Electric Vehicle Supply Equipment [EVSE]

EVSE Communications & Backend Management

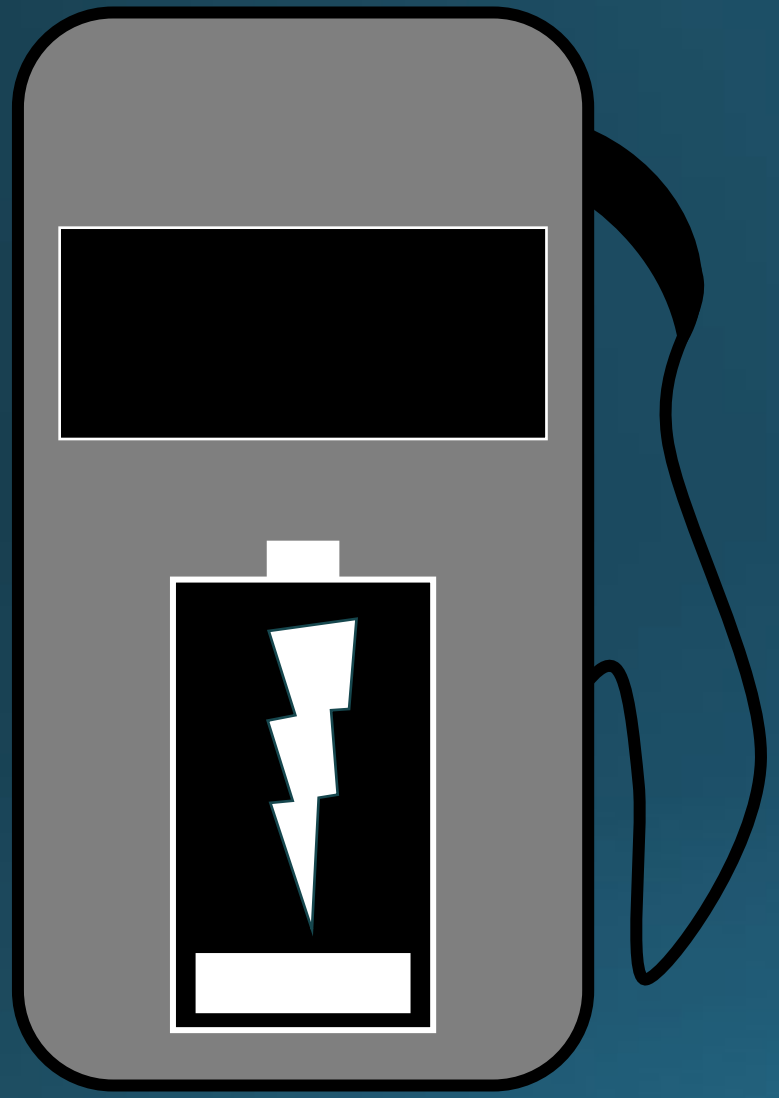
Supervising Special Investigator
Matt Douglas

California Department of Food Agriculture
Division of Measurement Standards

Disclaimer:

All companies, business interests, persons, and products presented here are for informational and illustrative purposes only.

The depictions, images, and names in this presentation do not represent an endorsement or recommendation of any individual company, product, vendor, or person by the California Department of Food and Agriculture, The Division of Measurement Standards, or the Presenter of this material.



Electric Vehicle Supply Equipment (EVSE)

A.K.A.

Electric Vehicle Fueling System (EVFS)

Sometimes referred to as a:

“Charge Point” (the point of the charge)

Note: There is a company named “ChargePoint, Inc.” the references to “Charge Point” throughout this presentation (such as “Open Charge Point Protocol”) do not refer to the company but to EVSE overall.

