



V2G is REAL – and Complicated

**V2G Critical Success Factors and
Harmonizing Standards**

May 2023



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Today's Presenters

- **James Mater, Director of Strategy, Smart Energy, QualityLogic**

James is one of the industry-leading experts on smart grid standards, interoperability, and the maturity of ecosystems of products based on these standards. James has given dozens of presentations and authored multiple papers on interoperability in the smart grid. He is a member of both the UL 1741SC, IEEE 2030, SunSpec J3072 Profile and IEEE 1547 Work Groups. He Co-Chairs the V2G Forum.



- **Steve Kang, General Manager, Smart Energy, QualityLogic**

Steve is a leading technical expert on IEEE 2030.5 and CA Rule 21 based Common Smart Inverter Profile (CSIP) implementation guide. He has been involved with IEEE 2030.5 since 2010 and has taught hundreds of people around the globe on IEEE 2030.5. Steve is leading the QualityLogic IEEE 1547.1 test tool effort.



Agenda



- **QualityLogic Introduction**
- **What is V2G and Why Does it Matter?**
- **Critical Success Factors for V2G**
- **Standardization of V2G**
 - Charging Standards and V2G
 - V2G Standards
 - Can ISO 15118 and OCPP Support US Grid Codes?
- **Harmonizing the Standards for a Global V2G Infrastructure**
 - Can the US and EU standards Co-Exist?
- **How QualityLogic's Test Products Enable V2G**
- **Interested in Making V2G a reality? V2G Forum**

QualityLogic's Role in the Smart Energy and EV Industries



- **QualityLogic is focused on Smart Energy Testing and Training**
 - IEEE 2030.5, OpenADR, IEEE 1547/UL 1741 SB
 - Used by NRTLs, Vendors, Utilities and Research labs to perform Testing/Certification
 - Technical Training and Consulting: 2030.5, 1547/UL1741SB, OpenADR and others
 - First vendor to offer 1547.1 Conformance Test Tools
- **QualityLogic is a Contributor to IEEE 2030.5/CSIP, IEEE 1547, UL 1741 and other standards**
 - Member of IEEE 2030.5, 1547-2018 and 1547.1-2020 and the new 1547 PAR working groups
 - Member of UL 1741 STP (SB revisions and UL 1741 SC)
 - SunSpec Modbus, SunSpec J3072 IEEE 2030.5 Profile
 - OpenADR, MESA-DER, SAE J3072, SEPA Test and Certification WG

What is V2G and Why Does it Matter



Managed charging, DC and AC V2G

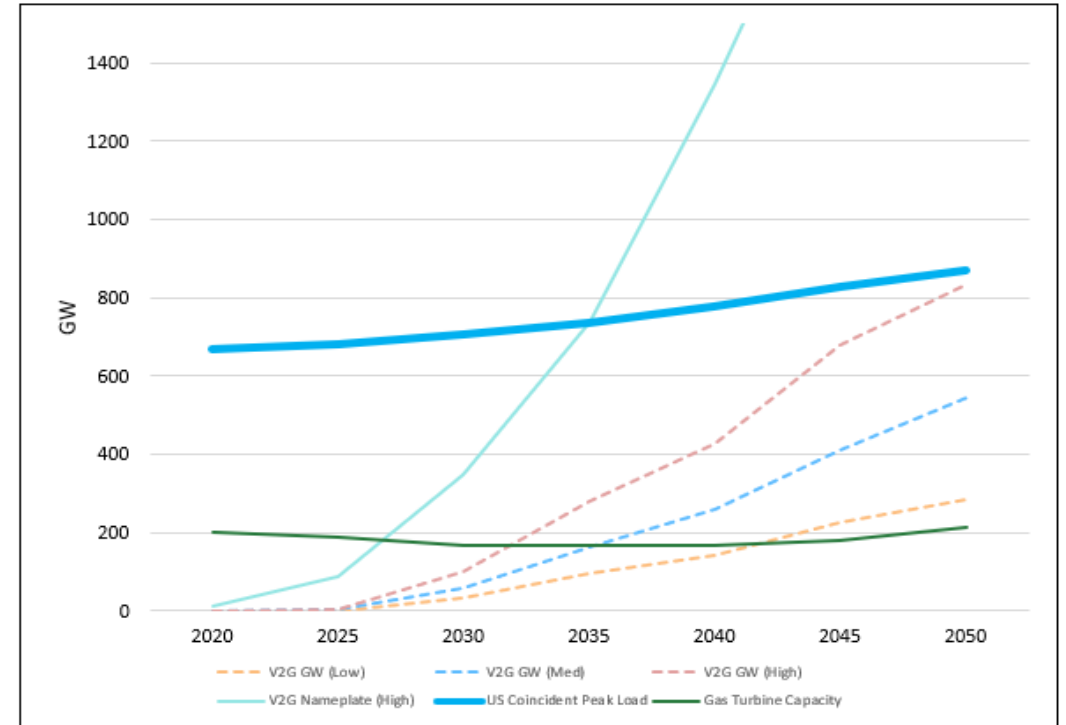
What is V2G?



- **We Think of Vehicle-Grid Integration (VGI) as:**
 - Coordinating the charging of mobile storage systems (electric vehicles, trucks, buses, etc) to assist with grid demand management and
 - Managing the use of the EV batteries as grid support Distributed Energy Resources (DER) when charging systems are capable of being DER.
- **V1G – i.e., one-way power flow with communications to influence charging schedules**
- **V2X – vehicle exports power to the X (building, another vehicle...)**
- **V2G – bi-directional power flows and communications**
 - Requires Utility Interconnection agreement and grid support certifications to export power
 - Grid support functions required for interconnected energy resources – e.g., Voltage/freq must trip, voltage/freq ride through, Anti-Islanding, etc
 - These functions insure safe operation and help stabilize the electrical grid

Why V2G Matters

- **Huge potential to upend how we make, store and use electricity:**
 - EPRI estimates just for CA, V2G is \$1 billion/year in potential value¹
 - Total EV battery capacity will exceed total US peak electricity demand in 2035²
- **EVs as DERs are treated like other DERs: subject to Utility Interconnection requirements**
 - INCLUDES UL 1741 SB (IEEE 1547-2018)
 - SAE J3072 requires IEEE 1547 conformance in onboard grid support inverters
- **However, EVs as DER more complex**
 - Scheduling, charging level, location, transportation purpose
 - IEEE 1547 has a new Task Group on V2G for IEEE 1547

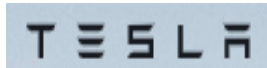


1. [Open Standards-Based Vehicle-to-Grid: Value Assessment \(epri.com\)](#)

2. Presented at an October 2022 EPRI Webex. Based on EIA projections of EV populations

Bi-Directional Charging: Catching on

- Publicly (or reported) announced plans for bi-directional capabilities on EVs



And batteries are getting bigger...



