Update protocol definition

Project deliverable D2.3

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101056874.

WWW.SCALE-HORIZON.EU

1 Deliverable administrative information

Deliverable number	D2.3
Deliverable title	Update protocol definition
Dissemination level	Public
Submission deadline	31/01/2024
Version number	V1.0
Authors	Jordan Sautreau (Trialog) Anais Walle (Trialog)
Internal reviewers	Yannick Huc (Trialog) Kevin Haesevoets (Enervalis) Eric Smets (Enervalis) Jelle Meersmans (Enervalis) Didier Bollen (GoodMoovs)
Document approval	Baerte de Brey (ElaadNL)

1.1 Legal Disclaimer

SCALE is funded by the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101056874. The views represented in this document only reflect the views of the authors and not the views of the European Commission. The dissemination of this document reflects only the author's view and the European Commission is not responsible for any use that may be made of the information it contains.

2 Project Executive Summary

SCALE (Smart Charging Alignment for Europe) is a three-year Horizon Europe project that aims at preparing EU cities for mass deployment of electric vehicles and the accompanying smart charging infrastructure.

3 SCALE partners

List of participating cities:

- Oslo (NO)
- Rotterdam & Utrecht (NL)
- Eindhoven (NL)
- Toulouse (FR)
- Greater Munich Area (GER)
- Budapest & Debrecen (HU)
- Gothenburg (SE)

List of partners:

- (Coordinator) STICHTING ELAAD NL
- POLIS - PROMOTION OF OPERATIONAL LINKS WITH INTEGRATED SERVICES, ASSOCIATION INTERNATIONALE POLIS BE
- GoodMoovs NL
- Rupprecht Consult – Forschung & Beratung GmbH RC DE
- Trialog FR
- WE DRIVE SOLAR NL BV NL
- UNIVERSITEIT UTRECHT NL
- LEW Verteilnetz GmbH DE
- BAYERN INNOVATIV - BAYERISCHE GESELLSCHAFT FUR INNOVATION UND WISSENSTRANSFER MBH DE
- ABB BV NL
- Enervalis BE
- GEMEENTE UTRECHT NL
- Equigy B.V. NL
- SONO MOTORS GMBH DE
- Meshcrafts As (Current) NO
- Research Institutes of Sweden AB SE
- ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (CERTH) GR

- FIER Automotive FIER NL
- Emobility Solutions Kft. HU
- Serviced Office Belbuda Kft HU
- Enedis FR
- L'ASSOCIATION EUROPEENNE DE LA MOBILITE ELECTRIQUE (AVERE) BE
- Norsk elbilforening NO
- VDL ENABLING TRANSPORT SOLUTIONS BV NL
- Urban Electric Mobility Initiative UEMI DE
- Renault FR
- Chalmers University SE
- Polestar SE
- Hyundai NL NL

Social Links:

twitter.com/scaleproject_

www.linkedin.com/company/ scale-project-smart-charging-alignment-for-europe

www.youtube.com/channel/UC1HVFu5uJPCNSV96b3l_rcg

For further information please visit **WWW.SCALE-HORIZON.EU**

4 Deliverable executive summary

4.1 Key words

Electric vehicles, smart charging, bidirectional charging, V2X, interoperability, flexibility, protocols

4.2 Summary

To be able to deliver energy services through charging session optimization, the seamless transfer of data between key actors is essential in optimizing energy services. Efficient communication and data exchange among electric vehicles (EVs), charging infrastructure providers, grid operators, and energy service providers enable real-time monitoring and control of energy consumption. This data-driven connectivity allows for load balancing, demand response, and predictive maintenance, enhancing the overall reliability and performance of the electric grid.

The strong need for connectivity between several actors shows the importance of interoperability. To foster a thriving and open market within the e-mobility sector, it is imperative that key actors embrace the use of open protocols over proprietary implementations. This approach not only promotes a more interconnected market but also encourages healthy competition and innovation. By avoiding proprietary implementations, stakeholders contribute to the creation of a level playing field, preventing the formation of closed ecosystems that limit consumer choice and stifle innovation.

To preserve the current interoperability between the actors while implementing new energy services, this document provides in section 8 an analysis of the existing and upcoming protocols regarding the required data to enable new energy services. The analysis of existing protocols helps in understanding the current state of interoperability and identifies areas where standardization has been successful. However, it also sheds light on potential limitations or gaps that might hinder seamless communication between different systems.
The examination of upcoming protocols enables stakeholders to align their strategies with evolving industry standards and prepare for future challenges.

To contribute to the standardization process and to ease the implementation of the service in the different pilots, extensions of existing and upcoming protocols are proposed in section 9. The identification of gaps and how to fill them in upcoming and existing protocols allows for early intervention into the standardization committees and speed up the adoption of protocols covering all expected use cases. This approach not only maximizes the efficiency of data transfer but also encourages a more interconnected environment for the benefit of all actors in the ecosystem.

Then, the extended protocols shall be used to enable the energy services experimented within SCALE project. To select the most relevant technical solution, section 10 lists the protocols that can be used to propose V1G services or V2G services.

Finally, this report explicits in section 11 the data journey within the ecosystem. Thanks to the flow diagrams provided, each actor can clearly understand which data it should process and apply the relevant protocol to connect to other actors and fulfill data privacy and cybersecurity requirements.

1 DELIVERABLE ADMINISTRATIVE INFORMATION 1

2 PROJECT EXECUTIVE SUMMARY 2

3 SCALE PARTNERS 2

4 DELIVERABLE EXECUTIVE SUMMARY 4

5 LIST OF ABBREVIATIONS AND ACRONYMS 6

6 PURPOSE OF THE DELIVERABLE 7

7 STRUCTURE OF THE DELIVERABLE & LINK WITH OTHER WORK PACKAGES 8

8 PROTOCOLS GAP ANALYSIS 9

9 PROTOCOLS EXTENSIONS 35

10 REQUIRED PROTOCOLS FOR ENERGY SERVICES 37

11 DATA JOURNEY 40

12 CONCLUSIONS 46

13 APPENDIX 47

5 List of abbreviations and acronyms

Acronym	Meaning
BPT	Bidirectional Power Transfer
CPO	Charge Point Operator
DSO	Distribution Grid Operator
EMS	Energy Management System
eMSP	e-Mobility Service Provider
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FSP	Flexibility Service Provider
JSON	JavaScript Object Notation
OCA	Open Charge Alliance
OCPI	Open Charge Point Interface
OCPP	Open Charge Point Protocol
OEM	Original Equipment Manufacturer
SCALE	Smart Charging Alignment for Europe
SCSP	Smart Charging Service Provider
SoC	State of Charge
TSO	Transmission System Operator
V2G	Vehicle-to-Grid
V2X	Vehicle-to-Everything
XML	Extensible Markup Language

6 Purpose of the deliverable

6.1 Attainment of the objectives and explanation of deviations

The objectives related to this deliverable have been achieved in full and as scheduled.

6.2 Intended audience

6.2.1 SCALE Consortium partners

The primary audience for this deliverable is the project partners involved in the development and implementation of V2X services. They can utilize the deliverable to select and implement protocols for their specific use cases.

6.2.2 E-mobility actors

The document, featuring a comprehensive gap analysis of existing protocols and proposing extensions to cover all use cases, greatly benefits e-mobility actors. By clearly outlining the limitations and opportunities within current protocols, e-mobility actors get valuable insights into how existing limitations may impact their operations. The sequence diagrams depicting data exchanges facilitate a deeper understanding of the interactions between various components. So, they can make informed decisions, choose protocols that align with their specific needs, and strategize for more efficient and seamless electric vehicle charging experiences.

6.2.3 Smart charging service providers

Smart charging services providers benefit from this report's insights and proposed extensions. The gap analysis informs them about the existing limitations in protocols that may impact the delivery of their services. The sequence diagrams offer a detailed view of data exchanges, enabling providers to streamline their offerings and enhance the user experience. With this information, they can make informed decisions on protocol selection, optimize their service delivery, and contribute to the development of optimized charging solutions.

6.2.4 Standardization bodies

This document provides standardization bodies with a comprehensive overview of existing gaps in protocols and offers well-reasoned extensions supported by sequence diagrams. This information incites standardization bodies to refine and update protocols, shaping an interoperable ecosystem. By addressing identified gaps, standardization bodies can contribute to the evolution of robust industry standards, promoting innovation and ensuring a sustainable framework for the diverse needs of e-mobility, grid operators, and smart charging services providers.

7 Structure of the deliverable & link with other work packages

In this analysis, our initial step involves listing all protocols currently available and those anticipated soon. This inventory lays the foundation for our investigation into the e-mobility ecosystem's communication frameworks. The information gathered will then be closely aligned with the findings documented in D2.2, establishing a link between protocol definitions and the analytical insights provided in our data analysis report.

Building on this link, our next objective is to identify gaps within the existing protocols. By mapping the content from our analysis in D2.2 against the defined protocols, we can pinpoint areas where information may be lacking or insufficient. This thorough examination sets the stage for proposing solutions to fill these identified gaps, creating a more exhaustive set of communication protocols within the e-mobility domain.

As part of our recommendations, we will provide guidance on selecting the most suitable protocols for specific use cases. This aims to assist stakeholders in making informed decisions, ensuring that the chosen protocols align seamlessly with the requirements of each unique scenario.

To enhance the practical application of our work, we will outline the data flow between different actors within the e-mobility ecosystem. This view highlights the roles of each actor and clarifies how data is handled at various stages of the communication process. This clarity in data flow is helpful for stakeholders aiming to understand the intricacies of information exchange within the ecosystem.

The outcomes of this work will be used as input for task T2.4. The insights gained from protocol definition, gap identification, and proposed solutions will serve as a roadmap for future developments, ensuring that advancements in the e-mobility communication landscape are guided by a thorough understanding of existing protocols and their potential enhancements.

