A SECURE TECHNOLOGY ALLIANCE PAYMENTS COUNCIL WHITE PAPER

Electric Vehicle Charging Open Payment Framework with ISO 15118

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Secure Technology Alliance
191 Clarksville Road
Princeton Junction, NJ 08550

www.securetechnologyalliance.org

About the Secure Technology Alliance

The Secure Technology Alliance is a not-for-profit, multi-industry association working to stimulate the understanding, adoption, and widespread application of secure solutions, including smart cards, embedded chip technology, and related hardware and software across a variety of markets including authentication, commerce, and Internet of Things (IoT).

The Secure Technology Alliance, formerly known as the Smart Card Alliance, invests heavily in education on the appropriate uses of secure technologies to enable privacy and data protection. The Secure Technology Alliance delivers on its mission through training, research, publications, industry outreach and open forums for end users and industry stakeholders in payments, mobile, healthcare, identity and access, transportation, and the IoT in the U.S. and Latin America.

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1 Introduction

This white paper introduces a future in which the driver of an electric vehicle (EV) can charge the vehicle at any charging station and pay without needing an account or membership. Charging a vehicle will be as simple as plugging the charging cable into the vehicle.

The technology required to implement an open payment infrastructure for electric vehicle charging is already available. Open payment technology can be leveraged successfully using the ISO 15118[1] Vehicle-to-Grid communication standard. The Plug&Charge (PnC) ISO 15118 use case is already being deployed and is a first step in simplifying secure EV charging. This paper presents a proposed approach to make secure EV charging even simpler and more ubiquitous by incorporating open payments technology.

PnC requires a contractual relationship between the EV driver and a mobility operator (MO). The MO can be a third party, but often the MO is a charge point operator (CPO)[2] or an EV manufacturer. The goals of the proposed approach described in this white paper are to enable drivers to not need more than one such relationship and to allow them to charge using any charging network.[3]

The following major ecosystem participants must be involved in implementation of EV charging open payments:[4]

- EV manufacturers, to facilitate delivery of the vehicle's payment credential at plug in
- The charging infrastructure, CPOs, and equipment manufacturers, to accept the payment credentials delivered by the vehicle

Open payments technology currently offers secure, interoperable, and convenient solutions. The worldwide implementation of chip card technology, mobile device payment, and tokenization constitutes a foundation on which to deploy easy-to-use, secure open payments technology into future EVs.

The research outlined in the paper focuses on a specific path to achieving ubiquitous open payment as part of ISO 15118 standard. While there may be other approaches to implement open payment, the approach presented is likely the most viable and technologically advanced. The PnC use case is already in the market with real world deployments.

By providing a focused recommendation and specific call to action, the Secure Technology Alliance believes this white paper will deliver more value and pragmatic results.

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1 https://www.iso.org/standard/55365.html
2 Also often referred to as "charge port operator."
3 A charging network is an infrastructure system of charging stations used to recharge electric vehicles.
4 Open payments refers to payments with a network-branded payment card (credit, debit, prepaid) without requiring a contract between the EV driver and the CPO.

2 Overview of EV Charging and Use Cases

According to the International Energy Agency, in 2019 electric vehicles accounted for 2.6% of global car sales, with a 6% growth in sales from 2018. This trend is expected to continue for the next 3–5 years with movements of major automotive manufacturers.[5] The EV charging infrastructure has also expanded rapidly in the last 10 years. In North America, at least 10 EV CPOs[6] are offering over 20,000 charging locations with over 60,000 charging outlets in the United States.[7]

The charging industry is expected to have a market value of over $100 billion in 2027.[8] While some of this growth is driven directly by the EV manufacturers, several independent CPOs rely on a self-sustaining business model with no affiliation with an EV manufacturer.

2.1 EV Charging

EV charging is categorized by the industry as Level 1, 2, or 3, depending on the type of current, charging rate, and connectors.

Level 1 uses a traditional household power outlet supplying AC current of up to 15 amps (A) at 110 volts (V), providing a maximum rate of 1.65 kilowatt hours (kWh).[9] This type of charging is typically found in EV owners' homes and is used to charge a vehicle overnight for a daily commute. Some public charging stations provide Level 1 charging, usually in combination with other levels. Since Level 1 charging can replenish only 3–5 miles of range per hour, its use in a public environment (e.g., parking garages at shopping malls, airports, and train stations) is limited and is usually offered as a complimentary service.

Level 2 EV chargers also supply AC household current but use a two-phase connector and upgraded wiring, allowing EVs to charge at 240V up to 30A–50A (in homes) and up to 80A in commercial locations.[10] These chargers produce charging rates of at least 7–10 kWh at residential locations.[11] Level 2 charging is very popular at parking garages in shopping malls, apartment complexes, and office buildings and can replenish EV driving ranges at typical rates of 30 miles per charging hour. Level 2 chargers are enough for what the industry calls "destination charging."[12] Typical charging time in public locations can range from an hour in shopping malls or grocery stores to 6–8 hours at places of work. EV owners who can upgrade their home wiring can use Level 2 charging overnight to handle a substantial daily commute without having to rely on public charging.

Level 3 charging, also known as DC fast charging, is the most equivalent to fueling a gasoline vehicle. Level 3 is where most of the innovation in battery technology and charging infrastructure occurs. DC fast chargers are significantly improved and currently offer charging rates of from 50kWh–350kWh,[13] with higher rates likely in the future. These chargers are more sophisticated and convert electricity from AC to DC, bypassing the vehicle's onboard converter, which often limits Level 2 charging speeds. The

[5] https://www.iea.org/reports/electric-vehicles
[6] https://www.prnewswire.com/news-releases/europe-and-north-america-ev-charging-infrastructure-report-2020-2024-number-of-connected-ev-charging-points-in-europe-and-north-america-to-reach-4-4-million-301128324.html
[7] https://www.energy.gov/eere/vehicles/articles/fotw-1089-july-8-2019-there-are-more-68800-electric-vehicle-charging-units
[8] https://www.prnewswire.com/news-releases/europe-and-north-america-ev-charging-infrastructure-report-2020-2024-number-of-connected-ev-charging-points-in-europe-and-north-america-to-reach-4-4-million-301128324.html
[9] https://freewiretech.com/difference-between-ev-charging-levels/
[10] https://www.chargepoint.com/index.php/resources/how-choose-home-ev-charger
[11] https://rmi.org/electric-vehicle-charging-for-dummies/
[12] https://www.nrdc.org/experts/patricia-valderrama/electric-vehicle-charging-101
[13] https://electricautonomy.ca/2019/11/15/electric-vehicle-fast-chargers-moving-beyond-50kw/

challenge for DC fast charging in trying to achieve higher charging rates is cooling the charging cable and the vehicle batteries. Level 3 charging is often used for long distance travel; enough EV driving range is replenished in minutes. The charging session at a DC fast charger typically takes 20–40 minutes and usually less than an hour. In addition, DC fast charging is often used by EV owners in urban locations where there are no options to charge overnight; a week's worth of commute can be replenished in a short time.

Although different connectors are used for charging, connectors do not impact the charging payment framework discussed in this white paper.

2.2 Scenario Examples and Use Cases

Many use cases are enabled by open EV charging payments. This section describes potential use cases and highlights a few relevant details. The use cases in Sections 2.2.2, 2.2.3 and 2.2.4 provide information on benefits that charging provides to property owners or managers. This information will help them evaluate whether a charging experience adds enough value for their current tenants or customers to justify implementation. By exploring these use cases, decision makers can develop formal business cases and suggest use cases for new market segments.

2.2.1 Charging Scenario Examples

Table 1 summarizes different charging scenarios. The table includes both current use cases and use cases that could be possible when EV charging technology evolves. The use cases identified as present may not all currently be implemented but are all technically feasible.

