



V2G and CCS Charging End-End Interoperability

**QualityLogic's Interop Solutions
February 2025**



Agenda



- **The Global Energy Transition and Interoperability**
 - The End-End Interoperability Challenge
- **Why do Interop Problems Exist?**
- **Getting to Vehicle-to-Grid (V2G) Interoperability, Conformance, Certification**
- **The Business Side of Interoperability**
- **QualityLogic's End-End Role and Interoperability Solutions**

The Global Energy Transition and Interoperability

Context and the Need for Interoperability

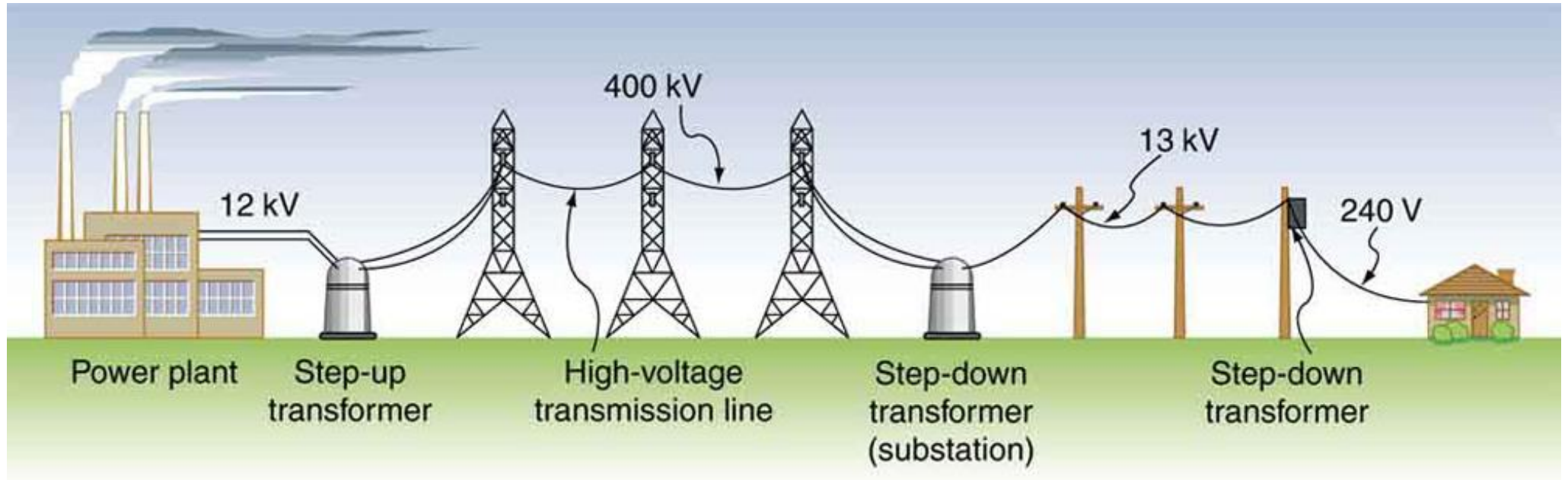
Smart Energy - Decarbonizing the Global Economy

- **International Energy Agency estimates we will need by 2050:**
 - 240 million rooftop PV systems and
 - 1.6 billion Electric Vehicles (EVs)
- **To meet global decarbonization goals and keep global temperatures under a 1.5 degree C increase**
- **Requiring \$4 Trillion/yr in investment by 2030 in transforming electric utilities and transportation industries**
 - US Annual budget = \$6 Trillion
 - US Debt = \$34 Trillion
 - US GDP = \$28 Trillion



Electric Sector Basics

- Traditional Power System



Electric Grid Simplified

- [NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 4.0](#)
- Managing the Power Grid is done through a set of interoperating domains
- Most complex machine in the world because of real-time generation matched to demand
- What is new is SCALE for DERs
 - Traditional power systems had at most a few hundred control points and interoperability could be custom engineered.
 - The new power system could have millions of devices generating, storing and using power that a utility can/should control for optimized resource use.
 - Custom engineering does not scale!!
 - Interoperability standards and real interoperability is required to scale rapidly and optimally