8 Protocols gap analysis

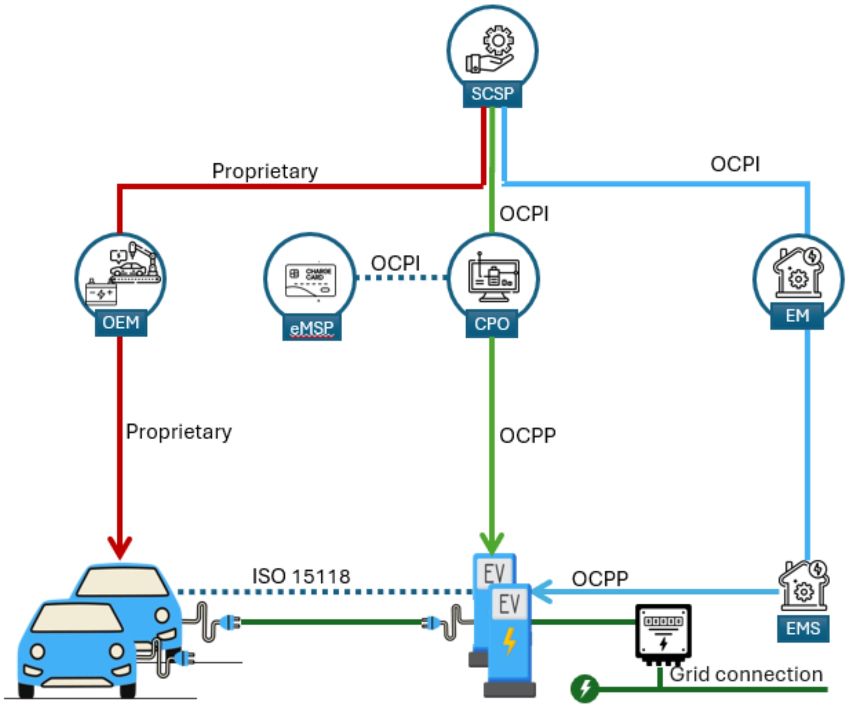
In this section, we aim to establish a robust foundation for the selection of protocols tailored to specific services. The objective is to conduct a comprehensive gap analysis, comparing the data requirements outlined in D2.2 with the information currently available in existing protocols. This examination serves as a pivotal step in our overarching mission to identify and recommend protocols that align seamlessly with the specified service criteria. Through a systematic approach, we pinpoint gaps between the required data elements and the provisions within various protocols. Then we are committed to proposing pragmatic solutions to bridge these discerned gaps effectively in section 11.

8.1 System Architecture

In the dynamic landscape of e-mobility, the following schema displaying the ecosystem architecture helps to understand the intricate connections between various actors. The schema delineates the essential links, showcasing the seamless integration of protocols across different stages. These protocols play a crucial role in orchestrating communication and data exchange between EVs, charging stations, and the grid. From the initial connection phase to the actual charging process and grid interaction, each link in the chain requires standardized protocols for efficient and secure operations.

To define and select the relevant protocols, the source and the destination of an information shall be known. Depending on the control topology, which actor acts as a FSP, this destination may vary. The FSP can be different actors: EMS, CPO, EV, … As the SCALE system architecture aims to support different control topologies while making switching FSPs as seamless as possible for customers, the FSP role should be separated from the existing roles known to the e-mobility eco-system.

The following diagram represents the generic architecture in SCALE project. Based on this diagram, all the links and their associated protocol shall be explicated to perform a gap analysis.



First, the link between the EV and the EVSE is based on ISO 15118. ISO 15118 is an international standard that focuses on the communication between electric vehicles (EVs) and charging stations, to standardize the protocols for electric vehicle charging. Specifically, ISO 15118 addresses the communication between the EV and the charging station, covering aspects such as authentication methods, charge parameters, both AC and DC charging, and secure data exchange. In this document we will focus on the ISO 15118-2 and ISO 15118-20 as they describe which and how data can be transmitted on this link.

Secondly, we will use the open protocol OCPP to communicate between charging stations and supervision systems: EVSE and CPO, and EVSE and EMS. Open Charge Point Protocol (OCPP) is an open-source communication protocol specifically designed for managing and monitoring charging stations. Developed to promote interoperability and standardization in the EV charging industry, OCPP facilitates communication between charging stations and central management systems and energy management systems.

Finally, OCPI is used to connect the CPO to the SCSP, the CPO to the eMSP, and the EM to the SCSP. The Open Charge Point Interface (OCPI) is a protocol designed for the interoperability of electric vehicle (EV) charging networks. Unlike specific protocols tailored for communication between charging stations and supervision systems (e.g., OCPP), OCPI focuses on enabling communication and data exchange between different, independently operated EV charging networks.

To be noted that interactions with other actors linked to the energy sector (DSO, TSO, BRP…) have not been considered for this analysis as these interactions are already addressed by other European project focused on flexibility: protocol selection will be done according to recommendations provided by these projects or based on recommendations from standardization work.

8.2 EV – EVSE Communication

8.2.1 ISO 15118-2

8.2.1.1 Data Coverage

For ISO 15118-2, the request messages are sent by the EV to the EVSE, and the response messages are sent by the EVSE to the EV. In the following table, the message name is written in bold. Those ending by Req are requests, those ending by Res are responses.

The version used for this analysis is ISO 15118-2 Ed1 released in 2014.

	Data Object	Protocol Message	Unit /Format	Remark
Charging Station (CS)	EVSE ID	**SessionSetupRes**::EVSEID		
	Maximum Charging Power	**ChargeParameterDiscoveryRes**::DC_EVSEChargeParameter::EVSEMaximumPowerLimit **CurrentDemandRes**::EVSEMaximumPowerLimit	W	Only sent in DC
	Active Power	**CurrentDemandRes**::EVSEPresentVoltage **CurrentDemandRes**::EVSEPresentCurrent	W	Not directly available but can be computed based on voltage current
	Session ID	**SessionSetupRes**::Header::SessionID		

	Composite Active Charging Profile	**ChargeParameterDiscoveryRes**::SAScheduleList		
	Charged Energy	**MeteringReceiptReq**::MeterInfo::MeterReading	Wh	
EV	Maximum Charging Power	**CurrentDemandReq**::EVMaximumPowerLimit **ChargeParameterDiscoveryReq**::DC_EVChargeParameter::EVMaximumPowerLimit	Wh	
	Present SoC	**CableCheckReq**::DC_EVStatusType::EVRESSSOC	Percent	
	Target Energy Request	**ChargeParameterDiscoveryReq**::DC_EVChargeParameterType::EVEnergyRequest	Wh	
User	UserID	**PaymentDetailsReq**::eMaid		Only available with PnC
	Departure Time	**ChargeParameterDiscoveryReq**::AC_EVChargeParameter::DepartureTime **ChargeParameterDiscoveryReq**::DC_EVChargeParameter::DepartureTime		Optional Field
	Maximum SoC	**ChargeParameterDiscoveryReq**::DC_EVChargeParameter::FullSOC		

	Minimum Green Level	**ChargeParameterDiscoveryRes**::SAScheduleList::SAScheduleListType::SAScheduleTupleType::SalesTariffType::SalesTariffEntryType::ConsumptionCostType::CostType::costKind	Optional Field

8.2.1.2 Gap analysis

The gap analysis reveals a comprehensive coverage of smart charging needs within the existing protocol. However, the analysis also brings to light some noteworthy gaps that require attention to enhance the protocol's functionality and adaptability:

- Maximum and minimum energy requests from the EV, major factors in optimizing charging processes.
- The minimum and maximum state of charge requested by the EV, useful for ensuring the longevity of electric vehicle batteries and maintaining optimal performance.
- Maximum charging power supported by the EVSE in AC Charging.

In addition to addressing the identified gaps, it is essential to understand that the protocol allows for optional parameters. It introduces a need for careful consideration during implementation. The optional nature of certain parameters underscores the importance of a thoughtful approach by implementers. The implementation specifications for the pilots shall clearly articulate the usage of optional to avoid interoperability issues. So, the usage of the following parameters shall be explicitly defined:

- Departure Time to ensure that user mobility needs are covered.

Finally, the analysis shows the absence of V2X parameters in ISO 15118-2. However, this was expected as V2X support was added to ISO 15118-20 and is not meant to be supported by ISO 15118-2.

8.2.2 ISO 15118-20

For ISO 15118-20, the request messages are sent by the EV to the EVSE, and the response messages are sent by the EVSE to the EV. In the following table, the message name is written in bold. Those ending by Req are requests, those ending by Res are responses.

The version used for this analysis is ISO 15118-20 Ed1 released in 2022.

8.2.2.1 Data coverage

	Data Object	Protocol Message	Unit /Format	Remark
Charging Station (CS)	EVSE ID	**SessionSetupRes**::EVSEID	36 bytes, ASCII String	
	Maximum Charging Power	**AC_ChargeParameterDiscoveryRes::**AC_CPDResEnergyTransferModeType::EVSEMaximumChargePower **DC_ChargeParameterDiscoveryRes::**DC_CPDResEnergyTransferModeType::EVSEMaximumChargePower	W	
	Active Power	**AC_ChargeParameterDiscoveryRes**::AC_CPDResEnergyTransferModeType::EVSEPresentActivePower	W	Only in AC
	Session ID	**SessionSetupRes**::Header::SessionID		
	Composite Active	**ScheduleExchangeRes**::Scheduled_SEResControlModeType::ScheduleTuple		

	Charging Profile		
	Charged Energy	**MeteringConfirmationReq::**MeterInfoType::ChargedEnergyReadingWh	Wh
	Discharged Energy	**MeteringConfirmationReq**::MeterInfoType::BPT_DischargedEnergyReadingWh	Wh
EV	Maximum Charging Power	**DC_ChargeParameterDiscoveryReq::**DC_CPDReqEnergyTransferModeType::EVMaximumChargePower **AC_ChargeParameterDiscoveryReq**::AC_CPDReqEnergyTransferModeType::EVMaximumChargePower **DC_ChargeLoopReq::**BPT_Dynamic_DC_CLReqControlModeType::EVMaximumChargePower **AC_ChargeLoopReq::**BPT_Dynamic_AC_CLReqControlModeType::EVMaximumChargePower	W
	Minimum Charging Power	**DC_ChargeParameterDiscoveryReq::**DC_CPDReqEnergyTransferModeType::EVMinimumChargePower **AC_ChargeParameterDiscoveryReq::**AC_CPDReqEnergyTransferModeType::EVMinimumChargePower **DC_ChargeLoopReq**::BPT_Dynamic_DC_CLReqControlModeType::EVMinimumChargePower **AC_ChargeLoopReq::**BPT_Dynamic_AC_CLReqControlModeType::EVMinimumChargePower	W