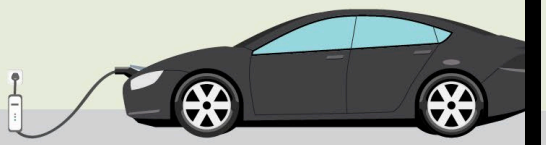
Contents

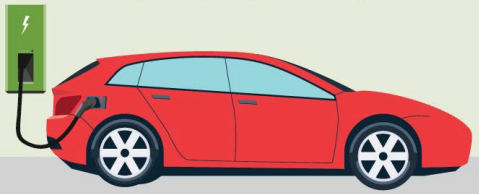
- Various types of EV Chargers and Connections (AC vs DC)
- EVSE Communication
  - Frontend Communication
  - Backend Communication
- Parties Associated with EVSE Infrastructure
- Conceptual difference between RMFD & EVSE
- Type Evaluation Considerations

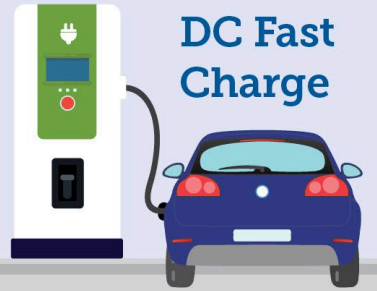
Various types of EV Chargers and Connections

(AC & DC)

LEVELS OF EV CHARGING







	AC Level One	AC Level Two	DC Fast Charge
	Level 1	Level 2	Level 3
Locations	Homes, Offices, Public	Homes, Offices, Public	Public Only
Output Current	Alternating Current (AC)	Alternating Current (AC)	Direct Current (DC)
Voltage	120V	208 – 240V	400 – 1,000V
Charging Speed	1.3 – 2.4kW	2.9 – 19.2kW	50 – 350kW
Charge Time (EV)	40 - 50 Hours	4 - 10 Hours	20 Minutes – 1 Hour
Charge Time (Hybrid)	5 – 6 Hours	1 – 2 Hours	n/a
Miles per Hour of Charging	2 – 5 Miles	10 – 45 Miles	180 – 240+ Miles
Power Source	Wall Outlet	In-Home Charger, 240V Outlet, Public Charger	Public Charger

Note: these are examples and estimates for conceptual & comparison purposes only.