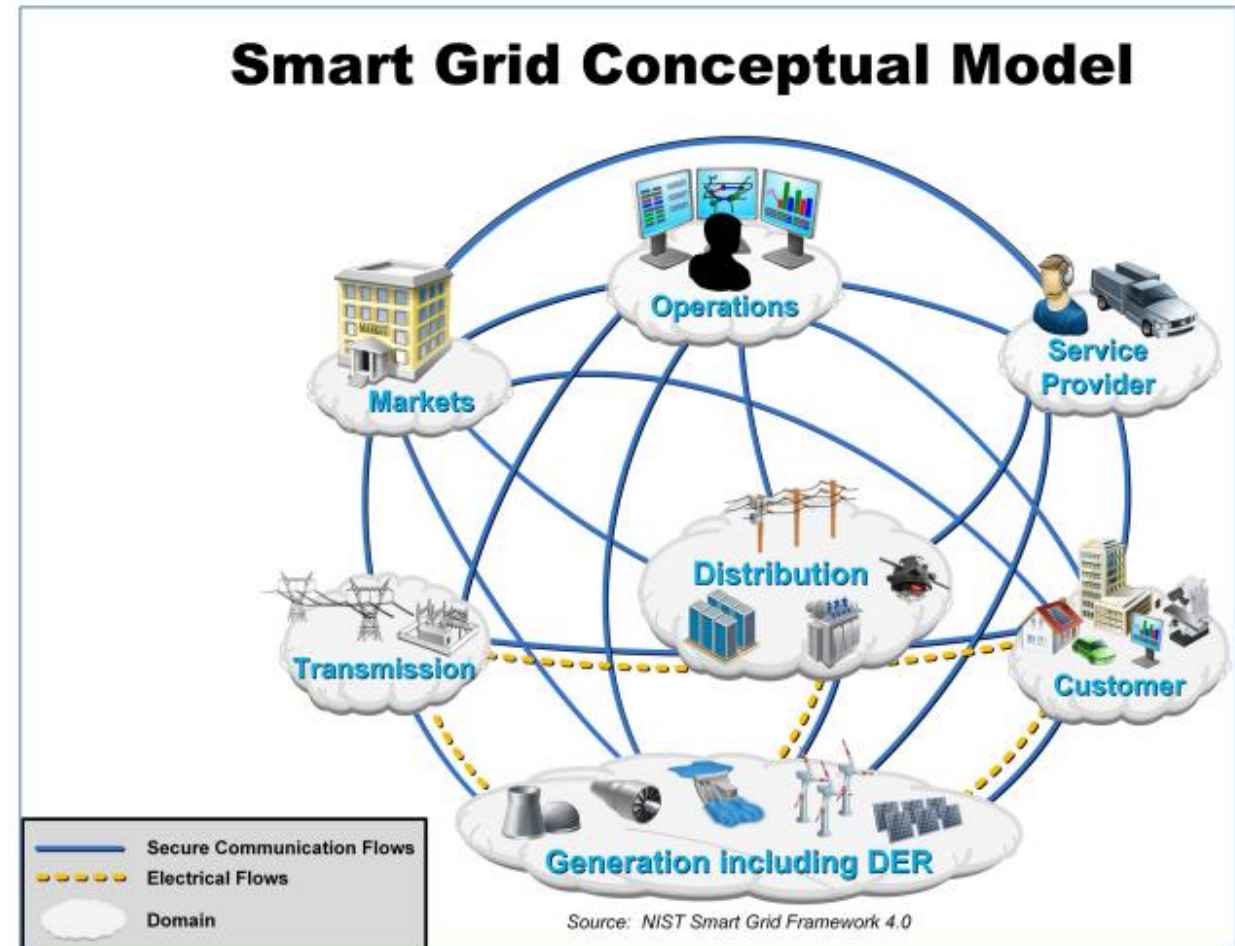


Figure 4 – Updated NIST smart grid conceptual model

Projected EV Battery Capacity

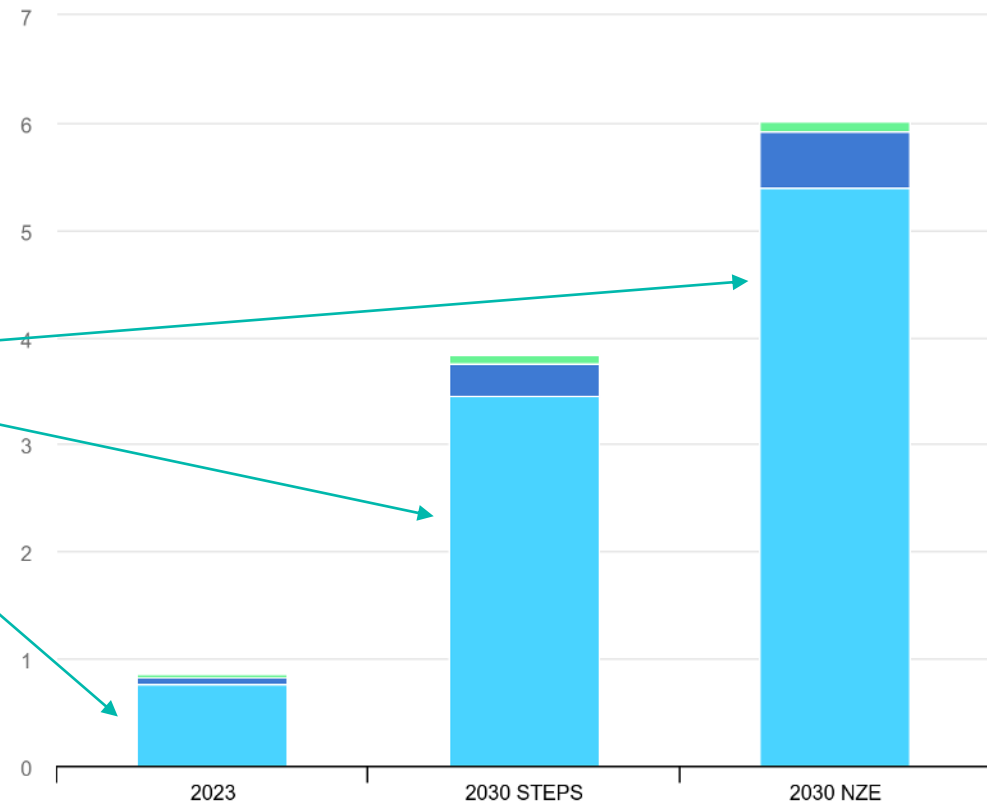
- Most new battery capacity will be in EVs, making V2G and Managed Charging important grid resources.
- But only if they can be integrated into grid operations, including interoperable communications.

Annual battery demand by application and scenario, 2023 and 2030

Last updated 19 Apr 2024

Batteries in EVs

- Electric vehicles
- Utility-scale batteries
- Behind-the-meter batteries

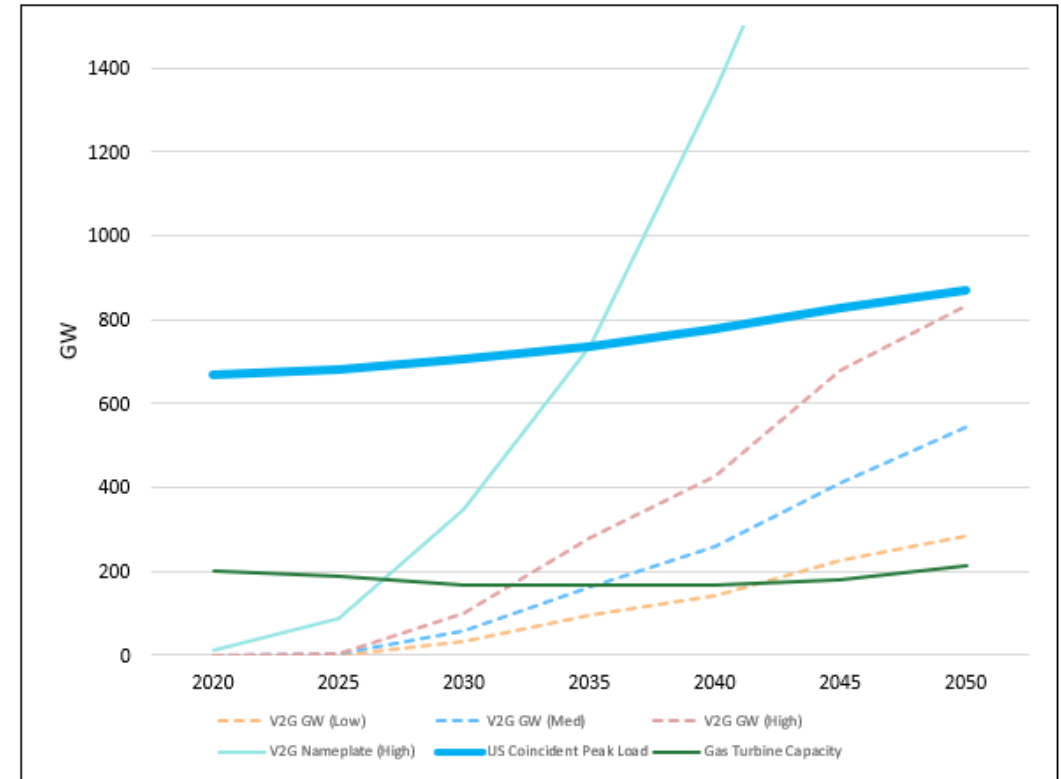


IEA (2024), Batteries and Secure Energy Transitions, IEA, Paris <https://www.iea.org/reports/batteries-and-secure-energy-transitions>, License: CC BY 4.0