2018 Focus EV - 34kWh



2022 Lightning - 131kWh



2015 Spark EV - 19kWh

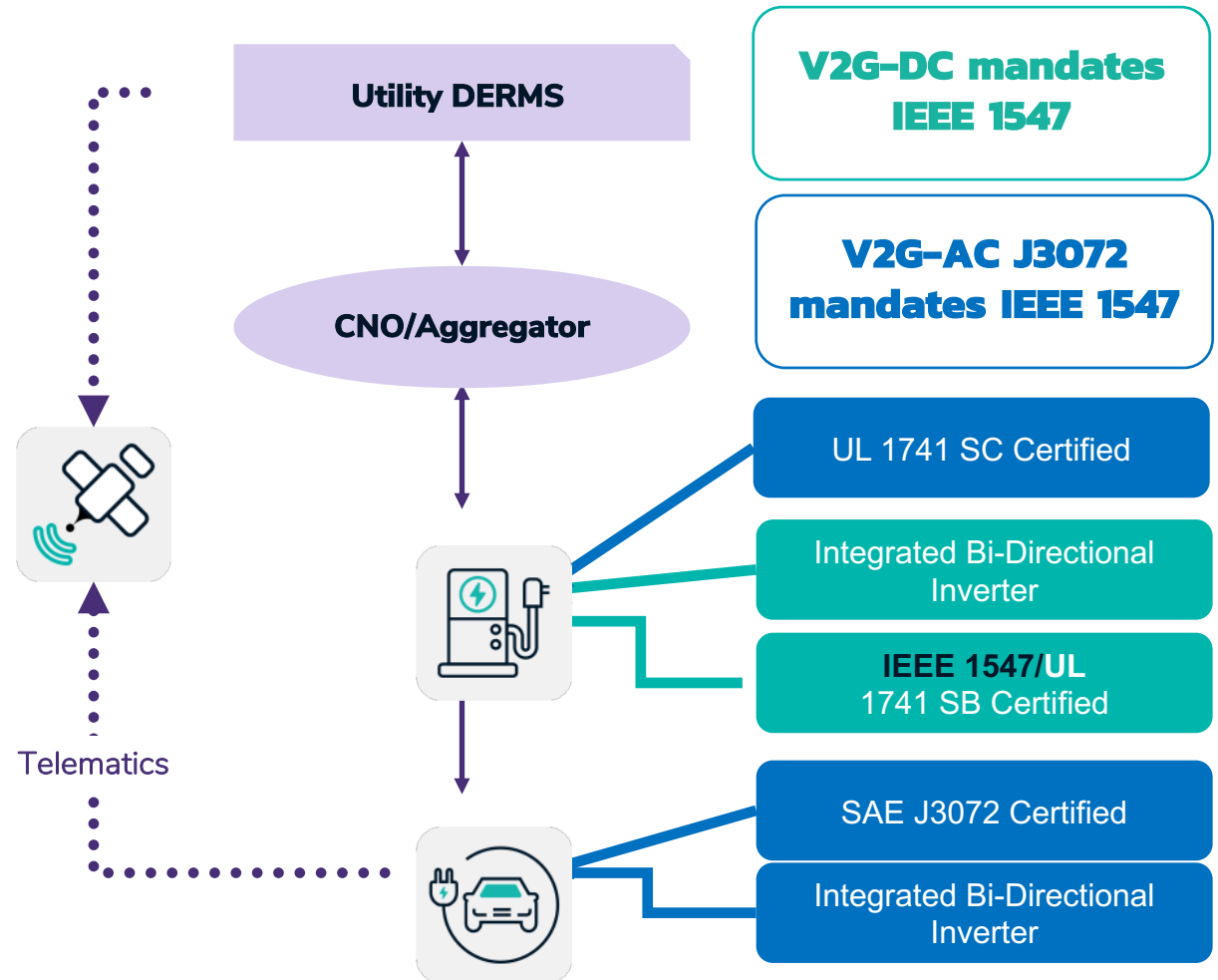


2022 Hummer EV - 212kWh

Source: Flex Power Control presentation during Veloz Webinar 8/23/2022 and SGO DR and DER Conference, October 13, 2022

Interconnection for EVSE as DER

- **IEEE 1547 is a REQUIREMENT for V2G in the US**
 - Interconnection standard for all DERs
 - ANY EXPORT to the Grid requires IEEE 1547 compliance.
 - IEEE 1547-2018 is the latest version and is required starting in 2022
 - SAE J3072 requires IEEE 1547 conformance in onboard grid support inverters
- **EVs as DERs are treated like other DERs: subject to Utility Interconnection requirements**
 - UL 1741 SB is the new certification requirement – certifies IEEE 1547 Compliance
 - V2G-DC can be interconnected with UL 1741 certification TODAY!



Interconnection for EVSE as DER – EU

- **EN 50549-1:2019 is a REQUIREMENT for V2G in the EU**
 - Interconnection standard for all DERs
 - Supersedes country specific grid codes (in theory)
 - Similar functions to IEEE 1547 – no interop requirement
- **EVs as DERs are treated like other DERs: subject to Utility Interconnection requirements**
 - EN 50549-10:2022 is the test specification for EN 50549.
- **No EU V2G-AC standards as yet**

Critical Success Factors for V2G



Key Challenges; Solutions Required

Challenges from the V2G Forum

- 1. End-end standards, certifications and interoperability**
 - a. Reliable, interoperable, certified HW and SW.
 - b. AC standardization issues unique
 - c. Certification or self-certification of EVs
- 2. Harmonization of standards (barrier to moving forward)**
 - a. Competing industry standards including other DER systems and integration of all DER
- 3. Quantifying value of V2G to utility and customers**
 - a. Incentives and compensation for customers, aggregators, others
 - b. Costs and feasibility of installation of V2G

- 4. Distribution utility preparation.**
 - a. Visibility of DER resources
 - b. Hosting capacity data and utility situational analysis of EVs
 - c. V2G integration with other DERs,
- 5. Regulatory: interconnection and roadblocks**
 - a. Lack of policy vision
 - b. Interconnection speed, ease of use. Alignment at federal level of requirements
- 6. Customer experience**
 - a. Support for EV, CNO and EVSE OEMs to deliver compelling customer experience
- 7. Battery technology**
- 8. Workforce development**

