Event Report

By Jose Torre-Bueno, PhD
Speaker, October 22, 2024

The forum was very informative with two major takeaways:

- One, the industry wants to move to AC V2G[1].
- Second, the relationship between various standards is more complex than previously thought but we now have a more detailed understanding of this challenge.

AC V2G

The argument for AC V2G is that every electric vehicle (EV) already has an AC to DC inverter built in to allow it to charge from wall current. The cost to make an inverter bidirectional is negligible so it seems obvious that an on-board inverter should do double duty which would greatly reduce the cost of bidirectional EVSE[2]. The downside is that the utilities require any inverter that is going to connect to the grid to meet requirements and standards that a stand-alone inverter for instance one used only for V2L would not have to meet.

Resolving this standards issue is made more difficult because stationary equipment connected to the electrical grid is certified by UL and mobile equipment is self-certified by the manufacturer to SAE standards. Also, in the utilities thinking Permission to Operate is given to a stationary device installed at a fixed address, they have a hard time envisioning something that could plug in anywhere injecting power. Another issue is that currently utility policy does not allow anything not certified by a lab like UL to be connected to the grid. On the other hand, the cost savings are very attractive. The cost of DC V2G EVSE is $6-7,000 because it must include an inverter while the cost of making the on-board inverter is negligible.

The solution being developed is to split the roles and have a stationary device which has Permission to Operate and enough computer power to carry out the required communication with the utility but no inverter. A new UL certification UL1741SC is being written for such a device. In parallel the SAE is writing a new specification SAEJ3072 for an on-board inverter that can connect to such a stationary interface. The combined standard envisions that the EV and the new style inverterless EVSE would

[1] Alternating current (AC) Vehicle-to-grid (V2G) versus direct current (DC)
[2] Electric vehicle served equipment (EVSE)

communicate and after confirming that the EV could provide AC power compatible with the EVSE PTO[3] the EVSE would close a relay and allow the EV to send power to the grid.

The intent of this split design is to reassure the utility that there is a UL listed device between the mobile EV's inverter and the grid. It is expected (hoped?) that on this basis the utilities will drop their requirement that everything connected to the grid be certified by a Nationally Recognized Testing Laboratory (i.e. UL) since the automakers are apparently unwilling to give up self-certification.

How long this is going to take is an open question. SCE did a pilot study, possibly only at laboratory scale. It appears to have revealed some issues they thought needed further study. SAEJ3072 is a released standard but UL1741SC is not and is not expected until sometime in 2025. The representative of one auto manufacturer told me confidently that there would be AC V2G vehicles on the market in 2026 but an expert from a company that deals in regulation thought getting all the regulations in place and AC V2G on the market would take "5 to 10 years."

Clarifications on Standards Relationships

I had a chance to speak to the authors of some of the standards to get clarification on the interrelationships. Several people told me flatly contradictory things but going by the people more directly involved in the standards development and after further research I can say the following:

Relationship between 15118-2 and 15118-20: We now know that -20 supersedes -2. Previously we were told that -20 defined advanced features that installed on top of -2 but this is incorrect. It is possible for EVSE to have both installed for compatibility with EVs with one or the other since -20 is not back compatible with -2.

Other BMS: Teslas may not run any version of 15118 although this is not clear; Scholer thought they might. There is also a DIN standard for communication between EVSE and EVs that some manufacturers may have adopted. Again, it is possible that EVSE could implement multiple protocols.

Cybersecurity: 15118-2 uses TLS1.2[4] and 15118-20 requires TLS1.3. This is one of the major differences between them. Although I have been told that Amendment 1 to -20 is about cybersecurity it appears this is not the case. It adds some features to allow future upgrades to security but keeps TLS1.3. The California Energy Commission (CEC) is very interested in the upgradeability of EVSE. They want to make 15118 "ready" a requirement for receiving state subsidies. I was told by representatives of one manufacturer that the hardware requirements of TLS1.3 would preclude software upgrades. However, from speaking to the expert from Electric Power Research Institute (EPRI) and researching the issue I am convinced that hardware that supports TLS1.2 can receive software upgrades to run TLS1.3. This means that the CEC's plan to require upgradability so that all the EVSE they are paying for will be able to run 15118-20 in the future is workable.

[3] Permission to operate (PTO)
[4] TLS: Transport Layer Security

Detection of EV software: According to Rich Scholer who wrote some of the standards it is unlikely that an EV manufacturer will reveal what code standard their BMS system was written to. On the other hand, when an EV plugs into an EVSE they exchange information about what standards they follow in a service discovery phase. According to Scholer it should be possible to create a test device that would rapidly establish what code standard an EV's BMS was following by looking at the messages it sent.

Some further research clarifies the sequence of events that occurs when an EV plugs into EVSE. The most basic communication does not use computers at all, just the detection of voltage drops and pulse width modulation (PWM) over the CP[5] pin pair which detects secure connection and basic voltage requirements.

Next signals are sent over the CP via PWM and Amplitude Shift Keying (ASK). The Data Link Layer for these messages is apparently a special one defined in 15118 and common to 15118-2 and 15118-20. Over this channel the EV will send a message defined in the specification called SupportedAppProtocolReq[6]. This message will include a list of protocols the EV will support including whether it supports 15118-20. If it supports -20, the key exchange to establish TLS1.3 will occur over the CP channel and then communication will switch to Power Line Communication (PLC) over the power pins. If only -2 is supported the TLS1.2 key exchange will not happen until after the switch to PLC.

For our purposes in learning what protocols an EV supports it seems we only need to read the CP pin differential pair and exchange enough messages to get to the SupportedAppProtocolReq message. The contents of that message will tell us the EV is using 15118 and which version. A test connector for this purpose need not have any power pins at all.

[5] Control pilot (CP). See https://www.versinetic.com/news-blog/ev-charging-connector-types-guide/
[6] SupportedAppProtocolRequest: An EV and charger use this to agree on a protocol version.