OCPP 1.X
RFC ISO/IEC 15118

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Version History

Version	Date	Author	Description
0.5	2016-09-15	Jonel Timbergen, Klaas van Zuuren - *ElaadNL* Stephan Cater, Christian Lewandowski *RWE*	Added new sequence diagrams: E1, E2, E3, F2
0.45	2016-07-18	Jonel Timbergen, Klaas van Zuuren *ElaadNL*	Added mapping of use cases, messages and elements.
0.4	2016-07-18	Jonel Timbergen, Robert de Leeuw *ElaadNL*	Minor fixes
0.3	2016-07-07	Jonel Timbergen *ElaadNL*	Added messages and new sequence diagram
0.2	2016-04-06	Jonel Timbergen *ElaadNL*	Added additional use cases from the 15118 specification.
0.1	2016-03-18	Jonel Timbergen *ElaadNL*	Added the first use cases belonging to this 15118 RFC.

1. Introduction

The ISO/IEC JWG 15118 for the Vehicle-to-Grid Communication Interface (V2G CI) was founded in 2009 with means to the need of a complementary international standard to IEC 61851-1 providing bi-directional digital communication based on Internet protocols. The major purpose of 15118 is to establish a more advanced and autonomously working charge control mechanism between EVs and charging infrastructures. The standard is currently under development and will ultimately provide means for various authentication schemes (e.g. plug charge vs. external identification means, like RFID cards), automatic handling of charging services as well as (proprietary) value added services, charge scheduling and advance planning, etc. It is structured accord- ing to the OSI-model of ISO/IEC 7498-1. The 15118 standard is of interest to the Open Charge Alliance, as it provides the ex- change of charging schedules and enables to control the amount of power that an EV may draw from a Charge Point, in which some form of vehicle to grid communication is necessary. Especially the second part, which specifies the messages to be exchanged between the communication partners (Application Layer), the associated data and data types (Presentation Layer) via TCPIIP based Transport and Network Layer, is important to acknowledge in this Request for Change (RFC). Here, the authorization for charging is provided in a certificate within the EVSE, handled by the certificate handling process in use case elements ”C”, eliminating the role of the Charge Point and its RFID reader.

For illustration purposes: the figure below shows a complete sequence with authorization and scheduling:

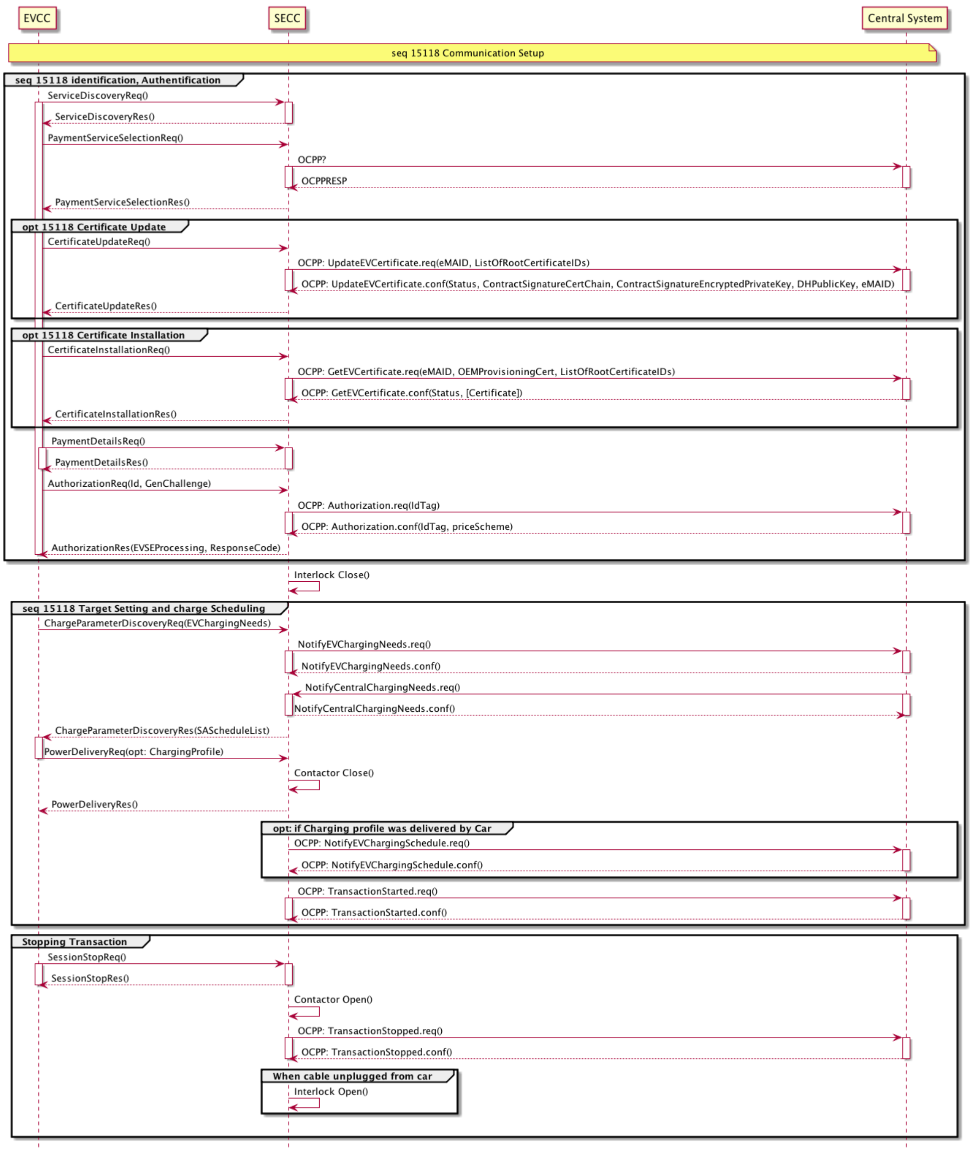

Figure 1. Sequence with Authorization and Scheduling

2. Goal

To enhance the current OCPP specification in order facilitate the 15118 functionalities regarding vehicle to grid communication, providing additional charging schedules, authorization certificates and plug and charge functionalities. It is important to align these two standards, as vehicle to grid communication will play a increasing prominent role in both the landscape of EVs and the smart grid.

This 15118 OCPP RFC has been designed to meet a number of alignment objectives: .To allow to the communication between an EV (BEV or a PHEV) and an EVSE .To allow the support of certificate handling at the EVSE, i.e. plug and charge

3. Scope

OCPP 2.0 allows Central Systems and Charge Points that both support the Smart Charging Profile to cooperate to provide smart charging of EVs. Smart charging in OCPP refers to a controlled charging process where a Charge Point or a Central System or both can set constraints to the amount of power that is delivered during the course of a charge transaction. It can be used at a local level to limit the total amount of power that may be used by a group of Charge Points, for example in a parking garage. It can also be used on a global level to adjust the power consumption of Charge Points to match the power generation capability of the grid or the availability of renewable energy sources. In order to control the amount of power that an EV may draw from a Charge Point some form of vehicle to grid communication is necessary. OCPP has been designed to support the ISO/IEC 15118 standard [15118] for communication between vehicle (EV) and Charge Point (EVSE). However, it is anticipated that for the coming years, the majority of EVs will only support the control pilot PWM signal [61851], so care has been taken to support smart charging with this as well.

The RFC will consist of the following elements:

1. Introductory section
2. Use case documentation
3. Sequence diagrams
4. Additional requirements
5. Messages
6. Data types and configuration keys (TODO)
7. Additional schema’s (TODO)
8. Test scripts (TODO)
9. Reference implementation (TODO)

4. Abbreviations

Table 1. Abbreviations

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	EV
EVCC	EV Communication Controller EVSE EV 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 EV Driver Vehicle User
VAS	Value-Added Services
V2G	Vehicle to Grid

5. 15118 use cases relevant for OCPP

The **bold** indicated use case component are identified as of influence of the OCPP communication.

Table 2. 15118 use cases relevant for OCPP

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 leveling 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 leveling 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**
F4	Reactive power compensation
F5	**Vehicle to grid support**
G1	Value added services
G2	Charging details
H1	**End of charging process**

6. ISO 15118 Certificate structure

Charging according to ISO 15118 requires several certificates as shown in the figure below. The certificate on the EVSE (marked in red) needs to be updated every 6 weeks. There is a mechanism needed in OCPP to transfer the certificate and the private key. The EVSE needs to check the validity of the contract certificate. To perform this check the certificate chain of the Mobility Operator (MO) must be installed on the EVSE. OCPP must support to maintain this certificate chain.