STEPS = IEA Stated Policy Scenario
NZE = Net Zero Emissions by 2050 Scenario

V2G Potential in the US

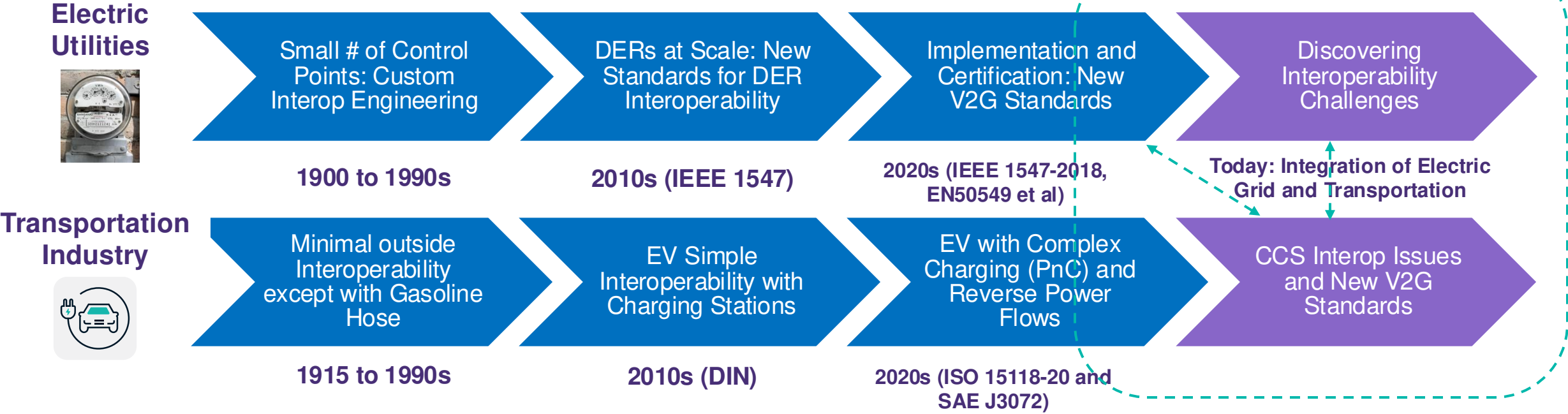
- **Huge potential to upend how we make, store and use electricity:**
 - Total EV battery capacity will exceed total US electricity demand in 2035
- **EVs as DERs are treated like other DERs: subject to Utility Interconnection requirements**
 - INCLUDES UL 1741 SB, EN 50549 and other interconnection grid codes



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

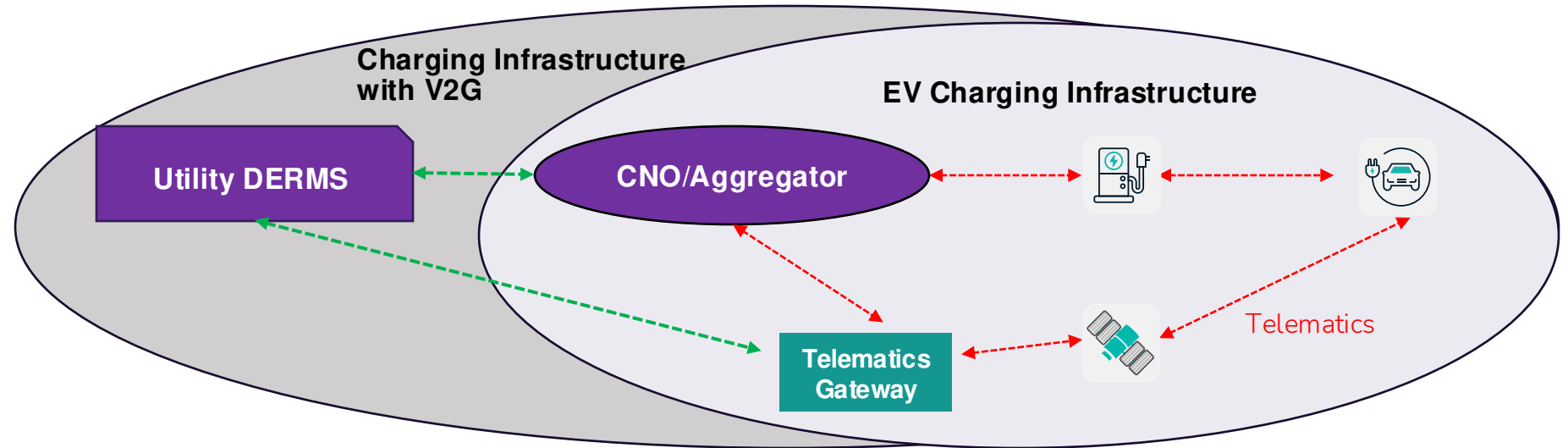
Two Industries: Two Interoperability Stories

Interoperability Journeys



V2G Relies on the EV Charging Infrastructure

- The EV Charging Infrastructure is at the core of V2G.
- V2G = EV Charging +
 - Certified grid support bi-directional systems
 - Grid interconnection
 - Grid code support in messaging protocols
 - SW to manage both charging and V2G
 - *INTEROPERABILITY* of both Charging and V2G.

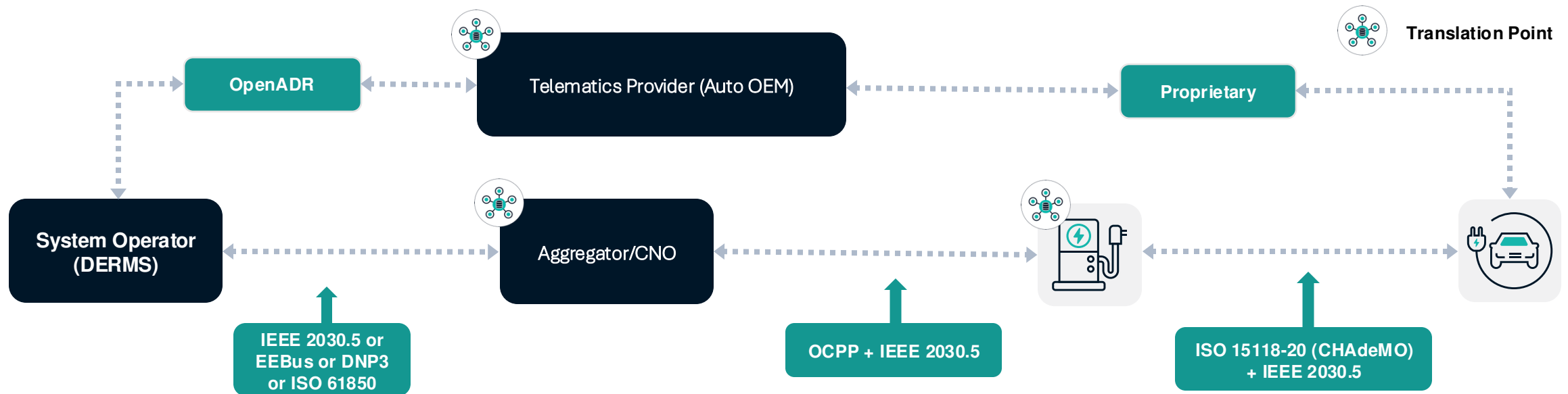


Interoperability Challenges: Two Cultures and Two Business Contexts

- **Utilities and the transport industry have been historically unintegrated**
 - Two very different businesses – just another customer for utilities
- **Very different businesses and culture**
 - Auto industry global in scope and driven by hyper-competition and market forces with some regulation – e.g., fleet average mpg rules and emissions rules
 - Utilities are a highly regulated public “good” with a strong service culture and very localized focus
- **Auto industry interoperability with systems outside of a car company was never an issue – until now.**
 - Biggest interoperability issue: standardization of fueling nozzles
- **Utility interoperability has been generally custom engineered**
 - Only with the advent of programmable DER resources at scale has the industry started to grapple with standardized and scalable interoperability
- **Bringing the two industries together for optimal decarbonization benefits is a challenge, to say the least**
 - Interoperability is a strategic success factor