The use cases are categorized according to these characteristics:

- Accessibility, which identifies the anticipated charging station environment
- Level 2 or Level 3, which represents the type of EV charging being performed
- Open payments applicability, which indicates the relevance of open payments technology to the use case

Table 1. Present and Future Charging Use Cases

Charger Location	Present/ Future	Location Accessibility	Level 2	Level 3	Open Payments Applicability
Home garage	Present	Restricted	x	--	--
Home exterior	Present	Restricted	x	--	--
Multi-family dwelling	Present	Restricted	x	--	x*
Multi-family dwelling	Present	Semi-Public	x	--	x*
Work/office	Present	Restricted	x	x	x*
Commercial fleet locations	Present	Restricted	x	x	--
Work/office	Present	Semi-Public	x	x	x*

Charger Location	Present/ Future	Location Accessibility	Level 2	Level 3	Open Payments Applicability
Entertainment/shopping/ restaurants	Present	Public	x	x	x
Gas stations in city	Present	Public	--	x	x
Street parking	Present	Public	x	--	x
Inductive charging on the road	Future	Public	x	--	x
ISO 15118 240V outlet	Future	Public	x	--	x
Peer-to-peer garage/ home/multi-family dwelling	Future	Restricted	x	--	x

*May not be applicable today but may be more applicable as use of open payment charging increases.

2.2.2 Use Case: EV Travel with Hotel Overnight Stay

An EV driver plans to stay overnight at a hotel where there are a few charging spots. The hope is that after spending the night at the hotel, the driver will be able to continue the trip with a fully charged vehicle. Currently, however, this hope is not guaranteed; the station may not be operational or all charging spots may already be occupied.

The average hotel in the United States in 2019 had roughly 160 rooms;[14] to accommodate current (approximately 2% of all vehicles)[15] and future demand for EV charging, the average hotel would need 3–6 charging stations. The U.S. has over 54,000 hotel properties, with a capacity of over 5 million guestrooms,[16] representing a potential requirement within the next few years for 150,000 to 300,000 EV charging stations. Hotels have already begun to respond to this demand. More than 3,137 EV charging stations are available and ready for use at Marriott® hotels.[17] Many hotels offer charging as a complimentary service, but fees may be applicable at others.

Demand will eventually increase enough that charging can no longer be offered as a complimentary service. When this happens, one issue for hotels is whether they can profit from their own EV charging stations. The hotels can cover the costs by offering charging as part of a package (like paid parking) or guests could pay for EV charging at checkout.

To provide a smooth and frictionless customer experience, guests should be able to pay for both their hotel stay and EV charging using the same payment method.

14 https://www.statista.com/statistics/823786/average-number-of-rooms-per-hotel-by-chain-type/

15 https://www.mckinsey.com/~/media/McKinsey/Industries/Automotive%20and%20Assembly/Our%20Insights/Expanding%20electric%20vehicle%20adoption%20despite%20early%20growing%20pains/Expanding-electric-vehicle-adoption-despite-early-growing-pains-final.pdf

16 https://www.ahla.com/faq

17 https://www.marriott.com/corporate-social-responsibility/electric-vehicle-hotels.mi

2.2.3 Use Case: Visit to the Grocery Store

On a weekly visit to the local grocery store, the EV driver realizes that the car is too low on power to make the return trip home. Fortunately, multiple EV charging stations are available. The driver parks the car in the EV charging station, sets up the car to begin charging, and goes inside to shop. When the driver returns, the EV has been charged enough to allow the driver to get home and finish charging there. The driver pays the EV charging station and departs.

Individuals visit a grocery store an average of 1.6 times per week; visits last an average of 43 minutes.[18] Grocery stores in the United States currently sell 14.5% of all gasoline nationwide.[19] Based on this data, the Alliance project team estimated that each grocery store would need approximately 5 EV charging stations to meet current demand; at least 10 stations would be needed in 5 years to meet anticipated demand.

The International Council on Clean Transportation found that meeting public EV charging demand in the largest U.S. metropolitan areas will require $940 million in investment by 2025. Grocery stores may be able to receive external grant funding to meet the ongoing demand for public EV charging; they can certainly leverage EV charging stations as a way to attract customers and a reason to extend customer time in store. Walmart, Target, and other large grocers or retailers have already committed to expanding their EV charging stations over the next few years.

Some grocery stores currently have a limited number of complimentary charging locations, but scaling complimentary charging to support mass adoption of EVs is not financially viable. Customers should have the ability to use the same payment method for both their groceries and EV charging and to pay for both at the same time.

2.2.4 Use Case: Residential Community or Workplace

According to the Commercial Buildings Energy Consumption Survey, there are at least 3.8 million office buildings in the United States.[20] The 2015 Rental Housing Finance Survey[21] indicates that there are at least 22.5 million housing properties in the United States. With so many places to work and live, EV charging stations represent an opportunity for homeowners and for the owners of office spaces to add value to a home or office building and distinguish their property from the competition.

EV drivers will be charging their vehicles while staying at these properties for extended periods of time, either during the day (office environment) or at night (residential). Because these drivers are repeat users, the availability of the charging stations is of more interest than the speed at which they charge. There will also be EV drivers who do not visit these locations regularly or who do not stay for a long time (such as patients visiting a doctor or someone visiting a friend). These drivers will be attracted by the availability of higher speed EV charging stations. By providing charging stations, property managers and owners can replace the traditional activity of getting gas before or after work with the opportunity to charge an EV either at the driver's home or office.

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[18] https://www.fivestarhomefoods.com/blog/grocery-shopping-facts

[19] https://cleantechnica.com/2017/11/21/walmart-costco-kroger-become-largest-ev-charging-centers-us/

[20] "2012 Commercial Buildings Energy Consumption Survey: Energy Usage Summary," U.S. Energy Information Administration, https://www.eia.gov/consumption/commercial/#:~:text=2012%20CBECS%20energy%20usage%20data%20coming%20soon%20,%20April%202016%20%204%20more%20rows%20

[21] "Rental Housing Finance Survey (RHFS)," United States Census Bureau, https://www.census.gov/programs-surveys/rhfs.html

Austin, Nashville, San Jose (California), and Columbus (Ohio)[22] are examples of cities where citizens care about having EV charging available. Properties such as the Flatiron Domain (Austin), the Gossett on Church (Nashville), and the Reserve (San Jose) include EV charging stations for their residents.[23] The Soleil Lofts Apartments (Salt Lake City) include over 100 EV charging stations for their residents.

Pacific Commons South, an advanced manufacturing and warehouse hub currently being built in the San Francisco Bay area, plans to include over 275 EV charging stations among 10 buildings. Timur Tecimer, CEO of Overton Moore Properties, the Pacific Commons South developer, stated that "installing the EV chargers is meeting the demand from our customers and more importantly, our small contribution to create sustainability through development."[24]

Using a charging station in a neighborhood should not require scheduled times based on other neighbor's schedules. In addition, how residents or office employees pay for their EV charging should be simple. Residential areas and office spaces should accept multiple payment methods to accommodate as many potential customers as possible. The benefits of recurring revenue should encourage more locations to include EV charging stations to meet the interests and needs of this increasing customer population.

[22] "Case Study: Increasing EV Charging Access at Multi-Unit Dwellings," Smart Columbus, https://smart.columbus.gov/Playbook-Assets/Electric-Vehicle-Charging/Case-Study--Increasing-EV-Charging-Access-at-Multi-Unit-Dwellings/

[23] These residential areas are managed by Greystar, the largest apartment manager in the United States, managing over 400,000 units according to the NMHC 2018 manager's list. For more information, see https://www.nmhc.org/research-insight/the-nmhc-50/top-50-lists/2018-manager-list/

[24] https://www.globest.com/2020/06/24/pacific-commons-south-features-one-of-the-largest-ev-charging-sites-on-a-spec-project/

3 Challenges to EV Charging Payments

Rapid growth and the absence of established standards have created challenges for the EV charging industry. Resolving these challenges could result in even faster growth during the next decade. To eliminate these challenges, CPOs need a simple and cost-effective approach that can guarantee service availability and access to charge point services.