Contract Certificates as XML signature credentials Contract Certificate is bound to a EMAID and used in XML signature to authorize the vehicle for charging. The Contract Certificate can be verified even if the SECC is offline. The contract binding is handled as follows:

XML Message	protected fields	signing entity (sender)	verifying entity (receiver)
AuthorizationReq	message body / all fields (if GenChallenge present)	EVCC	SECC
CertificateUpdateReq	message body / all fields	EVCC; signed with Contract Certificate, chain transmitted in message body element	secondary actor
CertificateUpdateRes	ContractSignatureCertChain ContractSignatureEncryptedPrivateKey DHpublickey eMAID	secondary actor: Certificate Provisioning Service	EVCC; certificate chain stored after successful verification
CertificateInstallationReq	message body / all fields	EVCC; signed with OEM Provision Certificate, transmitted in message body element	secondary actor
CertificateInstallationRes	ContractSignatureCertChain ContractSignatureEncryptedPrivateKey DHpublickey ContractID	secondary actor: Certificate Provisioning Service	EVCC; certificate chain stored after successful verification
MeteringReceiptReq	message body / all fields (optionally)	EVCC	SECC
ChargeParameterDiscoveryRes	SalesTariff (optional, required for PnC)	secondary actor: Mobility Operator Sub-CA 2	EVCC

Table 14 — Overview of applied encrytion

Figure 2. Overview of applied XML based signatures

Plug and charge 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.

E.1.5 Overview of the resulting certificate structure

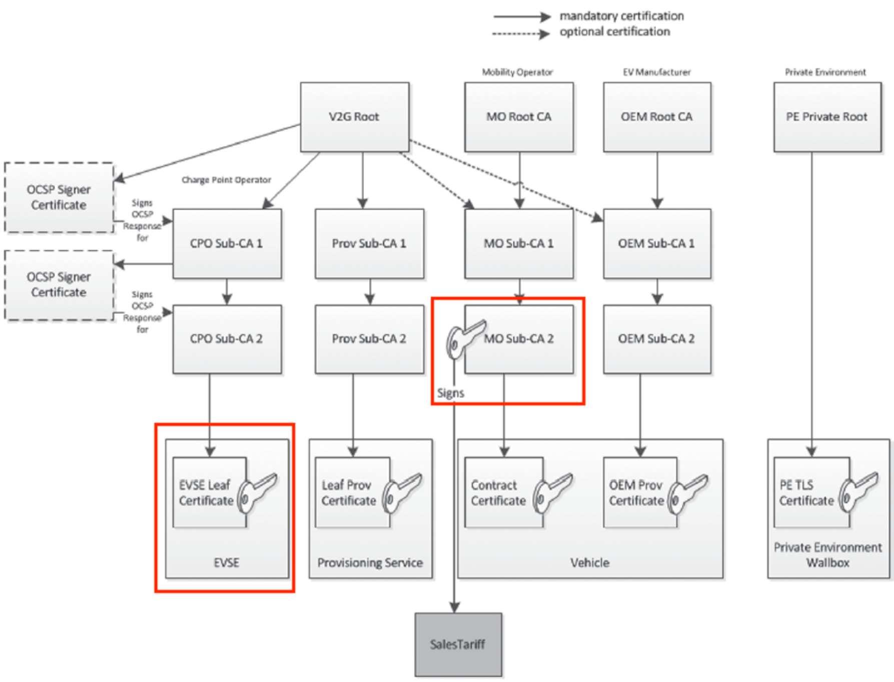

Figure 3. Overview of the resulting certificate structure

The datatype which is used to send a Charging Schedule to the EV is called SAScheduleTuple (Secondary Actor Schedule Tuple).

This data type consist of a Pmax Schedule and a SalesTariff. The SalesTariff must be signed and could be optionally encrypted with the private key of the Mobility Operator Sub-CA. The data structure of OCPP should be aligned to the 15118 data structure in this point.

7. Use cases from 15118

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: ISO 15118-1:2013(E).

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 EVs; 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.

8. Use cases and related messages

The below table provides insight in the relation of identification modes and use case elements, following Annex A (15118-2:2014).

Table 3. Relation of Identification Modes and Use Case Elements

No.	Use case element name / grouping	Messages
B1	**EVCC/SECC communication setup**	supportedAppProtocolReq/Res SessionSetupReq/Res
C1	**Certificate update**	ServiceDetailReq/Res ServicePaymentSelectionReq/Res CertificateupdateReq/Res
C2	**Certificate installation**	ServiceDetailReq/Res ServicePaymentSelectionReq/Res CertificateinstallationReq/Res
D2	**Authorization using Contract Certificates performed with help of SA**	ServicePaymentSelectionReq/Res PaymentDetailsReq/Res AuthorizationReq/Res
D4	**Authorization at EVSE using external credentials performed with help of SA**	ServiceDiscoveryReq/Res ServicePaymentSelectionReq/Res AuthorizationReq/Res
E1	**AC charging with load leveling based on High Level Communication**	ChargeParameterDiscoveryReq/Res PowerDeliveryReq/Res ChargingStatusReq/Res
E2	**Optimized charging with scheduling to secondary actor**	ChargeParameterDiscoveryReq/Res PowerDeliveryReq/Res ChargingStatusReq/Res
E3	**Optimized charging with scheduling at EV**	ChargeParameterDiscoveryReq/Res PowerDeliveryReq/Res
E4	**DC charging with load leveling based on High Level Communication**	ChargeParameterDiscoveryReq/Res PowerDeliveryReq/Res CableCheckReq/Res PreChargeReq/Res CurrentDemandReq/Res WeldingDetectionReq/Res
F3	**Charging loop with interrupt from the EVCC or user**	SessionStopReq/Res
H1	**End of charging process**	SessionStopReq/Res

8.1. A2 - Begin of charging process with concurrent IEC 61851-1 and High Level Communication

Table 4. A2 - Begin 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	**Success end conditions:** * - Successful set-up of High Level Communication at the data link layer. **Failure end conditions:** - No establishment of High Level Communication at the data link layer. - Failure of PWM signal - No correct association of SECC and EVCC or timeout in the binding process occurs.

8.2. C1 - Certificate Update

Table 5. C1 - Certificate Update

No.	Type	Description
1	**Name**	Certificate Update
2	**ID**	C1
3	**Objectives**	Replace the valid or expired certificate in the EV with a new and valid certificate from the secondary actor.
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 Communi- cation 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.
	Actors	— Primary actors: EVCC, SECC. — Secondary actors: EMOCH, FO, E-Mobility Operator
	Scenario description	The actors involved are: 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 cer- tificates 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.
	Alternative scenario’s	*(list of alternative use scenario’s, should be other use cases)*
5	**Prerequisites**	*(Preconditions for this use case)*
6	**Post conditions**	*(Post conditions after this use case is finished successfully)*
7	**Sequence diagram**	
8	**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.

8.3. C1 - Certificate installation

Table 6. C1 - Certificate installation

No.	Type	Description
1	**Name**	Certificate Installation
2	**ID**	*(ID of this use case (same as chapter name: UC.01??)*
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 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. *(Description of this use case)*
	Actors	The actors involved are: — Primary actors: EVCC, SECC. — Secondary actors: EMOCH, FO, E-Mobility Operator
	Scenario description	Scenario description: — EVCC requests a certificate installation by SECC. — 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.
	Alternative scenario's	*(list of alternative use scenario's, should be other use cases)*
5	**Prerequisites**	— Communication set-up according to use case element B1 shall be established successfully. — No Contract Certificate resp. no valid Contract Certificate is available in the EV. — A Bootstrap Certificate created by the OEM is available in the EV. — Online connection between SECC and secondary actor shall be possible or certificates to be updated shall be available on SECC.
6	**Post conditions**	Success end conditions: — Valid certificate (Contract Certificate) from secondary actor shall be stored in the EVCC. — The Bootstrap Certificate (created by the OEM) is still available in the EV. Failure end conditions: — Certificate update failed due to communication issue. — Certificate update failed due to rejection by the secondary actor. — Certificate update failed because no secondary actor with a matching con- tract can be found.
7	**Sequence diagram**	

8	**Error Handling**	*(What is the expected behaviour when something goes wrong?)*
9	**Remarks**	*(Add additional remarks here.)*

8.4. D4 - Authorization at EVSE using external credentials performed with help of SA

Table 7. D4 - 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. EV Driver 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	- EV Driver shall activate the authorization within a specific time after connect- ing the EV to the EVSE or the EVSE shall have an HMI to authorize the restart of the identification process. - EV Driver 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 EV Driver at the EVSE is not validated by the secondary actor. - The required service does not start. - EV Driver 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).

