Recommendations for OCPI Improvements

CHARGEX consortium

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Revision Log

Version Date	Description	Author
05.23.2025	Preliminary version released to members of the ChargeX Diagnostics Task Force	All authors and contributors
06.15.2025	Public release version	All authors and contributors

Table of Contents

List of Figures

List of Acronyms

Acronym	Description
AFIR	Alternative Fuels Infrastructure Regulation
CDR	Charge Detail Records
CPO	Charge Point Operator
CSMS	Charging Station Management System
CSO	Charging Station Operator
DIN	Deutschers Institut für Normung (German Institute for Standardization)
eMSP	E-Mobility Service Provider
EU	European Union
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
ISO	International Organization for Standardization
NAP	National Access Point
NTP	Network Time Protocol
OCPI	Open Charge Point Interface
OCPP	Open Charge Point Protocol
OEM	Original Equipment Manufacturer
OICP	Open InterCharge Protocol
UTC	Coordinated Universal Time
V2G	Vehicle-to-Grid
V2X	Vehicle-to-Everything
VAT	Value Added Tax
AFIR	Alternative Fuels Infrastructure Regulation

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1. Introduction

The Open Charge Point Interface (OCPI) is an open protocol that enables electric vehicle (EV) charging systems to work together across networks. It supports communication and data sharing between Charge Point Operators (CPOs), who manage charging stations, and e-Mobility Service Providers (eMSPs), who provide charging services to EV drivers. OCPI facilitates functions like user authorization, remote charge point control, charging session data exchange, and billing through Charge Detail Records (CDRs). This allows EV roaming, so drivers can charge at different networks without multiple accounts. As the EV market grows due to increased adoption and technological advancements, OCPI faces higher demands. This has revealed issues with CDR format consistency, timestamp standardization across regions, transmission of EV-side error codes for troubleshooting, and support for new use cases. These challenges can affect operations and user experience, particularly as the industry starts considering Vehicle-to-Grid (V2G) systems, where EVs supply energy to the grid, and Vehicle-to-Everything (V2X) technologies for broader energy interactions. Using feedback from the ChargeX Diagnostics taskforce discussions, industry 1-on-1 meetings, technical standards, and OCPI's evolution through versions (e.g., OCPI 2.1.1, 2.2, and 2.2.1), this report identifies these issues and suggests practical recommendations. These aim to improve interoperability, streamline operations, and prepare OCPI for future trends in the EV charging ecosystem.

2. Background

The Open Charge Point Interface (OCPI), managed by the EVRoaming Foundation, enables EV roaming by allowing drivers to charge across different networks without a need for multiple accounts. The protocol supports communication between Charge Point Operators (CPOs) and e-Mobility Service Providers (eMSPs) for functions like authorization, session data exchange, and billing through Charge Detail Records (CDRs). OCPI has evolved through versions, with 2.2.1 (2021) introducing signed meter values for regulatory compliance (e.g., Germany's Eichrecht), 2.3 (2025) adding support for EU Alternative Fuels Infrastructure Regulation (AFIR) and U.S. tax schemes, and the draft 3.0 focusing on architectural improvements and features like Plug & Charge. Despite these updates, challenges remain, including inconsistent CDR implementations, timestamp ambiguities, limited support for EV-side error codes, and variations in CDR formats across CPOs and eMSPs. These issues, identified via industry feedback, require targeted improvements to ensure OCPI's reliability, scalability, and uniform adoption across the diverse EV charging landscape shown in Figure.1.