3.1 Access to Service

One challenge EV drivers currently face is an inconsistent experience at the charging station. Due to the developing nature of the ecosystem, drivers often do not know what to expect.

Questions drivers ask themselves include:

- Is the service free, or will I be charged for it? What will I need to do to use it?
- Will I be able gain access to obtain service quickly and easily, or will I need time to figure it out?
- Will I understand the sign-in instructions? Will I need to call customer service or download an app?

3.2 Guarantee of Service Availability

Other challenges for EV drivers are the reliability and availability of service. The complexity of the current infrastructure limits the scalability of charging stations, and often only a limited number of stations may be available and operating. EV owners cannot be certain of being able to charge their cars while away from home, and they may only consider using a charging station when recharging is not critical to their plans.

Two issues affect guarantee of service availability:

- Functionality. Is the charging station operational and ready to use? Is everything functioning, so that drivers can connect and charge?
- Availability. The number of stations could be limited to the EV driver, due to increased infrastructure capital expenditures (i.e., for hardware and software) to the charging network or site host for wider enablement of EV charging.

3.3 Factors Affecting Infrastructure Growth

To grow the charging network infrastructure, operators need a simple and cost-effective approach to guarantee access and availability.

Today, many organizations are deploying charging infrastructure, but often the path to scale this infrastructure is not known. Entities such as municipalities, hotels, and property managers are waiting for a ubiquitous solution that can scale. As evidenced by some of the common EV charging use cases, it is not feasible for the current gasoline refueling infrastructure model to work the same way for EV charging. Contributing factors to these challenges include:

- It may not be sustainable to offer free charging at scale or include its cost in the primary service of the organization (selling goods, operating a property).
- Deploying a complex infrastructure of 10s or 100s of units in the same location is challenging – both due to the initial cost of equipment and the ongoing cost of electricity. Recharging

equipment must be small, simple, and cost effective to operate, but at the same time be able to recoup the cost of electricity.

- CPOs may not be able to scale up at every apartment building or hotel and in every parking lot. It is likely that in the near future, providing EV charging will be a necessity, similar to the current necessity to provide mobile phone and internet service.

In the future, organizations other than CPOs should be able to scale independently, using EV charging equipment they can buy in bulk.

4 ISO 15118 Fundamentals

ISO standard 15118 defines a digital communication protocol that enables the secure exchange of information between an EV and a charging station. The ISO 15118 Plug&Charge (PnC) use case enables an EV driver to charge an EV without requiring the driver to interact with the charging station. PnC provides an enhanced user experience with easy touchless payment access for charging.

ISO 15118 PnC is now being supported by multiple EV manufacturers (e.g., Audi, Daimler, Ford, Lucid, Porsche, VW) and multiple CPOs (e.g., Electrify America, Greenlots, Ionity).[25,26,27,28,29,30,31]

Two things are required to use the PnC authorization and payment technology: a car with ISO 15118 implemented and a payment account.

4.1 Overview of ISO 15118

The main features of ISO 15118 are:

- Communication specifications
- Automated authentication and authorization specifications

ISO 15118 specifies digital communication standards for all parties involved,[32] allowing an EV and the EV charging station (electric vehicle supply equipment [EVSE]) to talk to each other, sharing energy-related information and exchanging digital certificates to ensure secure communication. Automated authentication and authorization confirm the identity of each of the parties to a transaction, allow the transaction to be executed, and enable messaging for transaction management between an EV owner and a mobility operator (MO), and between MOs and CPOs.

ISO 15118 supports four use cases: PnC, smart charging, bi-directional charging, and wireless charging.

PnC eliminates the need for the EV driver to pay using a card or app. The driver simply plugs in and charging begins.

Smart charging enables two-way communication between the EV and the CPO to exchange energy data and to support load management. Smart charging enables load control for variable charging, management of multiple EVs charging without overloading the grid, and the possibility for choosing renewable power as the source of energy.

Bi-directional charging (vehicle to grid) enables two-way energy flow. The vehicle can act as a mobile battery storage unit.

Wireless charging is PnC without the cable (expected to be a use case for autonomous vehicles). ISO 15118 includes message sets for wireless charging.

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[25] https://cleantechnica.com/2019/10/20/free-webinar-electric-vehicle-adoption-iso15118/
[26] https://www.electrive.com/2020/08/19/my21-porsche-taycan-comes-with-plug-and-charge-plus-fod/
[27] https://www.electrive.com/2020/08/19/my21-porsche-taycan-comes-with-plug-and-charge-plus-fod/
[28] https://www.volkswagen-newsroom.com/en/quick-easy-and-convenient-charging-solutions-at-volkswagen-6599/f-outlook-the-future-of-charging-6605
[29] https://www.electrive.com/2020/12/15/plugcharge-the-missing-link-to-a-breakthrough/
[30] https://www.electrive.com/2020/12/15/plugcharge-the-missing-link-to-a-breakthrough/
[31] https://energycentral.com/c/pip/electrify-america-simplify-charging-select-ev-models-2021
[32] OEMs, CPOs, MOs, and certificate authority (CA).

4.2 ISO 15118 and Secure Communication

Key to the significance of ISO 15118 is the ability to ensure that communication between stakeholders is secure. Secure communication is achieved by authenticating each stakeholder using encrypted digital certificates. The use of digital certificates is essential for trust and for enabling the authentication process, which is the initial portion of any charging session that relies on ISO 15118 standards.

Figure 1 shows the PnC stakeholders and identifies the digital certificates each one holds.

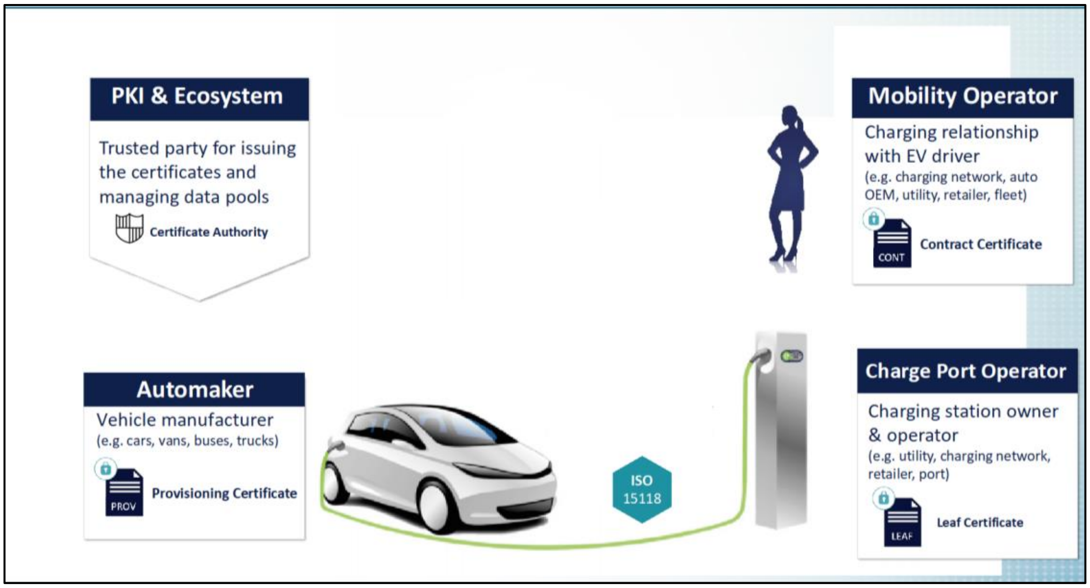

Figure 1. PnC Stakeholders and Their Associated Certificates

Figure 2 illustrates the connections between stakeholders in a charging session, the exchange of digital certificates and a public key infrastructure (PKI), which generates digital certificates.