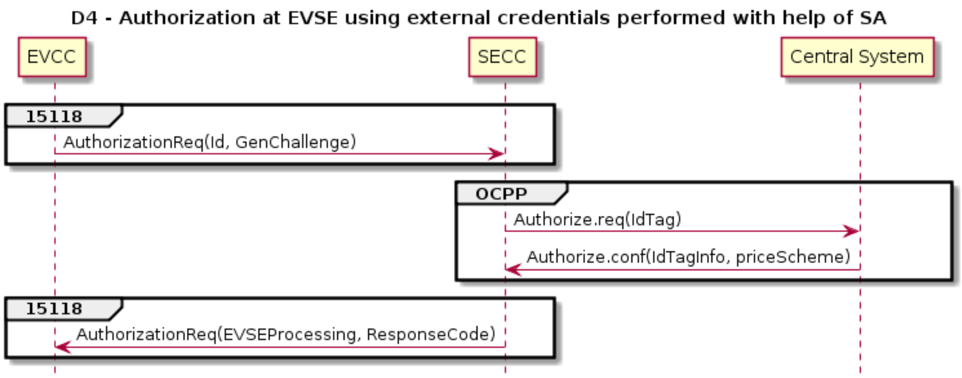

Figure 4. Sequence Diagram: Authorization at EVSE using external credentials performed with help of SA.

8.5. E1 - AC charging with load leveling based on High Level Communication

Table 8. E1 - AC charging with load leveling based on High Level Communication

No.	Type	Description
1	Use case element name	AC charging with load leveling 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 leveling 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	Combined scenario description	*15118* **1.** The EVCCC sends ChargeParameterDiscoveryReq to the SECC. *OCPP* **2**. The SECC sends NotifyEVChargingNeeds PDU to the Central System. **3.** The Central System sends a NotifyCentralChargingNeeds to the SECC. **4.** The SECC responds with ChargeParameterDiscoveryRes to the EVCC. **5.** THE EVCC sends a PowerDelivery PDU to the SECC marks the point in time when the EVSE provides voltage to its output power outlet and the EV can start to recharge its battery. *OCPP* 6.* Optionally the SECC sends a NotifyEVChargingShedule PDU to the Central System. **7.** The contactor is closed. **8.** The transaction is started with a TransactionStarted PDU. **9.** The EVCC sends a ChargingStatus PDU to the SECC.
7	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."
8	End conditions	**Success end conditions:** - EVSE delivers AC current within the max. local installation limits. - EV charges within the given local limits of EVSE. **Failure end conditions:** - EVSE does not deliver AC power due to contactor failure."

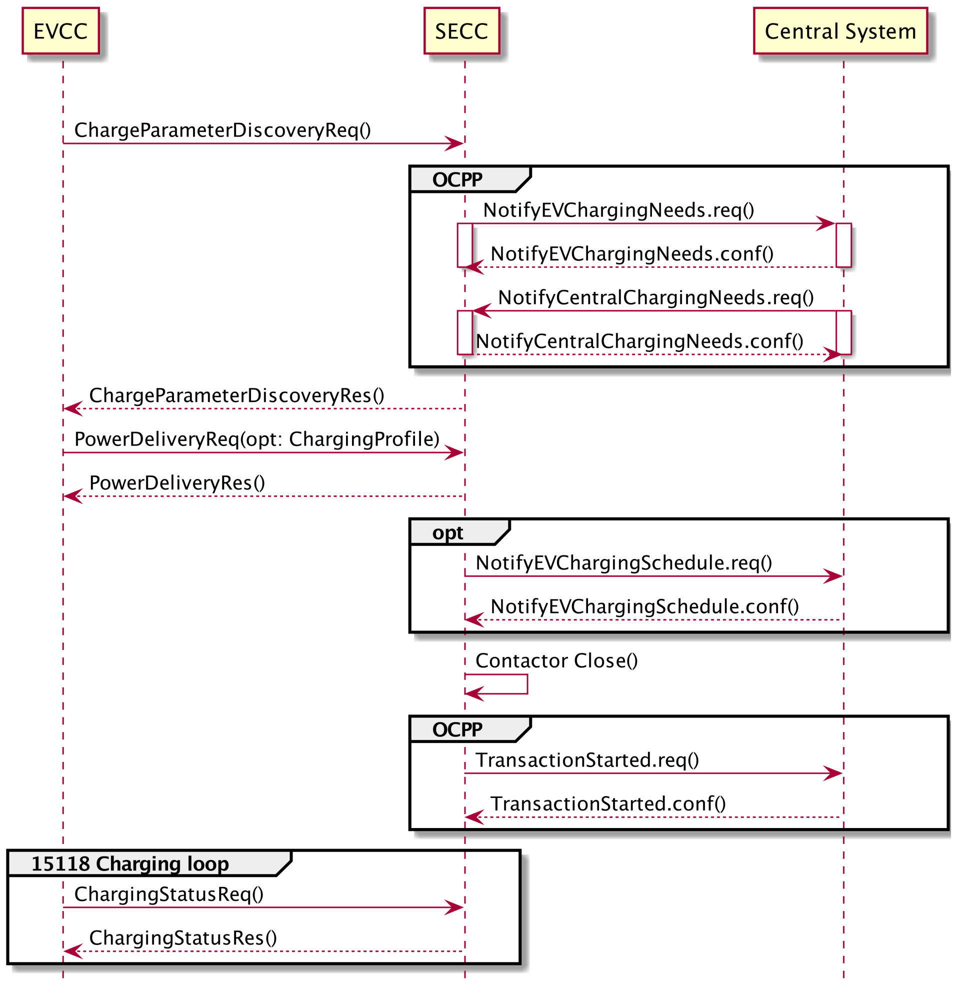

Figure 5. Sequence Diagram: AC charging with load leveling based on High Level Communication

8.6. E2 - Optimized charging with scheduling to secondary actor

Table 9. E2 - Optimized charging with scheduling to 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.
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:** - EV Driver 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 lim- its 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.
4	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.
6	Combined scenario description	*15118* **1.** The EVCC sends a ChargingStatus PDU to the SECC. *OCPP* **2.** The Central System sends a NotifyCentralChargingNeeds to the SECC. *15118* **3.** The EVCC sends ChargingStatus PDU to the SECC. **4.** The SECC responds with a EVSENotification = ReNegotiation value) *optional renegotiation* **5.** THE EVCC sends a PowerDelivery PDU to the SECC marks the point in time when the EVSE provides voltage to its output power outlet and the EV can start to recharge its battery. **6.** The EVCC sends ChargeParameterDiscoveryRes to the SECC. *OCPP* **7**. The SECC sends NotifyEVChargingNeeds PDU to the Central System. **8.** The Central System sends a NotifyCentralChargingNeeds to the SECC. **9.** The SECC responds with ChargeParameterDiscoveryRes to the EVCC. **10.** THE EVCC again sends a PowerDelivery PDU to the SECC marks the point in time when the EVSE provides voltage to its output power outlet and the EV can start to recharge its battery.
7	Requirements	- The EV Driver 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.
8	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.