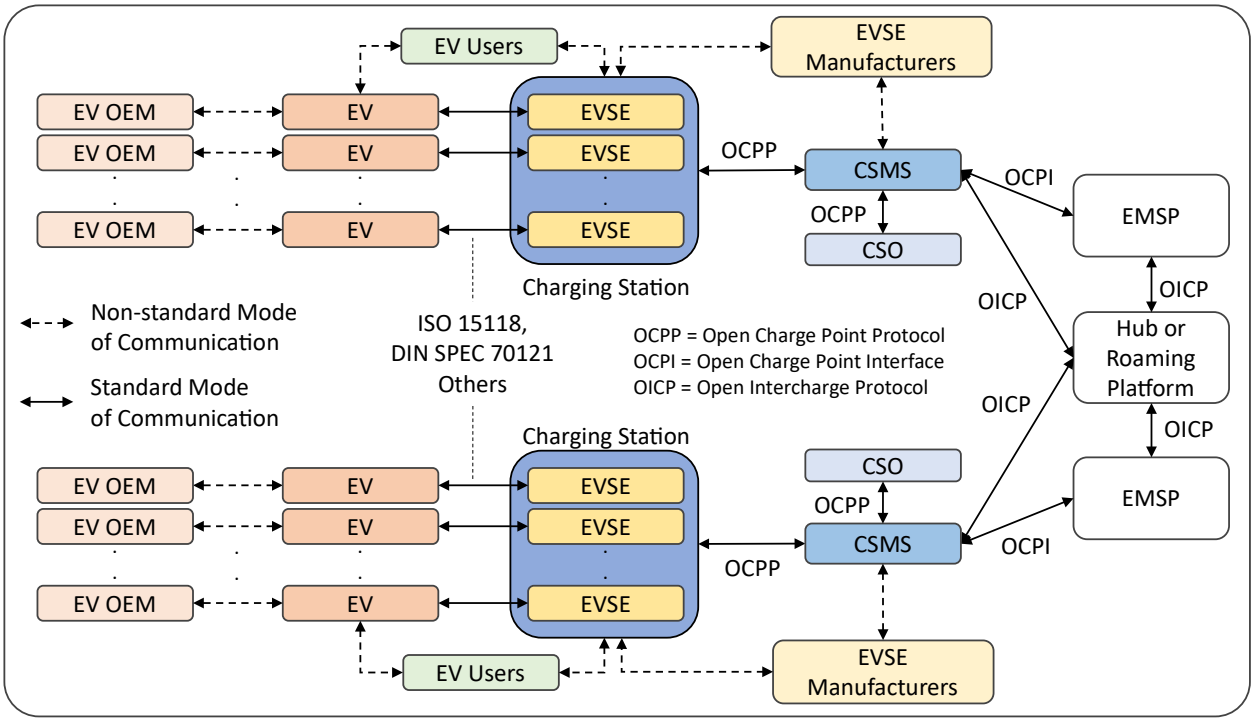

Figure 1. EV Charging Ecosystem.

2.1. Overview of OCPI Versions

The Open Charge Point Interface (OCPI) has evolved through versions 2.2.1, 2.3, and 3.0 (draft) to address regulatory, operational, and technological needs in the EV charging ecosystem. An overview of key differences, focusing on features relevant to the identified issues is as follows:

- OCPI 2.2.1 (2021): This version established core billing features, including signed meter values for regulatory compliance (e.g., Germany's Eichrecht) and Credit CDRs to correct billing errors. It uses RFC3339 DateTime format, assuming UTC (e.g., "2015-06-29T20:39:09Z"), but ambiguities in timezone offsets (e.g., "+00:00") persist due to inconsistent implementation. The session_id for linking CDRs to charging sessions is optional, relying on fragile timestamp and auth_id matching. CDRs include mandatory fields like location_id, evse_uid, connector_id, and total_cost, but lack dedicated fields for EV-side or OCPP error codes, using an ad-hoc remark field instead. Tariffs support fixed and variable costs but lack explicit VAT or tax fields. Version 2.2.1 is not compatible with 2.0/2.1, though hubs ensure 2.x compatibility.
- OCPI 2.3 (2025): Building on 2.2.1, this version maintains backward compatibility, allowing 2.2.1 clients to ignore new, mostly optional fields. It focuses on regulatory compliance, supporting the EU's Alternative Fuels Infrastructure Regulation (AFIR) for National Access Points (NAPs) and U.S. tax schemes. New features include a Direct Payment module, home_charging_compensation, and expanded CdrLocation fields (e.g., optional state, postal_code). The CdrToken now includes country_code and party_id for globally unique identification. However, it does not address session_id optionality or introduce structured error code fields, leaving timestamp and error handling issues unresolved.