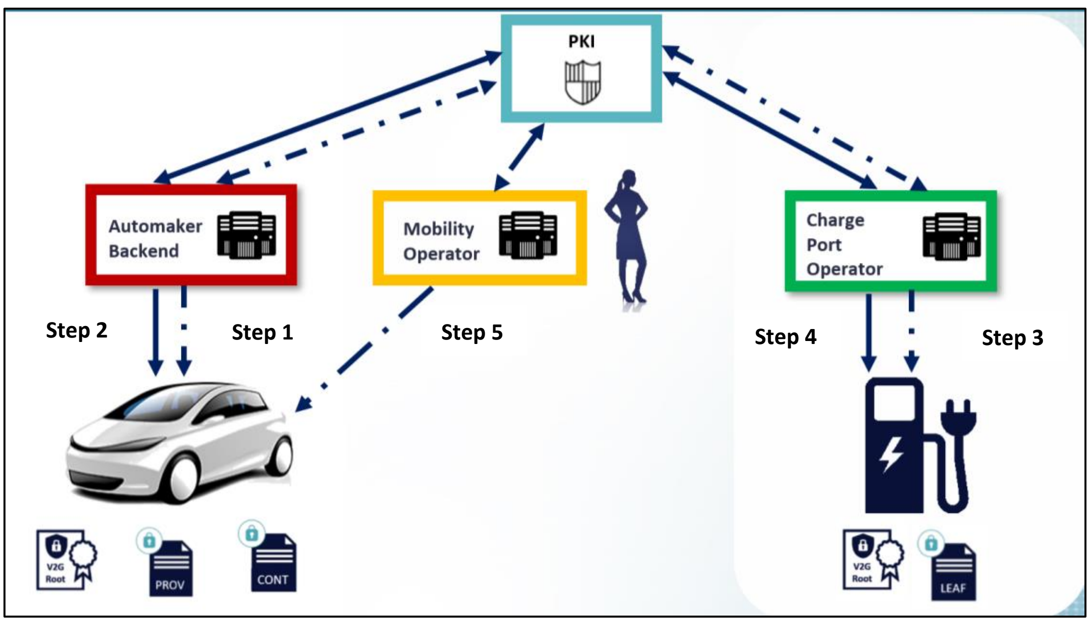

Figure 2. Stakeholder Connections and Certificates in a Charging Session

The flow starts with an electric vehicle. The **EV automaker** has a backend that manages all aspects of the car including security certificates authenticated by a **PKI** (either their own or third-party provider as shown in Figure 2). The EV needs to have a **provisioning "PROV" certificate** installed in the car which is signed by its own or a third-party PKI (Step 1 dotted line).

Then, the EV must have an ISO 15118-compliant **V2G root certificate** installed in the car's communication controller (Step 2 solid line).

On the right in Figure 2, is the **charging station**, which is connected to a **charge port operator's backend**. The charging station needs to have a **digital certificate "LEAF"** signed by a third-party V2G root CA PKI to authenticate itself during the charging session (Step 3 dotted line).

Similar to the EV, the charging station also needs to have the **V2G root certificate** installed in its communication controller (Step 4 solid line).

Once the EV is purchased, the EV owner can sign up for charging services with a provider called a **mobility operator**. This is the entity that has a contractual relationship with the EV owner. In many cases today, the mobility operator might be a CPO, but it could also be the EV automaker.

The EV owner shares payment details (e.g., credit card, debit card, bank account) with the mobility operator so that charges and costs from a charging session can be processed. The mobility operator stores this information and generates a **digital contract certificate ("CONT")** that needs to be signed by the V2G root PKI to authenticate the identity of the EV owner during a charging session. This contract certificate can be installed in the car directly or via the charging station. (Figure 2 shows it being installed directly in the car in Step 5.) With these steps, all digital certificates are in place for a Plug&Charge session to happen. Both the EV and charging station authenticate to each other to ensure secure communication as shown in Figure 3.

When a charging cable is plugged into the car, the charging station sends its LEAF certificate to the EV using ISO 15118. The LEAF certificate will have been signed previously by the PKI that originates from the V2G root certificate in the EV. The EV can then authenticate the LEAF certificate to enable a secure communication channel with a TLS handshake. No external payment or identification (e.g., membership card, mobile app, credit, or debit card) is required.

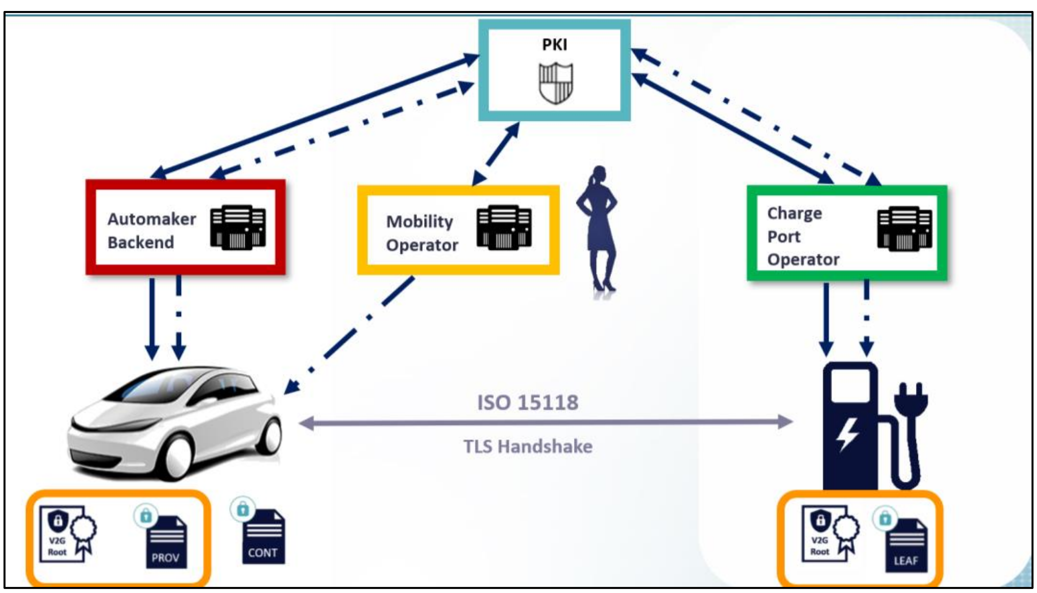

Figure 3. Communications Enabling PnC

In Figure 4, after the TLS handshake, the EV driver is authenticated via the contract certificate. The contract certificate is sent to the charging station to be authenticated against the V2G root certificate stored in the charging station.

The contract certificate includes an identifier for the driver's mobility operator (the eMobility Account ID, or EMAID). After the contract certificate is authenticated, the charge port operator sends the EMAID to the corresponding mobility operator for authorization.[33] The mobility operator verifies it has the EV driver's payment details (e.g., credit card, bank account) to be able to pay the charge port operator for electricity used during the charging session.

Authorization of the transaction is completed and the charging session begins.

