Evaluation of OCPP and IEC 61850 for Smart Charging Electric Vehicles

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**Agenda**

- Introduction to EVSE Backend Communication
- Standardization Landscape for V2G Communication Interface
  - Focus on ISO/IEC 15118
- State of the Art Backend Communication
  - Open Charge Point Protocol (OCPP)
  - IEC 61850-90-8 E-Mobility Object Model
- Comparison of OCPP & IEC 61850-90-8
- Lessons Learned
- Outlook
Introduction to EVSE Backend Communication

- Use Case Overview for EVSE Backend Communication
  - Today’s / Short Term Use Cases
    - Charge Authentication (incl. Roaming)
    - Billing of Charging Processes
    - Remote Customer Support
    - Charge Spot Reservation
    - Infrastructure Operations
    - Asset Management
  - Mid- & Long Term Use Cases
    - Smart Charging Support for Local Infrastructures (Local Scope)
    - Smart Charging Support for Grid Services (≥ Regional Scope)

- Mid- & Long Term Use Cases enabled by ISO/IEC 15118 Support
Standardization Landscape of E-Mobility V2G Interface

1. Plugs, In- & Outlets
   - IEC 62196-1
   - IEC 62196-2
   - IEC 62196-3
   - IEC 61980-1

2. Charging Topology
   - IEC 61439-1
   - IEC 61439-7
   - IEC 61850
   - IEC 62351

3. Communication
   - ISO/IEC 15118

4. Security
   - ISO/IEC 27000
   - IEC 61850

5. Safety
   - IEC 61850-21
   - IEC 61851-23
   - IEC 61980-1
   - IEC 61980-3
   - IEC 61980-2
   - IEC 61851-22
   - IEC 61851-24
   - ISO 6469-3
   - ISO 17409
   - ISO 60364-7-722
   - IEC 61140
   - IEC 62040
   - IEC 60529
   - IEC 60364-7-722
Scope of ISO/IEC 15118 Vehicle-to-Grid Communication Interface

**Primary Actors**
- Electric Vehicle
- Charge Spot

**Secondary Actors**
- Spot Operators
- Service Providers

**EvCC Service Impl. Interface**
- Frontend Comm.

**SECC Service Impl. Interface**
- Backend Comm.

**In Scope of ISO/IEC 15118:**
- Complete Technical Specification for Front-End Communication Interface between EVCC and SECC

**In Scope of ISO/IEC 15118:**
- Specification of trustworthy End-to-End (EV to Secondary Actors) Data Sets, e.g. Auth. Credentials, Tariffs, Schedules etc.

**Not in Scope of ISO/IEC 15118:**
- Backend Communication Interfaces to Secondary Actors
V2G CI Message Sequence Chart – Backend Relevance
V2G CI Message Sequence Chart – Backend Relevance
V2G CI Message Sequence Chart – Backend Relevance

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Setup
- Application Prot. Handshake
- Session Setup
- Service Discovery
- Service Details (opt.)
- Service & Payment Selection
- Certificate Inst. / Upd. (opt., PnC)
- Payment Details (PnC)
- Contract Authentication
- Charge Parameter Discovery

Finalization Charge
- AC / DC specific Messages
- Session Stop

AC specific Messages
- Power Delivery
- Charging Status
- Metering Receipt (opt., PnC)

DC specific Messages
- Cable Check
- Pre-Charge
- Power Delivery
- Current Demand
- Power Delivery
- Welding Detection

Legend
- PnC: Plug & Charge
- Contactor OFF
- Contactor ON

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Evaluation of OCPP and IEC 61850 for Smart Charging Electric Vehicles
Open Charge Point Protocol (OCPP)

- Introduction through e-laad in 2009
- Official Release Version 1.5 defines:
  - Charge Point Service (CPS) → 14 Operations
  - Central System Service (CSS) → 9 Operations

OCPP 1.5 scope limited to set of most important “short term” use cases
OCPP Protocol Design Paradigms