Standardizing V2G

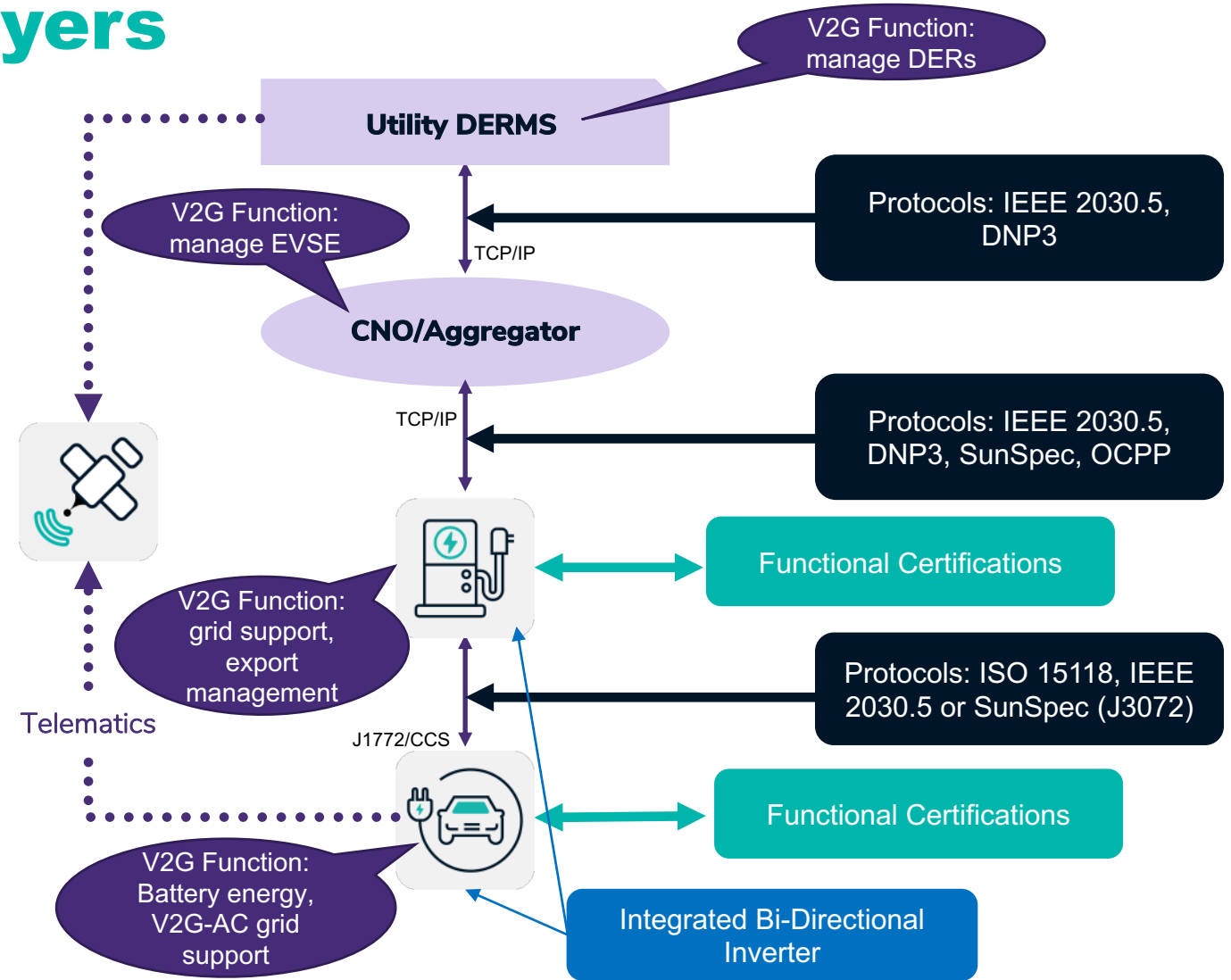


Are we getting there?

V2G Architectural Layers

3 layers of V2G architecture

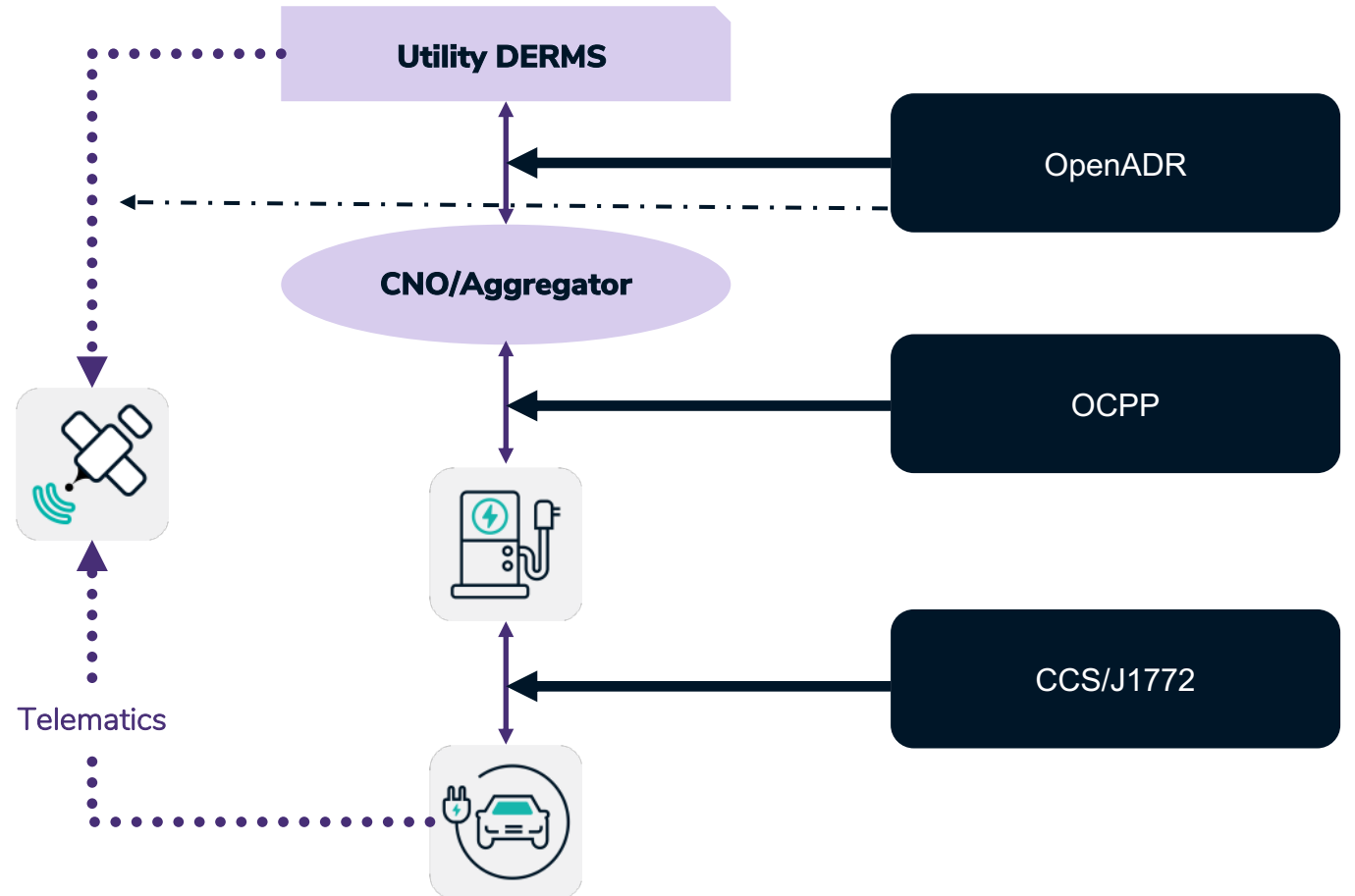
- Functional layer
 - Which system does what
 - Functional requirements and certifications
 - Physical/Network layer
 - Mostly TCP/IP
 - But unique EVSE-EV comms
 - And proprietary telematics
 - Messaging protocol layer
 - Exchange of actionable information
 - Standards for syntax and semantics
- *NOTE: The focus is on mandated CA and NEVI protocols which do not include CHAdeMO.*