End-End Interoperability Challenge

- **End-End Interoperability is complicated by multiple communications protocols.**
 - V2G: IEEE 2030.5 (or EE Bus, DNP3, ISO 61850) to OCPP to ISO 15118-x (CHAdeMO, GB/T in China)
 - Solar/storage DER: IEEE 2030.5 to proprietary aggregator protocol to SunSpec Modbus inverter interface.
 - Each interface between messaging protocols requires translation for V2G. Each translation increases risks and costs.



Why Do Interop Problems Exist



Conformance, Interoperability, and Certification

Conformance vs Interoperability

What is Interoperability

- When two systems implement the same Interop standards connect and interoperate without hassle

Conformance Testing

- Ensures that a system (DER, EV or EVSE) conforms to the required standard – e.g. ISO 15118-2.
- It is done using a detailed test specification and tools that simulate one side of the charging interactions to evaluate the unit under test for conformance.

Interoperability Testing

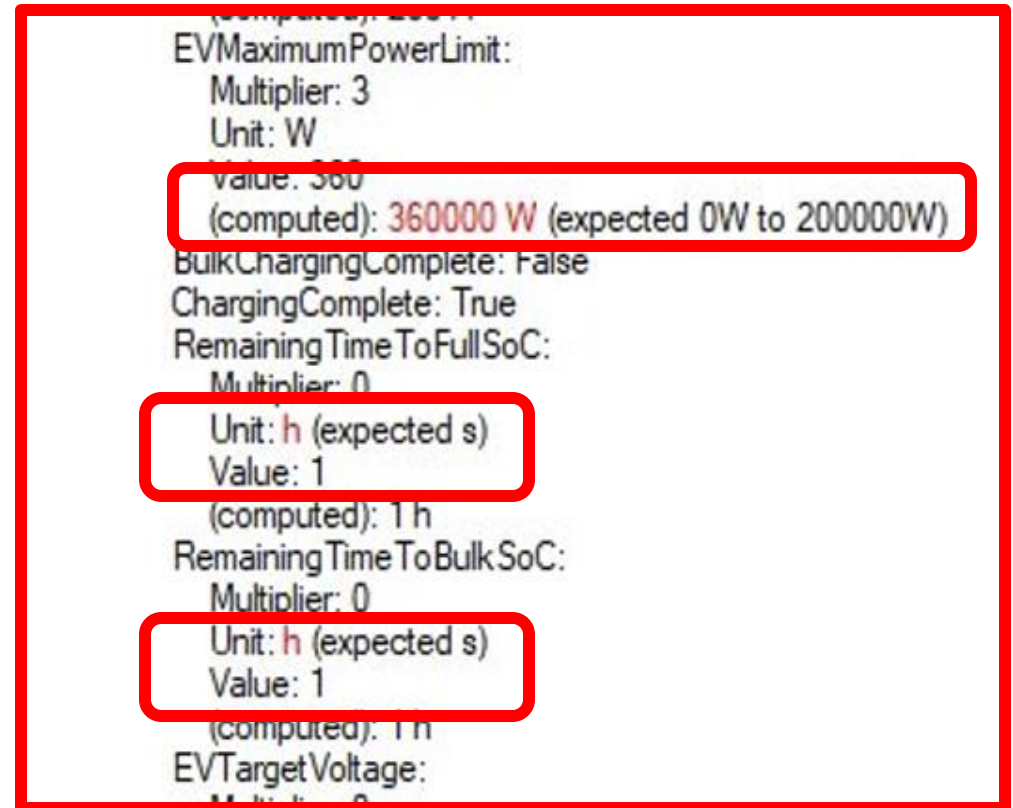
- Pairs real systems (DERMS and DER; EVs with EVSEs) to validate that they work together or, if not, identify the issues that cause interoperability. This is a normal part of technology maturity.
- Testing is done in a formal event called a Plugfest (Testival for CCS) or at the EV or EVSE OEM facility or at a field EVSE location.



Causes of CCS Interoperability Issues

Anomalies that may cause interop issues

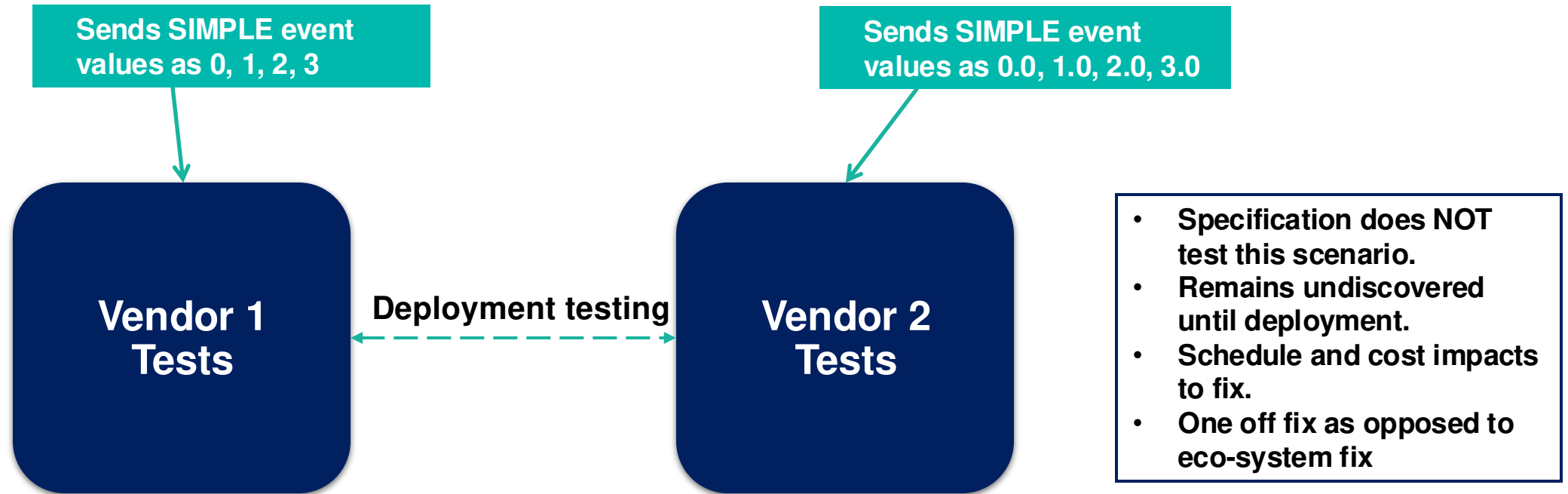
- **Message/Sequence timing**
 - Performance timeouts of individual messages
 - Sequence timeouts of spans of messages
- **Physical value constraints/units**
- **Charge schedule deviation**
 - Deviations from the agreed schedule
- **Power delivery deviation**
 - Deviations from the requested current
 - EVSE not following requested EV current ramp down
 - EVSE not honoring trickle charge request after charging complete
- **EVSE/EVCC ID format incorrect or missing**
- **No current actually delivered**
 - No current demanded/delivered
- **Low priority protocol selection**
- **Incorrect SLAC attenuation profile calculation**
- **Low level communications errors**
 - TLS Negotiation Fatal Failures
 - TCP Port Resets
 - Malformed packets