	Maximum Discharging Power	**DC_ChargeParameterDiscoveryReq::**BPT_DC_CPDReqEnergyTransferModeType::EVMaximumDischargePower **AC_ChargeParameterDiscoveryReq**::BPT_AC_CPDReqEnergyTransferModeType::EVMaximumDischargePower **DC_ChargeLoopReq::**BPT_Dynamic_DC_CLReqControlModeType::EVMaximumDischargePower **AC_ChargeLoopReq::**BPT_Dynamic_AC_CLReqControlModeType::EVMaximumDischargePower	W	
	Minimum Discharging Power	**DC_ChargeParameterDiscoveryReq::**BPT_DC_CPDReqEnergyTransferModeType::EVMinimumDischargePower **AC_ChargeParameterDiscoveryReq::**BPT_AC_CPDReqEnergyTransferModeType::EVMinimumDischargePower **DC_ChargeLoopReq::**BPT_Dynamic_DC_CLReqControlModeType::EVMinimumDischargePower **AC_ChargeLoopReq::**BPT_Dynamic_AC_CLReqControlModeType::EVMinimumDischargePower	W	
	Present SoC	**AC_ChargeLoopReq::**DisplayParametersType::PresentSOC **DC_ChargeLoopReq**::DisplayParametersType::PresentSOC	Percent	Shall not be used to control a charge
	Minimum Energy Request	**AC_ChargeLoopReq::**Dynamic_CLReqControlModeType::EVMinimumEnergyRequest **AC_ChargeLoopReq::**Scheduled_AC_CLReqControlModeType::EVMinimumEnergyRequest **DC_ChargeLoopReq::**Dynamic_CLReqControlModeType::EVMinimumEnergyRequ	Wh	

		est **DC_ChargeLoopReq::**Scheduled_DC_CLReqControlModeType::EVMinimumEnergy Request **ScheduleExchangeReq::**Dynamic_SEReqControlModeType::EVMinimumEnergyRe quest **ScheduleExchangeReq::**Scheduled_SEReqControlModeType::EVMinimumEnergy Request	
	Target Energy Request	**ScheduleExchangeReq::**Dynamic_SEReqControlModeType::EVTargetEnergyRequ est **ScheduleExchangeReq::**Scheduled_SEReqControlModeType::EVTargetEnergyRe quest **AC_ChargeLoopReq::**Dynamic_CLReqControlModeType::EVTargetEnergyRequest **AC_ChargeLoopReq::**Scheduled_AC_CLReqControlModeType::EVTargetEnergyR equest **DC_ChargeLoopReq::**Dynamic_CLReqControlModeType::EVTargetEnergyRequest **DC_ChargeLoopReq::**Scheduled_DC_CLReqControlModeType::EVTargetEnergyR equest	Wh
	Maximum Energy Request	**ScheduleExchangeReq::**Dynamic_SEReqControlModeType::EVMaximumEnergyR equest **ScheduleExchangeReq::**Scheduled_SEReqControlModeType::EVMaximumEnergy Request **AC_ChargeLoopReq**::Dynamic_CLReqControlModeType::EVMaximumEnergyRequ est **AC_ChargeLoopReq::**Scheduled_AC_CLReqControlModeType::EVMaximumEnerg yRequest **DC_ChargeLoopReq**::Dynamic_CLReqControlModeType::EVMaximumEnergyRequ	Wh

		est **DC_ChargeLoopReq::**Scheduled_DC_CLReqControlModeType::EVMaximumEnergyRequest		
	V2X Warranty Constraints	**ScheduleExchangeReq**::Dynamic_SEReqControlModeType::EVMaximumV2XEnergyRequest **AC_ChargeLoopReq::**Dynamic_CLReqControlModeType::EVMaximumV2XEnergyRequest **DC_ChargeLoopReq::**Dynamic_CLReqControlModeType::EVMaximumV2XEnergyRequest **ScheduleExchangeReq::**Dynamic_SEReqControlModeType::EVMinimumV2XEnergyRequest **AC_ChargeLoopReq::**Dynamic_CLReqControlModeType::EVMinimumV2XEnergyRequest **DC_ChargeLoopReq::**Dynamic_CLReqControlModeType::EVMinimumV2XEnergyRequest	W	
	Discharging capable	**ServiceDiscoveryReq::**SupportedServiceIDs		
User	Departure Time	**ScheduleExchangeReq**::Dynamic_SEReqControlModeType::DepartureTime **ScheduleExchangeReq::**Scheduled_SEReqControlModeType::DepartureTime **ScheduleExchangeRes::**Dynamic_SEResControlModeType::DepartureTime **ScheduleExchangeRes::**Scheduled_SEResControlModeType::DepartureTime **DC_ChargeLoopReq::**Dynamic_DC_CLReqControlModeType::DepartureTime **DC_ChargeLoopRes**::Dynamic_DC_CLResControlModeType::DepartureTime **AC_ChargeLoopReq**::Dynamic_AC_CLReqControlModeType::DepartureTime **AC_ChargeLoopRes**::Dynamic_AC_CLResControlModeType::DepartureTime	Seconds	Optional

	Minimum SoC	**ScheduleExchangeReq**::Dynamic_SEReqControlModeType::MinimumSOC **ScheduleExchangeRes::**Dynamic_SEResControlModeType::MinimumSOC **AC_ChargeLoopReq**::DisplayParametersType::MinimumSOC **DC_ChargeLoopReq::**DisplayParametersType::MinimumSOC **AC_ChargeLoopRes::**Dynamic_AC_CLResControlModeType::MinimumSOC **DC_ChargeLoopRes::**Dynamic_DC_CLResControlModeType::MinimumSOC	Percent	Dynamic mode only
	Target State of Charge	**ScheduleExchangeReq::**Dynamic_SEReqControlModeType::TargetSOC **ScheduleExchangeRes::**Dynamic_SEResControlModeType::TargetSOC **AC_ChargeLoopReq::**DisplayParametersType::TargetSOC **DC_ChargeLoopReq**::DisplayParametersType::TargetSOC **AC_ChargeLoopRes::**Dynamic_AC_CLResControlModeType::TargetSOC **DC_ChargeLoopRes::**Dynamic_DC_CLResControlModeType::TargetSOC	Percent	Dynamic mode only
	Maximum SoC	**AC_ChargeLoopReq::**DisplayParametersType::MaximumSOC **DC_ChargeLoopReq::**DisplayParametersType::MaximumSOC	Percent	Shall not be used to control a charge
	Minimum Green Level	**ScheduleExchangeReq**::EVEnergyOfferType::EVAbsolutePriceSchedule::EVAbsolutePriceScheduleType::EVPriceRuleStackListType::PriceRuleStackListType::PriceRuleStackType::PriceRuleType::RenewableGenerationPercentage		

8.2.2.2 Gap analysis

The gap analysis reveals a comprehensive coverage of smart charging and V2X needs within the existing protocol. However, the analysis also brings to light some noteworthy gaps that require attention to enhance the protocol's functionality and adaptability:

- Grid codes to ensure compliance with local grid codes based on local grid measurements.
- V2X state of health to have information related to the remaining budget from the absolute V2X warranty constraints so that they can be included in the optimization problem.
- Round trip efficiency to avoid injection that can result in low charging power whereby the round-trip efficiency of the on-board inverter could be low.
- Allowance to discharge to get the explicit consent of the driver to perform bidirectional charging.
- EVSE active power in DC Charging.

The usage of the following parameters shall be explicitly defined in specifications of the different pilots:

- Departure Time to ensure that user mobility needs are covered.

8.3 EVSE – CPO/EMS Communication

8.3.1 OCPP 1.6

8.3.1.1 Data Coverage

The version used for this analysis is OCPP 1.6 edition 2 released in 2017.

	Data Object	Protocol Message	Unit /Format	Sender	Remark
Charging Station (CS)	Active Power	**MeterValues.Req**::MeterValue::SampledValue::Measurand::Power.Active.Import **StopTransactionReq**::MeterValue::SampledValue::Measurand::Power.Active.Import	W	CS	
	Composite Active Charging Profile	**SetChargingProfile.Req**::csChargingProfiles		CSMS	
	Charged Energy	**MeterValues.Req**::MeterValue::SampledValue::Measurand::Energy.Active.Import.Register **StopTransaction.Req**::MeterValue::SampledValue::Measurand::Energy.Active.Import.Register	Wh	CS	
EV	Present SoC	**MeterValues.Req**::MeterValue::SampledValue::Measurand::SoC **StopTransactionReq**::MeterValue::SampledValue::Measurand::SoC	Percent	CS	

8.3.1.2 Gap analysis

The analysis shows the absence of V2X parameters and a restricted set of smart charging data in OCPP 1.6. However, this was expected as the support of these features have been added to newer versions of the protocol and are not meant to be supported by this version according to OCA.

8.3.2 OCPP 2.0.1

8.3.2.1 Data Coverage

The version used for this analysis is OCPP 2.0.1 edition 2 released in 2022.

	Data Object	Protocol Message	Unit /Format	Sender	Remark
Charging Station (CS)	EVSE ID	**GetVariablesResponse** with **SecurityCtrlr**::Identity variable		CS	
	Maximum Charging Power	Use PhysicalComponents **GetVariablesResponse** with ChargingStation:: Power(MaxLimit) variable	W	CS	
	Active Power	**MeterValuesRequest**::MeterValueType::SampledValueType::MeasurandEnumType::Power.Active.Import **TransactionEventRequest**::MeterValueType::SampledValueType::MeasurandEnumType::Power.Active.Import	W	CS	
	Composite Active Charging Profile	**SetChargingProfileRequest**::ChargingProfileType		CSMS	

	Charged Energy	**MeterValuesRequest**::MeterValueType::SampledValueType::MeasurandEnumType::Energy.Active.Import.Register **TransactionEventRequest**::MeterValueType::SampledValueType::MeasurandEnumType::Energy.Active.Import.Register	Wh	CS
EV	Maximum Charging Power	**NotifyEVChargingNeedsRequest**::ChargingNeedsType::DCChargingParametersType::evMaxPower	Wh	CS
	Present SoC	**NotifyEVChargingNeedsRequest**::ChargingNeedsType::DCChargingParametersType::stateOfCharge **MeterValuesRequest**::MeterValueType::SampledValueType::MeasurandEnumType::SoC **TransactionEventRequest**::MeterValueType::SampledValueType::MeasurandEnumType::SoC	Percent	CS
	Target Energy Request	**NotifyEVChargingNeedsRequest**::ChargingNeedsType::DCChargingParametersType::energyAmount	Wh	CS
User	User ID	**AuthorizeRequest**::idToken		
	Departure Time	**NotifyEVChargingNeedsRequest**::ChargingNeedsType::departureTime	RFC3339	CS
	Maximum SoC	**NotifyEVChargingNeedsRequest**::ChargingNeedsType::fullSoC	Percent	CS

	Minimum Green Level	**ReportChargingProfilesRequest**::ChargingProfileType::ChargingScheduleType::SalesTariffType::SalesTariffEntryType::ConsumptionCostType::CostType::costKind	CostKindEnumType	CS

8.3.2.2 Gap analysis

The gap analysis reveals a comprehensive coverage of smart charging needs within the existing protocol. However, the analysis also brings to light some noteworthy gaps that require attention to enhance the protocol's functionality and adaptability:

- EV minimum charge power to adapt the power delivered by the EVSE according to the minimum charging power supported by the vehicle.
- EV Minimum and maximum Energy Request to ensure that mobility needs are met.
- Priority charging to know if the user is allowed overrule smart of bidirectional charging at any time and switch to the maximum charging speed directly.
- Minimum and target state of charge requested by the EV to ensure that mobility needs are met.
- Session ID to link a charging schedule to an active charging transaction.

Finally, the analysis shows the absence of V2X parameters in OCPP 2.0.1. However, this was expected as V2X support is meant to be added in OCPP 2.1.

8.3.3 OCPP 2.1

8.3.3.1 Data Coverage

The version used for this analysis is OCPP 2.1 Draft v0.41 released in 2023.