US Market V1G: Standards

Use Case: V1G Charge Management

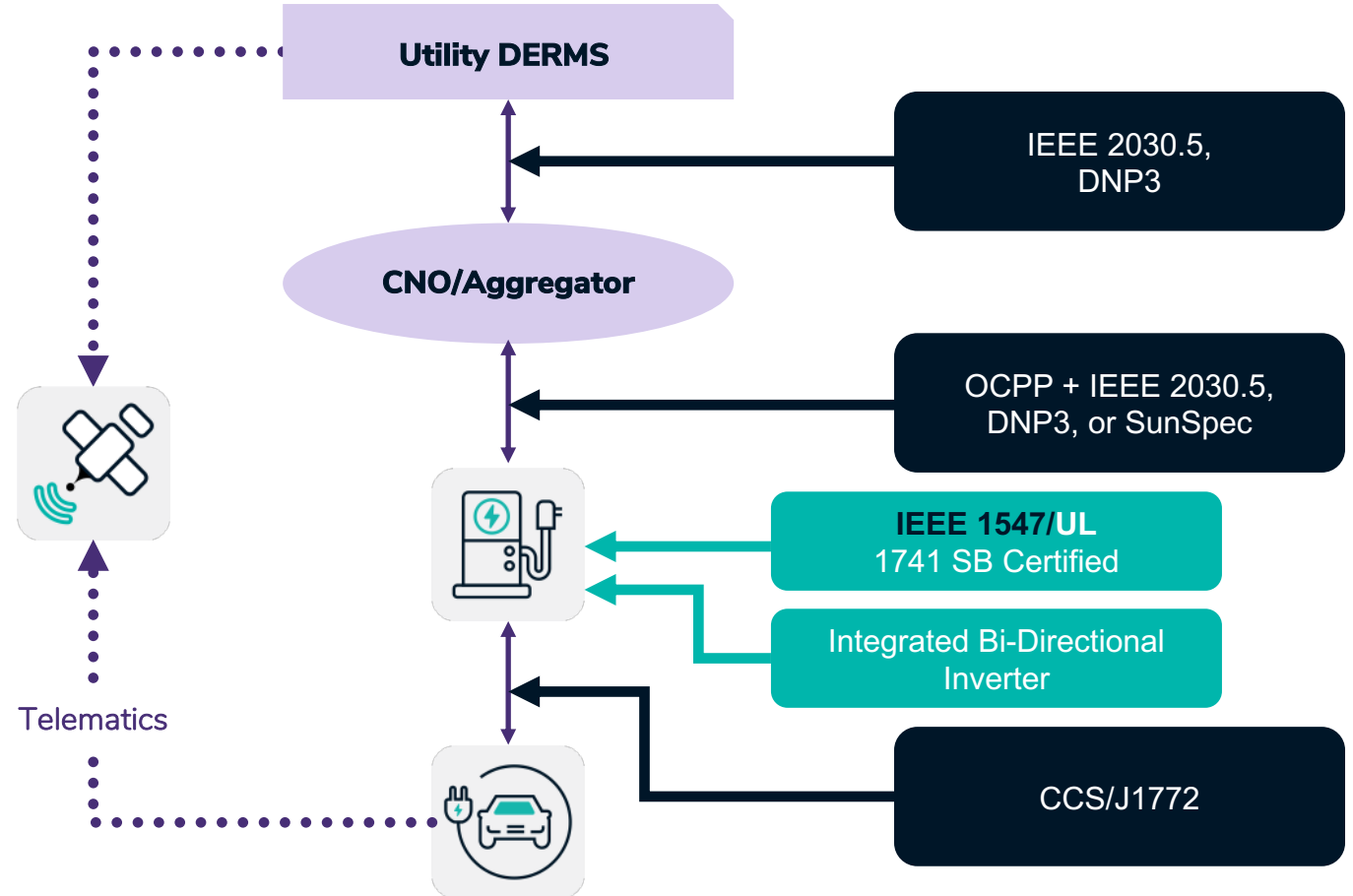
- One directional EVSE power flow
- Grid Operator interactions – when to charge, charge rate, etc
- Mitigation of demand spikes – duck curve
- But no energy/power support for the grid
- *NOTE: Other protocols such as IEEE 2030.5, EEBus, IEC 61850 may be used if V2G is a future use case*



US Market V2G-DC: Standards

Use Case: V2G-DC Charge + Energy + Power Management

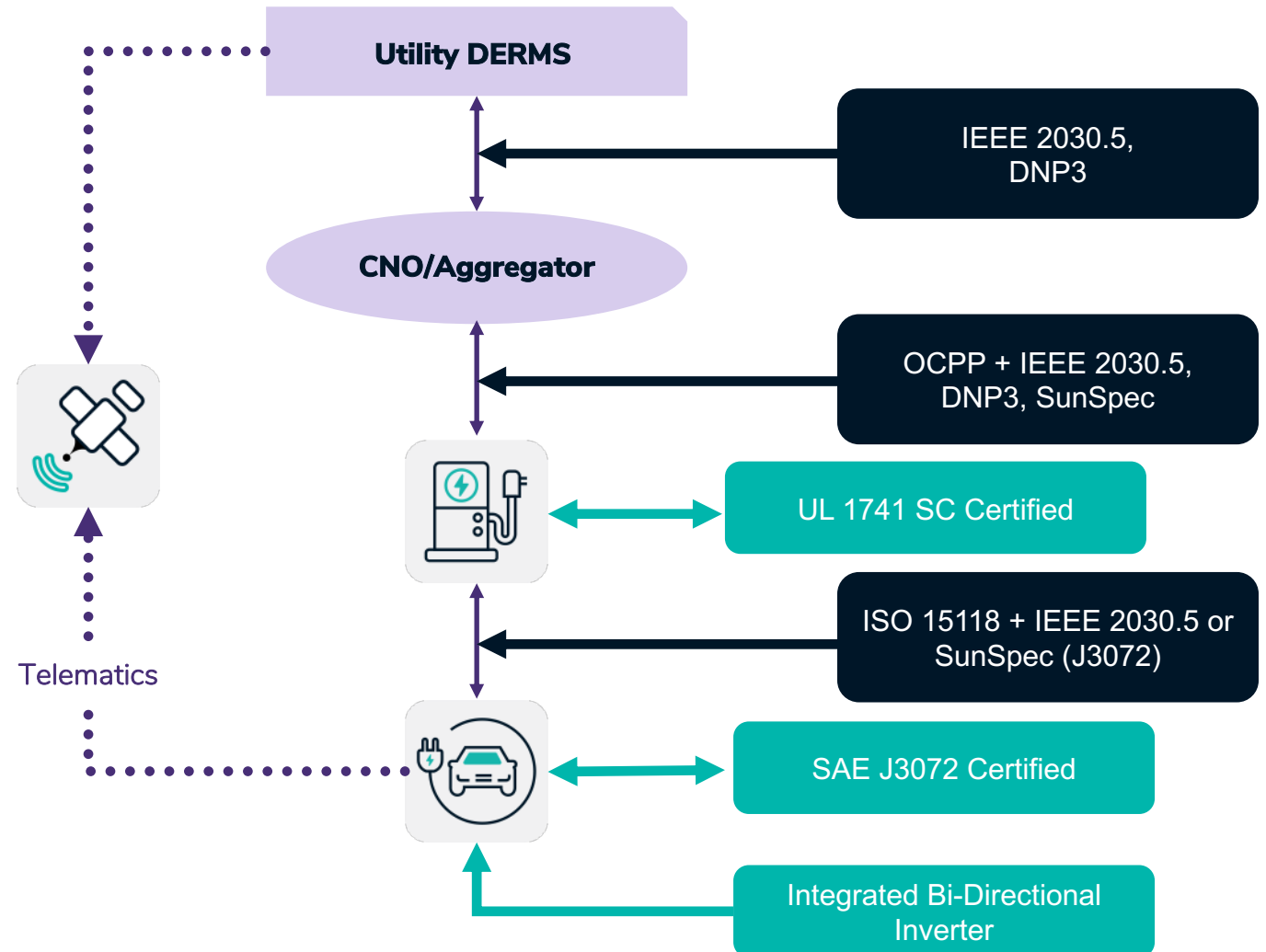
- Bi-directional EVSE Inverter
- Interconnected at the UL 1741 SB EVSE
- Grid interactions at the EVSE – charge/export time, power settings, IEEE 1547 Curves and Controls