Although the schema allows 'h' as a unit, conformance rule V2G2-932 indicates it must be 's' in this usage as defined in Table 68 of the ISO 15118-2 specification.

RemainingTimeToBulkSoC:

Why Do Interoperability Problems Occur?



Getting to V2G Interoperability



Complexity, Lack of Conformance Certification, and More

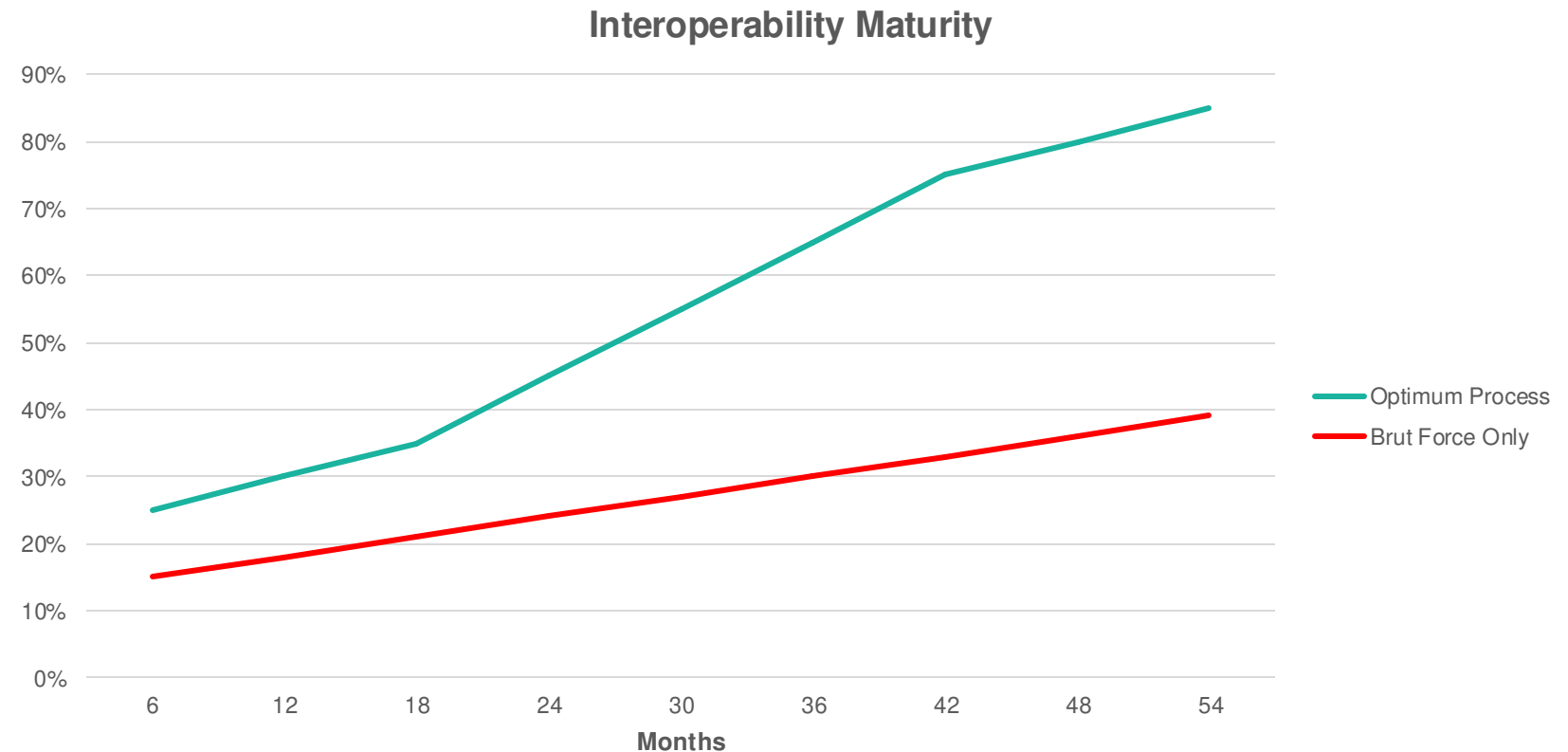
CCS Charging: Achieving Interoperability Through Bi-Lateral Testing (Brute Force)?



- **Typical eco-system interoperability uses plugfests (Testivals for CCS) to**
 - Validate conformance and interoperability test cases for use in automated test systems
 - Improve both the standard and the conformance testing for the standard
- **In lieu of Conformance certification testing, CCS is attempting to achieve interoperability through bi-lateral and plugfest testing events – Brute Force interoperability.**
- **Costs of “Brute Force” interoperability**
 - Time-consuming and expensive
 - Slows interoperability achievement
 - Becomes unwieldy to scale
 - Fixes are bi-lateral one-offs vs community improvements