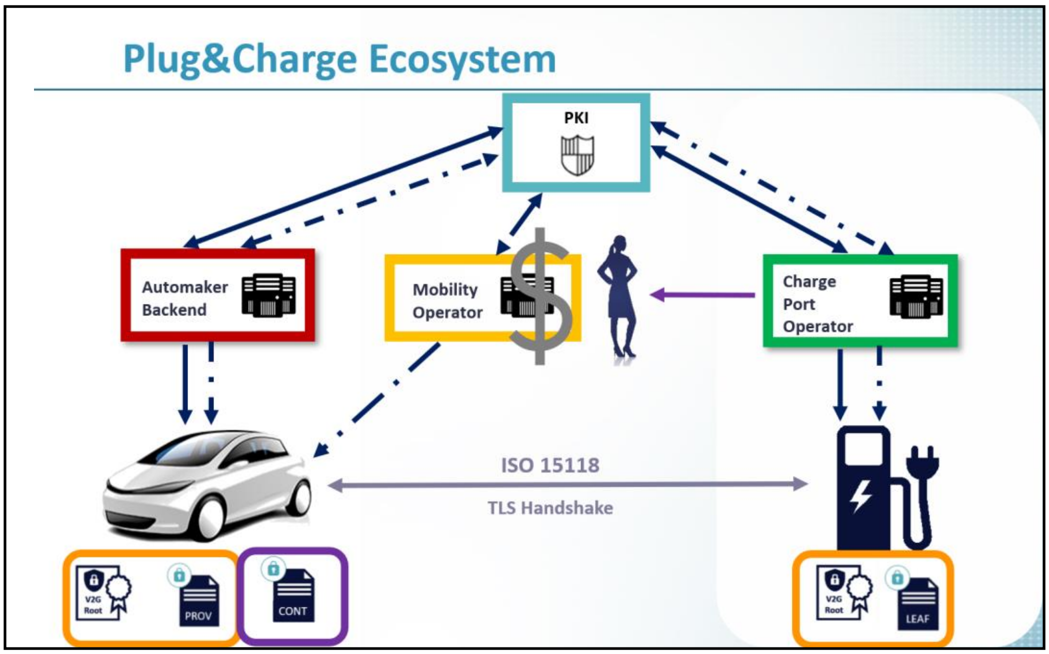

Figure 4. Payment Process for EV Charging Using ISO 15118

[33] A mutual commercial agreement is required between the two parties.

5 EMV Payment Technology Fundamentals

The past several years have seen significant innovations in how payments are made globally. Payments that rely on alternative form factors or channels are becoming increasingly popular. For example:

- Contactless payments are made in-store using a mobile or wearable device
- In-app e-commerce payments for goods and service are made using digital payment wallets
- Recurring subscription payments are made by a card on file
- IoT payments are initiated by a variety of devices in homes and businesses

All of these examples are based on globally adopted EMV payment technology that uses credentials stored in device- or cloud-based secure elements to execute financial transactions. The technology uses a variety of cryptographic methods, including a worldwide PKI infrastructure.

Recently, adoption of payment credential tokenization has accelerated. Tokenization allows a payment credential, such as a credit or debit card number, to be proliferated to multiple devices, apps, or wallets by using an alternate number for the card's primary account number (PAN). The alternate number is linked to the original PAN but its use is limited, thus protecting the PAN itself and any other alternate numbers being used for that PAN. In addition, the cardholder controls the PAN's lifecycle.

Figure 5 illustrates how tokenization can proliferate payment credentials.[34]

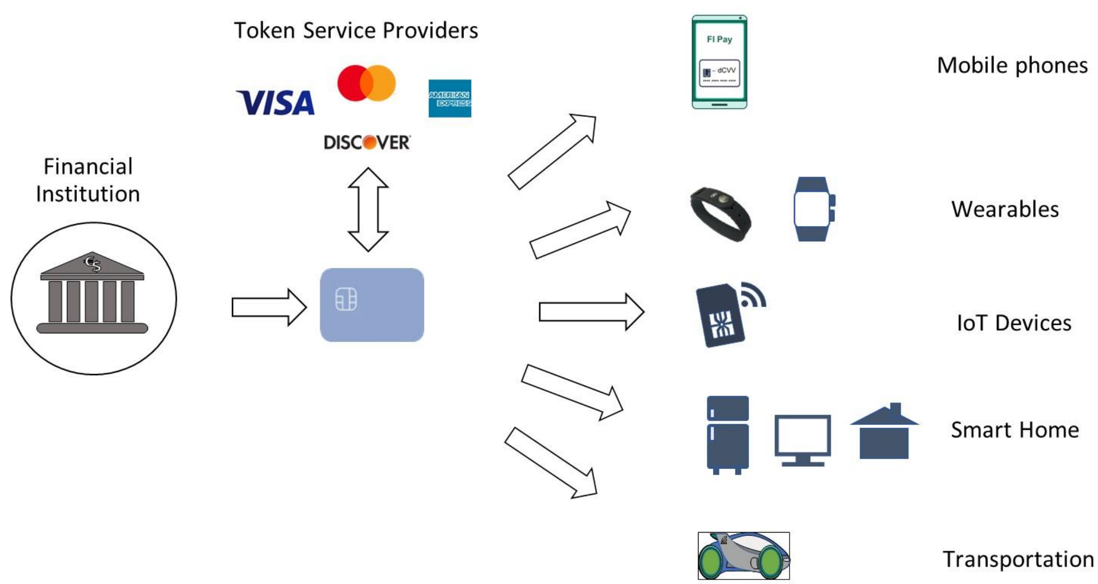

Figure 5. Payment Credential Proliferation by Tokenization

EMV and tokenization can be integrated into ISO 15118-compliant EV charging technology to facilitate frictionless payment and allow the EV owner to control the resulting financial transaction.

[34] Additional information on EMV payment tokenization can be found in the U.S. Payments Forum white paper, "EMV Payment Tokenization Primer and Lessons Learned," https://www.uspaymentsforum.org/emv-payment-tokenization-primer-and-lessons-learned/.

6 Proposed Framework for Secure Open Payments for EV Charging

EVs and CPOs are already adopting the ISO 15118 standard, but there are still limitations in the payment process that will only intensify as the market matures. Every CPO must have bilateral agreements with other providers. And future CPOs could be almost any organization—an electric power generation company, a grocery store, a hotel chain, or even the owner of an apartment building.

To resolve this challenge today, every charging station is required to have a payment terminal. This approach ignores the potential represented by the software and data processing capabilities built into an EV. EVs can use electricity not only for propulsion but also to power electronic equipment.

By combining current EV charging interface and payment industry standards, built-in "direct payment" can be added to the ISO 15118 PnC use case. The method this paper proposes is a hybrid solution that combines contract-based PnC and its alternative, external payment, but with one significant difference: a payment terminal may not be required when routing a payment credential supplied directly by the EV.

The EV can store a tokenized payment credential. When no contract can be validated, the EV can supply the payment card token directly to the charging station to route to the financial networks (Figure 6). This method not only improves the driver experience, but it also increases transaction security and simplifies the EV charging station—especially important for charging stations that may not be able to accept external payment.

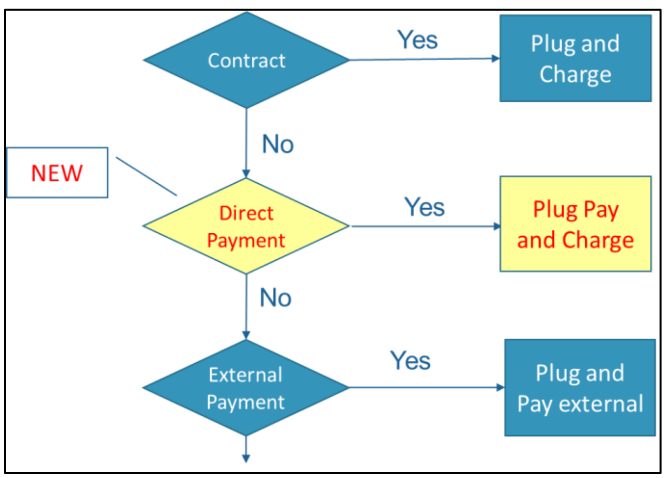

Figure 6. Payment Options When the Proposed Open Payment Framework Is Available

A direct payment transaction involves three steps:

1. Identify the EV or driver as a device or driver.
2. Authenticate to ensure that the EV presents a valid, trusted credential.
3. Authorize. Currently, authorization means receiving a valid contract. The proposed method delegates authorization to the financial network.