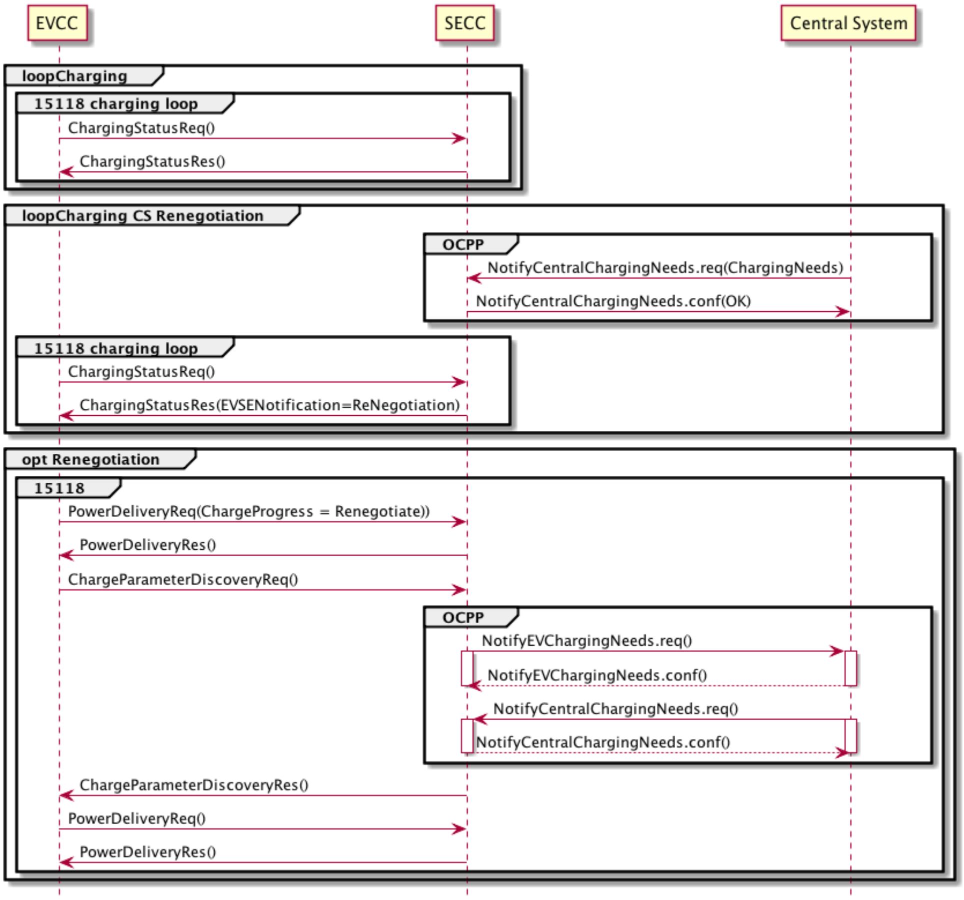

Figure 6. Sequence Diagram: Optimized charging with scheduling to secondary actor

8.7. E3 - Optimized charging with scheduling at EV

Table 10. E3 - 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.
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:** - EV Driver 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 infor- mation 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."
6	Combined scenario description	*15118* **1.** THE EVCC sends a PowerDelivery PDU to the SECC marks the point in time when the EVSE provides voltage to its output power outlet and the EV can start to recharge its battery. **2.** The EVCC sends ChargeParameterDiscoveryRes to the SECC. *OCPP* **3**. The SECC sends NotifyEVChargingNeeds PDU to the Central System. **4.** The Central System sends a NotifyCentralChargingNeeds to the SECC. **5.** The EVCC sends with ChargeParameterDiscoveryReq to the SECC. **6.** THE EVCC again sends a PowerDelivery PDU to the SECC marks the point in time when the EVSE provides voltage to its output power outlet and the EV can start to recharge its battery.
7	Requirements	The EV Driver 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.
8	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.

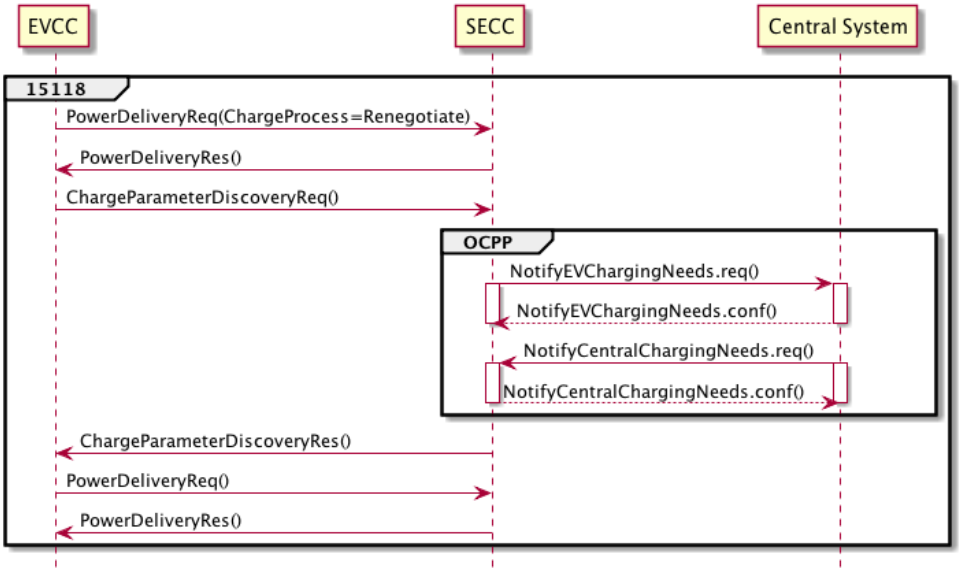

Figure 7. Sequence Diagram: Optimized charging with scheduling at EV

8.8. F1 - Charging Loop with metering information exchange

TODO

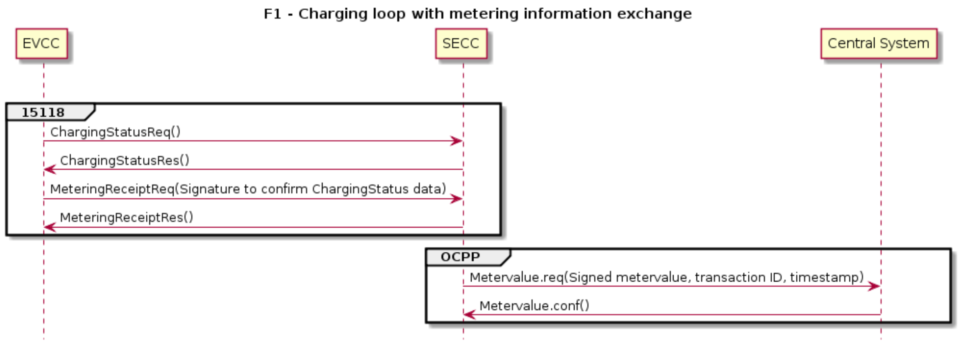

Figure 8. Charging Loop with metering information exchange

When sending a MeteringReceiptReq message the EVCC acknowledges that the data elements MeterInfo record, SessionID and the SAScheduleTupleID included in the ChargingStatusRes message prior to this request have been received from the SECC. This confirmation is implemented by applying a signature to the message body of the MeteringReceiptReq message.

8.9. F2 - Charging loop with interrupt from the SECC

Table 11. F2 - Charging loop with interrupt from the 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 leveling, 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 EV Driver 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	Combined scenario description	*15118* **1.** THE EVCC sends a PowerDelivery PDU to the SECC marks the point in time when the EVSE provides voltage to its output power outlet and the EV can start to recharge its battery. **2.** The EVCC sends ChargeParameterDiscoveryRes to the SECC. **3.** THE EVCC again sends a PowerDelivery PDU to the SECC marks the point in time when the EVSE provides voltage to its output power outlet and the EV can start to recharge its battery. *Charging OK* *OCPP* **4**. The SECC sends NotifyEVChargingSchedule PDU to the Central System. *15118* **4.** The Central System sends a NotifyCentralChargingNeeds to the SECC. **5.** The EVCC sends a ChargingStatus PDU to the SECC. **6. The SECC responds with a EVSENotification = StopCharging.** ***7.** THE EVCC again sends a PowerDelivery PDU to the SECC marks the point in time when the EVSE provides voltage to its output power outlet and the EV can start to recharge its battery. **8.** The contactor is opened. **9.** The SECC responds with a PowerDeliveryRes. *10. The session is stopped.
7	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.
8	End conditions	**Success end conditions:** - Charging loop interrupt occurred and either charging set-up or end-of-charging process starts. **Failure end conditions:** - Charging loop doesn’t start again.