The Impact of Certification on Interoperability Maturity

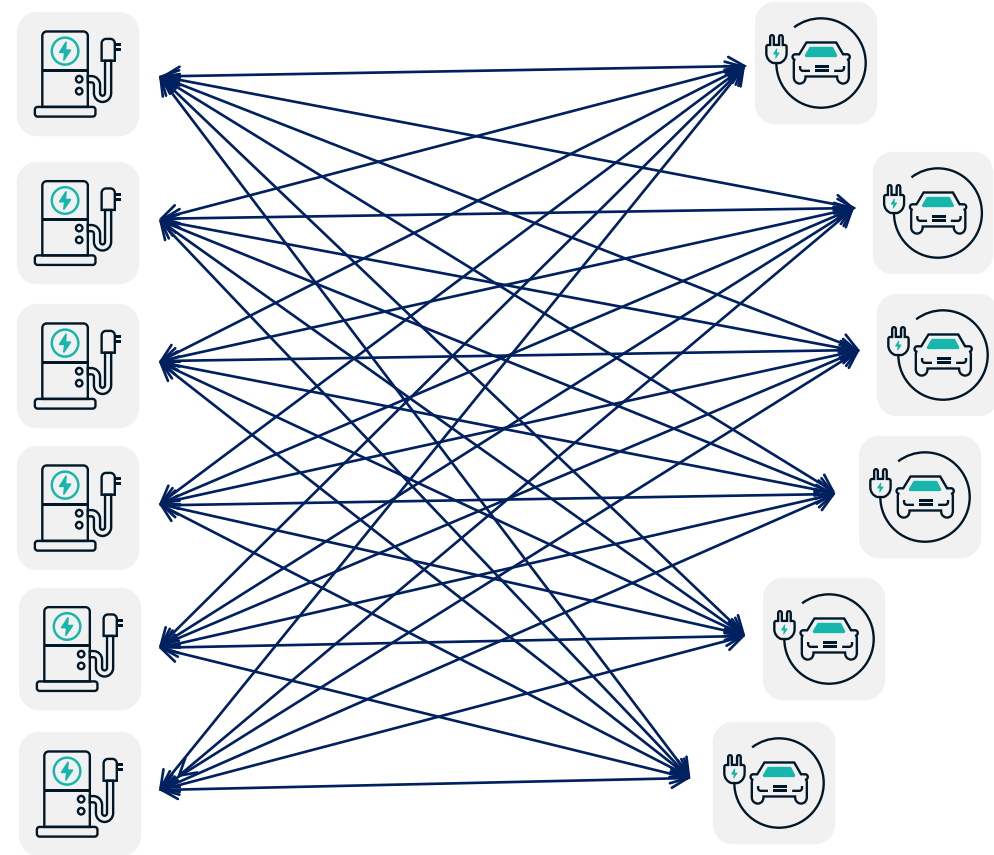
- **Conformance certification creates a baseline for all players and speeds maturity. Interoperability testing ensures interoperability maturity.**
- **Interoperability testing only is much slower to achieve maturity**



CCS Interoperability Challenge: Bi-Lateral Interop

Bi-Lateral Interoperability (every OEM responsible for interop with all EVs or EVSEs)

- Charge or conform to the standard
- Non-conformant solutions
- Expensive process
- Costly to scale



It's Only Going to Increase in Complexity



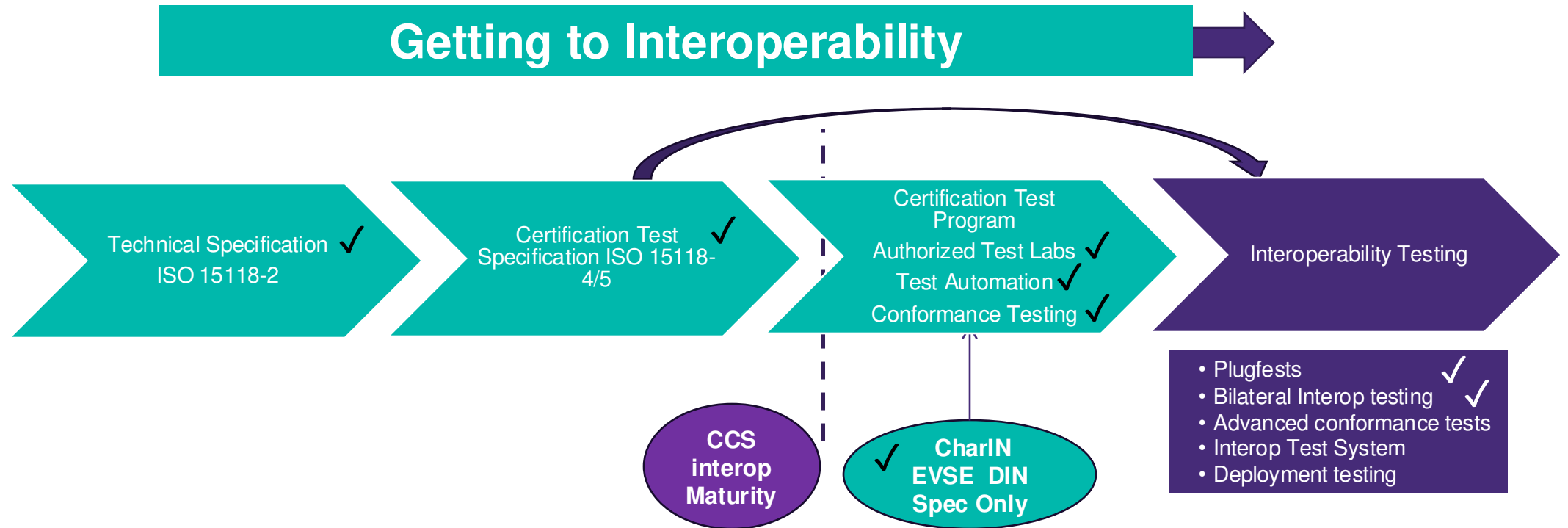
- **More OEMs implement the full ISO 15118-2 with Plug and Charge and TLS**
- **More vendors enter the domain**
- **ISO 15118-20 implementations become more common**
- **OEMs implement wireless charging and communications**
- **Medium and Heavy-duty vehicles implement MCS**
- **Vendors implement V1G (Managed Charging) and V2G support**