US Market V2G-AC: Standards

Use Case: V2G-AC Charge + Energy + Power Management

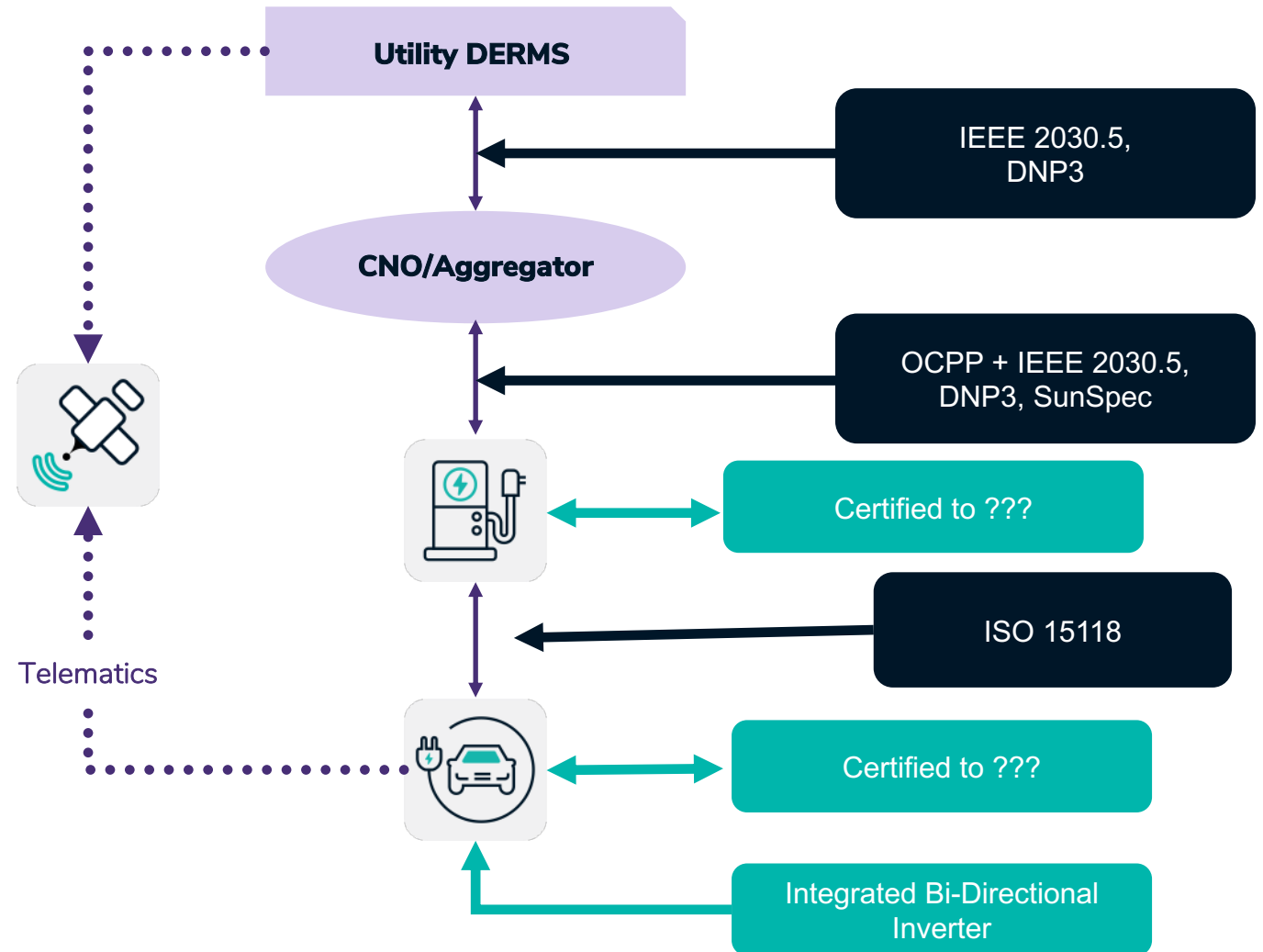
- Bi-directional J3072 EV Inverter
- Interconnection at a UL 1741 SC Certified EVSE
- Grid interactions at the EV – charge/export time, power settings, IEEE 1547 Curves and Controls



A Split Inverter Model?

Use Case: Inverter on EV; Grid Codes on EVSE

- Bi-directional EV Inverter
- EVSE receives and implements Grid Codes; “micro-manages” EV Inverter
- Grid interactions – EVSE/EV Combination certified to UL 1741 SB or other Grid Codes.
- Accommodation of other EVs?
- Standards and certification gaps
 - EVSE certification to ???
 - EV certification to ???
 - Interface standards certification