Figure 7 shows how direct payment can be incorporated into the ISO 15118 data flow.

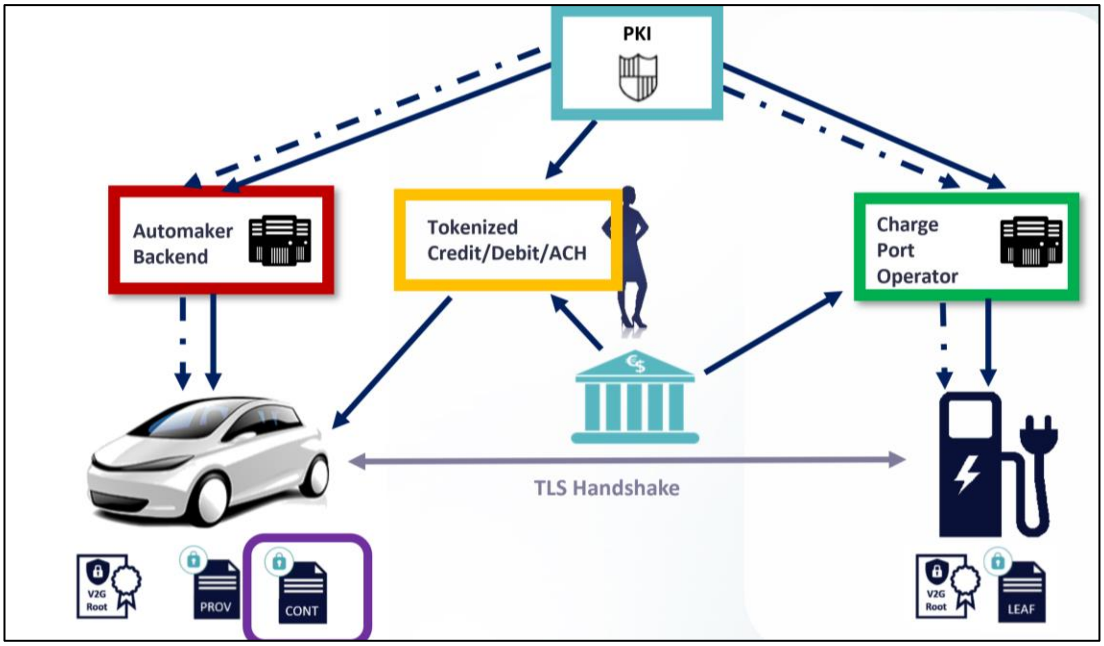

Figure 7. How Direct Payment Fits in the ISO 15118 Data Flow

6.1 PnC Direct Payment Credential Options

This section describes two options for paying directly at a charging station:

- Using a tokenized EMV payment credential
- Using an eCommerce payment credential

6.1.1 PnC Direct Payment: Tokenized EMV Payment Credential

EMV technology defines a protocol for payment data exchange using the ISO 7816 standard, which was originally designed for chip cards but is now widely used in other form factors. The proposed approach uses EMV ISO 7816 messages with the built-in EV software, similar to how mobile payments are implemented today. There is no need to change the format of the messages. ISO 15118 can wrap EMV messages, as has been previously done (for example) for contactless payments using the ISO 14443 standard.

The payment credential is tokenized: no PAN is stored in the EV. The payment credential and cryptogram are communicated directly to the charging station, using ISO 15118 communication protocols, either automatically or at the request of the consumer. The charging station processes the payment through the payment network as if it were any payment made using a chip card or phone app. The vehicle becomes an extension of a chip card.

Figure 8 illustrates the process flow for making a payment using a tokenized EMV payment credential.

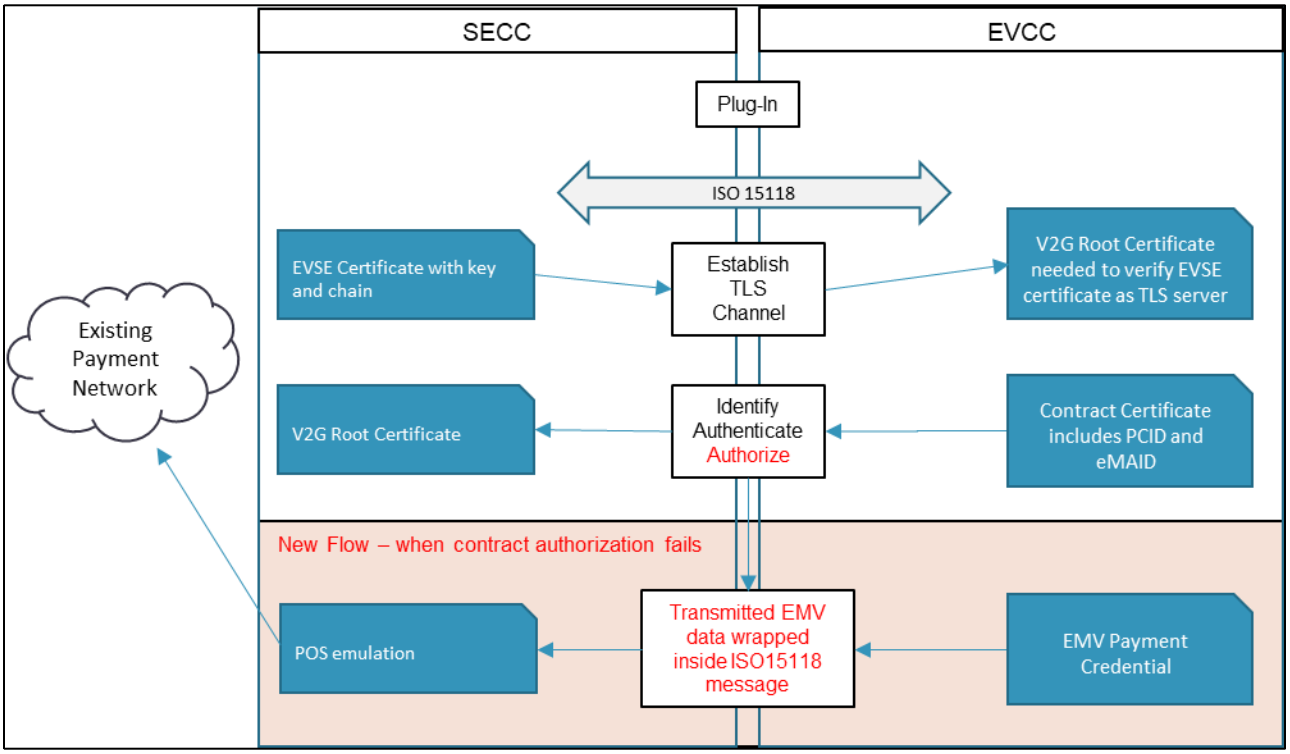

Figure 8. Direct Payment Using Tokenized EMV Payment Credentials

One advantage of this option is that it is highly scalable, because it does not affect the payment networks. While charging stations would still require a POS device, it would be a much simpler one, needing no external interface to accept a payment card or produce a display. The EV can communicate with the driver either on the dash display or a mobile app, tracking the payment process and allowing the driver to accept payment rates and initiate or halt a charging session.

The challenge presented by this solution is how to store the credential in an EV. Three methods are available:

- Use software-based solution in vehicle. The EV's hardware security module protects the credential. Host Card Emulation (HCE)[35] is one implementation.
- Use hardware-based solution in vehicle. Store the payment application and payment credential in the EV's embedded secure element.