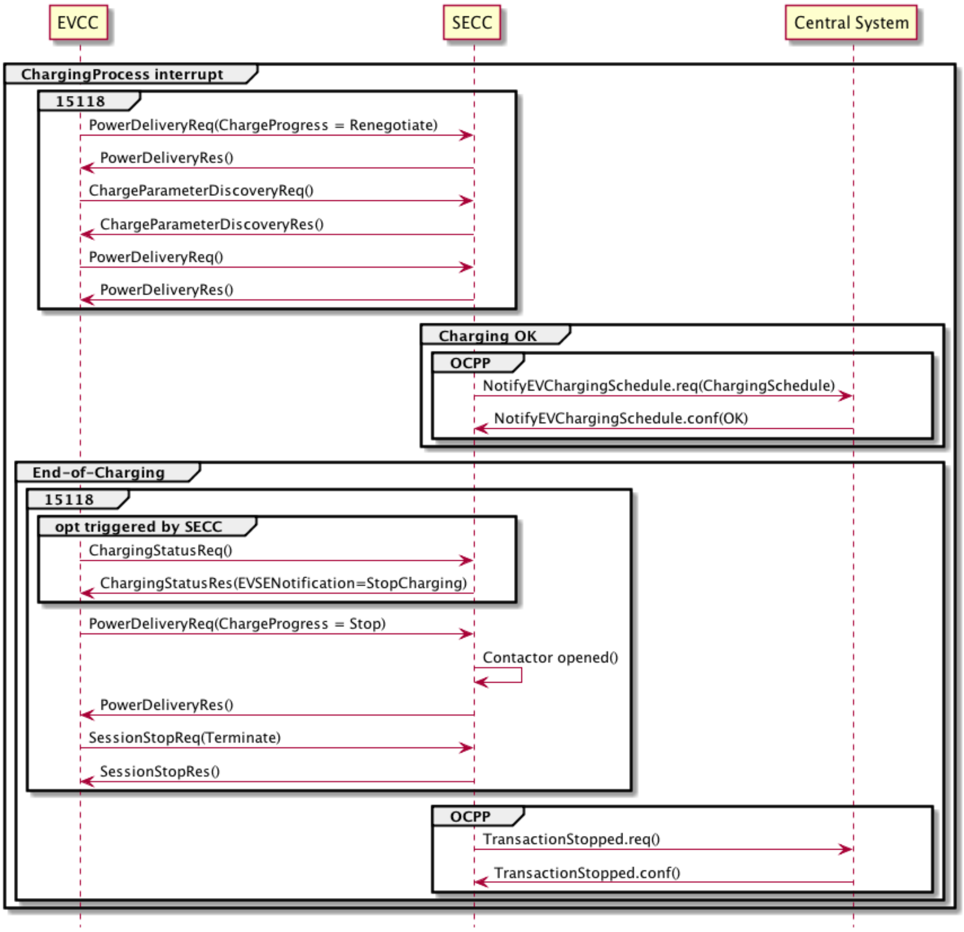

Figure 9. Sequence Diagram: Charging loop with interrupt from the SECC

8.10. F3 - Charging loop with interrupt from the EVCC or user

Table 12. F3 - 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 EV Driver to interrupt the charging loop.
4	Description	EVCC or EV Driver interrupts charging process when e.g. charging schedule changes or unpredictable event in the EV occurs or EV Driver 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 EV Driver 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.

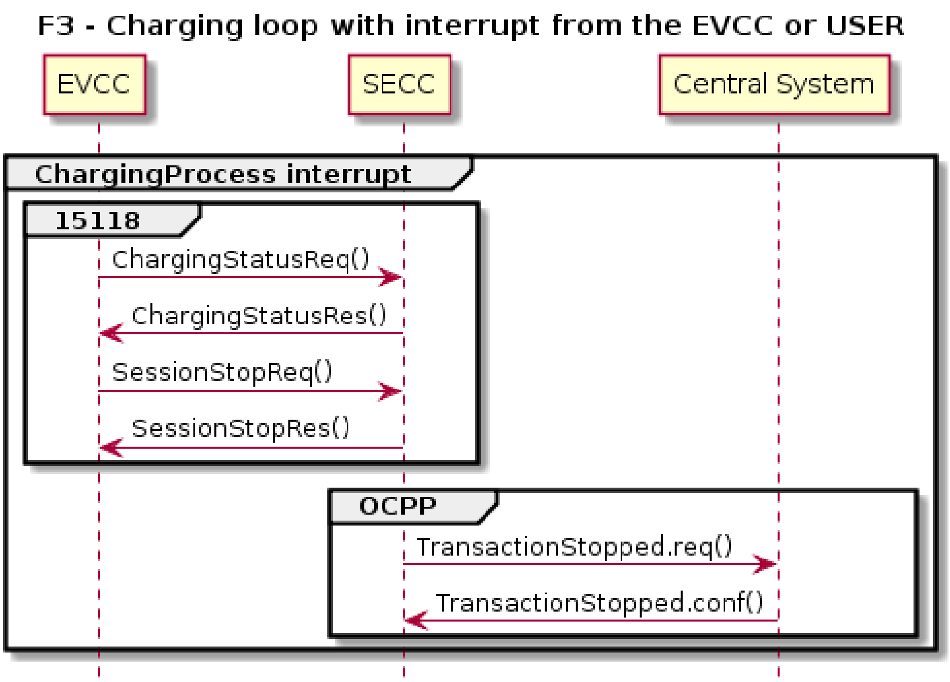

Figure 10. Sequence Diagram: Charging loop with interrupt from the EVCC or user

8.11. H1 - End of charging process

Table 13. H1 - 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, EV Driver Basic elementary use case description: - EV Driver returns to the EV / EVSE and initiate ending the charge process. - Usually the EV Driver 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 EV Driver 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. - EV Driver / 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"

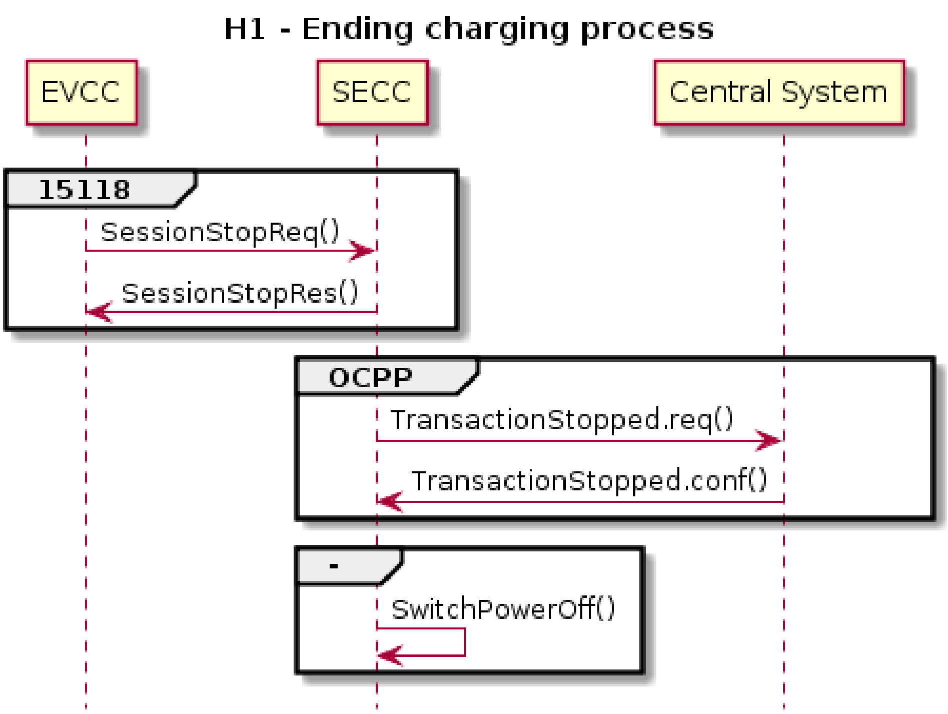

Figure 11. Sequence Diagram: End of charging process

9. Trust Relationships

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

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

10. Messages

To implement the 15118 use case highlighted in this document, a number of messages need to be added and some existing ones need to be modified, this section describes these additions.

1. 15118 Messages and Elements
2. Elements without a 15118 message
3. New OCPP messages to be defined
4. Current OCPP 2.0 15118 messages

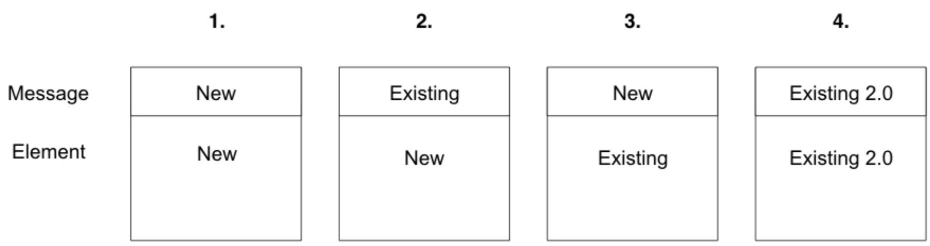

Figure 12. Message options

10.1. 15118 Messages and Elements

10.1.1. SessionSetupRes

By using the SessionSetupReq message the EVCC establishes a V2G Communication Session.

Element Name	Type	Semantics
EVSEID	simpleType: evseIDType string (min length: 7, max length:37)	

10.1.2. ServiceDiscoveryRes

Are these relevant for OCPP?