- Bi-directional Client-Server Web Service Architecture
  - Limited to Request Response Message Exchange Patterns
- Mostly atomic operations
  - No predefined sequences as opposed to ISO/IEC 15118
OCPP Protocol Stack

- OCPP 1.5 adopts SOAP-based WS Messaging Architecture
- Information Model and Message Binding based on XML Schema and WSDL
- FTPS used for Firmware Update and uploading Diagnostics Data
- Channel to EVSE may be secured by HTTPS (SSL / TLS)
IEC 61850 - Communication Networks and Systems for Power Utility Automation

- IEC 61850 defines series of standards for automating grid assets
  - According to IEC Roadmap IEC 61850 is Core Standard for future Smart Grid Deployments
- Initial Application Area:
  - Intra- and Inter-Substation Automation Domain
- Today's supplementary Application Area:
  - Growing Domain of Distributed Energy Resources (DERs)

✔ Modelling of DERs necessary
IEC 61850-90-8 E-Mobility Object Model (1/2)

- DER Information Model for EVs
  - AC & DC Charging
  - Bottom Up Modeling Approach based on E-Mobility V2G Interface Standardization Landscape
  - Harmonized with other types of DERs supporting portfolios with heterogeneous DERs

- Scope considers more “mid & long term” use cases:
  - Integration of EV as DER in the Grid (Operational State of EV-based DER)
  - Charge Negotiation / Smart Charging

IEC 61850-90-8 Operations & Load Profile Propagation

IEC 61850-90-8 Operations:

<table>
<thead>
<tr>
<th>Service</th>
<th>Supported Operations</th>
</tr>
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</table>
| IEC 61850 Charge Point Service | Get EVSE (& EV) Nameplate                                                                  Get Charge Power Rating  
|                              | Get Charge Cable Rating                                                                   Get Plug Present  
|                              | Get (Available) Connection Type                                                            Enable / Disable Dig. Comm.  
|                              | Get State (A, B, C, D, E, F)                                                              Get User Target Settings (Energy Amount & Departure Time)  
|                              | Get EV Charge Power Rating                                                                Set Local Load Limit Profile (EVSE/Station Limits)  
|                              | Set Local Load Limit Profile (EVSE/Station Limits)                                          Report Local Load Reservation Profile (EV/EV Pool Reservation)  

- **Get EVSE (& EV) Nameplate**
- **Get Charge Power Rating**
- **Get Charge Cable Rating**
- **Get Plug Present**
- **Get (Available) Connection Type**
- **Get State (A, B, C, D, E, F)**
- **Enable / Disable Dig. Comm.**
- **Get User Target Settings (Energy Amount & Departure Time)**
- **Get EV Charge Power Rating**
- **Set Local Load Limit Profile (EVSE/Station Limits)**
- **Report Local Load Reservation Profile (EV/EV Pool Reservation)**

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Diagram:

1. **Set LocalLoadLimitProfile**
2. **Charge Parameter Discovery**
3. **Power Delivery**
4. **Report LocalReservationProfile**

1. Defines max. power over time to be consumed from feeder of the EVSE
2. User and EV target settings (energy amount to charge until departure time + EV limitations)
3. Max. power schedule for outlet referring to LocalLoadLimitProfile (1)
4. EV charging profile with indication of power to be consumed over time from outlet
5. Acknowledgement of EV charging profile unless EV violates max. power schedule from (3)
6. Report on local load profile associated to the EVSE
IEC 61850 Protocol Stack

- Object-oriented Modeling Approach
- Client-Server Messaging Paradigm for less time critical Messages with TCP/IP Stack
- ACSI in order to abstract from concrete SCSM Implementation like MMS
- Communication Channel secured by TLS
- Supports Role Based Access Control (RBAC) through IEC 62351
# Comparison of OCPP 1.5 & IEC 61850-90-8