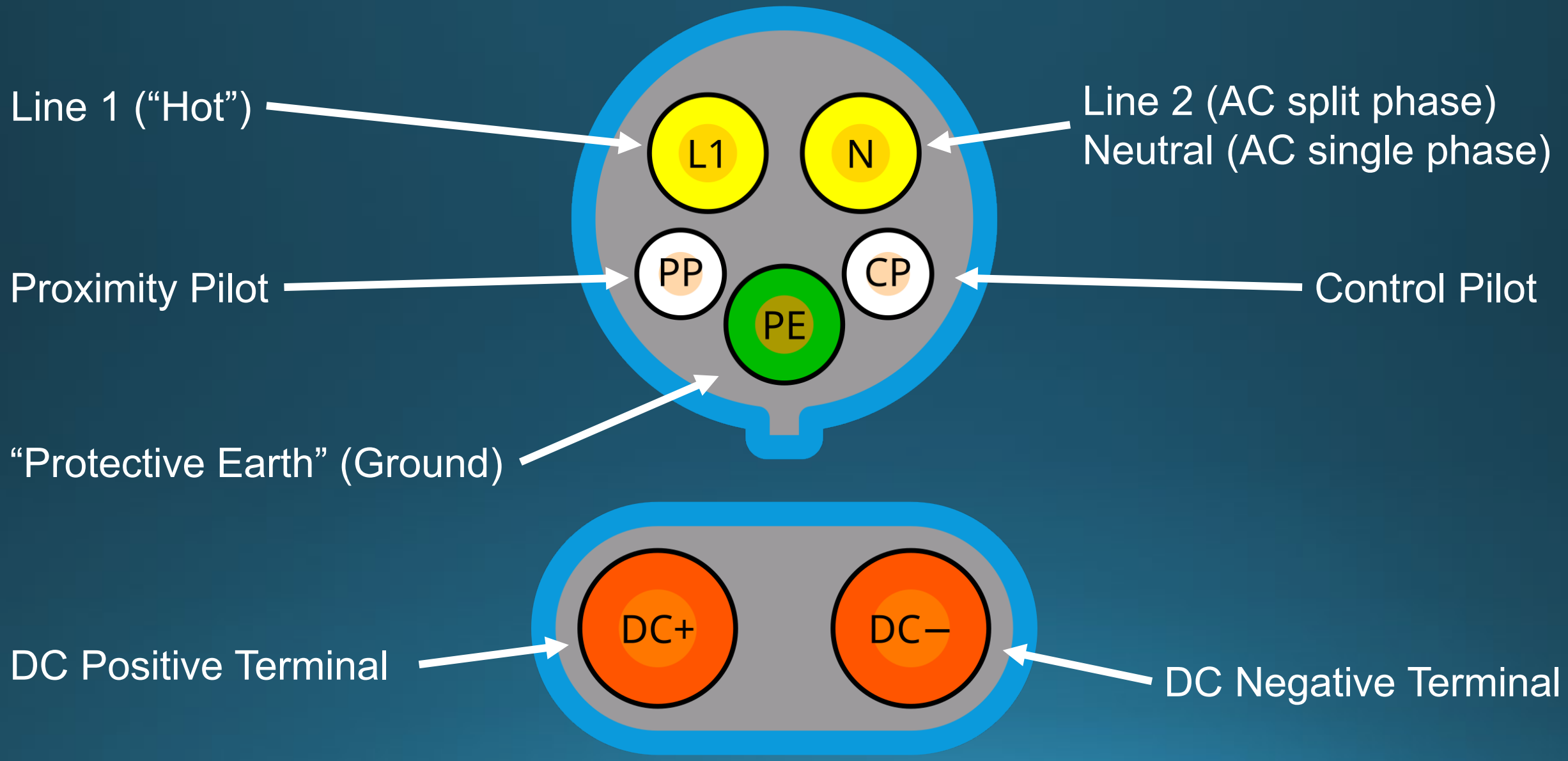
EVSE Charging Connectors

	Japan	N.America	Europe	China	All Markets
AC	 J1772 (TYPE 1)	 J1772 (TYPE 1)	 Mennekes (TYPE 1)	 GB/T	 Tesla (NACS)
DC	 CHAdeMO	 ccs 1	 ccs 2	 GB/T	

J1772 (AC)

Combined Charging System 1 (CCS1) [AC/DC]