After receiving the ServiceDisoveryReq message of the EVCC the SECC sends the ServiceDiscoveryRes message. In case of a successful service discovery, the response lists all available services of the SECC for the defined criteria. In case the service discovery failed the service list is empty and the ResponseCode indicates potential reasons.

Element Name	Type	Semantics
PaymentOptionList	complexType: PaymentOptionListType refer to 8.5.2.9	This element includes the list of payment options an SECC offers to the EVCC indicating what method could be chosen to pay for the services. The EVCC can only select one payment method for all services used by the EVCC.
ChargeService	complexType: ChargeServiceType refer to subclause 8.5.2.3	Available charging services supported by the EVSE.
ServiceList	complexType: ServiceListType refer to subclause 8.5.2.2	Optional: A list containing information on all other services than charging services offered by the EVSE. The returned service list is a filtered list based on the ServiceScope and ServiceType indicated in the ServiceDiscoveryReq message. The number of service elements is limited to eight.

10.1.3. ServiceDetailRes

Are these relevant for OCPP?

After receiving the ServiceDetailReq message of an EVCC the SECC sends the ServiceDetailRes message and provides details about services.

Element Name	Type	Semantics
ServiceID	simpleType: serviceIDType unsignedShort refer to Annex C.6 for the type definition	This element identifies a service which has been offered by the SECC in the ServiceDiscoveryRes message.
ServiceParameterList	complexType: ServiceParameterListType refer to subclause 8.5.2.21	Includes the list of parameters for a specific serviceID received from the SECC in the ServiceDiscoveryRes message.

10.1.4. PaymentServiceSelectionReq

This request message transports the information on the selected services and on how all the selected services are paid (see subclause 8.6.3.1).

Element Name	Type	Semantics
eMaid	simpleType: eMAIDType string (min length: 14, max length: 15) refer to Annex C.6 for the type definition	This element identifies the charging contract. The format is defined in Annex H.

10.1.5. PaymentServiceSelectionRes

Are these relevant for OCPP?

With this message the SECC informs the EVCC whether the selected services and payment option were accepted. Depending on the selected payment additional messages (PaymentDetails message pair) are exchanged.

Element Name	Type	Semantics
SelectedPaymentOption	simpleType: paymentOptionType enumeration refer to Annex C.6 for the type definition	This element is used for indicating the payment type selected for the use of all selected services in the selectedServiceList.

10.1.6. ChargeParameterDiscoveryReq

By sending the ChargeParameterDiscoveryReq message the EVCC provides its charging parameters to the SECC. This message provides status information about the EV and additional charging parameters, like estimated energy amounts for recharging the vehicle, capabilities of the EV charging system and the point in time the vehicle operator intends to leave the EVSE.

Element Name	Type	Semantics
MaxEntriesSAScheduleTuple	simpleType: unsignedShort refer to Annex C.6 for the type definition	Optional: Indicates the maximal number of entries in the SAScheduleTuple (applies for both Pmax and Tariff). The EVSE can transmit up to the maximum number of entries defined in the parameter.
RequestedEnergyTransferMode	simpleType: EnergyTransferModeType enumeration refer to Annex C.6 for the type definition and the Table 63	Selected energy transfer mode for charging that is requested by the EVCC.
AC_EVChargeParameter	complexType: AC_EVChargeParameterType substitutes abstract type EV_ChargeParameterType refer to subclause 8.5.3.2	This element is used by the EVCC for initiating the target setting process for AC charging.
DC_EVChargeParameter	complexType: DC_EVChargeParameterType substitutes abstract type EV_ChargeParameterType refer to subclause 8.5.4.3	This element is used by the EVCC for initating the target setting process for DC charging.

10.1.7. ChargeParameterDiscoveryRes

With the ChargeParameterDiscoveryRes message the SECC provides applicable charge parameters from the grid’s perspective. Next to general charge parameters of the EVSE this optionally includes further information on cost over time, cost over demand, cost over consumption or a combination of these. The term cost refers to any kind of cost (see subclause 8.5.2.20) specified in this version of the standard and is not limited to monetary costs. Based on this cost information the EV may optimize its charging schedule for the requested amount of energy.

NOTE 1 By "cost", the EVSE may stimulate - not force - the EV to charge in periods where it is advantageous for the grid (e.g. because in these periods, a lot of wind-power is to be expected, etc.)

Element Name	Type	Semantics
SAScheduleList	complexType: SAScheduleListType substitutes abstract type SASchedulesType refer to subclause 8.5.2.12	Optional: Includes several tuples of schedules from secondary actors. The SECC shall only omit the parameter 'SAScheduleList' in case EVSEProcessing is set to 'Ongoing'.
AC_EVSEChargeParameter	complexType: AC_EVSEChargeParameterType substitutes abstract type EVSE_ChargeParameterType refer to subclause 8.5.3.3	This element is used by the SECC for initiating the target setting process for AC charging.
AC_EVSEChargeParameter	complexType: DC_EVSEChargeParameterType substitutes abstract type EVSE_ChargeParameterType refer to subclause 8.5.4.4	This element is used by the SECC for initating the target setting process for DC charging.

10.1.8. PowerDeliveryReq

By sending the PowerDeliveryReq the EVCC requests the SECC to provide power on and transmits the ChargingProfile the EVCC will follow during the charging process.

NOTE 1 The point in time this message is sent does not necessarily correlate with the start of the charging process. The EV may decide on the basis of its schedule when the charge process starts.

Element Name	Type	Semantics
ChargingProfile	complexType: ChargingProfileType refer to subclause 8.5.2.10	Optional: Allows an EV to reserve a specific charging profile for the current charging session (i.e. maximum amount of power drawn over time).

10.1.9. CertificateUpdateReq

By sending the CertificateUpdateReq the vehicle requests the SECC to deliver new certificate that belongs to the currently valid contract of the vehicle

Element Name	Type	Semantics
ContractSignatureCertChain	complexType: CertificateChainType refer to subclause 8.5.2.5	Contains the currently available signature certificate including the certificate chain in the EVCC. The SECC uses this certificate(chain) to check the message signature included in the header of the message. The complete chain is transmitted to allow stand-alone verification of the signature.
eMAID	simpleType: eMAIDType string (min length: 14, max length: 15) refer to Annex C.6 for the type definition	This element identifies the charging contract. The format is defined in Annex H.
ListOfRootCertificateIDs	complexType: ListOfRootCertificateIDsType refer to subclause 8.5.2.27	This list contains the Certificate IDs of all Root Certificates currently installed in the EVCC.

10.1.10. CertificateUpdateRes

After receiving the CertificateUpdateReq of the EVCC the SECC retrieves the requested certificate from the SA. It therefore needs to establish an online connection. Then the SECC sends the CertificateUpdateRes including the new certificate to the EVCC. Finally the EVCC installs this certificate.

Element Name	Type	Semantics
SAProvisioningCertificateChain	complexType: CertificateChainType refer to subclause 8.5.2.5	The transmitted certificate chain is used by the EVCC to verify the signature in the message header.

Element Name	Type	Semantics
ContractSignatureCertChain	complexType: CertificateChainType refer to subclause 8.5.2.5	The new certificate chain for signature purposes that has to be installed in the EVCC.
ContractSignatureEncryptedPrivateKey	complexType: ContractSignatureEncryptedPrivateKeyType refer to subclause 8.5.2.28	The private key that belongs to the new certificate for signature purposes. It has to be installed in the EVCC as well. This is secret data that has to be encrypted using the old Contract Certificate of the EVCC (based on ContractSignatureCertChain contained in message CertificateUpdateReq) and using the calculated DH secret for encryption as described in 7.9.2.4.3.
DHpublickey	complexType: DiffieHellmanPublickeyType refer to 8.5.2.29 for the type definition	Diffie Hellman ephemeral public key parameter from the SA for generating the session key at the EVCC in order to encrypt the Contract Signature Private Key at the SA and decrypt it a the EVCC.
eMAID	complexType:EMAIDTyperefer to 8.5.2.30 for the type definition	This element identifies the charging contract. The format is defined in Annex H.
RetryCounter	simpleTypeshortrefer to Annex C.6 for the type definition	Optional: If the ResponseCode was “FAILED_NoCertificateAvailable” or “FAILED_ContractCanceled”, this field contains information, when the EVCC should try to get the new certificate again. The following entries are possible: x > 0: after “x” days 0: immediately (at next charging) -1: never

10.1.11. CertificateInstallationReq

By sending the CertificateInstallationReq the vehicle requests the SECC to deliver the certificate that belong to the currently valid contract of the vehicle.