<table>
<thead>
<tr>
<th>Criteria</th>
<th>OCPP 1.5</th>
<th>IEC 61850-90-8</th>
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<tbody>
<tr>
<td><strong>Functional Scope</strong></td>
<td>- Support for operational tasks (e.g. authentication &amp; transaction handling, metering, reservation etc.)&lt;br&gt;- Support for maintenance tasks (e.g. status notifications, configuration &amp; firmware mgmt., diagnostics etc.)&lt;br&gt;- No Grid Services / Smart Charging Support&lt;br&gt;- No RBAC Support</td>
<td>- Limited support for operational tasks (e.g. no authentication &amp; transaction handling, reservation etc.)&lt;br&gt;- Limited support for maintenance tasks&lt;br&gt;- Grid Services / Smart Charging Support&lt;br&gt;- RBAC Support</td>
</tr>
<tr>
<td><strong>Technical Issues / Drawbacks</strong></td>
<td>- Huge Message Overhead due to Plain Text SOAP-over-HTTP Binding e.g. resulting in complex Heartbeat Mechanism</td>
<td>- Inflexible and cumbersome MMS binding mechanism (WG17 working on WS-based binding mechanism)</td>
</tr>
<tr>
<td><strong>Specification &amp; Standard Maturity</strong></td>
<td>- Specification does not clearly formulate requirements (conformance issues)&lt;br&gt;- Lack of specification and conformance details is dealt with open reference implementation</td>
<td>- Specification does not clearly formulate requirements&lt;br&gt;- Complexity of IEC 61850 (long learning curves)&lt;br&gt;- Complex and time consuming standardization process</td>
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Lessons Learned

- Combined approaches of OCPP and IEC 61850-90-8 would offer:
  - Added value in terms of functional coverage (short, mid and long-term use cases for operations, maintenance tasks, and grid services)
  - Consideration of EVSE- and Grid-Operator’s business focus’
- Integration options:
  1. Leverage IEC 61850-90-8 E-Mobility Object Model as Meta Model for Smart Charging in OCPP
  2. Integrated approach with separate OCPP and IEC 61850-90-8 services and unified WS-based binding mechanism
Outlook

- Roadmap for OCPP 2.0
  - Consideration of ISO/IEC 15118 Smart Charging (schedules)
  - Advanced diagnostics
  - Optimized transport mechanisms (for e.g. bandwidth optimization)
  - More detailed compliance definition

- eMI³ Group
  - WG5 currently consolidates requirements for charge spot backend protocols
  - Various backend protocols were proposed / nominated
  - WG5 goal: Drafting of backend protocol description based on lessons learned from consolidation process

  ➢ Keep IEC compliance for harmonized grid integration of EVs with other types of grid assets e.g. heterogeneous DER portfolios
Thank you for your attention
Backup
IEC 61850 Information Modeling

Device with local intelligence: e.g. control / monitoring capabilities, advanced communication means or electrical protection functions

Abstract logical view on the IED topology (Group of Logical Nodes)

Defines the services on top of the OIM. Binding the Logical Node and its Object Information Model to service and communication interfaces

Function of the IED: e.g. protection, (self-) monitoring, auto-reclosure, control and communication

Describes one functional entity as Logical Nodes according to IEC 61850-7-4 & IEC 61850-7-420 specifically for DERs

Object Information Model (OIM) Object Information Model (OIM) of a Logical Node according to its type definitions

Underlying communication protocol stack for IED communication functions
All relevant E-Mobility Standards for the Vehicle-to-Grid Interface mapped to IEC 61850-7-420 with four new/adapted Logical Nodes:

- DESE: EV Supply Equipment
- DEOL: EVSE Outlet
- DEEV: Electric Vehicle
- DSCH: Energy & Ancillary Service Schedule
- MMTR
- XSWI: Contactor
- XCBR: Circuit Breaker
- RCCB: Residual Current Device
- ZSAR: Surge Arrester

Proposed E-Mobility Object Model for IEC 61850-7-420

[Diagram showing the model with DESE, DEOL, DEEV, and DSCH nodes and various protective devices connected to a Charge Spot.]