	Data Object	Protocol Message	Unit /Format	Sender	Remark
Charging Station (CS)	Grid Code Coordinates	**SetChargingProfileRequest::**ChargingProfileType::ChargingScheduleType::ChargingSchedulePeriodType::v2xFreqWattCurve::V2XFreqWattEntryType **SetChargingProfileRequest::**ChargingProfileType::ChargingScheduleType::ChargingSchedulePeriodType::v2xSignalWattCurve::V2XSignalWattEntryType		CSMS	
	EVSE ID	**GetVariablesResponse** with **SecurityCtrlr**::Identity variable		CS	
	Maximum Charging Power	NotifyEVChargingNeedsRequest::V2XChargingParametersType::maxChargePower	W	CS	
	Active Power	**MeterValuesRequest**::MeterValueType::SampledValueType::MeasurandEnumType::Power.Active.Import **TransactionEventRequest**::MeterValueType::SampledValueType::MeasurandEnumType::Power.Active.Import **ReportChargingProfilesRequest**::ChargingScheduleType::ChargingSchedulePeriodType::limit	Wh	CS	
	Composite Active	**SetChargingProfileRequest**::ChargingProfileType		CSMS	

	Charging Profile			
	Charged Energy	**MeterValuesRequest**::MeterValueType::SampledValueType::MeasurandEnumType::Energy.Active.Import.Register **TransactionEventRequest**::MeterValueType::SampledValueType::MeasurandEnumType::Energy.Active.Import.Register	Wh	CS
	Discharged Energy	**MeterValuesRequest::**MeterValueType**::**SampledValueType::MeasurandEnumType::Energy.Active.Export.Register **TransactionEventRequest::**MeterValueType::SampledValueType::MeasurandEnumType::Energy.Active.Export.Register	Wh	CS
EV	Maximum Charging Power	**NotifyEVChargingNeedsRequest**::ChargingNeedsType::DCChargingParametersType::evMaxPower **NotifyEVChargingNeedsRequest**::ChargingNeedsType::V2XChargingParametersType::maxChargePower	W	CS
	Minimum Charging Power	**NotifyEVChargingNeedsRequest::**ChargingNeedsType::V2XChargingParametersType::minChargePower	W	CS
	Maximum Discharging Power	**NotifyEVChargingNeedsRequest::**ChargingNeedsType::V2XChargingParametersType::maxDischargePower	W	CS

	Minimum Discharging Power	**NotifyEVChargingNeedsRequest::**ChargingNeedsType::V2XChargingParametersType::minDischargePower	W	CS
	Present SoC	**NotifyEVChargingNeedsRequest::**ChargingNeedsType::DCChargingParametersType::stateOfCharge	Percent	CS
	Minimum Energy Request	**MeterValuesRequest::**MeterValueType::SampledValueType::MeasurandEnumType::EnergyRequest.Minimum **TransactionEventRequest::**MeterValueType::SampledValueType::MeasurandEnumType::EnergyRequest.Minimum	Wh	CS
	Target Energy Request	**MeterValuesRequest::**MeterValueType::SampledValueType::MeasurandEnumType::EnergyRequest.Target **TransactionEventRequest::**MeterValueType::SampledValueType::MeasurandEnumType::EnergyRequest.Target	Wh	CS
	Maximum Energy Request	**MeterValuesRequest::**MeterValueType::SampledValueType::MeasurandEnumType::EnergyRequest.Maximum **TransactionEventRequest::**MeterValueType::SampledValueType::MeasurandEnumType::EnergyRequest.Maximum	Wh	CS
	V2X Warranty Constraints	**NotifyEVChargingNeedsRequest::**ChargingNeedsType::V2XChargingParametersType::evMinV2XEnergyRequest **NotifyEVChargingNeedsRequest::**ChargingNeedsType::V2XChargingParametersType::evMaxV2XEnergyRequest	Wh	CS

	Discharging capable	**NotifyEVChargingNeedsRequest::**ChargingNeedsType::EnergyTransferModeEnumType	Wh	CS	
User	User ID	**AuthorizeRequest**::idToken		CS	
	Departure Time	**NotifyEVChargingNeedsRequest::**ChargingNeedsType::departureTime	Seconds	CS	
	Minimum State of Charge	**NotifyEVChargingNeedsRequest::**ChargingNeedsType::V2XChargingParametersType::evMinEnergyRequest	Percent	CS	Need conversion with battery capacity
	Target State of Charge	**NotifyEVChargingNeedsRequest::**ChargingNeedsType::V2XChargingParametersType::evTargetEnergyRequest	Percent	CS	Need conversion with battery capacity
	Maximum State of Charge	**NotifyEVChargingNeedsRequest::**ChargingNeedsType::V2XChargingParametersType::evMaxEnergyRequest	Percent	CS	Need conversion with battery capacity
	Discharging allowed	**AuthorizeResponse**::allowedEnergyTransfer		CS	

	Priority charging	**UsePriorityChargingRequest**::activate	Boolean	CS
	Minimum Green Level	**NotifyEVChargingScheduleRequest::**ChargingProfileType::ChargingScheduleType::SalesTariffType::SalesTariffEntryType::ConsumptionCostType::CostType::costKind		CS

8.3.3.2 Gap analysis

The gap analysis reveals a comprehensive coverage of smart charging and V2X needs within the existing protocol. However, the analysis also brings to light some noteworthy gaps that require attention to enhance the protocol's functionality and adaptability:

- Session ID to link a charging schedule to an active charging transaction.
- V2X state of health to have information related to the remaining budget from the absolute V2X warranty constraints so that they can be included in the optimization problem.
- Tariffs overrule capacity
- Round trip efficiency to avoid injection that can result in low charging power whereby the round-trip efficiency of the on-board inverter could be low.

8.4 CPO – SCSP/MSP communication

This link is used for communication between MSP and CSMS as well as SCSP and CSMS whereby the MSP represents the EV driver within the e-mobility ecosystem. Thereby the MSP should send to the CSMS the driver related via OCPI in the case some actor other than the MSP is the FSP (example departure times, SoC settings, priority charging....). The driver should also be able to be informed on the status of a charging session, on achievements (savings etc) from a (smart) charging session.... This means that the MSP can also acts as a data consumer for certain use cases and get information from the CPO.

8.4.1 OCPI 2.2.1

8.4.1.1 Data Coverage

The version used for this analysis is 2.2.1 published in June 2021.

	Data Object	Protocol Message	Unit /Format	Remark
Site	Consumption Retail Tariff	**Tariff::**elements::price_components		
	Grid connection capacity	**EVSE::**connectors::max_electric_power	W	
		EVSE::connectors::max_amperage	A	
	Active grid power	**Session::**charging_periods::dimensions::volume	W	
		CDR::charging_periods::dimensions::volume	W	

	Location	**Location::**coordinates		
	Contracted power	**EVSE::**connectors::max_electric_power	W	
	Capacity Tariff	**PriceComponent**	currency/kWh	Use type=ENERGY
	Site EAN	**Session::**meter_id		
		CDR::meter_id		
	BSP ID (EAN)	**Location::**energy_mix::supplier_name		
Charging Station (CS)	EVSE ID	**EVSE::**uid		
		EVSE::evse_id		
	Maximum Charging Power	EVSE::connectors::max_electric_power	W	
	Active Power	**Session::**charging_periods::dimensions::volume	W	
		CDR::charging_periods::dimensions::volume	W	
	Session ID	**Session::**id		
		CDR::id		

	Composite Active Charging Profile	**ActiveChargingProfileResult::**profile	
	Charged Energy	**Session::**kwh	Wh
		CDR::total_energy	Wh
		Session::charging_periods::dimensions::volume	Wh
		CDR::charging_periods::dimensions::volume	Wh
	Discharged Energy	**Session::**charging_periods::dimensions::volume	Wh
		CDR::charging_periods::dimensions::volume	Wh
EV	Target Energy Request	**ChargingPreferences::**energy_need	Wh
User	User ID	**Session**::cdr_token::uid	
		CDR::cdr_token::uid	
		Session::cdr_token::contract_id	
		CDR::cdr_token::contract_id	
		Token::uid	

		Token::contract_id	
	Departure Time	**ChargingPreferences::**departure_time	
	Discharging allowed	**ChargingPreferences::**discharge_allowed	boolean

8.4.1.2 Gap analysis

The gap analysis reveals a comprehensive coverage of smart charging needs within the existing protocol. However, the analysis also brings to light some noteworthy gaps that require attention to enhance the protocol's functionality and adaptability:

- Local frequency to comply with local grid codes.
- Local Voltage to comply with local grid codes.
- Feed-in/injection tariff to optimize the charging cost while meeting charging needs.
- Capacity Period
- Highest measured peak consumption
- BRP ID to facilitate BSP switching processes.
- EV related Data to optimize the charging session and follow the EV constraints.

The analysis also shows the absence of V2X parameters in OCPI 2.2.1. However, this was expected as V2X support is meant to be added to OCPI 3.0. Finally, most of EV-related data is missing. We will discuss the impact on data flow in section 11.4

8.4.2 OCPI 3.0

The EVRoaming Foundation is working on OCPI 3.0 to handle V2X parameters. As there was no available draft version of the specification when this document was written, the analysis was not performed: this study will be done at a later stage if this version is released before the end of the project.

8.5 Conclusion

In conclusion, the assessment of existing and emerging protocols for smart charging reveals that initial gaps identified in earlier versions of protocols have been addressed in their newer iterations. The strides made in refining these protocols demonstrate a commitment to enhancing interoperability and functionality within the e-mobility ecosystem. While most deficiencies pertaining to smart charging have been effectively bridged in the latest releases, a few gaps persist, particularly concerning V2G services.

The analysis also shows the importance of defining the use cases that need to be covered by OCPI. On the one hand, OCPI is already used in the electromobility ecosystem, so it may be relevant to extend the protocol to share flexibility information. On the other hand, it may lead to a complex protocol that can slow down its implementation. In the energy field, some protocols are under development, such as FlexOffer or OpenADR, which may be more adapted to cover the requirements.

Consequently, this analysis is subject to updates following the introduction of OCPI 3.0 but also the final release of OCPP 2.1.

9 Protocols extensions

The proposed solutions focus solely on extending messages without introducing entirely new ones. Furthermore, we adhere to a principle of judiciously incorporating additional fields only when they are absent in the current version of the protocol. If a more recent version of the protocol already includes specific fields, we will not add them to our proposed extensions to avoid redundancy. We also detail how the data currently available can be used to deduce information that is not explicitly present in the messages. These decisions not only ensure streamlined messaging but also promote compatibility with evolving protocol standards.

Regarding ISO 15118 extensions, we decided to propose additions to ISO 15118-2 even if ISO 15118-20 has been released. We see that the deployment of ISO 15118-20 on the field is complex, mostly due to cybersecurity constraints. To maximize the feedback from pilots' experimentation on smart charging use cases, ISO 15118-2 can be used with the proposed customized messages.

