



VGI Communications Protocols

April 2018

CPUC VGI Working Group Objective

Assess **how and whether the adoption of a communications protocol** is necessary to enable Plug-In Electric Vehicle-Grid Integration (VGI) resources to more economically participate in electricity markets at scale

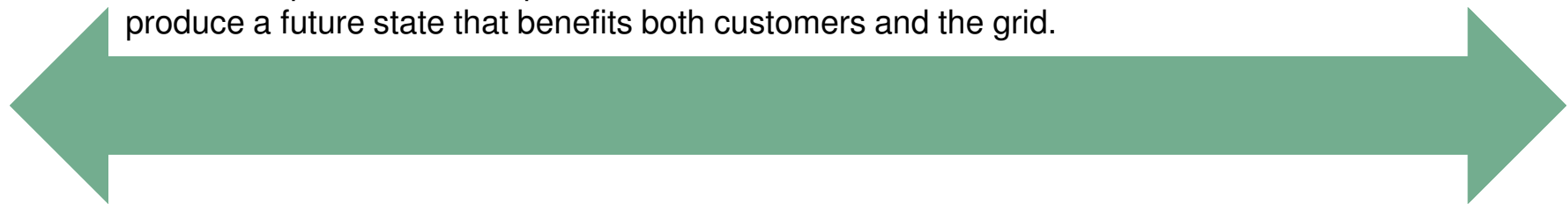
- Sep 2016 – ED recommends that utilities ‘VGI programs’ utilize 15118 standard*
- Q4 2016 – Stakeholders provided input to CPUC
 - Several expressed concern that 15118 decision was not supported in record
- Q1 2017 – Inter-agency VGI Communications Protocol Working Group formed (CPUC, CEC, CARB, Go-Biz, & CAISO)
 - Assess whether the adoption of a communications protocol is necessary to enable Plug-In Electric Vehicle-Grid Integration (VGI) resources to more economically participate in electricity markets at scale
 - Assess policy, valuation and business-model considerations, focused on the adoption of one or a set of a communications protocol(s), to enable Vehicle-Grid Integration (VGI) market development.

Vehicle Grid Integration can mean many things, Working Group focused on V1G



Vehicle Grid Integration (VGI) involves modifying when and at what power level grid-connected electric vehicles charge or discharge to provide benefits or services to the grid, to society, the EV driver, or charging site host.

VGI encompasses a wide spectrum of activities that will all need to be coordinated to produce a future state that benefits both customers and the grid.



Time of Use Rates

For drivers that see a price when charging, TOU rates are a proven way to shift EV charging. Utility must communicate rates but daily interaction is not needed.

Example – PG&E's EV Residential Rate

V1G aka Smart Charging

V1G typical refers to a more active load management approach than TOU rates, EVs are signaled (by the utility or by an aggregator) to stop charging, charge at a lower level or wait to charge at a specific time. Can be used to both decrease or increase load at specific times.

Example – PG&E's BMW pilot

V2G Vehicle to Grid

For EVs and chargers that are equipped to handle discharge, V2G would allow stored energy in the EV battery to be utilized for grid needs.

Note – interconnection standards and processes have not yet been determined for V2G installations

Internal Approach to Support PG&E's Participation



Developed Principles to Guide our 3-pronged Approach:

1. Create structure to enable agility and transparency
 - Identified internal stakeholders and created Managing Committee
2. Develop technical understanding to evaluate Working Group proposals
 - Created internal working group of cross-functional SMEs
3. Collaborate externally increase learnings and identify points of alignment
 - Resulted in PG&E joining other stakeholders in several rounds of joint comments

PG&E Principles	VGI Protocol Implications
PG&E is generally agnostic to EVSE-EV communications protocol type	Cost-Effective
The market should decide on EVSE-EV communications	
Any communications protocol requirements should be implemented in a lowest cost manner	Secure & Compatible
All communications to and from the utility must be secure	
PG&E will communicate using OpenADR 2.0 or IEEE 2030.5	
The selected communications protocol(s) should be technology agnostic, where possible	

External Working Group Process & Deliverables

Deliverable 1: Map VGI Use Cases with existing Communication Protocols to Network Architectures

- **Glossary**
- **Use Cases** – “some use cases do not require any high-level communications protocols it is premature to select a single protocol at this time”
- **Requirements**
- **Protocols Mapped to Requirements** – “Markets, protocols, and technology are rapidly developing, and at this time we do not want to preclude any protocols or use cases that can deliver VGI value.”