Element Name	Type	Semantics
Id	simpleType: ID string refer to Annex C.6 for the type definition	This element is used for referencing the entire message body in the message header when a signature needs to be applied.
OEMProvisioningCert	simpleType certificateType base64Binary (max. length 800) refer to Annex C.6 for the type definition	An EV specific certificate that was earlier installed in the EVCC typically by an OEM. The ID of this certificate together with the information stored at the SA (contract partner) is used to identify the currently valid contract of the EV. The certificate ID is given to the SA by the customer using a different communication channel. The certificate itself (i.e. its public key) is used to encrypt in the CertificateInstallationRes later on. The certificate is DER encoded. Please refer also to Annex E.1 and Annex 0.
ListOfRootCertificateIDs	complexType: ListOfRootCertificateIDsType refer to subclause 8.5.2.27	This list contains the Certificate IDs of all Root Certificates currently installed in the EVCC.

10.1.12. CertificateInstallationRes

After receiving the CertificateInstallationReq from the EVCC, the SECC sends the CertificateInstallationRes including the requested certificate. Then the EVCC installs this certificate.

There is only one certificate delivered to the EVCC: the one for signing messages. It belongs to the currently valid contract of the EV.

Element Name	Type	Semantics
SAProvisioningCertificateChain	complexType: CertificateChainType refer to subclause 8.5.2.5	The transmitted certificate chain is used by the EVCC to verify the signature in the message header.

Element Name	Type	Semantics
ContractSignatureCertChain	complexType: CertificateChainType refer to subclause 8.5.2.5	The new certificate chain for signature purposes that has to be installed in the EVCC.
ContractSignatureEncryptedPrivateKey	complexType: ContractSignatureEncryptedPrivateKeyType refer to subclause 8.5.2.28	The private key that belongs to the new certificate for signature purposes. It has to be installed in the EVCC as well. This is secret data and therefore has to be encrypted using the provided OEM Provisioning Certificate of the EVCC (based on the OEMProvisioningCert contained in message Certificate Installation Request) and using the calculated DH secret for encryption as described in 7.9.2.4.3
DHpublickey	complexType: DiffieHellmanPublickeyType refer to 8.5.2.29 for the type definition	Diffie Hellman public key from the SA for generating the session key at the EVCC in order to encrypt the Contract Signature Private Key at the SA and decrypt it a the EVCC.
eMAID	complexType: EMAIDType refer to 8.5.2.30 for the type definition	This element identifies the charging contract. The format is defined in Annex H.

10.2. Elements without a 1511 message

Element Name	Type	Semantics
SessionID	simpleType: SessionIDType hexBinary (max length: 8) refer to Annex C.6 for the type definition	This message element is used by EVCC and SECC for uniquely identifying a V2G Communication Session. This element is identical with the one included in the message header. It is placed in the body in addition to be able to apply a signature to it (complete body is signed).
SAScheduleTupleID	simpleType: SAIDType short refer to Annex C.6 for the type definition	Optional: Unique identifier within a charging session for a SAScheduleTuple element. This element is just an echo of the value received either in the ChargingStatusRes (during AC charging) or the CurrentDemandRes (during DC charging) message from the SECC. An SAID remains a unique identifier for one schedule throughout a charging session.
MeterInfo	complexType MeterInfoType refer to subclause 8.5.2.6.	If the SECC indicated in the ChargingStatusRes (AC charging)/ CurrentDemandRes (DC charging) that a MeteringReceiptReq is required this message element is the echo of the MeterInfo record received in the ChargingStatusRes (AC charging)/ CurrentDemandRes (DC charging) from the SECC.

10.2.1. ReceiptRequired

Element Name	Type	Semantics
ReceiptRequired	simpleType boolean refer to Annex C.6 for the type definition	Optional: This element is used by the SECC to indicate that the EVCC is required to send a MeteringReceiptReq message for the purpose of signing the meter info record. If ReceiptRequired is equal to True, the EVCC is required to send a MeteringReceiptReq message including the a signature. If ReceiptRequired is equal to False the EVCC is not required to send a MeteringReceiptReq message.

10.2.2. DC_EVSEStatus

Element Name	Type	Semantics
DC_EVSEStatus	complexType: DC_EVSEStatusType refer to subclause 8.5.4.1	Current status of the EVSE

Element Name	Type	Semantics
BulkChargingComplete	simpleType boolean refer to Annex C.6 for the type definition	Optional: If set to TRUE, the EV indicates that bulk charge (approx. 80% SOC) is complete.
ChargingComplete	simpleType boolean refer to Annex C.6 for the type definition	If set to TRUE, the EV indicates that full charge (100% SOC) is complete.
RemainingTimeToFullSoC	complexType PhysicalValueType refer to subclause 8.5.2.7	Optional: Estimated or calculated time until full charge (100% SOC) is complete.
RemainingTimeToBulkSoC	complexType PhysicalValueType refer to subclause 8.5.2.7	Optional: Estimated or calculated time until bulk charge (approx. 80% SOC) is complete.
EVTargetVoltage	complexType PhysicalValueType refer to subclause 8.5.2.7	Target voltage requested by the EV.

10.3. New OCPP messages to be defined

TODO

Certificate Installation

Please consult Figure 3. Sequence with Authorization and Scheduling

10.4. Current OCPP 2.0 15118 messages

10.4.1. NotifyEVChargingSchedule.req

The Charge Point uses this message to communicate the charging schedule as calculated by the EV to the Central System. This is only applicable in case of ISO/IEC 15118 charging.

Field Name	Field Type	Card.	Description
evse	Evse	1..1	Mandatory. The charging schedule contained in this notification applies to an EVSE and connector. evse.id must be > 0.
timeBase	DateTime	1..1	Mandatory. Periods contained in the charging profile are relative to this point in time.
chargingSchedule	ChargingSchedule	1..1	Mandatory. Planned energy consumption of the EV over time. Always relative to timeBase.

10.4.2. NotifyEVChargingSchedule.conf

Field Name	Field Type	Card.	Description
status	GenericStatus	1..1	Mandatory. Returns whether the Central System has been able to process the message successfully. It does not imply any approval of the charging schedule.

Class

Details of transaction usage in TransactionStopped.req.

Field Name	Field Type	Card.	Description
values	MeterValue	1..*	Optional. Meter values related to a transaction. + Note: In OCPP 1.5 the cardinality was mistakenly 0..*

10.4.3. TransactionStarted.req

Note: in OCPP 1.5 and earlier this PDU was known as StartTransaction.

This section contains the field definition of the TransactionStarted.req PDU sent by the Charge Point to the Central System.

Field Name	Field Type	Card.	Description
evse	Evse	1..1	Mandatory. This identifies which EVSE (evse.id number (>0)) is used. + Optionally, the connector used may be specified by evse.ConnectorId and/or evse.connectorType, but this is not mandatory.
IdToken	IdToken	1..1	Mandatory. This contains the identifier for which a transaction has to be started.
IdTokenPayer	IdToken	0..1	Optional. An IdToken of type EVCOID or EMAID identifying the contract owner responsible for payment when this differs from the IdToken that is used for authorization.
meterStart	integer	1..1	Mandatory.This contains the meter value in Wh for the connector at start of the transaction. MUST be 0 when no meter in CP.
timestamp	dateTime	1..1	Mandatory. This contains the date and time on which the transaction is started.
reservationId	integer	0..1	Optional. This contains the id of the reservation that terminates as a result of this transaction.

Field Name	Field Type	Card.	Description
priceSchemeId	priceSchemeId	integer	Optional. Id of price scheme to apply to this transaction. If absent, then real-time pricing is not used and no cost will be displayed during and after transaction.
evChargingNeeds	ChargingNeeds	0..1	Optional. Charging needs collected at the Charge Point (e.g. using ISO15118 communication, a EV Driver interface at the Charge Point or another facility). Charging needs might not be fully available.
transactionId	TransactionId	0..1	Optional. If present, this transaction id, generated by the Charge Point, shall be used by the Central System.

If any sub connector types are provided then these should be ignored. When a start transaction is received these relate to the connector.

10.4.4. TransactionStarted.conf

This contains the field definition of the TransactionStarted.conf PDU sent by the Central System to the Charge Point as response to a TransactionStarted.req PDU.