This document will not define extensions for OCPI as the required extensions will likely be part of the upcoming new version.

This section lists the impacted messages for each protocol. XML and JSON schemas are available in the appendix to ease the implementation.

9.1 ISO 15118-2

The proposed extensions of ISO 15118-2 messages consider the content of ISO 15118-20 to avoid redundancy. So, we only propose to fill gaps for smart charging use case as V2X use case is covered by a more recent version. The schemas are available in section 13.1.

To optimize the charging process, the EVSE needs to get the maximum and minimum energy request from the EV and the corresponding maximum and minimum SoC. This data can be added to the **ChargeParameterDiscoveryReq** message sent by the EV. As the content of this message is different for AC and DC charging, it shall be added in both cases.

To maximize the delivered powered in AC charging, the EVSE requires the maximum charging power supported by the EV. This can be added in **ChargeParameterDiscoveryReq** message for AC.

9.2 ISO 15118-20

The gap analysis performed in section 8.3 pointed out the need to transmit grid codes to the EV to perform bidirectional charging. There is currently a working group led by CharIN who is working on this topic, so we will not propose a way to fill this gap. This is not an issue for the pilots of SCALE because each pilot can retrieve the constraints from the country where the pilot takes place. We will analyze the content of CharIN proposal when it will be available.

Most of the gaps concern discharging capability. The EVSE needs to get from the EV the V2X state of health and round-trip efficiency. They can be added to **AC_ChargeParameterDiscoveryReq** and **DC_ ChargeParameterDiscoveryReq.** Then, the EV needs to get the active power measured by the EVSE. This data is currently not available in AC so it shall be added to **AC_ChargeLoopRes** message.

The messages do not contain explicitly a flag saying if the discharge is allowed by the driver or not. In this case, the EV shall remove bidirectional charging from the supported services sent to the EVSE.

The schemas are available in section 13.2.

9.3 OCPP 2.0.1

The proposed extensions of OCPP 2.0.1 messages consider the content of OCPP 2.1 to avoid redundancy. So, we only propose to fill gaps for smart charging use cases as V2X use cases are covered by a more recent version. The schemas are available in section 13.3.

The message mainly impacted is **NotifyEVChargingNeedsRequest** to provide missing EV information to the CPO. The EV minimum charging power for both AC and DC, the EV maximum charging power in AC (already present in DC), the minimum energy request and the corresponding SoC of the EV, its maximum energy request and the targeted SoC at the end of the charging session.

To be able to track the sessions, the CPO also requires the session ID of the current charging session. This information can be obtained using the **TransactionEventRequest** message. When communication with EV is established, the EVSE can add this information to **TransactionEventRequest** with the status Started or Updated.

9.4 OCPP 2.1

As for OCPP 2.0.1, the id of the ongoing sessions is needed by the CPO. It can be added to the **TransactionEventRequest** message in the same conditions described in paragraph 9.3.

Specific information related to discharge capabilities shall be added to the **NotifyEVChargingNeedsRequest** message. The CPO shall know the V2X state of health of the car and the round-trip efficiency.

The schemas are available in section13.4.

9.5 OCPI 2.2.1

This document does not propose extensions for OCPI 2.2.1 because the missing parameters listed in paragraph 8.4.1.2 are not mandatory to implement energy services or because they are needed for V2X use cases. The V2X use cases will be covered by OCPI 3.0.

The local frequency, the local voltage, and the feed-in injection tariff are used in V2X use cases. Then, the capacity period and the highest measured peak consumption are provided by the DSO and the DSO is not part of the actors using OCPI now. The SCSP can retrieve this information using communication channels other than OCPI. The BRP ID can be shared to facilitate the BSP switching processus, so it is not mandatory to deliver the service. This need will be pushed to the current work for OCPI 3.0. Finally, EV related data is missing but the SCSP can indirectly get the EV constraints by getting the charging profile of the session from the CPO. This mechanism is described in section 11.4.

10 Required protocols for energy services

In the dynamic landscape of energy services, the efficient exchange of information is paramount for ensuring optimal functionality. To achieve this, the need for systematic mapping of the data required for energy services becomes imperative. Mapping data facilitates a comprehensive understanding of the diverse information elements essential for the seamless operation of energy-related systems. Furthermore, it lays the groundwork for defining the necessary communication protocols that enable the exchange of information among different systems within the energy infrastructure. This process not only enhances the interoperability of various energy services but also establishes a foundation for innovation and integration of emerging technologies, ultimately contributing to a more resilient, responsive, and interconnected energy ecosystem. Based on the gap analysis of section 8, this section aims to define the minimum version of the protocol required to enable the different services.

All the services used in the data analysis of D2.2 can rely on both charging and discharging features. Depending on the pilots' constraints and objectives, they will use only V1G or both V1G and V2G. This document defines the required protocols for the different possible implementations.

10.1 V1G based services

The V1G based services need to either charge or smart charge EVs. To do so, the protocols used shall implement charging control and charging profiles control. The protocols given in the following table support these features.

Link	Protocol
EV <-> EVSE	ISO 15118-2 ✓ ISO 15118-20 ✓
EVSE <-> CPO	OCPP 1.6 ✓ (with limitation) OCPP 2.0.1 ✓ OCPP 2.1 ✓
CPO <-> FSP	OCPI 2.2.1 ✓ OCPI 3.0 ✓

ISO 15118-2 both addresses the communication protocol for AC and DC charging and implements security mechanisms unlike DIN 70121. It incorporates authentication and encryption protocols. These mechanisms implement requirements FR.DL.03, FR.DL.11, and FR.CR.06 defined in D2.2.

OCPP 1.6 offers limited charging functionalities: the transition from OCPP 1.6 to OCPP 2.0.1 provides support for advanced charging functionalities. OCPP 2.0.1 introduces features such as dynamic charging, enabling more flexible and efficient energy management. Dynamic charging allows for real-time adjustments to charging parameters based on factors like grid conditions, energy prices, and user preferences. This capability provides a more intelligent and adaptive charging system, optimizing the use of available resources. Moreover, OCPP 2.0.1 introduces native support of ISO 15118-2 capabilities on authentication and smart charging.

Additionally, OCPP 2.0.1 offers improved security mechanisms compared to OCPP 1.6. OCPP 2.0.1 incorporates enhanced authentication and encryption protocols. These mechanisms are partially implemented in OCPP 1.6 security whitepaper. Implementing one of these two protocols fulfills requirements FR.DL.04, FR.DL.11, and FR.CR.06.

Finally, as OCPP 1.6 will not undergo further evolution according to OCA, we encourage all parties involved to consider transitioning to OCPP 2.0.1 for long-term sustainability.

10.2 V2G based services

The V2G based services need to either charge, discharge, smart charge or smart discharge EVs. To do so, the protocols used shall implement charging and discharging control and discharging profiles control. The following table explains the protocols that natively support these features and those who do not.

Link	Protocol
EV <-> EVSE	ISO 15118-2 ✗ ISO 15118-20 ✓
EVSE <-> CPO	OCPP 1.6 ✗ OCPP 2.0.1 ✗ OCPP 2.1 ✓
CPO <-> FSP	OCPI 2.2.1 ✓ (with limitation) OCPI 3.0 ✓

ISO 15118-20, released in April 2022, is a communication protocol for AC and DC discharging, instead of ISO 15118-2 that only addresses AC and DC charging. As communication link encryption is mandatory in this protocol, the requirements FR.DL.03, FR.DL.11, and FR.CR.06 are fulfilled.

OCPP 2.1 provides the support of discharging capabilities and native integration of ISO 15118-20. This protocol is under development: draft versions are available for OCA members to come up with early implementations.

OCPI 3.0 is currently under development by the EV Roaming Foundation, so there is no sharable draft for early implementers. The missing data for smart charging and the required data for V2X will be given to the EV Roaming foundation as inputs for the new version. So OCPI 2.2.1 shall be used instead with some missing data for V2G services as described in paragraph 8.4.1.

11 Data journey

In the intricated e-mobility ecosystem, understanding the dynamic flow of data is paramount for optimizing operations and ensuring seamless interactions among various actors. This section aims to unravel the complex web of data flow within the ecosystem by employing detailed graphs. These graphs depict the journey of data, categorizing it into distinct groups to enhance readability. As we delve into the intricacies of the e-mobility data flow, the primary objective is to illuminate the path from data source to data consumer, elucidating the roles of intermediate systems along the way. By visually mapping out this comprehensive data flow, we seek to provide valuable insights into the interplay of information across the ecosystem.

This section only focuses on data present on Start, Ongoing and End of charge information defined in D2.2 and that can be exchanged using protocols. All data sent using proprietary protocols are not described in this document. For example, the FSP can directly retrieve information from the EV Driver just before a charging session.

The onboarding data are static, so they do not need to be updated all through the charging process. They shall be exchanged before charging sessions.

11.1 Data categories

The figures presented in this section aim to explain the data journey. To have comprehensive diagrams, data are grouped into categories based on the links and the usage of these data by the different actors. The data labels come from D2.2. As a reminder, a definition for non-obvious data labels extracted from D2.2 is added.

The following categories have been defined:

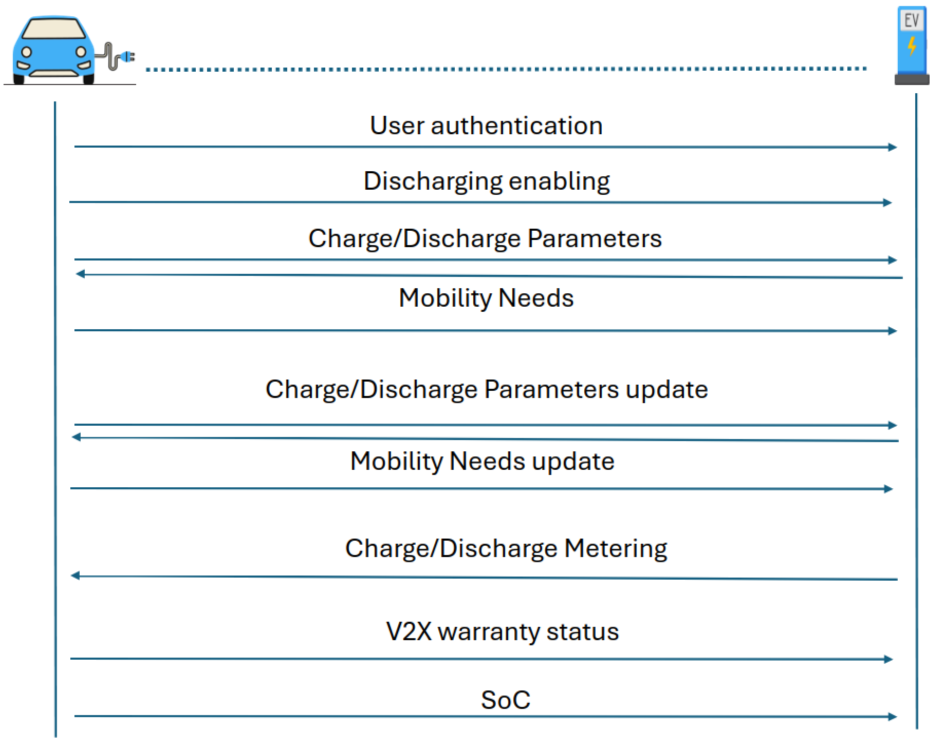
- **Charge Parameters**
  - EVSE maximum charging power
  - EVSE Active Power
  - EV maximum charging power
  - EV minimum charging power
  - EV minimum energy request
  - EV target energy request
  - EV maximum energy request
  - EV present SoC
  - Composite charging schedule: The resulting charging profile as computed by the charging station considering all received charging profiles and local grid limitations.
- **Discharge Parameters**
  - EV maximum discharge power
  - EV minimum discharge power
  - Round trip efficiency: Round trip efficiency of the onboard inverter for charging and discharging.
- **Mobility Needs**
  - Departure Time
  - Minimum SoC: The minimum state of charge to guarantee an available range for emergency leaves.