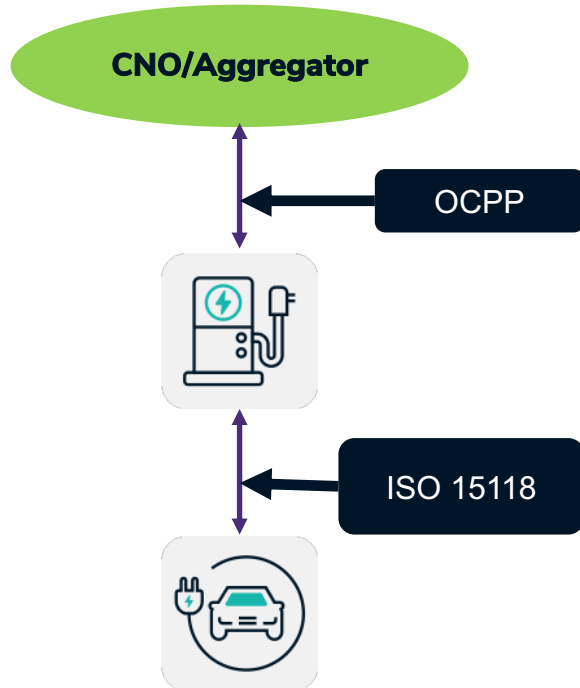
Harmonizing US and EU Standards

Key Challenge requiring Solutions to Accelerate V2G

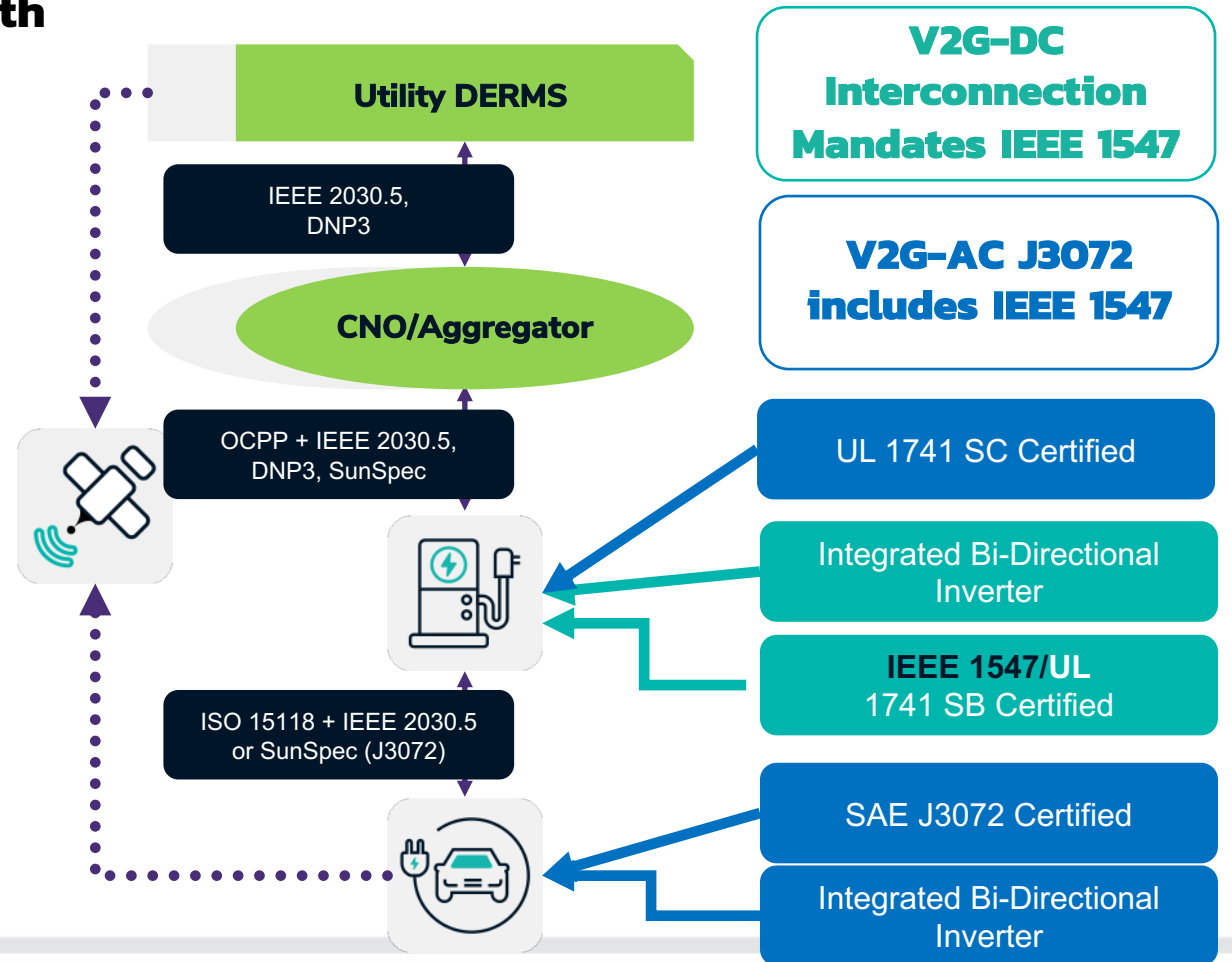
OCPP/ISO 15118 Charging Infrastructure and V2G

How does a US V2G infrastructure co-exist with an OCPP/15118 Charging Infrastructure?

CHARGING INFRASTRUCTURE



V2G INFRASTRUCTURE



ISO 15118/OCPP and J3072

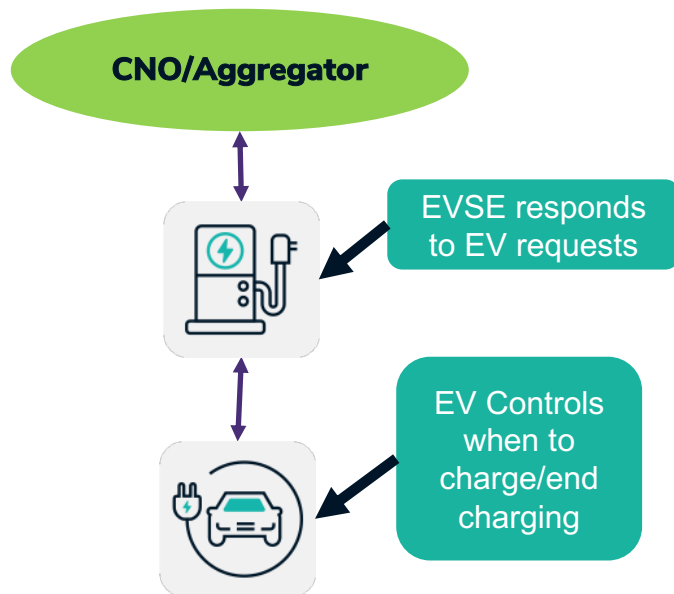


- **Co-existence of ISO 15118/OCPP and J3072 IEEE 2030.5/SunSpec communication required to support US V2G requirements TODAY**
- **Two major issues: control of the EV/EVSE behaviors and communicating IEEE 1547 grid support functions**