Interoperability State of the CCS Industry



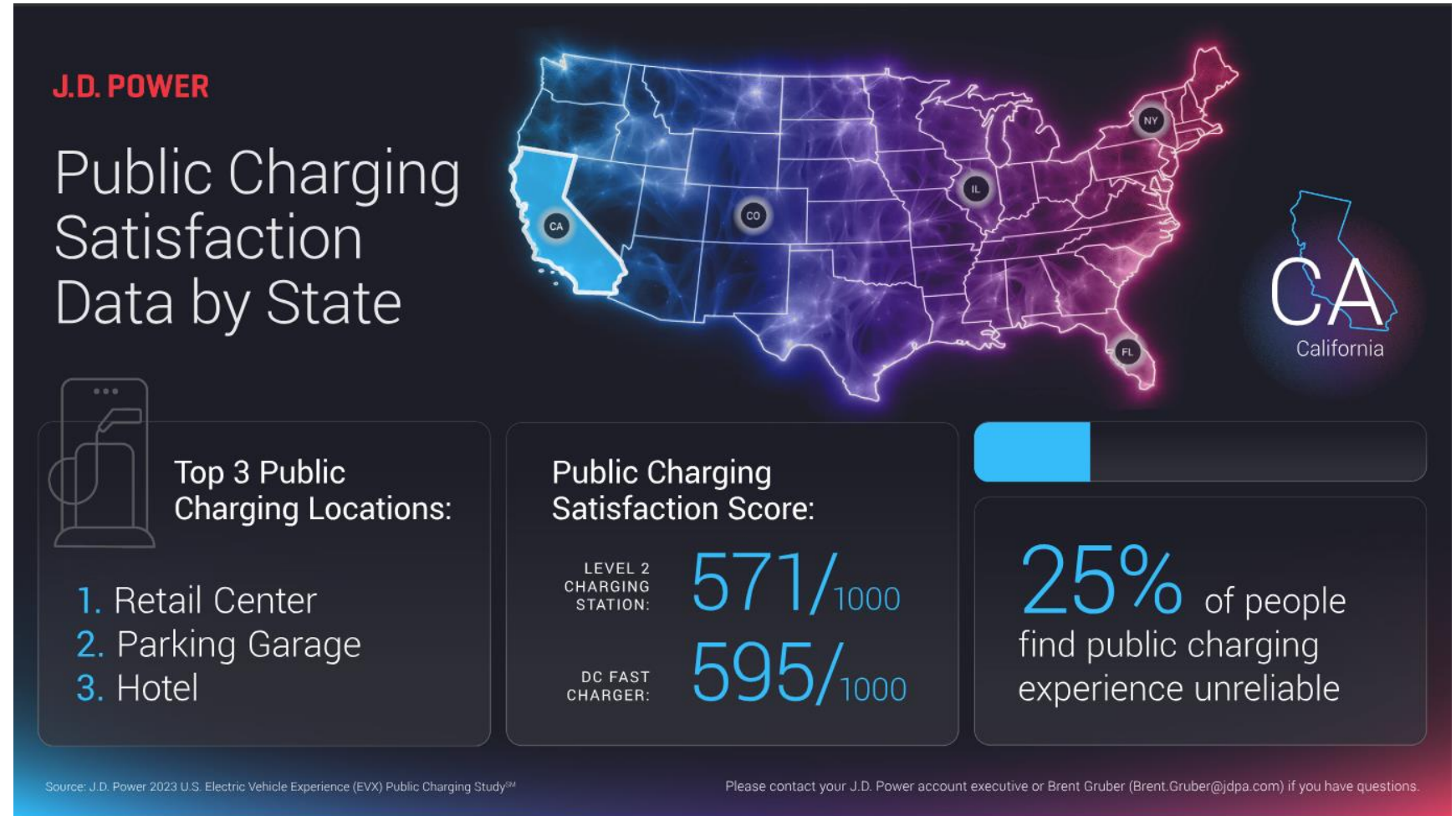
How are we doing with CCS charging infrastructure interoperability?

State of CCS Interoperability












Public Charging Satisfaction Drag on EV Sales

- “...public Level 2 charging has declined to 617 (on a 1,000-point scale), 16 points lower than a year ago...”
- Major issues are charging speed, location and charging failures: **1 in 5 visits result in not charging.**
- JD Power 2023 US EV Experience Public Charging Study, Aug 2023.



EV Comms Certification Programs and Maturity

Standard	Certification Program(s)	Owner	ATLs	Certified Products	Interop Maturity
OpenADR	OpenADR 2.0a/b	OpenADR Alliance	10	>200	
IEEE 1815 (DNP3)	DNP3	DNP3 Users Group	1	11	
IEEE 2030.5	CSIP	SunSpec Alliance	11	66	
ISO 15118	ISO 15118-4/5	CharIN	2	1	
OCPP	OCPP 1.6	OCA	6	200	
CHAdeMO	CHAdeMO	CHAdeMO	7	>400	
SunSpec Modbus	SunSpec Modbus	SunSpec Alliance	11	69	
IEEE 1547.1	UL 1741 SB	OSHA	11	>100	
802.11	Wifi Certified	Wifi Alliance	12	~70,000	

Utility DER Interoperability

- **Standards and certifications are developed or in development for DER interoperability**
- **However, even certified products are not interoperating as hoped:**
 - EPRI convened an Industry Working Group in Feb 2024 because there were so many interop issues with “certified” UL 1741 SB inverters using SunSpec. The work continues today.
 - No visibility into interoperability issues with other grid codes but no others include an interoperability requirement.
 - We haven’t even started to seriously address interoperability with V2G!!
- **The Electric Utility industry rarely uses Plugfests to achieve interoperability**
 - Rather, the industry relies on third-party certifications and integration testing to discover interoperability issues
- **The V2G challenge: getting both the EV Charging and V2G Interoperable.**

The Business Side of Interoperability



The Value and Strategy of Interoperability

Business Reasons for Interoperability Investment

Businesses invest in interoperability for two primary reasons

- **The business requires it to operate – e.g., charging stations and EV infrastructure**
 - Investment in standards implementation and testing
 - Cost of non-interoperability: financial and reputational increased risks
- **Regulators mandate some form of certification**
 - Typically, conformance to a standard rather than real interoperability (much more challenging)
 - Certified by authorized test labs like UL, Intertek, TUV, CSA, etc.



SCE Advice Letter 4824-E/E-A/E-B/E-C, effective August 29, 2023, Rule 21 applicants are required to use inverters that comply with UL 1741 SB requirements as specified in Section Hh of SCE's Rule 21 tariff. These requirements **include certification for UL 1741 and UL 1741 SB** as well as an attestation for Smart Inverter Phase 2 Communication requirements as established in Resolution E-5000 and as modified in Resolution E-5036.

Business Success Requires Optimization



- **Whatever the reason for investing in interoperability, business success depends on doing it:**
 - As fast as possible
 - With minimal costs in staff and equipment
 - But with *adequate quality*
- **What is “adequate quality”? Depends...**
 - For operating interoperability, trade-off between quality and non-interoperability costs
 - For mandated interoperability (conformance), depends on the level of ecosystem interoperation
- **OEMs must decide on the trade-offs between investment in interoperability and risks/costs of being less interoperable than competitors – optimize benefits/minimize costs and risks**

The Interoperability Business

Ecosystem Components

- **OEMs building products**
- **Standards Development Organizations (SDOs)**
 - Internationally recognized collaborative standards development: ISO, IEC, NECA, SAE, etc
- **Interoperability Test and Certification Authority (ITCA)**
 - Wifi, CharIn, SunSpec, OpenADR, etc
- **Regulators, governments**
- **Independent, authorized test labs**
 - Research labs: NREL, Elaad
- **Test tool suppliers**
 - Tools to improve productivity, schedule and quality of testing and certification



QualityLogic's End-End Interoperability Solutions

Expertise, Test Tools, Training, and Consulting

QualityLogic's Role in the Smart Energy and EV Industries



- **Focused on Electric Utility-DER (EVs, etc) interoperability**
- **Experts in interoperability: 40 years of experience working with multiple technology eco systems.**
- **Engaged with electric utility DER interoperability since 2010 and EV charging interoperability since 2021.**
- **Our contributions include**
 - Industry interoperability standards
 - Conformance test automation tools for compliance testing
 - Interoperability test automation tools, and
 - Training for engineering and management teams responsible for interoperability in EV Charging and V2G.
- **Strategic partner for ecosystem interoperability.**

QualityLogic's Unique Contributions

QualityLogic test tools and services are:

- Primarily SW based (vs HW for other vendors)
- Improve productivity – faster schedules, better results
- Reduce costs of OEM and ecosystem interoperability
- Improve interoperability quality – reducing business risks

“Now I’m able to run 50-100 or more sessions in the same time it takes to manually analyze just one session. This enables us to look at files we otherwise wouldn’t have had time for, giving us the ability to identify hidden issues.”