  - Target SoC: The state of charge that must be reached at the end of the charging session.
  - Maximum SoC: The state of charge that cannot be exceeded to avoid battery degradation.
  - Priority charging: Parameter to indicate whether the driver wants to charge as fast as possible for the active charging session.
  - Minimum Green Level: The minimum percentage of local green energy that the user wants for charging to take place at any point in time.
  - Tarriff Overrule: Possibility to overrule the tariff calculation.
- **Discharging enabling**
  - Discharging capable
  - Discharging allowed by user
- **Metering**
  - Charged Energy
  - Discharged Energy
- **V2X Warranty**
  - V2X Warranty constraints: Absolute discharging limitations overtime imposed by the OEM.
  - V2X state of health: The remaining budget from the V2X warranty constraints.
- **EVSE identification**
  - EVSE ID: The unique identifier of EVSE from the charging station.
  - Site EAN: Unique identifier of the grid connection point.
- **Capacity constraints**
  - Contracted power: Yearly contracted capacity for the grid connection.
  - Capacity Tarriff: Tariff of capacity for the site.
  - Capacity period: Period over which the highest peak power is measured for capacity tariff billing purposes.

11.2 EV/EVSE Link

This link relies on ISO 15118. This protocol can be used for the following control topologies:

- EV is the FSP. In this case the EV is the data consumer which requires that the EVSE provides all data to which the EV has no direct access to.
- A third party is the FSP. The EV must provide access to all data related to the EV data object to the EVSE so the EVSE can provide it to the FSP.



Starting and ending data is transmitted once during the charging session by the EV to the EVSE. On this link, the starting data is user authentication, charge parameters and mobility needs. If a bidirectional charge is performed, the discharging enabling and discharge parameters data shall also be sent. The mobility needs are transmitted before the power exchange to allow the charging station to compute a charging schedule according to the EV constraints. The EV driver can be identified through the eMAID of the contract installed into the car if a Plug and Charge authorization is used. Otherwise, another way to identify the user shall be used.
At the end of the session, the EV Status of Charge and possibly the warranty status in case of a bidirectional charging is transmitted.

The data sent during the charging session has different frequency updates, based on ISO 15118 requirements. The ISO 15118 defines two types of timers for the messages: timeouts and performance timings. If a timeout time is exceeded, the related error handling is initiated. If a performance time is exceeded, no error may occur but the probability of causing a timeout is high. We will compute the following delays for both types of timings.

During the charging loop, a message is sent by the EV each 250 milliseconds maximum for DC charging and each 2 seconds maximum for AC charging according to timeout. If we use the performance timers, these delays decrease to 25 milliseconds for DC charging and 1,5 seconds for AC charging. These timings represent the maximum delay for the charging station to be informed of a change in the EV mobility needs.

For the metering information, the EV shall reply within 2 seconds (timeout) or 1,5 seconds (performance) to the charging station.

To change the charging or discharging parameters, we shall differentiate the mechanisms available in ISO 15118-2 and ISO 15118-20. In ISO 15118-2, the session is based on a schedule, this means the EV and the EVSE shall renegotiate a schedule if the parameters have changed.
In ISO 15118-20, the session can be based on a schedule, but it can also be handled dynamically by the charging station. When a schedule is used, if the EV wishes to change the charging or discharging parameters, it shall use a renegotiation mechanism. To do so, several messages shall be exchanged on the link. For a DC charge, the maximum delay for the EVSE to get the new data is 7 seconds in the worst case (timeout) and 6 seconds (performance time). The EVSE may also wish to change the charging or discharging parameters to apply a change requested by the CPO. The same renegotiation mechanism will be used with the same timing constraints.

When the charge is handled by the charging station, the parameters can be updated when the EVSE receives them from the CPO.

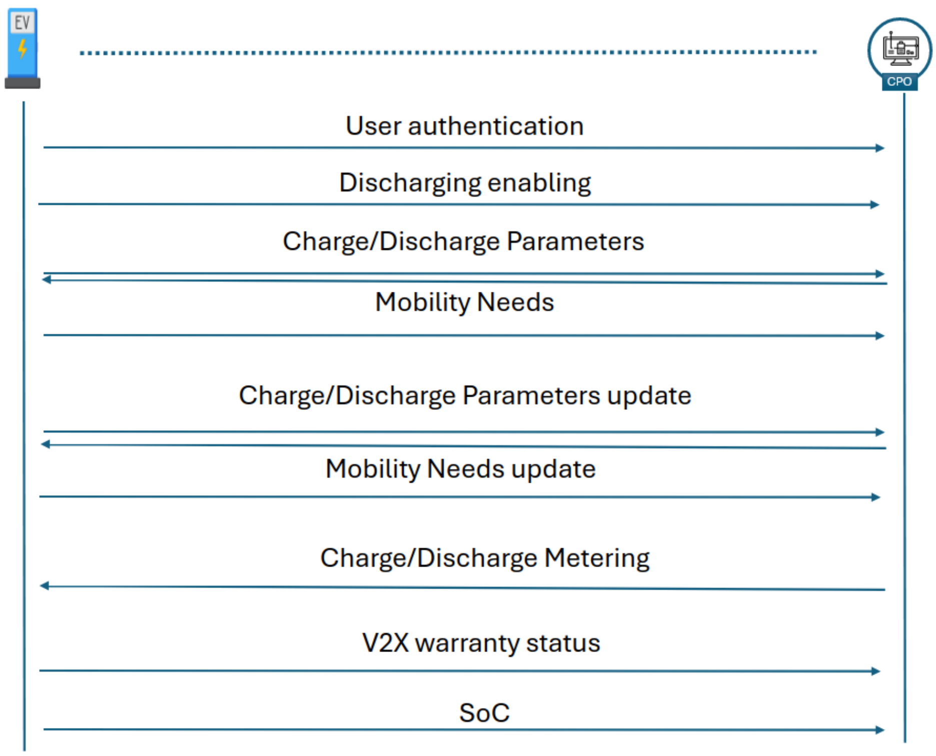
11.3 EVSE/CPO/EMS Link

This link relies on OCPP. This protocol can be used for the following control topologies:

- CSMS is the FSP. The EVSE provides EVSE and EV related data to the CSMS and receives back charging schedules or setpoints to be executed. It secondly also needs to act as sensor of dynamic site related data such as grid measurements towards the CSMS.
- EMS is the FSP. The EVSE provides EVSE and EV related data to the CSMS and receives charging schedules or setpoints to be executed.
- EVSE is the FSP. The EVSE needs to collect site-related data such as electricity tariffs and inform other actors on ongoing charging sessions.

All data received by the EVSE from the EV is transmitted to the CPO. This flow is displayed in the figure below.

From the CPO point of view, the OCPP constraints and the required time by the EVSE to compute EV data shall be added to ISO 15118 timing constraints to get all required information. From the EVSE point of view, the time needed by the CPO to process the received messages can lead to blocking issues. The CPO needs to interact with secondary systems to authorize the charge, retrieve composite schedules and send them to station, etc. ... So, the reactivity of the CPO depends on the reactivity of other systems.

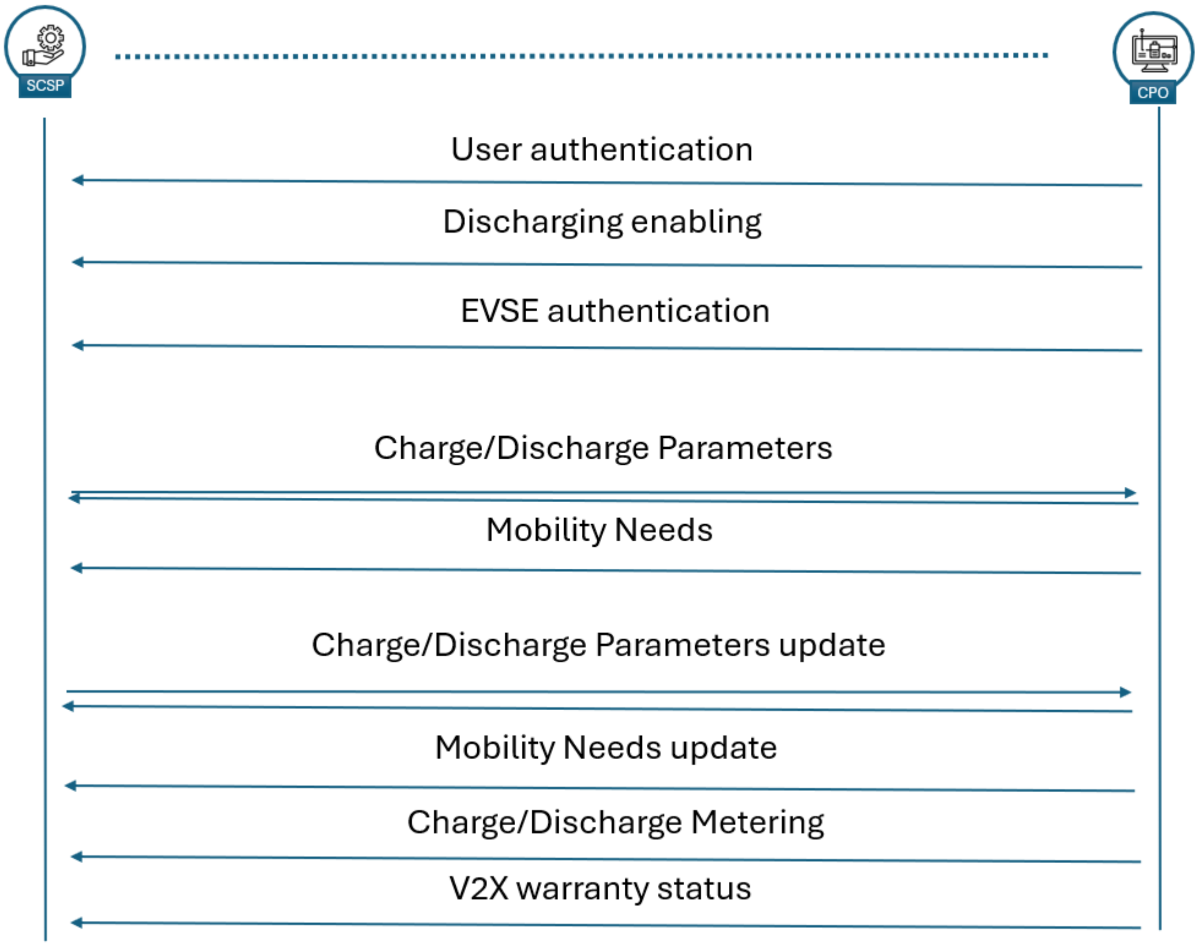


OCPP does not define timeouts or performance timings as defined in ISO 15118. Then, we are not able to estimate the worst-case response time.