Deliverable 2: Identify Opportunity Costs and Benefits from Stakeholders’ Perspectives

- **ABANDONED – no deliverables**
- Costs were not possible to obtain (anti-trust and proprietary concerns) and benefits were difficult to quantify

Deliverable 3: Value Proposition and Enabling Policy

- **No deliverables** – lots of stakeholder discussion through, unclear if final report will include any specific recommendations
- **Stakeholders recommended pilots to determine VGI Value** – “Some automakers and service providers need a better understanding of the value of some VGI use cases to create a business case for implementing the hardware and software necessary to enable VGI at scale”

Overall – “Markets, protocols, and technology are rapidly developing, and at this time we do not want to preclude any protocols or use cases that can deliver VGI value.”

Working Group Timeline: April 2017 – December 2017

1] Map Use Cases & Reqs to Existing Protocols

2] Cost/Benefit

3] Policy Rec.

List of communication standards reviewed

The sub-working group was formed to analyze different VGI communication protocol standards – with more emphasis on the following seven standards. Shown below are the standards with a brief description of each standard.

- **OpenADR - Open Automated Demand Response (ADR) version 2.0b.**
 - *Provides demand response messaging and transactive energy signaling. These events can relay price information or specific energy consumption change requests.*

- **IEEE 2030.5 (SEP 2.0) - Institute of Electrical and Electronics Engineers (IEEE) 2030.5 aka Smart Energy Profile v2.0**
 - *Allows communications between energy-related devices in the Home Area Network (HAN) with zero-configuration.*

- **OCPP - Open Charge Point Protocol (OCPP) version 1.6.**
 - *An open communication standard that enables communication between charging stations and central vendor systems.*

- **ISO/IEC 15118 - International Organization for Standardization (ISO) 15118, version 1.**
 - *Point to point protocol that provides communication mainly between the EVSE and EV. It supports DC Charging.*

- **SAE Suite - Society of Automotive Engineers (SAE) suite of standards**
 - *The SAE suite outlines the different communication standards developed by SAE. They include J3072, J2847, J2931, J1772.*

- **IEEE 2030.1.1**
 - *Developed as CHAdeMO specification in 2005-2009 for DC Fast charging*

- **Vehicle Telematics**
 - *Proprietary lower level network protocol utilized by Automakers to facilitate monitoring and communications between the vehicle and corresponding vehicle telematics server.*

Functional Requirements & Communication Standards



Shown below is an evaluation of each of the communication protocols and if they support the different use case requirements. The matrix table below maps each communication standard to the functional requirements they (or don't) support.