- OCPI 3.0 (Draft): Under development, OCPI 3.0 aims for architectural improvements and new modules, such as Plug & Charge (ISO 15118) and support for Vehicle-to-Grid (V2G) scenarios. It plans to ensure interoperability with 2.x systems through modular upgrades. Expected enhancements include mandatory UTC offset clarification (e.g., "+00:00"), a mandatory session reference or unified transaction ID for CDR-session linking, and richer CDR data with human-readable physical_reference for EVSEs. It is likely to introduce standardized error/status fields, potentially integrating ISO 15118 diagnostics, and refine tariff structures for complex billing and V2G use cases.

3. Issues and Recommendations for OCPI

Feedback from the ChargeX Diagnostic Taskforce members and industry 1-on-1 discussions highlights key issues in the Open Charge Point Interface (OCPI) that affect interoperability, reliability, and future-readiness. Below is a consolidated list of these challenges and actionable recommendations, focusing on Charge Detail Records (CDRs), timestamp standardization, EV-side error codes, CDR format consistency, and support for Vehicle-to-Grid (V2G) and Vehicle-to-Everything (V2X) technologies.

3.1. Charge Detail Records (CDRs)

CDRs are essential for billing and reconciliation between Charge Point Operators (CPOs) and e-Mobility Service Providers (eMSPs), but inconsistencies and limitations hinder their effectiveness.

3.1.1. Issues

- Format Variations: Despite a defined CDR structure in the OCPI 2.2.1 specification, inconsistent use of optional fields (e.g., currency, token_type) and proprietary extensions disrupt interoperability.
- Session-CDR Linking: The optional session_id leads to fragile matching using auth_id and timestamps, complicating reconciliation, especially for multiple sessions started closely.
- Data Granularity: eMSPs need detailed CDRs for complex tariffs (e.g., time-of-use, idle fees), but the mandatory total_cost field lacks itemized breakdowns.
- CDR Correction: Credit CDRs for corrections lack explicit links to original records, complicating audits.
- Zero-Energy Sessions: Sessions with no energy dispensed (e.g., failed starts) lack standardized handling, causing reporting confusion.
- Regulatory Compliance: Signed meter data for regulations like Germany's Eichrecht is supported but varies across systems, as discussed in OCPI 2.2.1 release notes.

3.1.2. Recommendations

- Introduce a mandatory session_id or transaction ID to link CDRs, sessions, and commands, addressing session-CDR linking.

- Require itemized cost breakdowns in charging_periods (e.g., energy, time, taxes, VAT) for transparency.
- Mandate a credit_reference_id for Credit CDRs to ensure traceable corrections.
- Add a session_type field (e.g., "authorization_only") for consistent reporting of zero-energy sessions.
- Standardize signed meter data inclusion for relevant regulations.
- Develop validation tools to enforce CDR schema compliance and semantic correctness, as suggested in OCPI community discussions.
- Include human-readable EVSE identifiers (e.g., charger number) in CDRs to aid drivers and support staff, as planned for OCPI 3.0.

3.2. Timestamp Standardization

Accurate timestamps are critical for CDRs, sessions, tariffs, and location data, but inconsistencies create challenges.

3.2.1. Issues

- Format Variability: The OCPI 2.2.1 specification mandates UTC with RFC3339, but some platforms omit the "Z" designator or use local offsets (e.g., "+00:00"), causing ambiguity.
- Local Time Ambiguity: Location hours in local time conflict with UTC-based system communication.

3.2.2. Recommendations

- Enforce strict RFC3339 UTC formatting with "Z" or "+00:00" for all timestamps, clarifying ambiguities in the OCPI specification.
- Mandate UTC for all DateTime fields across OCPI modules (CDRs, sessions, tariffs).
- Convert local times at the presentation layer, keeping underlying data in UTC.
- Require Network Time Protocol (NTP) for sub-second clock synchronization.

3.3. Transmission of EV-Side Error Codes

Clear error reporting is essential for diagnosing charging failures, but OCPI lacks robust mechanisms.