11.4 CPO/SCSP/MSP Link

This link is used for communication between MSP and CSMS as well as SCSP and CSMS whereby the MSP represents the EV driver within the e-mobility ecosystem. Thereby the MSP should send to the CSMS the driver related data via OCPI in the case some actor other than the MSP is the FSP (example departure times, SoC settings, priority charging....). The driver should also be able to be informed on the status of a charging session, on achievements (savings etc.) from a (smart) charging session.... This means that the MSP can also act as a data consumer for certain use cases and get information from the CPO.

As shown in the gap analysis, the SCSP cannot retrieve the EV charging parameters to compute a charging profile. It can propose a profile based on the driver's departure time and the energy request he requests. Then the SCSP, or any other actor using OCPI and aims to send a charging profile to the station, shall retrieve the active charging profile to consider the EV constraints. Then this profile can be sent to the CPO and then the EVSE to be sent back to the EV. It can only compute schedules based on tariff constraints



12 Conclusions

In conclusion, this document has successfully defined extended versions of protocols to enable energy services. The outputs of this report will serve as a guide for pilots to develop interoperable systems and to understand which data they need to handle with the associated constraints.

Recognizing that the standardization process is inherently a lengthy one, it becomes crucial for stakeholders to anticipate future needs and actively provide input to shape upcoming versions of protocols. This forward-thinking approach is essential to ensure that protocols remain adaptable and responsive to the evolving demands of the e-mobility market.

As the sector continues to expand and integrate with emerging technologies, the importance of open protocols cannot be overstated. Their role in maximizing interoperability, keeping an open market, and encouraging competition remains crucial. Stakeholders must remain vigilant, actively participating in the ongoing evolution of protocols to ensure a resilient and future-ready e-mobility ecosystem.

It is important to note that the FSP stands at the top of the chain, gathering information from various actors. The protocols play an indispensable role in facilitating seamless communication and data exchange between these diverse entities. The efficiency and reliability of protocols has become paramount in enabling the FSP to perform its central function effectively.

In essence, this document provides a snapshot of the current state of protocols in the e-mobility sector, recognizing achievements, acknowledging challenges, and showing the importance of collaboration within the industry.

13 Appendix

This section contains the updated schemas in XML for ISO 15118 and JSON for OCPP of extended messages and/or data structures.

13.1 ISO 15118-2

The structures AC_EVChargeParameter and DC_EVChargeParameter are used in ChargeParameterDiscoveryReq.

```
<xs:element name="EVChargeParameter" type="EVChargeParameterType" abstract="true"/>
<xs:element name="AC_EVChargeParameter" type="AC_EVChargeParameterType" substitutionGroup="EVChargeParameter"/>
<xs:complexType name="AC_EVChargeParameterType">
	<xs:complexContent>
		<xs:extension base="EVChargeParameterType">
			<xs:sequence>
				<xs:element name="EAmount" type="PhysicalValueType"/>
				<xs:element name="EVMaxVoltage" type="PhysicalValueType"/>
				<xs:element name="EVMaxCurrent" type="PhysicalValueType"/>
				<xs:element name="EVMaxPower" type="PhysicalValueType"/>
				<xs:element name="EVMinCurrent" type="PhysicalValueType"/>
				<xs:element name="EVMaxEnergyRequest" type="PhysicalValueType"/>
				<xs:element name="EVMinEnergyRequest" type="PhysicalValueType"/>
				<xs:element name="EVMaxSoc" type="PhysicalValueType"/>
				<xs:element name="EVMinSoc" type="PhysicalValueType"/>
			</xs:sequence>
		</xs:extension>
	</xs:complexContent>
</xs:complexType>

<xs:element name="DC_EVChargeParameter" type="DC_EVChargeParameterType"
substitutionGroup="EVChargeParameter"/>
<xs:complexType name="DC_EVChargeParameterType">
	<xs:complexContent>
		<xs:extension base="EVChargeParameterType">
		<xs:sequence>
			<xs:element name="DC_EVStatus" type="DC_EVStatusType"/>
			<xs:element name="EVMaximumCurrentLimit" type="PhysicalValueType"/>
			<xs:element name="EVMaximumPowerLimit" type="PhysicalValueType" minOccurs="0"/>
			<xs:element name="EVMaximumVoltageLimit" type="PhysicalValueType"/>
			<xs:element name="EVEnergyCapacity" type="PhysicalValueType" minOccurs="0"/>
			<xs:element name="EVEnergyRequest" type="PhysicalValueType" minOccurs="0"/>
			<xs:element name="EVMaxEnergyRequest" type="PhysicalValueType"/>
			<xs:element name="EVMinEnergyRequest" type="PhysicalValueType"/>
```

```
                <xs:element name="FullSOC" type="percentValueType" minOccurs="0"/>
                <xs:element name="BulkSOC" type="percentValueType" minOccurs="0"/>
                <xs:element name="EVMaxSoc" type="PhysicalValueType"/>
                <xs:element name="EVMinSoc" type="PhysicalValueType"/>
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
```

13.2 ISO 15118-20

The structures BPT_AC_CPDReqEnergyTransferModeType and BPT_DC_CPDResEnergyTransferModeType are used respectively in AC_ChargeParameterDiscoveryReq and DC_ChargeParameterDiscoveryReq.

```
<xs:element name="BPT_AC_CPDReqEnergyTransferMode" type="BPT_AC_CPDReqEnergyTransferModeType"
substitutionGroup="AC_CPDReqEnergyTransferMode"/>
<xs:complexType name="BPT_AC_CPDReqEnergyTransferModeType">
    <xs:complexContent>
        <xs:extension base="AC_CPDReqEnergyTransferModeType">
            <xs:sequence>
                <xs:element name="EVMaximumDischargePower" type="v2gci_ct:RationalNumberType"/>
                <xs:element name="EVMaximumDischargePower_L2" type="v2gci_ct:RationalNumberType"
                minOccurs="0"/>
                <xs:element name="EVMaximumDischargePower_L3" type="v2gci_ct:RationalNumberType"
                minOccurs="0"/>
                <xs:element name="EVMinimumDischargePower" type="v2gci_ct:RationalNumberType"/>
                <xs:element name="EVMinimumDischargePower_L2" type="v2gci_ct:RationalNumberType"
                minOccurs="0"/>
                <xs:element name="EVMinimumDischargePower_L3" type="v2gci_ct:RationalNumberType"
                minOccurs="0"/>
                <xs:element name="RemainingV2GEnergy" type="v2gci_ct:RationalNumberType"/>
                <xs:element name="RoundTripEfficiency" type="v2gci_ct:RationalNumberType"/>
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>

<xs:element name="BPT_DC_CPDResEnergyTransferMode" type="BPT_DC_CPDResEnergyTransferModeType"
substitutionGroup="DC_CPDResEnergyTransferMode"/>
<xs:complexType name="BPT_DC_CPDResEnergyTransferModeType">
    <xs:complexContent>
        <xs:extension base="DC_CPDResEnergyTransferModeType">
```

```
            <xs:sequence>
                <xs:element name="EVSEMaximumDischargePower" type="v2gci_ct:RationalNumberType"/>
                <xs:element name="EVSEMinimumDischargePower" type="v2gci_ct:RationalNumberType"/>
                <xs:element name="EVSEMaximumDischargeCurrent" type="v2gci_ct:RationalNumberType"/>
                <xs:element name="EVSEMinimumDischargeCurrent" type="v2gci_ct:RationalNumberType"/>
                <xs:element name="RemainingV2GEnergy" type="v2gci_ct:RationalNumberType"/>
                <xs:element name="RoundTripEfficiency" type="v2gci_ct:RationalNumberType"/>
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
```

The structure Dynamic_AC_CLReqControlModeType is used in AC_ChargeLoopRes.

```
<xs:complexType name="BPT_Dynamic_AC_CLReqControlModeType">
<xs:complexContent>
    <xs:extension base="Dynamic_AC_CLReqControlModeType">
        <xs:sequence>
            <xs:element name="EVMaximumDischargePower" type="v2gci_ct:RationalNumberType"/>
            <xs:element name="EVMaximumDischargePower_L2" type="v2gci_ct:RationalNumberType"
            minOccurs="0"/>
            <xs:element name="EVMaximumDischargePower_L3" type="v2gci_ct:RationalNumberType"
            minOccurs="0"/>
            <xs:element name="EVMinimumDischargePower" type="v2gci_ct:RationalNumberType"/>
            <xs:element name="EVMinimumDischargePower_L2" type="v2gci_ct:RationalNumberType"
            minOccurs="0"/>
            <xs:element name="EVMinimumDischargePower_L3" type="v2gci_ct:RationalNumberType"
            minOccurs="0"/>
            <xs:element name="EVMaximumV2XEnergyRequest" type="v2gci_ct:RationalNumberType"
            minOccurs="0"/>
            <xs:element name="EVMinimumV2XEnergyRequest" type="v2gci_ct:RationalNumberType"
            minOccurs="0"/>
            <xs:element name="EvsePresentActivePower" type="v2gci_ct:RationalNumberType"/>
        </xs:sequence>
    </xs:extension>
</xs:complexContent>
</xs:complexType>
```