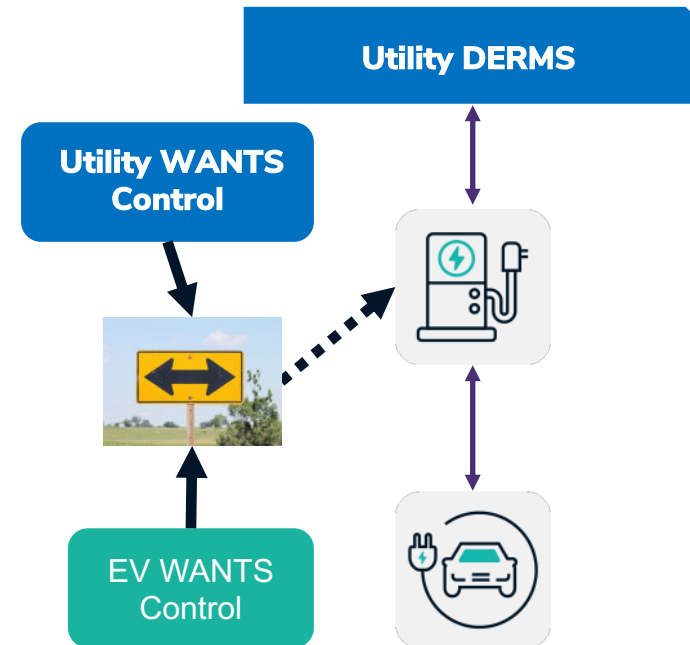
Multiple Challenges

- **Two key V2G technical issues**
 - Control of the EV/EVSE actions
 - Grid Support functions

CHARGING CONTROL MODEL



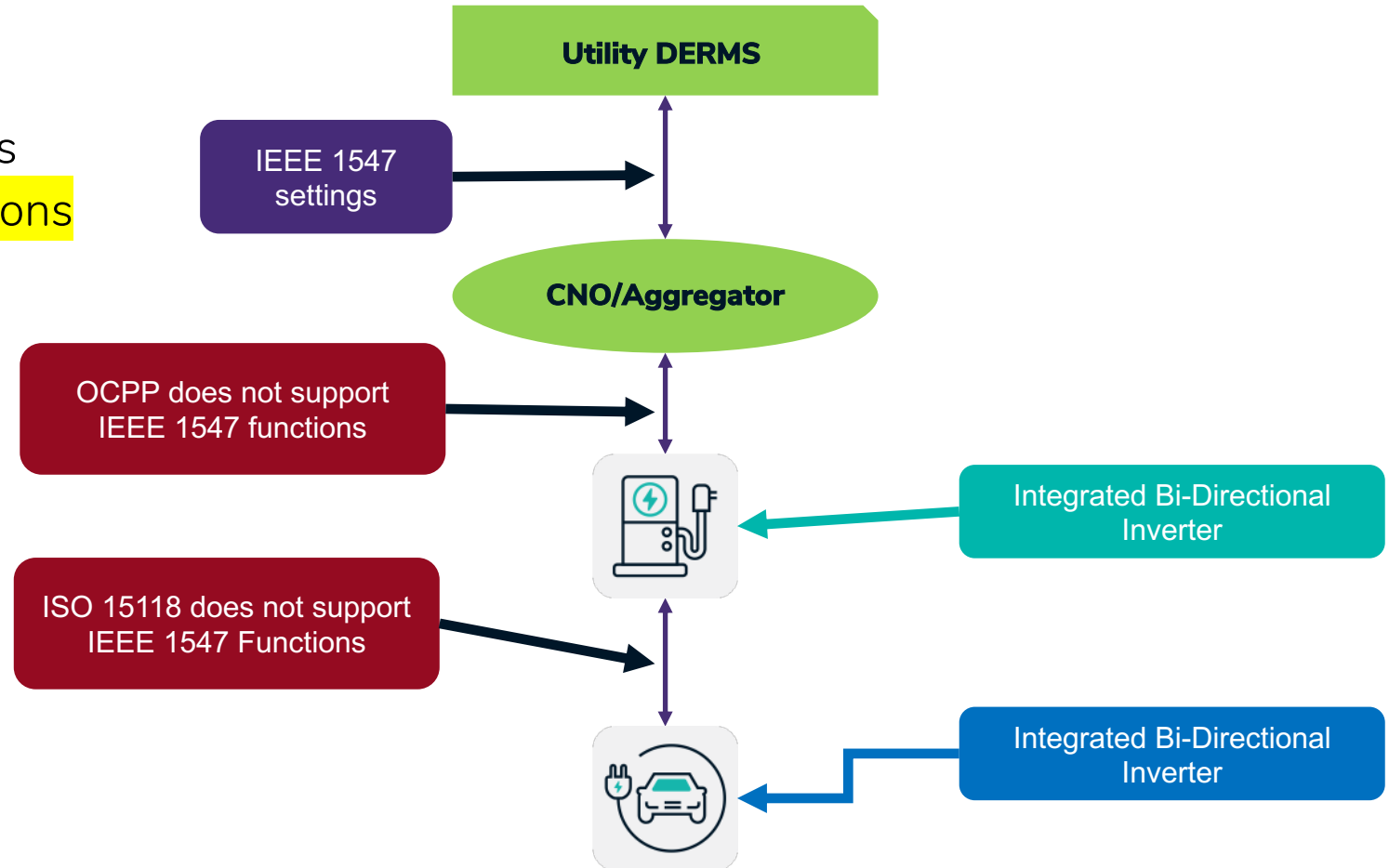
V2G CONTROL MODEL ON CHARGING MODEL



Multiple Challenges

- **Two key V2G technical issues**

- Control of the EV/EVSE actions
- IEEE 1547 Grid Support functions



Can (When will?) ISO 15118 and OCPP Support Grid Codes?

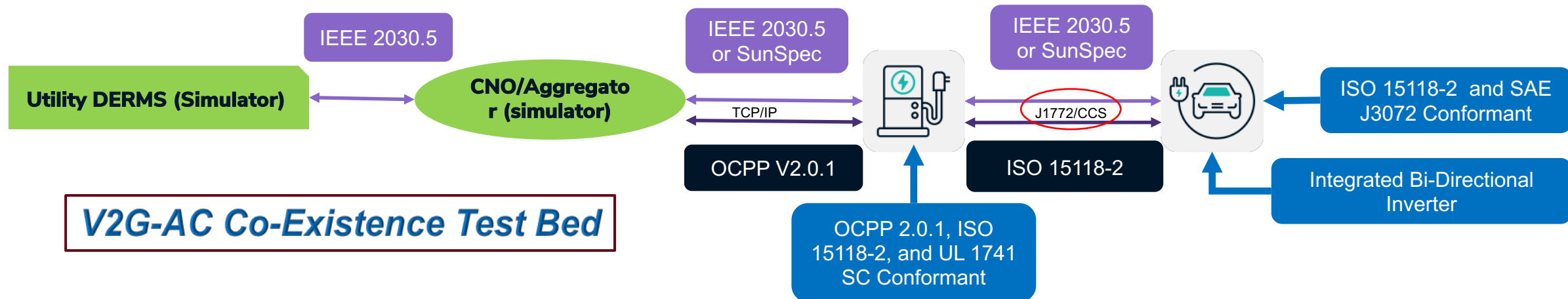
- **Is it just a question of WHEN? And what happens in the meantime?**
- **OCPP actively working on V2.1 to accommodate grid codes**
 - V2.0 approved in 2018; updated with V2.0.1. Certification program starting Q2 2023.
 - How long will it take to finish, introduce and start certifying V2.1 with Grid Code support?
 - NEVI requires that “Chargers must conform to Open Charge Point Protocol 1.6J or higher” and “By February 28, 2024, chargers must conform to OCPP 2.01 (but not V2.1)”
- **ISO 15118-20 just released in 2022. Certification test standard in process. Certification program years away?**
 - Discussions but no specific work underway on supporting grid codes in ISO 15118.
 - When will that happen?
 - NEVI mandates hardware “capable of implementing both ISO 15118-2 and ISO 15118-20”. While conformance to ISO 15118-2 and Plug and Charge is mandated by February 28, 2024, no dates are mandated for conformance to ISO 15118-20 (with potential to support split inverter model).
- **Note that NEVI does not address V2G capabilities**
 - Neither OCPP V2.0.1 nor ISO 15118-20 support V2G in the US..