Field Name	Field Type	Card.	Description
transactionId	TransactionId	1..1	Mandatory. This contains the transaction id supplied by the Central System. If a transaction id was supplied by the Charge Point in the TransactionStarted.req, then that SHALL be used here.
IdTokenInfo	IdTokenInfo	1..1	Mandatory. This contains information about authorization status, expiry and group id.
contractIdInfo	IdTokenInfo CHECK met regel hierboven	0..1	Optional. This contains information authorization status of the contractId if that was present in the TransactionStarted.req.
maxAllowedHours	decimal	0..1	Optional. This contains the maximum number of hours that energy is allowed to flow from EVSE to EV. When this limit is reached, the Charge Point SHALL stop the delivery of energy to the EV, but the transaction remains active.
maxAllowedKwh	decimal	0..1	Optional. This contains the maximum number of kWh the EV is allowed to charge. When this limit is reached, the Charge Point SHALL stop the delivery of energy to the EV, but the transaction remains active.
csChargingNeeds	ChargingNeeds	0..1	Optional. Charging needs collected at the Central System (e.g. using a smart phone application or values from the database at the Central System). If the Charge Point communicates charging needs, they will be processed at the Central System and incorporated into the charging needs element sent with the reply.
csChargingProfile	csChargingProfile	0..3	Optional. Profile with maximum power the EV can use over time. The charging profiles SHALL have a charging profile purpose of TxProfile.

10.5. TransactionStopped.req

Note: in OCPP 1.5 and earlier this PDU was known as StopTransaction.

This contains the field definition of the TransactionStopped.req PDU sent by the Charge Point to the Central System.

Field Name	Field Type	Card.	Description
transactionId	transactionId	1..1	Mandatory. This contains the transaction-id as received by the TransactionStarted.conf.
IdToken	IdToken	0..1	Optional. This contains the identifier which requested to stop the charging. It is optional because a Charge Point may terminate charging without the presence of an id- tag, e.g. in case of a reset. + You should only provide the IdToken if it is actually used to terminate the transaction.
meterStop	integer	1..1	Mandatory. This contains the meter value in Wh for the connector at end of the transaction.

Field Name	Field Type	Card.	Description
timestamp	dateTime	1..1	Mandatory. This contains the date and time on which the transaction is stopped.
stopReason	StopReason	1..1	Mandatory. This indicates the reason for stopping the transaction.
timeSpentCharging	integer	0..1	Optional. This contains the total time that energy flowed from EVSE to EV during the transaction (in seconds). Note that timeSpentCharging is smaller or equal to the duration of the transaction.
transactionData	TransactionData	0..1	Optional. This contains transaction usage details relevant for billing purposes.
notice	Notice	0..*	Optional. Can be used to report detailed information about significant events that occurred during the charging session, and/or the values of relevant Variables at session end (e.g. vehicle SOC, tethered cable holstered, charging bay vacated). Example notice for normal termination: notice(trigger=Completion, component(name=EVChargingSession, variable(name=Complete, value=1) variable(name=StateOfCharge, value=80)))

10.5.1. TransactionStopped.conf

This contains the field definition of the TransactionStopped.conf PDU sent by the Central System to the Charge Point as response to a TransactionStopped.req PDU.

Field Name	Field Type	Card.	Description
IdTokenInfo	IdTokenInfo	0..1	Optional. This contains information about authorization status, expiry and group id. It is optional, because a transaction may have been stopped without an identifier .
totalCost	Cost	0..1	Optional. Total cost of the transaction.

10.5.2. SetChargingProfile.req

The Central System uses this message to send charging profiles to a Charge Point. Multiple charging profiles with possibly different charging profile purposes and/or stack levels MAY be sent at once (see: 11.7.2).

Field Name	Field Type	Card.	Description
evse	Evse	1..1	Mandatory. The EVSE and connector to which the charging profile applies. If evse.id = 0, the message contains an overall limit for the Charge Point.
csChargingProfiles	ChargingProfile	1..*	Mandatory. The charging profiles to be set at the Charge Point. Compliancy Note: The supported upper limit on the cardinality of ChargingProfile elements in one SetChargingProfile.req PDU is implementation- dependent, and SHOULD be reported by the Charge Point during the CapabilityInventory process, where supported, using SmartChargingManager.Count [2/ ChargingProfilesPerSetCP](Ma xLimit).

10.5.3. SetChargingProfile.conf

SetChargingProfile.conf

Field Name	Field Type	Card.	Description
status	GenericStatus	1..1	Mandatory. Returns whether the Charge Point has been able to process the message successfully. It does not imply acceptance or adherence to the charging profile by the EV.

11. DataType

(new/changed datatypes)

11.1. ExampleEnum

Enumeration

(Add description of the enumeration here, also add link to message it is used in.)

Value	Description
Value1	*(description of value1)*
Value2	*(description of value2)*

11.2. ExampleClass

Class

(Add description of the class here, also add link to message it is used in.)

Name	Field Type	Card.	Description
Field1	Field1Type	0..*	*(Description of field1)*
Field2	Field1Type	0..1	*(Description of field2)*

12. Configuration Keys

(new/changed configuration keys)

12.1. NewKeyName

Required/optional	*(required / optional)*
Accessibility	*(R / RW)*
Type	*(Data type of this key)*
Description	*(Add description of this configuration key here)*

13. Appendix

13.1. Local Smart Charging (15118)

```
@startuml
skinparam dpi 300
hide footbox

actor "EV" as EV
participant "EVSE" as ES
participant "Local Controller" as LC
participant "Central System" as CS


EV -> ES : local charging needs()
activate EV
activate ES
ES -> CS : TransactionStarted.req(id-tag, evChargingNeeds)
activate CS

CS --> ES : TransactionStarted.conf(OK, chargingProfile, csChargingNeeds)
deactivate CS

ES --> EV : send charging limits()
deactivate ES
loop  Transaction (until transaction is finished)

loop Charging
EV ->o EV : calculate charging schedule()

ES -> ES: send and execute charge schedule(ChargingSchedule)
activate ES

ES -> LC : NotifyEVChargingSchedule.req(ChargingSchedule)

activate LC

LC --> ES : NotifyEVChargingSchedule.conf(OK)
deactivate ES
deactivate LC

note left of ES : EV is charging according to schedule...

opt Renegotiation by Central System


CS -> ES : SetChargingProfile.req(connector, limit)
activate CS
activate ES
ES --> CS : SetChargingProfile.conf(OK)
deactivate CS
deactivate ES

ES -> EV : send charging limits()
```

```
end
EV ->o ES :  finished charging schedule()
deactivate EV

note right of ES : Process may be repeated as result of\ncabin preheating after
charging.
end



end

note right of EV : EV Driver terminating and disconnecting

ref over EV,CS #FAE4E7
**IdToken/Plug & Charge Authorization**
end


ES -> CS : TransactionStopped.req(id-tag)
activate CS
activate ES
CS --> ES : TransactionStopped.conf(OK)
deactivate CS
deactivate ES


@enduml
```

13.2. Central Smart Charging (15118)

```
@startuml
skinparam dpi 300
hide footbox

title Central Smart Charging (15118)

actor "EV" as EV
participant "EVSE" as ES
participant "Central System" as CS


EV -> ES : local charging needs()
activate EV
activate ES
ES -> CS : TransactionStarted.req(id-tag, evChargingNeeds)
activate CS

CS --> ES : TransactionStarted.conf(OK, chargingProfile, csChargingNeeds)
deactivate CS

ES --> EV : send charging limits()
deactivate ES
loop  Transaction

loop Charging
```

```
EV ->o EV : calculate charging schedule()

EV -> ES : send and execute charge schedule(ChargingSchedule)
activate ES

ES -> CS : NotifyEVChargingSchedule.req(ChargingSchedule)

activate CS

CS --> ES : NotifyEVChargingSchedule.conf(OK)
deactivate ES
deactivate CS

opt Renegotiation by Central System



CS -> ES : SetChargingProfile.req(connector, limit)
activate CS
activate ES
ES --> CS : SetChargingProfile.conf(OK)
deactivate CS
deactivate ES

ES -> EV : send charging limits()


end
EV ->o ES :  finished charging schedule()
deactivate EV

note right of ES : Process may be repeated as result of\ncabin preheating after
charging.
end



end

note right of EV : EV Driver terminating and disconnecting

ref over EV,CS #FAE4E7
**IdToken/Plug & Charge Authorization**
end


ES -> CS : TransactionStopped.req(id-tag)
activate CS
activate ES
CS --> ES : TransactionStopped.conf(OK)
deactivate CS
deactivate ES



@enduml

----
```