13.3 OCPP 2.0.1

The structure ACChargingParametersType and DCChargingParametersType are used in NotifyEVChargingNeedsRequest.


```
"DCChargingParametersType": {
    "description": "DC_ Charging_ Parameters\r\nurn:x-oca:ocpp:uid:2:233251\r\nEV DC charging parameters\r\n\r\n\r\n",
    "javaType": "DCChargingParameters",
    "type": "object",
    "additionalProperties": false,
    "properties": {
        "customData": {
            "$ref": "#/definitions/CustomDataType"
        },
    "evMaxCurrent": {
        "description": "DC_ Charging_ Parameters. EV_ Max. Current\r\nurn:x-oca:ocpp:uid:1:569215\r\nMaximum current
        (amps) supported by the electric vehicle. Includes cable capacity.\r\n",
        "type": "integer"
    },
    "evMaxVoltage": {
        "description": "DC_ Charging_ Parameters. EV_ Max. Voltage\r\nurn:x-oca:ocpp:uid:1:569216\r\nMaximum voltage
        supported by the electric vehicle\r\n",
        "type": "integer"
    },
    "energyAmount": {
        "description": "DC_ Charging_ Parameters. Energy_ Amount. Energy_ Amount\r\nurn:x-
        oca:ocpp:uid:1:569217\r\nAmount of energy requested (in Wh). This inludes energy required for
        preconditioning.\r\n",
        "type": "integer"
    },
    "evMaxPower": {
        "description": "DC_ Charging_ Parameters. EV_ Max. Power\r\nurn:x-oca:ocpp:uid:1:569218\r\nMaximum power (in
        W) supported by the electric vehicle. Required for DC charging.\r\n",
        "type": "integer"
    },
    "stateOfCharge": {
        "description": "DC_ Charging_ Parameters. State_ Of_ Charge. Numeric\r\nurn:x-oca:ocpp:uid:1:569219\r\nEnergy
        available in the battery (in percent of the battery capacity)\r\n",
        "type": "integer",
        "minimum": 0.0,
        "maximum": 100.0
    },
```

"evEnergyCapacity": {
"description": "DC_ Charging_ Parameters. EV_ Energy_ Capacity. Numeric\r\nurn:x-oca:ocpp:uid:1:569220\r\nCapacity of the electric vehicle battery (in Wh)\r\n",
"type": "integer"
},
"fullSoC": {
"description": "DC_ Charging_ Parameters. Full_ SOC. Percentage\r\nurn:x-oca:ocpp:uid:1:569221\r\nPercentage of SoC at which the EV considers the battery fully charged. (possible values: 0 - 100)\r\n",
"type": "integer",
"minimum": 0.0,
"maximum": 100.0
},
"bulkSoC": {
"description": "DC_ Charging_ Parameters. Bulk_ SOC. Percentage\r\nurn:x-oca:ocpp:uid:1:569222\r\nPercentage of SoC at which the EV considers a fast charging process to end. (possible values: 0 - 100)\r\n",
"type": "integer",
"minimum": 0.0,
"maximum": 100.0
},
"minSoC": {
"description": "DC_ Charging_ Parameters. Min_ SOC. Percentage\r\nurn:x-oca:ocpp:uid:1:569221\r\n Minimum percentage of SoC required by the EV at the end of the charging session. (possible values: 0 - 100)\r\n",
"type": "integer",
"minimum": 0.0,
"maximum": 100.0
},
"targetSoC": {
"description": "DC_ Charging_ Parameters. Target_ SOC. Percentage\r\nurn:x-oca:ocpp:uid:1:569221\r\n Target SoC asked by the EV at the end of the charging session. (possible values: 0 - 100)\r\n",
"type": "integer",
"minimum": 0.0,
"maximum": 100.0
},
"evMinPower": {
"description": "DC_ Charging_ Parameters. EV_ Min. Power\r\nurn:x-oca:ocpp:uid:1:569215\r\nMinimum Power (Watt) supported by the electric vehicle.\r\n",
"type": "integer"
},
"evMinEnergyRequest": {
"description": "DC_ Charging_ Parameters. EV_ Min. Energy_ Amount\r\nurn:x-oca:ocpp:uid:1:569217\r\n Minimum Amount of energy requested (in Wh). This inludes energy required for preconditioning.\r\n",
"type": "integer"
},

"evMaxEnergyRequest": {
"description": "DC_ Charging_ Parameters. EV_ Min. Energy_ Amount\r\nurn:x-oca:ocpp:uid:1:569217\r\n Minimum Amount of energy requested (in Wh). This inludes energy required for preconditioning.\r\n",
"type": "integer"
}
},
"required": [
"evMaxCurrent",
"evMaxVoltage"
]
}
}

"ACChargingParametersType": {
"description": "AC_ Charging_ Parameters\r\nurn:x-oca:ocpp:uid:2:233250\r\nEV AC charging parameters.\r\n\r\n",
"javaType": "ACChargingParameters",
"type": "object",
"additionalProperties": false,
"properties": {
"customData": {
"$ref": "#/definitions/CustomDataType"
},
"energyAmount": {
"description": "AC_ Charging_ Parameters. Energy_ Amount. Energy_ Amount\r\nurn:x-oca:ocpp:uid:1:569211\r\nAmount of energy requested (in Wh). This includes energy required for preconditioning.\r\n",
"type": "integer"
},
"evMinCurrent": {
"description": "AC_ Charging_ Parameters. EV_ Min. Current\r\nurn:x-oca:ocpp:uid:1:569212\r\nMinimum current (amps) supported by the electric vehicle (per phase).\r\n",
"type": "integer"
},
"evMaxCurrent": {
"description": "AC_ Charging_ Parameters. EV_ Max. Current\r\nurn:x-oca:ocpp:uid:1:569213\r\nMaximum current (amps) supported by the electric vehicle (per phase). Includes cable capacity.\r\n",
"type": "integer"
},
"evMaxVoltage": {
"description": "AC_ Charging_ Parameters. EV_ Max. Voltage\r\nurn:x-oca:ocpp:uid:1:569214\r\nMaximum voltage supported by the electric vehicle\r\n",
"type": "integer"

```
},
"minSoC": {
    "description": "DC_ Charging_ Parameters. Min_ SOC. Percentage\r\nurn:x-oca:ocpp:uid:1:569221\r\n Minimum percentage of SoC required by the EV at the end of the charging session. (possible values: 0 - 100)\r\n",
    "type": "integer",
    "minimum": 0.0,
    "maximum": 100.0
},
"targetSoC": {
    "description": "DC_ Charging_ Parameters. Target_ SOC. Percentage\r\nurn:x-oca:ocpp:uid:1:569221\r\n Target SoC asked by the EV at the end of the charging session. (possible values: 0 - 100)\r\n",
    "type": "integer",
    "minimum": 0.0,
    "maximum": 100.0
},
"evMinPower": {
    "description": "DC_ Charging_ Parameters. EV_ Min. Power\r\nurn:x-oca:ocpp:uid:1:569215\r\nMinimum Power (Watt) supported by the electric vehicle.\r\n",
    "type": "integer"
},
"evMinEnergyRequest": {
    "description": "DC_ Charging_ Parameters. EV_ Min. Energy_ Amount\r\nurn:x-oca:ocpp:uid:1:569217\r\n Minimum Amount of energy requested (in Wh). This inludes energy required for preconditioning.\r\n",
    "type": "integer"
},
"evMaxEnergyRequest": {
    "description": "DC_ Charging_ Parameters. EV_ Min. Energy_ Amount\r\nurn:x-oca:ocpp:uid:1:569217\r\n Minimum Amount of energy requested (in Wh). This inludes energy required for preconditioning.\r\n",
    "type": "integer"
}
},
"required": [
"energyAmount",
"evMinCurrent",
"evMaxCurrent",
"evMaxVoltage"
]
}

"$schema": "http://json-schema.org/draft-06/schema#",
"$id": "urn:OCPP:Cp:2:2020:3:TransactionEventRequest",
```

```
"comment": "OCPP 2.0.1 FINAL",
"definitions": {
    "CustomDataType": {
    "description": "This class does not get 'AdditionalProperties = false' in the schema generation, so it can be extended with arbitrary JSON properties to allow adding custom data.",
    "javaType": "CustomData",
    "type": "object",
    "properties": {
        "vendorId": {
        "type": "string",
        "maxLength": 255
    }
    },
    "required": [
        "vendorId"
    ]
    },
    "sessionId": {
        "description": "Session ID. Session_ ID\r\nSession if of the ongoing charging session as defined in ISO 15118.\r\n",
        "javaType": "string",
        "type": "string",
        "additionalProperties": false
    },

    ...

    "required": [
        "eventType",
        "timestamp",
        "triggerReason",
        "seqNo",
        "transactionInfo"
    ]
}
```

13.4 OCPP 2.1


```
"$schema": "http://json-schema.org/draft-06/schema#",
"$id": " urn:OCPP:Cp:2:2022:3:TransactionEventRequest",
"comment": "release candidate",
"definitions": {
    "CustomDataType": {
    "description": "This class does not get 'AdditionalProperties = false' in the schema generation, so it can be extended with arbitrary JSON properties to allow adding custom data.",
    "javaType": "CustomData",
    "type": "object",
    "properties": {
        "vendorId": {
        "type": "string",
        "maxLength": 255
    }
    },
    "required": [
        "vendorId"
    ]
    },
    "sessionId": {
        "description": "Session ID. Session_ ID\r\nSession if of the ongoing charging session as defined in ISO 15118.\r\n",
        "javaType": "string",
        "type": "string",
        "additionalProperties": false
    },

    ...

    "required": [
        "eventType",
        "timestamp",
        "triggerReason",
        "seqNo",
        "transactionInfo"
    ]
}
```


The structure V2XChargingParametersType is used in NotifyEVChargingNeedsRequest.


```
"V2XChargingParametersType": {
    "javaType": "V2XChargingParameters",
```

```
"type": "object",
"additionalProperties": false,
"properties": {
    "customData": {
    "$ref": "#/definitions/CustomDataType"
},
"minChargePower": {
    "type": "number"
},
"minChargePower_L2": {
    "type": "number"
},
"minChargePower_L3": {
    "type": "number"
},
"maxChargePower": {
    "type": "number"
},
"maxChargePower_L2": {
    "type": "number"
},
"maxChargePower_L3": {
    "type": "number"
},
"minDischargePower": {
    "type": "number"
},
"minDischargePower_L2": {
    "type": "number"
},
"minDischargePower_L3": {
    "type": "number"
},
"maxDischargePower": {
    "type": "number"
},
"maxDischargePower_L2": {
    "type": "number"
},
"maxDischargePower_L3": {
    "type": "number"
},
"minChargeCurrent": {
```

"type": "number"
},
"maxChargeCurrent": {
"type": "number"
},
"minDischargeCurrent": {
"type": "number"
},
"maxDischargeCurrent": {
"type": "number"
},
"minVoltage": {
"type": "number"
},
"maxVoltage": {
"type": "number"
},
"evTargetEnergyRequest": {
"type": "integer"
},
"evMinEnergyRequest": {
"type": "integer"
},
"evMaxEnergyRequest": {
"type": "integer"
},
"evMinV2XEnergyRequest": {
"type": "integer"
},
"evMaxV2XEnergyRequest": {
"type": "integer"
},
"targetSoC": {
"type": "integer",
"minimum": 0.0,
"maximum": 100.0
},
"remainingV2GEnergy": {
"type": "integer"
},
"roundTripEfficiency": {
"type": "integer"
}

```
        },
        "required": [
        "maxChargePower",
        "maxDischargePower"
        ]
    }
},
```