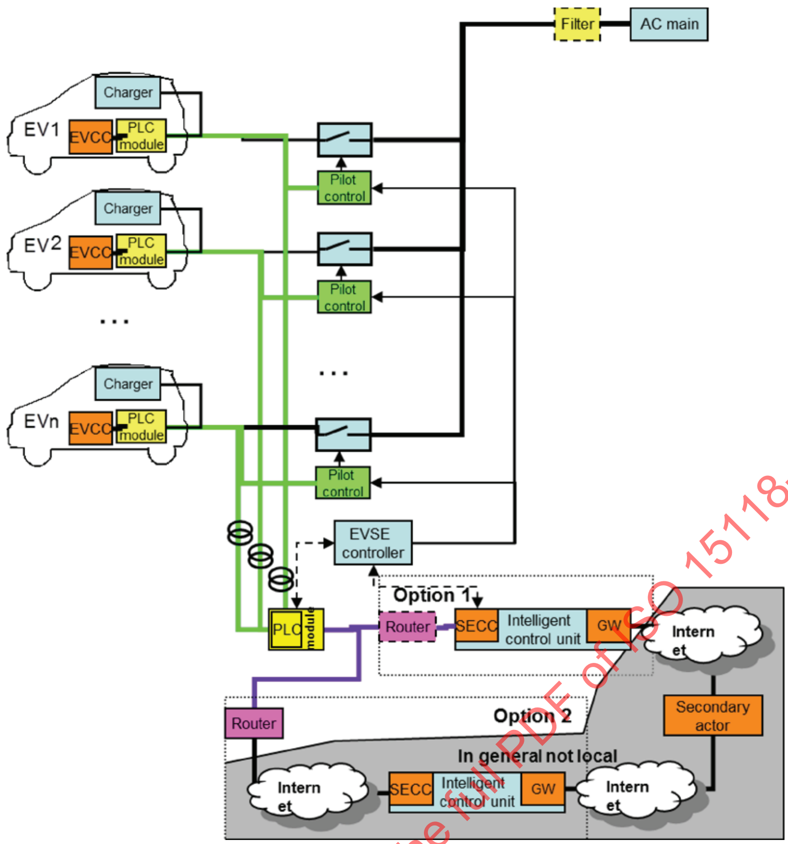


Figure A.4 — General communication architecture set-up

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 15118-3 document for detailed requirements. Depending on PLC technology, additional elements may be necessary (not shown here), see ISO 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 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.4 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.4 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.4 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, with implemented control flow between the EVSE controller and the PLC module. Details are specified in ISO 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 EVSEwith 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 15118.

— Optional EVCC IP communication to HAN through PLC module and router or SECC.

A.3 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 the charging process be finished

— How much energy is needed

— Charging preferences like fast charging, cheapest charging, least CO_2 charging, etc.

— Electricity Provider

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

— Sales tariff table containing a price, efficiency or CO_2 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.

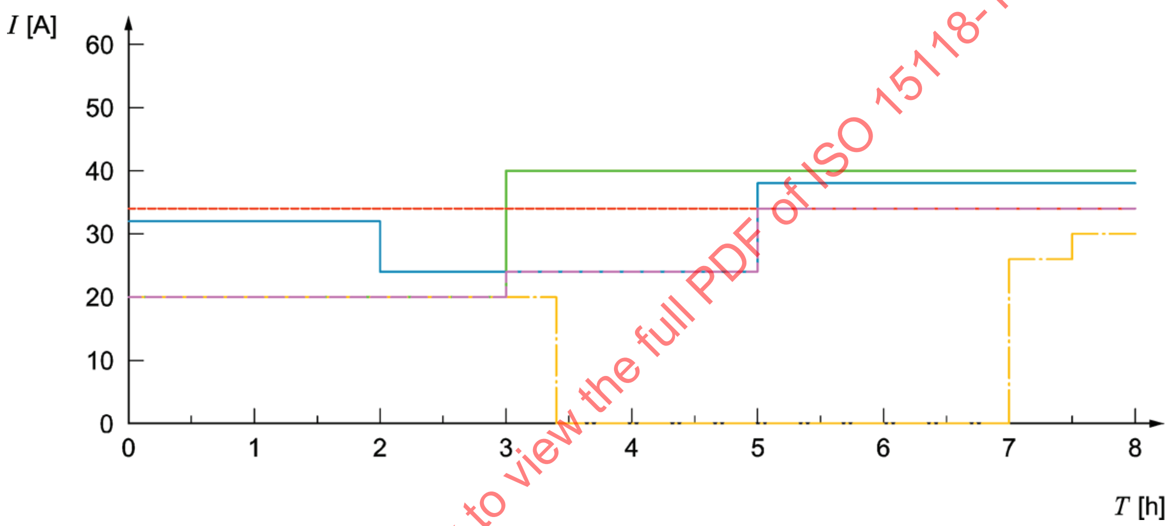
'Scheduling' covers the compilation of 'Target Setting' and 'Demand and Prognosis' information when necessary to create a charging schedule, i.e. charging current vs. time prognosis, for the current charging process.

— 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.



Key

green solid line	Contract-based current limitation provided by secondary actor to SECC/EVCC, contained in sales tariff table from SECC to EVCC
blue solid line	Grid-based current limitation available at SECC provided by secondary actor, contained in grid schedule from SECC to EVCC
red dashed line	Logical physical limit, minimum of rating of the outlet and cable
purple dashed line	Level selection minimum of sales tariff and grid current limitations done at EV or EVSE
yellow dash-dot line	Scheduled current limitation the EV follows while charging, contained in charge schedule from EVCC or SECC

Figure A.5 — Effects of scheduling on communicated current

'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.