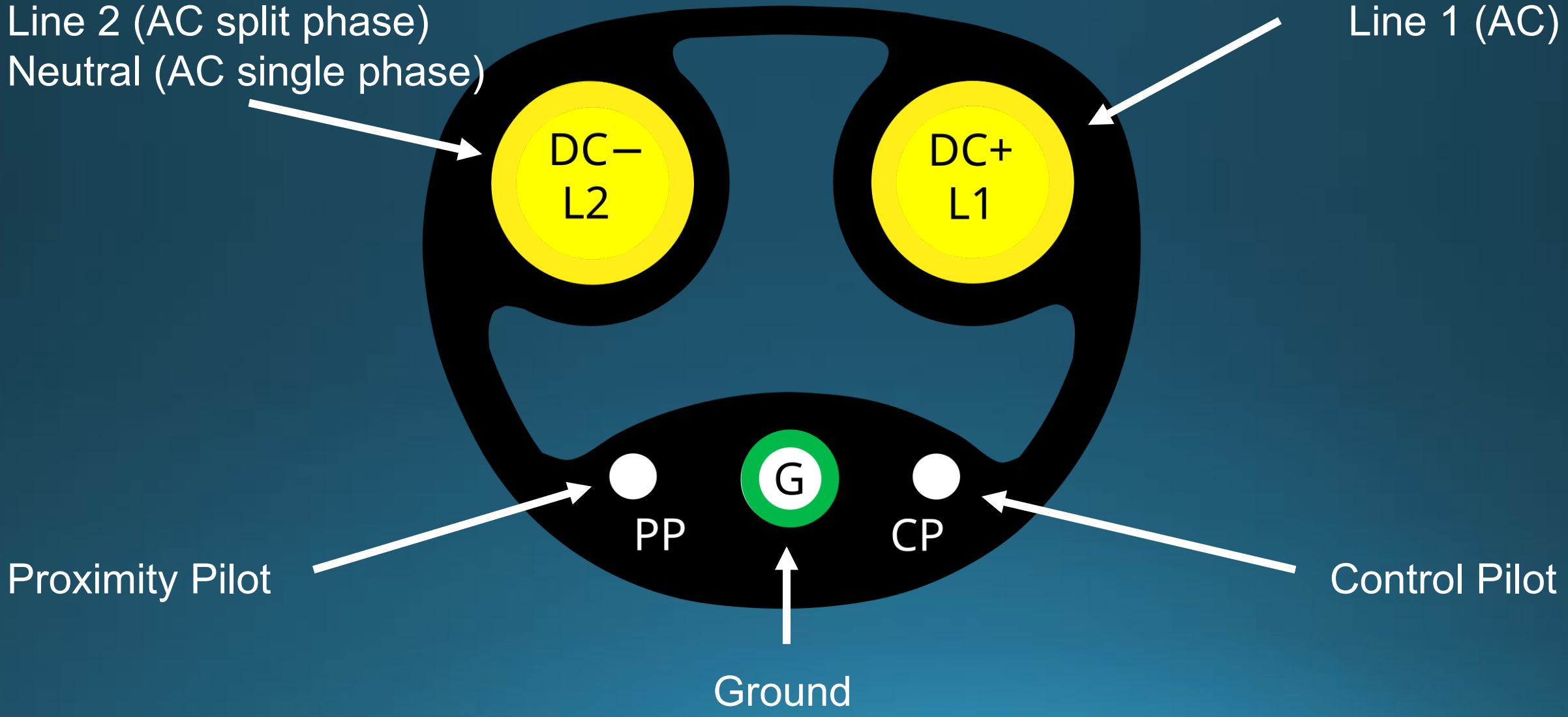
Pin Layout of CCS1 Connector



CHADEMO (DC)

TESLA
North American Charging Standard
(NACS) [AC/DC]