3.3.1. Issues

- Limited Granularity: OCPI relies on OCPP or ad-hoc remark fields for EV/EVSE diagnostics, lacking dedicated fields.
- Custom Error Fragmentation: Manufacturer-specific codes create inconsistency.

3.3.2. Recommendations

- Define high-level error codes for CPO-eMSP communication (e.g., "EV_PLUG_NOT_DETECTED").

- Integrate standardized error sets such as the ChargeX Minimum Required Error Codes (MRECs), DIN DKE 99003 Unified Error Codes, etc. into CDRs and Sessions.
- Add a dedicated error module or fields in CDRs/Sessions for EV, EVSE, or grid errors, including source and severity.
- Relay critical OCPP/ISO 15118 diagnostics via standardized OCPI containers.

3.4. Standardizing CDR Format Across eMSPs and CPOs

Uniform CDR implementation is critical for interoperability, but variations persist.

3.4.1. Issues

- Inconsistent Interpretation: Ambiguities in field usage cause discrepancies.
- Optional Fields: Inconsistent use of optional fields (e.g., currency, token_type) complicates processing.
- Proprietary Extensions: Custom extensions disrupt uniformity.
- Cost Breakdowns: Lack of standardized cost representation hinders complex billing when including tariffs, taxes, etc.

3.4.2. Recommendations

- Enforce strict CDR schema adherence with updated documentation in the OCPI specification.
- Encourage comprehensive data inclusion, even for optional fields.
- Standardize tariff element breakdowns (energy, time, VAT).
- Develop semantic validation tools and a certification program.
- Encourage community collaboration to share best practices and implementation guidelines.

3.5. Enabling V2G/V2X and Future-Proofing OCPI

OCPI must adapt to support bidirectional energy flows and emerging technologies like V2G and V2X.

3.5.1. Issues:

- Limited V2G Support: OCPI lacks fields for energy export or grid service remuneration.
- Current architecture may not support future innovations in charging technologies.

3.5.2. Recommendations:

- Add energy_exported_kwh and direction fields to CDRs to track V2G energy flows.
- Introduce a V2G/V2X module for discharge tariffs and grid services, as suggested in OCPI 3.0 draft discussions.
- Relay V2G parameters (e.g., discharge power) from ISO 15118 via CPOs.
- Support WebSocket-based streaming for real-time V2G/grid signals.

- Adopt a plug-in framework for new modules (e.g., V2X, V2G, megawatt charging, wireless charging).
- Enhance authentication and consent management for V2G data privacy.
- Align with OCPP, ISO 15118, OpenADR, and IEEE 2030.5 for interoperability, as referenced in ISO 15118 standards.

4. Summary

The Open Charge Point Interface (OCPI), managed by the EVRoaming Foundation, enables EV roaming by allowing drivers to charge across different networks without multiple accounts. It supports communication between Charge Point Operators (CPOs) and e-Mobility Service Providers (eMSPs) for functions like authorization, session data exchange, and billing through Charge Detail Records (CDRs). Despite advancements in versions 2.2.1 and 2.3, challenges persist, including inconsistent CDR formats, fragile session-CDR linking, ambiguous timestamp standardization, limited EV-side error code transmission, and varying CDR implementations across providers. These issues, identified via industry feedback, hinder interoperability and reliability. Proposed improvements include mandatory session identifiers, itemized cost breakdowns, standardized error codes, stricter CDR guidelines, and support for Vehicle-to-Grid (V2G) and Vehicle-to-Everything (V2X) technologies. With OCPI 3.0's anticipated architectural upgrades, these enhancements aim to ensure OCPI remains a robust, interoperable, and future-ready protocol for the growing EV charging ecosystem.

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About the ChargeX Consortium

The National Charging Experience Consortium (ChargeX Consortium) is a collaborative effort between Argonne National Laboratory, Idaho National Laboratory, National Renewable Energy Laboratory, electric vehicle charging industry experts, consumer advocates, and other stakeholders. The ChargeX Consortium's mission is to work together to measure and significantly improve public charging reliability and usability by June 2025.
For more information, visit chargex.inl.gov.

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