Either implementation requires review, both to evaluate security and ensure compliance with PCI (see Section 7.1).

Modern EVs already include the hardware required to support this option. ISO 15118 implementation requires similar hardware; any EV on the market that supports ISO 15118 can support direct payment as described here.

[35] For more information on HCE, see https://www.securetechalliance.org/publications-host-card-emulation-101/

6.1.2 PnC Direct Payment: eCommerce Payment Credential

Many tokenization providers and merchants use eCommerce tokens. This payment token was designed to replace a card on file for merchants who process multiple payments using the same payment credential. Payments using eCommerce tokens, however, do not follow the same payment flow as payments made using a card or a mobile payment. To adopt this option, the charging station must support eCommerce tokens via its backend processing and acquiring relationships.

Most EV CPOs may already support the use of eCommerce tokens, as they have accounts on file for their own customer base. To implement this payment option, they would simply need to be able to receive these tokens on the fly rather than storing them.

For the EV, implementation of direct payment using an eCommerce token affects only the ISO 15118 software implementation. Since an eCommerce token is typically static, it can be passed on as part of the ISO 15118 authentication.

Figure 9 illustrates the process flow for this payment option.

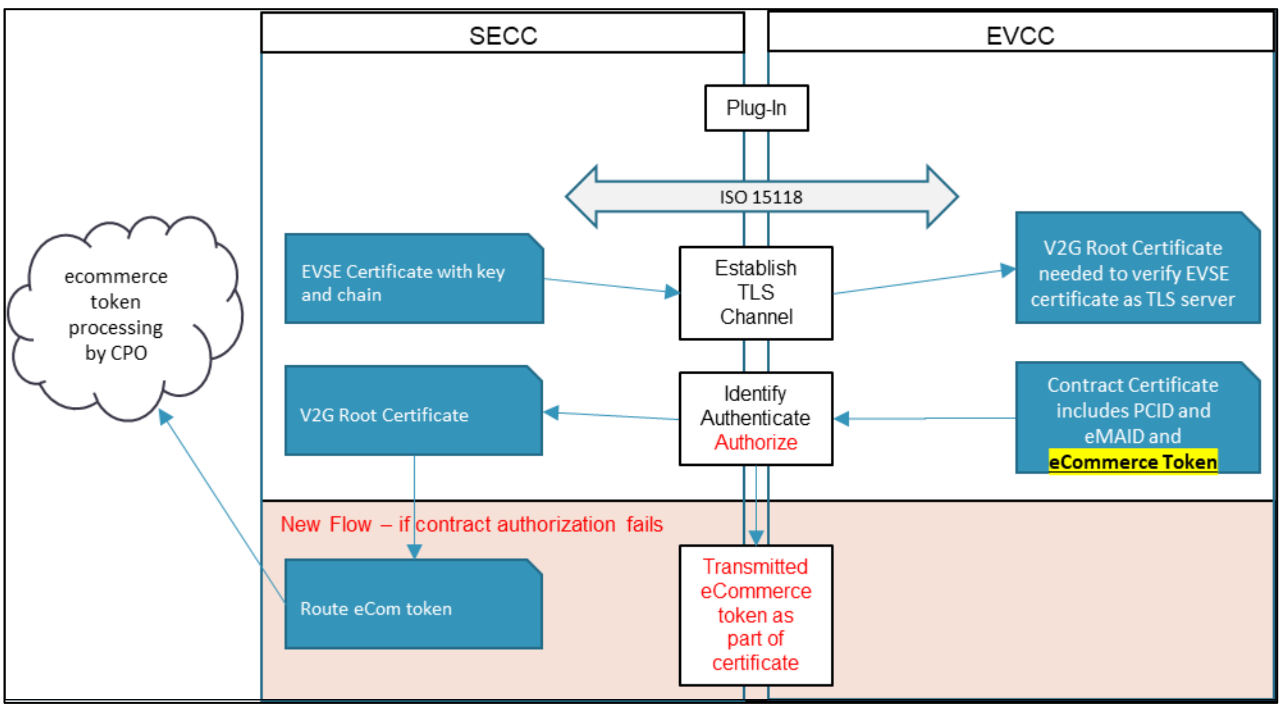

Figure 9. Direct Payment Using eCommerce Payment Credentials

7 Considerations for Open Payments for EV Charging

Before proposing new payment technology frameworks for EV charging, it is necessary to understand the interaction between payments and EV charging. Knowledge of how EV charging station software works is helpful when making recommendations for integrating payment technologies. The open payment framework recommended in this white paper suggests improvements to the technologies used by EV charging stations and PnC as currently implemented.

The following sections list some considerations.

7.1 Considerations Relevant to Where Processing Occurs

One consideration is whether the charging control software acts as a merchant unit. If so, there are no additional requirements; a separate off-the-shelf unattended POS terminal can process payments. The charging control software simply prompts the payment request.

However, if the charging control software also has a role in EMV payment processing, then various certifications may be required, both for the software and the hardware running the software (e.g., EMVCo Level 1, Level 2, Level 3, PCI, PCI-DSS).

Another consideration is whether a transaction needs to be identified as coming from a vehicle and whether this will be different from existing payment transaction types. The data source is neither a chip nor a contactless device, so if data are transferred using ISO 15118 protocols, a new communication type may be needed (perhaps card-not-present or eCommerce). Depending on where the payment credentials are stored, a new form factor may also be needed.

7.2 Considerations Relevant to the POS-EV Interaction

If the POS is not visible to the driver, as is the case for Tesla's solution, one consideration is whether the dashboard screen will need to have open access to allow charging stations to prompt the driver. If so, there may be other requirements depending on the regional rules (for example, conforming with PSD2). If the car dashboard becomes the user interface for transactions and a PIN is required, then PCI DSS compliance will be required.

Another issue is whether there are any physical requirements for the connection between the EV and the charging station. For example, consideration may include whether the cord must meet security standards other than ISO 15118 and whether its performance is sufficient.

ISO 15118-2 includes topics regarding identification, authentication, and authorization of payment data. If PnC is not enabled on either the EV or the charging station, then payment for charging session will be possible using the ISO 15118 method External Identification Mean (EIM): physical payment card, app to scan a QR code or RFID card at the charging station. The standard goes into various levels of detail on payment selection options and surrounding topics. These details will suffice for the closed-loop payments system currently being implemented. There should be a review of the standard to make sure and confirm that an open-loop payments system can be supported in a similar fashion. The Secure Technology Alliance Payments Council project team recommends that, if needed, the ISO 15118-2 standard be updated appropriately so that an open-loop payment system can have the ability to be implemented in the future. This could involve incorporating relevant EMVCo and PCI guidelines into the standard.

7.3 Considerations for Consumer Experience

Loading a payment credential in the vehicle is likely going to be done once. The EV manufacturers should outline the process in the owner's manual. Thereafter when using direct payment or PnC in general, the vehicle or its mobile app will provide details about the payment experience. Since this is what the EV driver will use daily regardless of where they charge, they would be familiar with and confident in the process. It is expected that drivers will be aware that their vehicle supports PnC. Possibly the charging station will indicate this as well, but to avoid uncertainty of whether a contract is needed between the driver's provider and the charging station, it would be recommended that the charging station present its support of PnC with direct payment. The driver will simply know that they can plug and charge even if this is the first time they stopped at an unknown charging station.

8 Benefits of Proposed Open Payments for EV Charging

The adoption of electric vehicles worldwide is a significant event on a par with other rapid innovations in technology, such as the internet and mobile computing. Although the EV charging infrastructure is technologically immature in many respects, deployment is approaching mass penetration. Therefore, the time to enhance this technology is now.