Pin Layout of NACS Connector

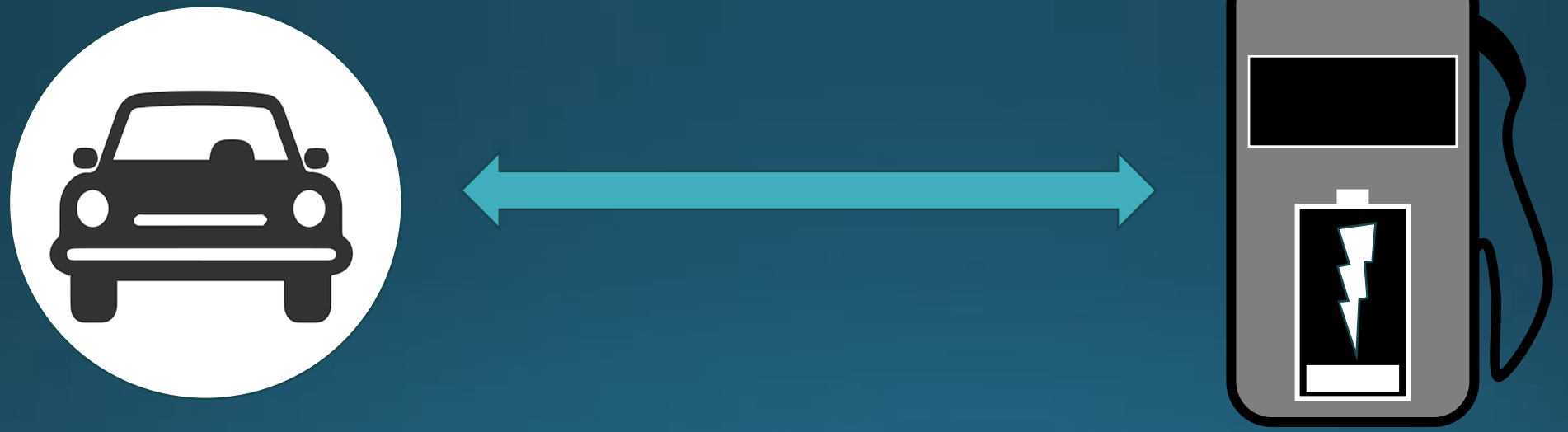


“Frontend” Communication

EVFS Communication

Electric Vehicle

EVSE



Frontend Communication

Frontend Communication

Control Pilot

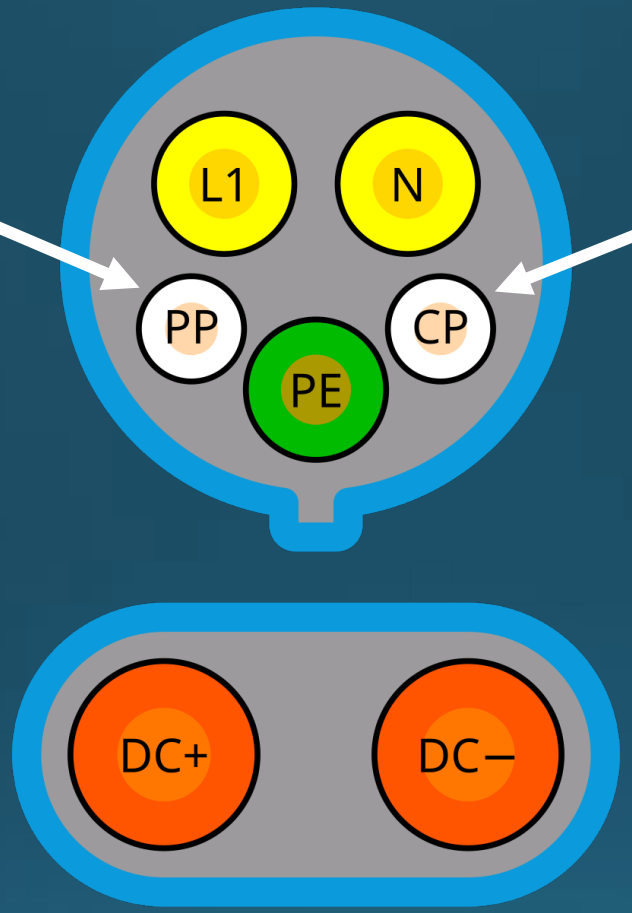
- The primary communication channel between the vehicle and the EVSE.
- The EVSE and vehicle “negotiate” charging parameters such as the Maximum Deliverable Amperage (MDA).
- Monitors the charging state and controls the charging rate.

Proximity Pilot

- Confirms the physical connection of the charging cable between the EVSE and the vehicle.
- Prevents the vehicle form being driven away while connected.
- In some cases, also communicates the maximum current capacity of the cable to the vehicle.

Proximity Pilot

Control Pilot



Is the connector physically inserted into the vehicle?

Are we ready to charge, and if so, what is the maximum amperage you can you handle?

Once physical connection is confirmed, the EVSE & Vehicle begin sending signals to each other through the control pilot.

The EVSE and Vehicle then begin to communicate and “negotiate” through the control pilot.

Vehicle : “Hi, I’m a vehicle and I could use a charge!”

EVSE : “Hi, I’m an EVSE and I have POWER!!!! I’m available to provide up to 32 amps.”

Vehicle : “I can handle 32 amps, but my battery is at 85%, I would like to request 24 amps.”

EVSE : “I hear you; the MDA is 24 amps.”

EVSE Communication

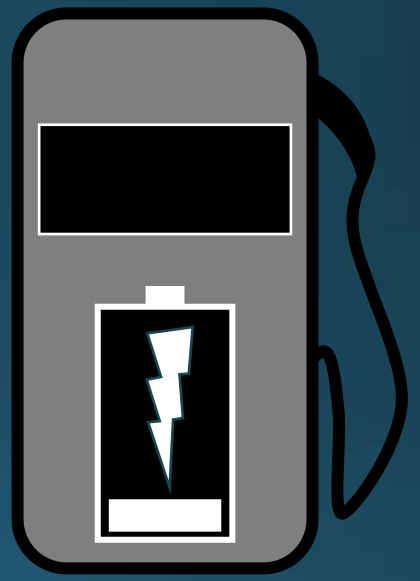
Electric Vehicle

EVSE

IEC 61851-1
(AC & DC)
[Control Pilot & Proximity Pilot]

ISO 15118
(AC & DC)
[Plug & Charge]

DIN SPEC 70121
(DC Only)
[Rapid communication for DC Charging]



Frontend Communication

“Backend” Communication

EVSE Communication

Communication between the vehicle and EVSE.

What about activation of the device?

What about payment verification, price determination, invoicing…?