~ Jeremy Bibeau, EVgo

“This is a unique product and compliments the current set of CCS engineering tools and sniffers for charging session analysis.”

~ Beat Kreuter, DEKRA

Improving Interop Analysis Speed

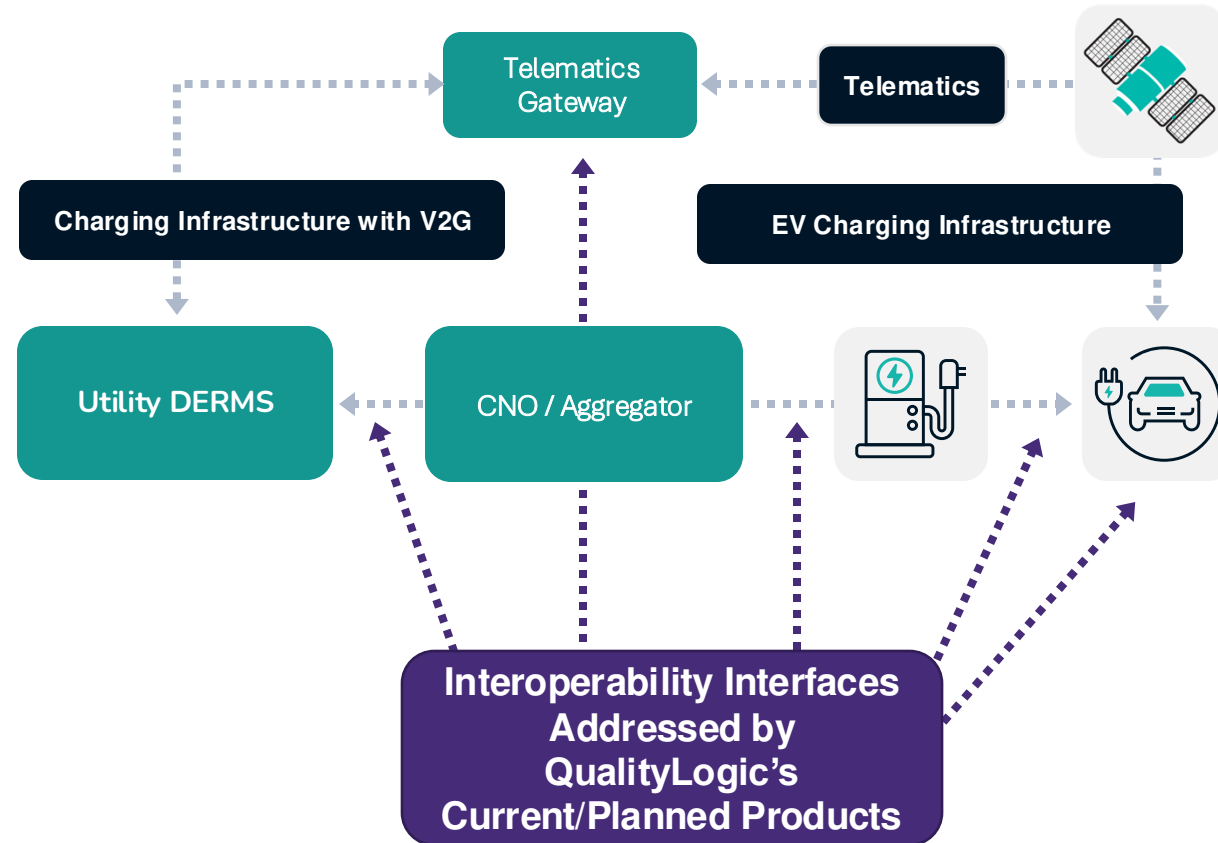
- Manual analysis estimate (typical failed charging session)
- Experienced engineer = 10-30 minutes to hours
- CCS Analyzer = < 1minute
- **10-30 X FASTER!**

Speeding up UL 1741 SB Certification Testing

- Manual testing – 3-4 weeks
- QualityLogic Tools – 30 hours
- Improved consistency
- **4-5 X FASTER!**

QualityLogic Products for End-End Interoperability

- Tools to test compliance with Charging and V2G standards
- Support for end-end testing



QualityLogic Products by Function



Protocol Compliance Test Products

OpenADR Certification Tool

IEEE 2030.5/CSIP/CSIP AUS test Tools

IEEE 2030.5 J3072 Profile

SunSpec Modbus Compliance

Protocols Training

Functional/Safety Compliance Test Products

IEEE 1547/UL 1741 SB Test Tools

UL 1741 SC V2G-AC EVSE

EN 50549+ Grid Code Compliance Tests

Grid Code Training

Interoperability Test Products

CCS Interop Analyzer V1.1

IEEE 1547 Interop Protocols: IEEE 2030.5, SunSpec, DNP3

IEEE 1547 V2G-AC Protocols: OCPP 2.1, ISO 15118-20 Am 1

Protocols and Grid Code Training

Current Products

Current Services

Planned Products

Summary



IEEE 1547 Critical for US V2G

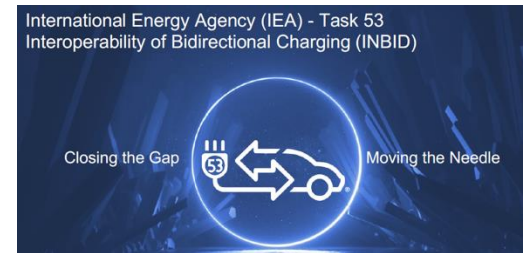
Summary



- **The energy transition involves two industries with very different contexts and cultures**
 - And a very recent history of having to deal with interoperability between systems
- **Interoperability (two systems using the same standards working together seamlessly) is challenging to any ecosystem**
 - But more so for utilities and EVs that have not had to be interoperable until now.
- **QualityLogic's role: accelerate standardized, interoperable eco-systems for charging, V1G and V2G infrastructures**
 - Automating testing processes to improve productivity, lower costs and improve quality
 - Training on standards and engineering/certification processes and test tools
 - And participating in standards development
- **In short, we are interoperability experts focused strategically on the intersection of electric utility and transportation electrification infrastructure**

For More Information on QualityLogic Interoperability Products and Industry Activities

- [Smart Energy Test Tools – QualityLogic](#)
- [Smart Energy Technology Training – QualityLogic](#)
- [Smart Energy – QualityLogic](#)
- Or contact info@qualitylogic.com
- Upcoming Webinars – watch for invites
 - CCS Analyzer V1.2 Introduction in March
 - IEEE 1547/UL 1741 SB Testing Webinar in April
- Upcoming Events



CharIN **Testival NORTH AMERICA 2025** - Detroit

Questions?



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