Can US and EU Standards Co-Exist?

- **Is this what we are mandating?**

- NEVI and CA mandating OCPP and ISO 15118-20 capabilities
- CA already requires UL 1741 SB for V2G-DC with required support for IEEE 2030.5, SunSpec or DNP3 (but not OCPP) “upstream” to the CNO or DERMS
- CA may mandate J3072 and UL 1741 SC requiring IEEE 2030.5 or SunSpec for EV-EVSE V2G-AC communications without mention of ISO 15118 or OCPP.

- **Do we need to just try the combinations and use cases to see if they can co-exist?**



QualityLogic's V1G and V2G Test Tools



Training, testing and certification to leading standards

Tools and Services for V1G and V2G

Protocol	V1G	V2G-DC	V2G-AC	Charging
OpenADR	QTT	NA	NA	NA
IEEE 2030.5 CSIP	QTT	QTT	QTT	NA
IEEE 2030.5 J3072	NA	QTT	QTT	NA
IEEE 1547/UL 1741 SB (EVSE)	NA	QTT	NA	NA
J3072 UL 1741 SC (EVSE)	NA	NA	Planned	NA
EV J3072 Certification	NA	NA	QTT	NA
OCPP	Not Planned	??	??	Not Planned
CCS/ISO 15118 interop	Prototype	Prototype	Prototype	Prototype
CCS/ISO 15118-20 + GC	NA	NA	??	??

QTT = QualityLogic Tools Available Today

NA = Not Applicable

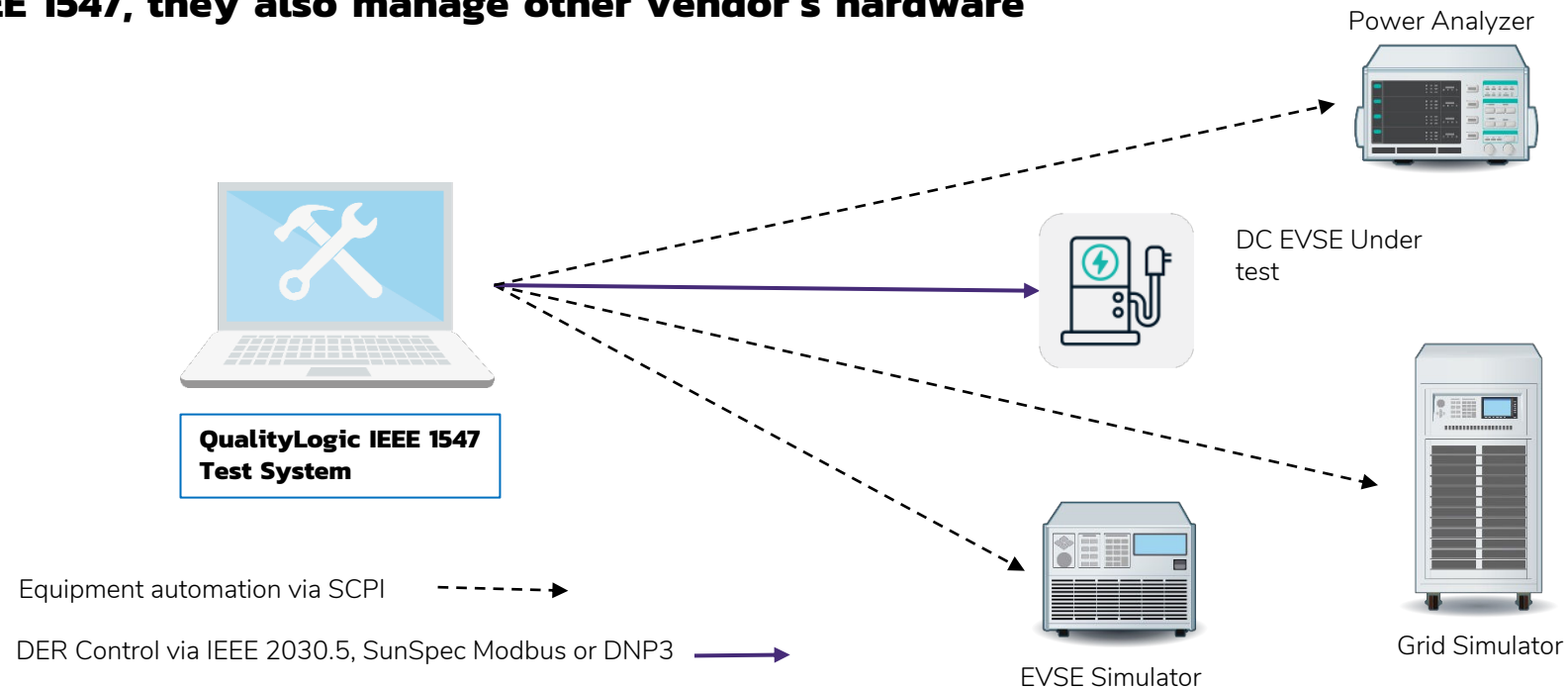
?? – Possible test tool but no decision today

QualityLogic Training Available Today

- **OpenADR**
- **IEEE 2030.5**
- **IEEE 1547**
- **Exec Workshops**

Tools are Mostly Software

- **QualityLogic's Test Tools are primarily SW based**
- **However, with IEEE 1547, they also manage other vendor's hardware**



Want to Get Involved?



V2G Forum

Want to Work on V2G? Participate in V2G Forum



- **Co-Chaired, Sponsored 1st V2G Forum Feb 28–Mar 1, SCE**
- **V2G Forum October 17–19, Detroit**
- **DRAFT Agenda**
 - Day 1 – Introduction to V2G – ½ day Workshop
 - Day 2 – Learning Day: Panels, Breakout Sessions
 - Day 3 – Working day. SCE TAB WGs, V2G Policy WG
- **Interim Work Groups tackling key Challenges to V2G**

Summary



V2G is Real and Coming to a Place Near You

Summary

- **V2G is a compelling opportunity**
- **But VERY CHALLENGING on multiple fronts**
- **V2G-DC is standardized in the US,**
 - But not the EU
- **V2G-AC US standardization is in process**
 - But in the EU?
- **US Charging Infrastructure moving to OCPP and ISO 15118**
 - Don't support V2G grid code requirements
 - Creates challenges for V2G in the US
- **Standards harmonization and/or co-existence?**
- **QualityLogic's role: enable standardized, interoperable eco-systems for charging, V1G and V2G infrastructures**
 - Through training and engineering/certification test tools

Questions?



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