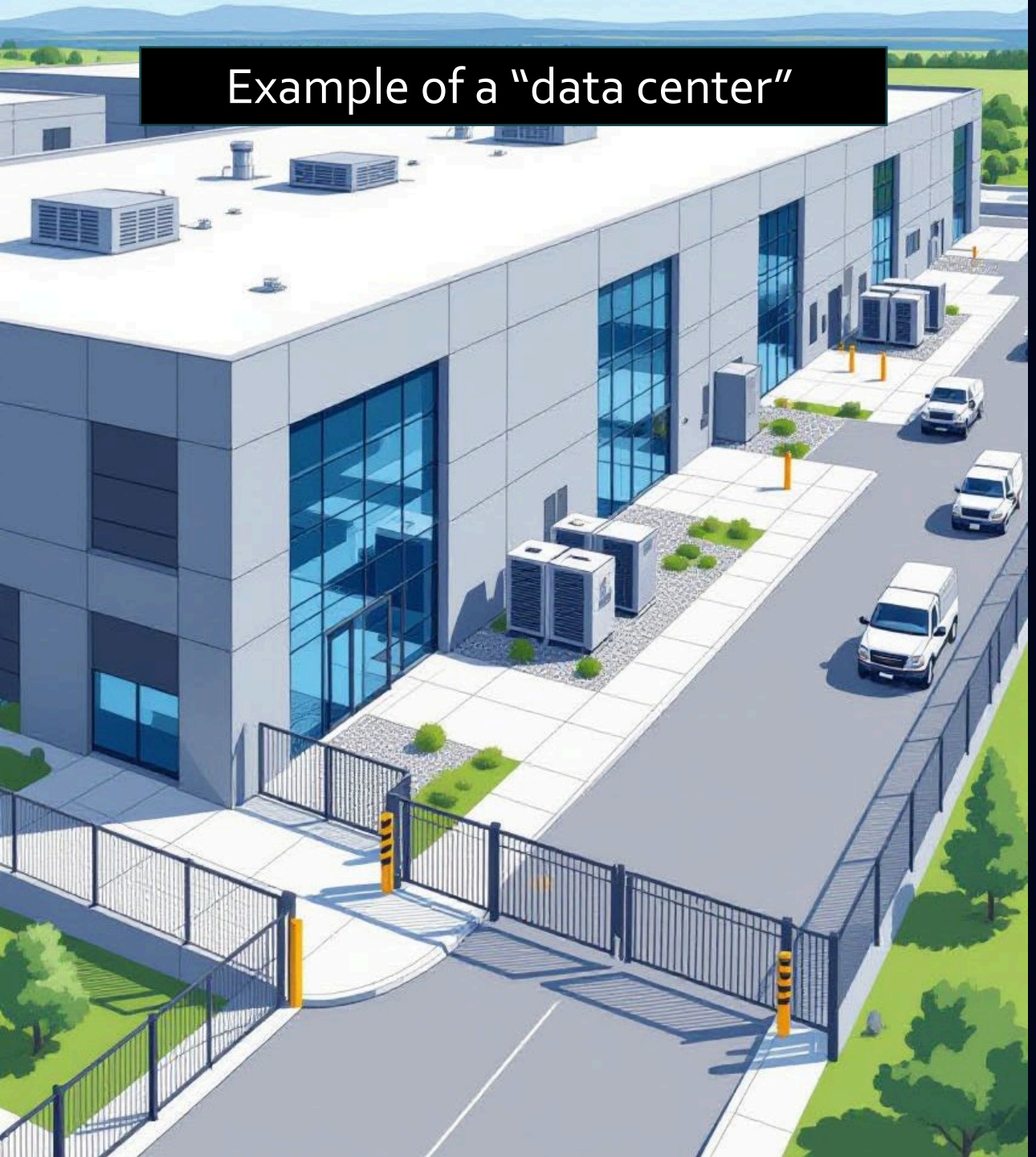
Frontend Communication

Backend Communication

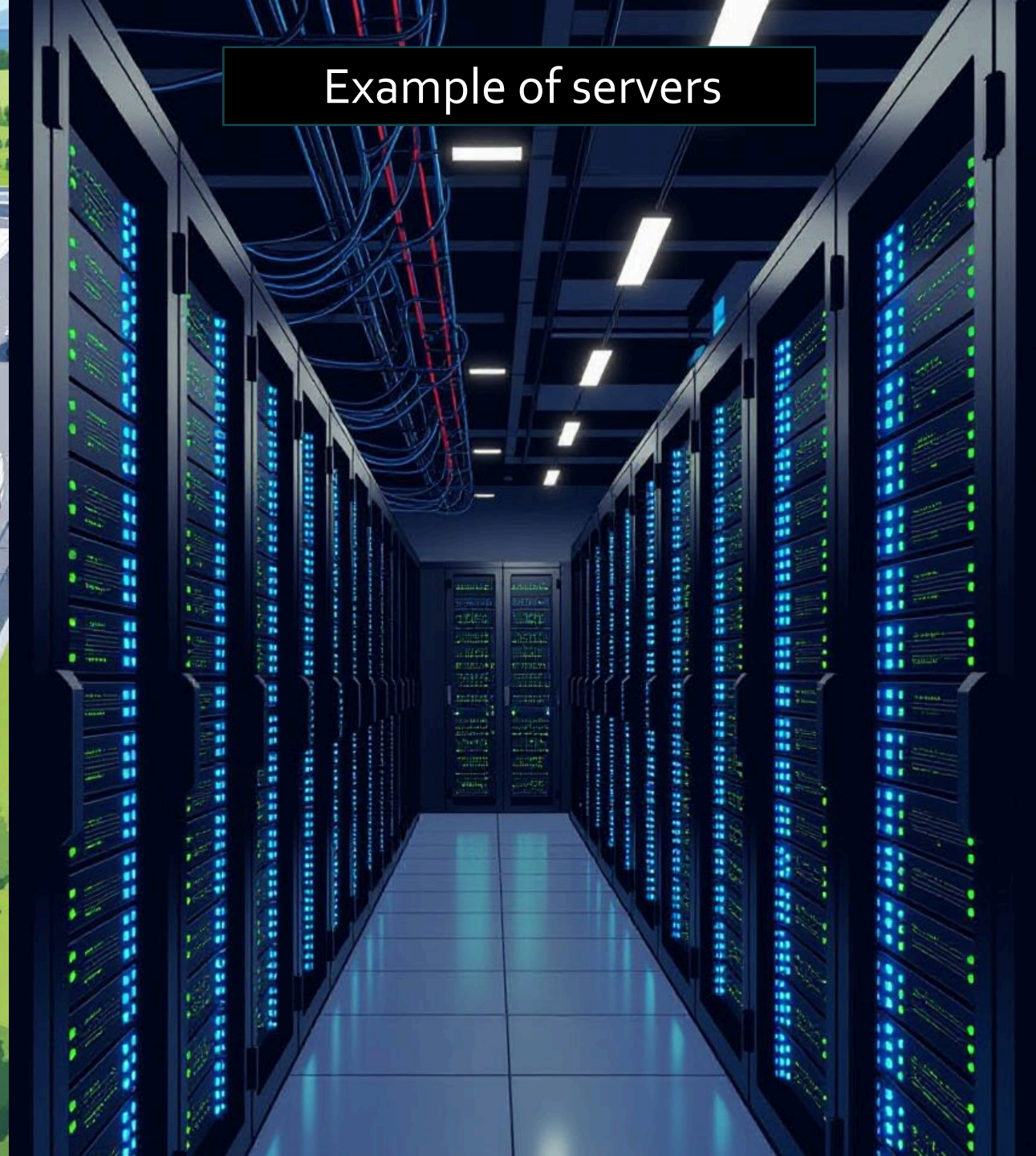
Central Management System
(CMS)
aka
Backend Management System

- Software platform (runs on servers)
- Oversees operation of a charging network.
  - Remote reboot/reset
  - Software and firmware updates
- Utilizes protocols like OCPP to exchange information with chargers from different manufacturers.
- Manages charging sessions.
  - Session authorization
- Network & Energy Management
  - Power distribution
- Analytics & Reporting
  - Network Performance
  - Energy Usage
  - Predictive maintenance

Example of a “data center”