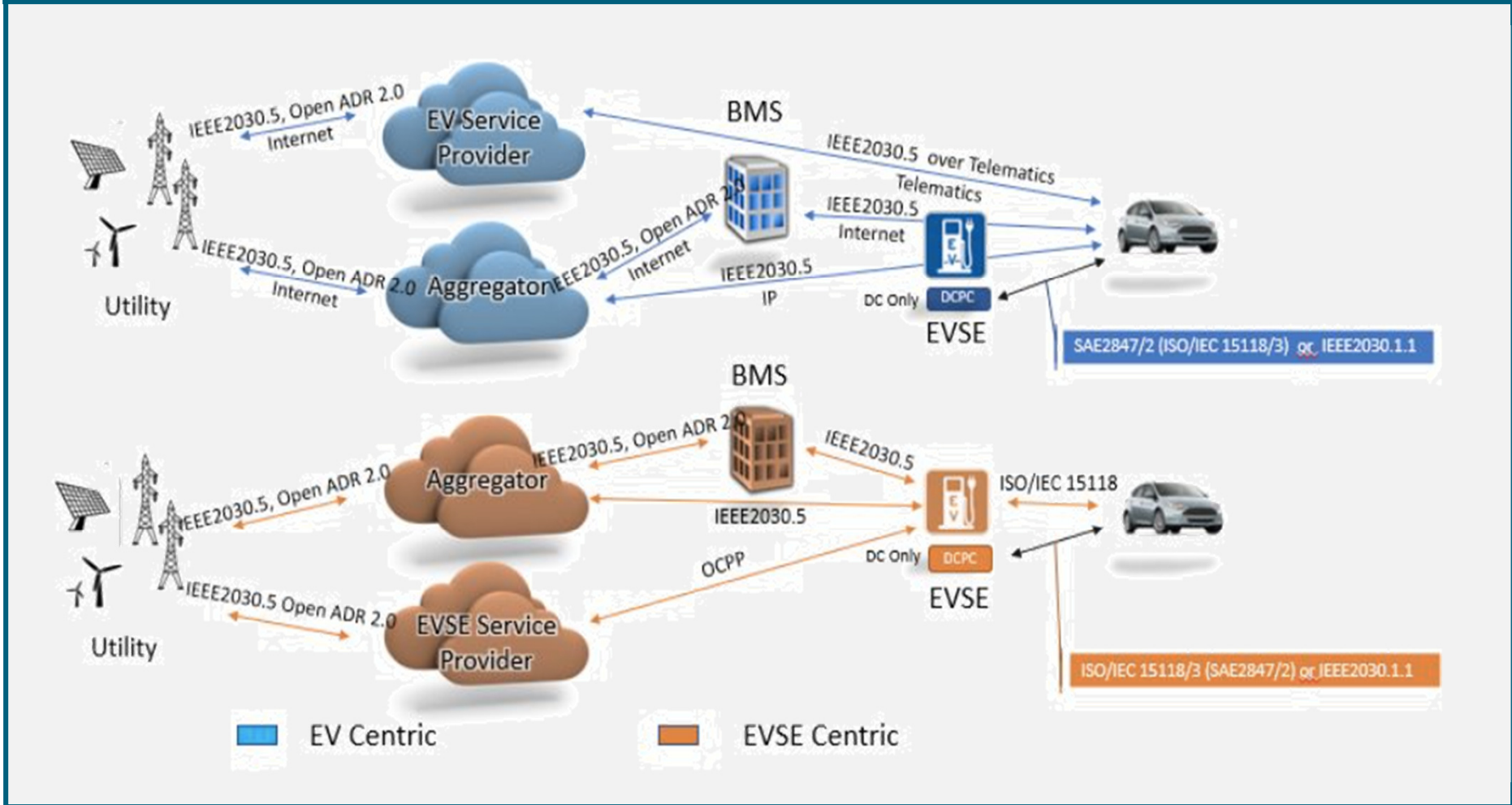
Communication Standards / Functional Requirements	OpenADR (2.0b)	IEEE 2030.5	OCPP v1.6	Telematics	SAE Suite	IEEE 2030.1.1	ISO 15118
Rule 21	Supported	Supported	Not Supported	Supported in Combination	Supported in Combination	Supported in Combination	Not Supported
Pricing	Supported	Supported	Not Supported	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination
Load Control	Supported	Supported	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination
Smart Charging	Supported in Combination	Supported	Not Supported	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination
Monitoring	Supported in Combination	Supported	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination
Restart	Supported	Supported	Not Supported	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination
Miscellaneous (GPS Location etc)	Not Supported	Not Supported	Not Supported	Supported in Combination	Not Supported	Supported in Combination	Not Supported
Legend	*Supported	**Not Supported	***Supported in Combination				
	<ul style="list-style-type: none"> * Supported – means the protocol gets the message there, end to end ** Not Supported – means the protocol doesn't get the message there at all *** Supported in Combination - means the protocol can transmit the message with some support from other protocols and/or implementation of specific programming 						

Key take away: There is no existing standard that meets all functional requirements (i.e. there is currently no plug and play)

- a new version of IEEE 2030.5 due in 2018 should address the items currently not supported

Interaction between the communication standards

EV – EVSE Communications Standards connect various actors in real-world applications