In addition, certain jurisdictions in the United States, as well as many countries worldwide, have regulations or are in the process of creating legislation/regulation to encourage EV adoption. The Innovation, Science and Economic Development Canada (ISED) has defined billing methods for charging electric vehicles on their website.[36] Representatives from the Smart Grid Center of Excellence at Eskom Research Testing & Development in South Africa mentioned that creating revenue streams by adding points of sale or remote charging with billing will help companies adjust traditional business models to match this growing market.[37] The Indian government has contracted a company to build out their EV charging infrastructure which will include various payment methods and billing system management.[38] The United Kingdom published their “National Infrastructure Strategy” in November 2020. This document stated they will be consulting on regulations to improve the consumer experience at public charge points which includes payment methods/roaming and insurance of pricing transparency.[39] In the United States, the California Air Resources Board adopted the EVSE Standards Regulation to implement the “Electric Vehicle Charging Stations Open Access Act” (Senate Bill 454; Statutes of 2013). This bill has a section defined in Attachment A section 2360.2 titled “Payment Method Requirements for Electric Vehicle Supply Equipment,” which details specific payment technology requirements with which an ESVE needs to comply. In this section, there are clauses that require credit card readers to be installed on each ESVE with the intent to promote open and fair use.[40]

Some jurisdictions also present requirements to address the needs of unbanked/underbanked consumers. The tokenization of payment credentials can facilitate digitizing and storing an open payment prepaid card in the vehicle. Drivers can purchase prepaid cards from almost any store today. Direct payment will present even more flexibility to consumers who do not have banking or CPO contract relationships.

This paper demonstrates that current payment technology can be used in a way that will benefit EV owners and CPOs. More important, direct payment can accelerate infrastructure deployment and encourage new industry participants to enter the EV charging business, which in turn will drive faster consumer adoption of EVs.

In the last few years, a similar payment technology transformation has been seen in the public transit sector. While many transit agencies relied on a so-called “closed loop” payment infrastructure in the past, agencies are now adopting open payment standards at transit gates.

The proposed direct payment solution is not intended as a replacement for the current payment methods, but rather as an addition. EV owners can still choose to have multiple contracts with CPOs.

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[36] https://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm04949.html

[37] https://www.smart-energy.com/industry-sectors/electric-vehicles/whats-putting-the-brakes-on-ev-adoption-in-south-africa/

[38] https://www.globalbankingandfinance.com/bringing-indias-first-public-electric-vehicle-charging-network-online-with-tcs-chargecore-on-hobstm/

[39] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938049/NIS_final_web_single_page.pdf

[40] https://ww2.arb.ca.gov/sites/default/files/2020-06/evse_fro_ac.pdf

EV CPOs can realize the following benefits from direct payment:

- Reduce the costs of account management associated with closed-loop subscription-based payments.
- Reduce the complexity of EV charging equipment.
- Accelerate infrastructure deployment.
- Achieve regulatory compliance through open payment credit/debit or prepaid cards indirectly facilitating cash payment.
- Increase usage, due to simplification.
- Reduce fraud.

EV drivers can realize the following benefits from direct payment:

- Eliminate uncertainty about the accessibility and availability of EV charging stations.
- Simplify and enhance the charging experience.
- Achieve a consistent charging experience across all networks as the payment is now facilitated by their vehicle.
- Reduce or eliminate the need to have a contract with multiple CPOs. One contract would allow drivers to charge anywhere, but they could still have multiple contracts.
- Eliminate the fear of where to charge and make the EV ownership decision solely based on transportation preference.
- Make long distance travel with EVs faster and more convenient.

Retailers and other organizations willing to deploy EV charging can realize the following benefits from direct payment:

- Deployment can be scaled with off-the-shelf solutions.
- Deployment and integration with the existing payment infrastructure are flexible.
- Costs of operation are reduced.
- An improved consumer experience will attract more customers.

9 Conclusion and Call to Action

The proposed framework described in this paper has the potential to simplify the EV charging payment process and help to stimulate further adoption of EVs. The Secure Technology Alliance and its Payment Council members urge the automotive and payment industry as well as policy makers to work together to further define this approach.

Standardization Bodies: ISO, EMVCo

Consider this paper as a foundation for enhancing existing ISO and EMV standards to allow global deployment of the direct payment approach.

Global Payment Network and Payments Industry Participants

Consider offering global specifications for EV open payment on existing or new standards which are easy to implement and certify and which leverage existing technology and principles.

Automotive Manufacturers

Implementation of this approach is technically feasible. The mobile phone industry was able to deploy EMV open payment technology in almost every phone today, proving the viability of this approach. The automotive industry has acknowledged that an EV is a (mobile) computer on wheels. All the necessary hardware is available in the EV; software development and implementation are needed. Built-in payment functionality is just another software function, one that is of great use to the EV driver.

CPOs

The proposed approach does not conflict with or in any way restrict present ISO 15118 Plug&Charge implementation. The approach is simply an enhancement that could accelerate adoption of the standard. Consider implementing the standard with the proposed direct payment option in collaboration with automotive manufacturers.

Policy Makers – City, County, State/Province, Federal Jurisdictions

Even though this is not an existing standard as of today, consider reviewing the proposal since this may represent an opportunity to draft new or amend existing policy to offer better value to consumers and less burden for service provider compliance.

The Secure Technology Alliance invites industry stakeholders to participate in a cross-industry discussion to assess what is needed to support the proposed open payments framework.

10 Publication Acknowledgements

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Publication of this document by the Secure Technology Alliance does not imply the endorsement of any of the member organizations of the Alliance.

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- **Leigh Garner**, Discover Financial Services
- **Nils Gerhardt**, Giesecke+Devrient
- **Tyson Goings**, Discover Financial Services
- **Nareg Guregian**, Visa
- **Mike Harris**, Discover Financial Services
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- **Basil Ittiavara**, UL
- **Zoltan Jeszenszki**, UL
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- **Brian Summerhayes**, Barnes International
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- **Alan Whittemore**, American Express

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About the Secure Technology Alliance Payments Council

The Secure Technology Alliance Payments Council focuses on securing payments and payment applications in the U.S. through industry dialogue, commentary on standards and specifications, technical guidance, and educational programs, for consumers, merchants, issuers, acquirers, processors, payment networks, government regulators, mobile providers, industry suppliers and other industry stakeholders.

The Council's primary goal is to inform and educate the market about the means of improving the security of the payments infrastructure and enhancing the payments experience. The group brings together payments industry stakeholders to work on projects related to implementing secured payments across all payment channels and payment technologies. The Payments Council's projects include research projects, white papers, industry commentary, case studies, web seminars, workshops, and other educational resources.

Additional information on the Payments Council can be found at https://www.securetechalliance.org/activities-councils-payments/.

11 Acronyms

- **CA -** certificate authority
- **CPO -** charge port operator – owns or operates the EVSE
- **EMA -** E-Mobility Account
- **EMAID -** E-Mobility Authentication Identifier
- **EV -** electric vehicle
- **EVCC -** electric vehicle communication controller
- **EVSE -** electric vehicle supply equipment. Note that EV supply equipment is used in description according to IEC 61851-1. EVSE is applied only for parameter name or message definition.
- **MO -** mobility operator – has a contractual relationship with the EV driver
- **OCSP -** online certificate status protocol
- **OEM -** original equipment manufacturer
- **PLC -** power line communication
- **PnC -** Plug and Charge/Park and Charge
- **SDP -** SECC discovery protocol
- **SECC -** supply equipment communication controller
- **TLS** - transport layer security
- **V2G -** vehicle to grid communication
- **V2G CI** - vehicle-to-grid communication interface
- **V2GTP** - V2G transfer protocol
- **WPT** - wireless power transfer