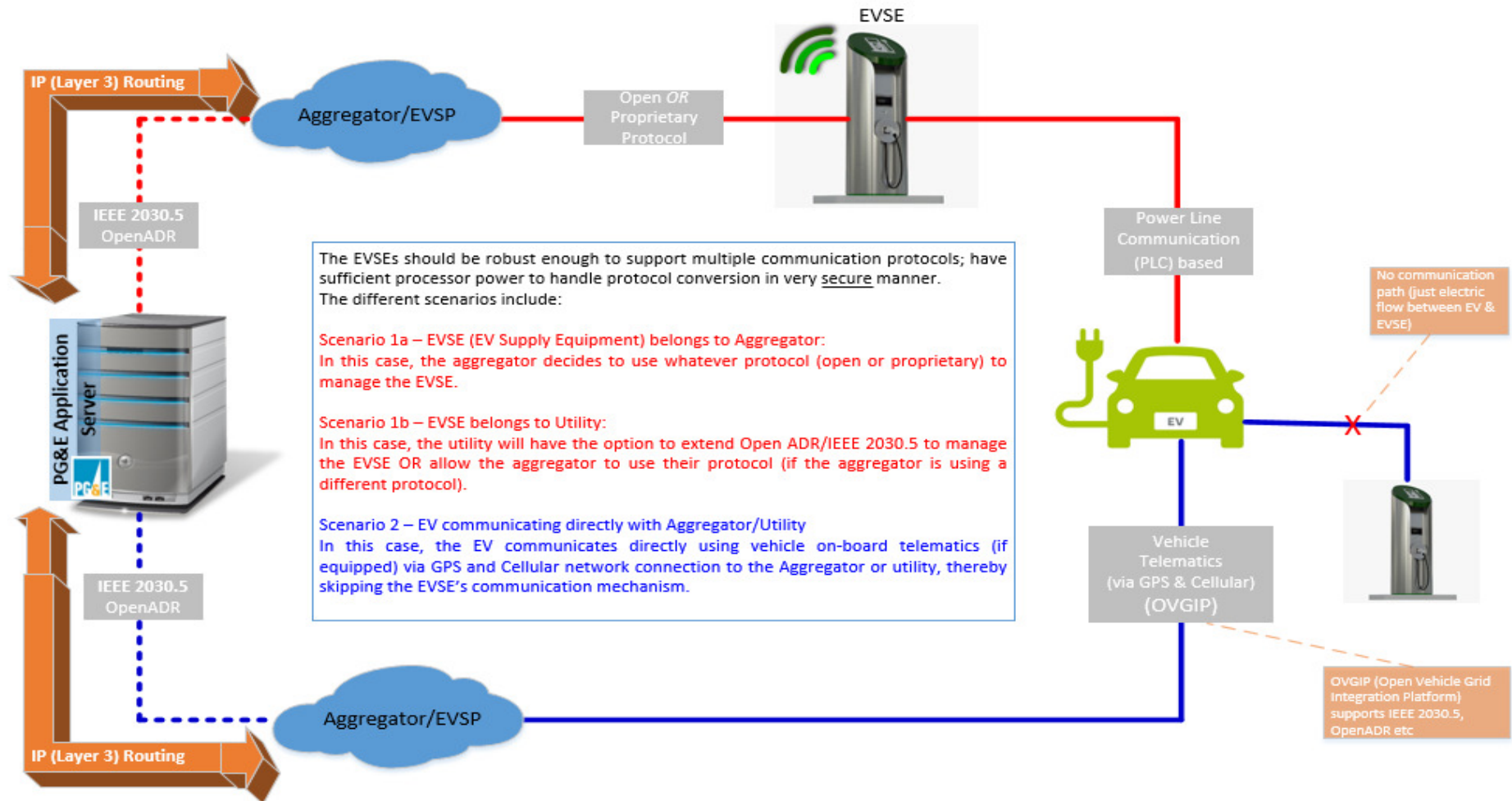


Hardware Requirement for Public, Multi-User L2 Chargers will Support all Communication Protocols and Enable Future Proofing



PG&E Supported Recommendation

Utilize IP Layer 3 routing for communications between all players, from the utility to the aggregator, EVSE, and EV.



Legend:

— Scenario 1 —

— Scenario 2 —

Communication Protocol

Draft Recommendation of Working Group Builds on Joint IOU Concept



Inter-Agency Draft Recommendation to the CPUC (as of 12/15/17)

HARDWARE REQUIREMENT

Rather than require a specific protocol, EVSE hardware shall be capable to support *all* major communications protocols and methods

PFE* ↔ EVSE	For comms between Power Flow Entity* and EVSE – enable Internet Protocol with both Wi-Fi and Ethernet hardware	Well established and commonly used
EVSE ↔ EV	For comms between EVSE and EV – HomePlug Green PHY	
Processing Power	“sufficient processing power to perform real time protocol translation and encryption/decryption, supporting IP stack”	Not defined, unclear how to certify
Future Proofing	“Hardware extensibility” as well as “field upgradable” capability	

Applies to AC Level 2, conductive, multi-user EVSEs deployed through ratepayer-funded IOU programs

COMMUNICATION PROTOCOLS RECOMMENDATION

The Working Group identified the current protocols that provide VGI-enabling functionalities

PFE* ↔ EVSE	OpenADR 2.0b, IEEE 2030.5 OCPP 1.6, IEC 63110
EVSE ↔ EV	ISO 15118 v1 IEEE 2030.5
OEM ↔ EV	Telematics (proprietary or IEEE 2030.5)

NOT ADDRESSED

- Metering requirements
- Cyber-security requirements

* Power Flow Entity (PFE) - An off-site entity that is requesting or mandating VGI activities, could be Aggregator, Utility, Site Host, EVSP, Energy Service Company, Alternative Energy Supplier, Energy Portal, or Clearing House.