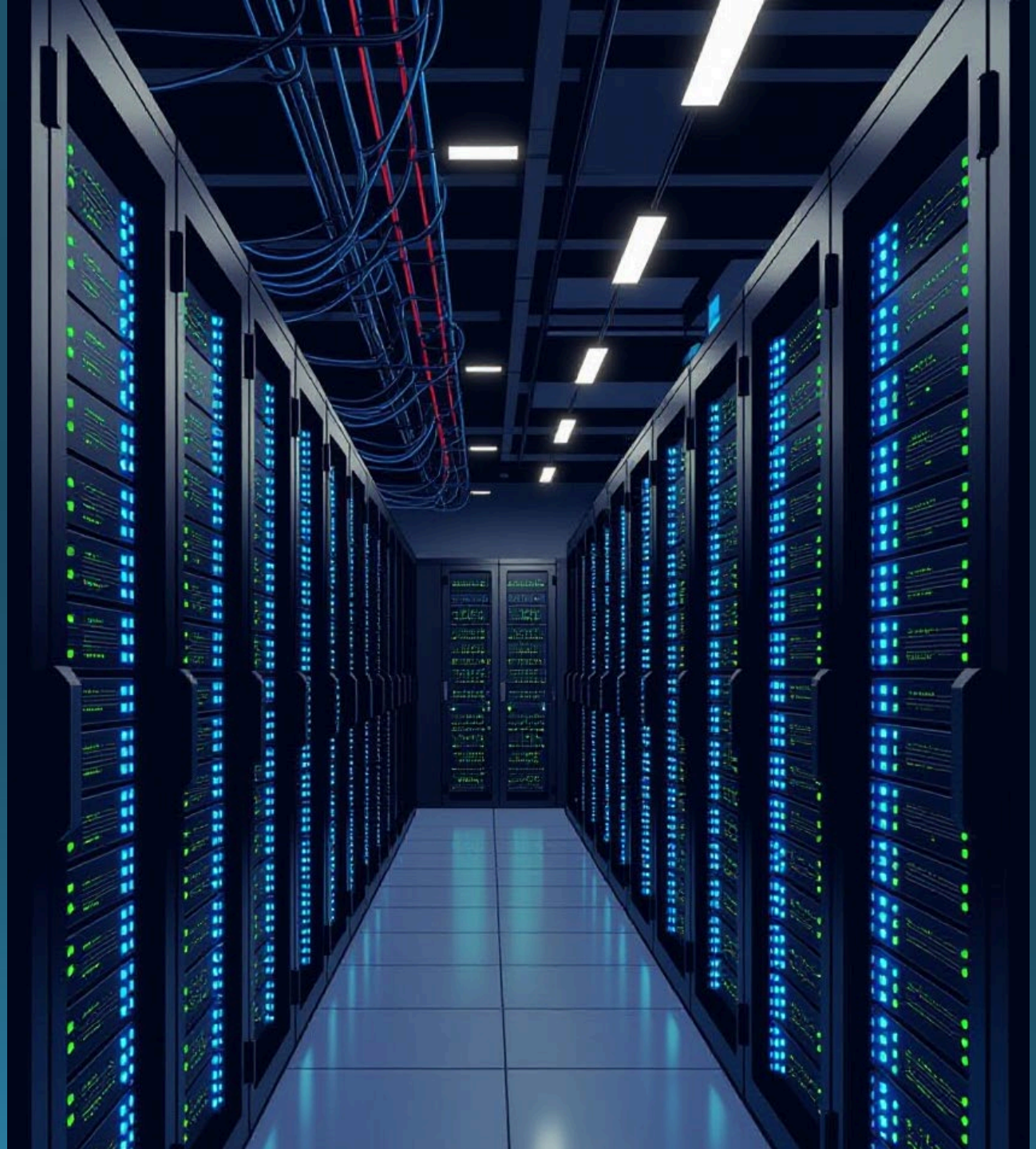


Example of servers



Central Management System
(CMS)
aka
Backend Management System

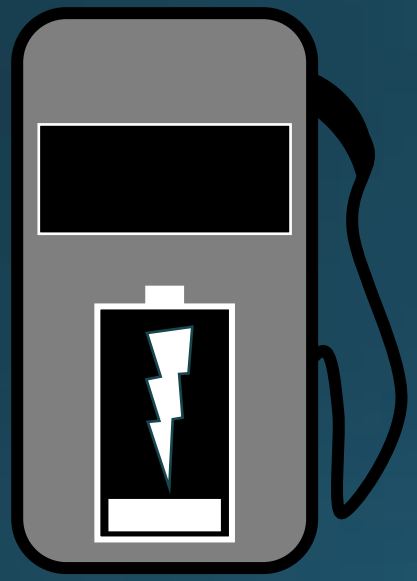
Runs on servers



EVSE Communication

EVSE

Central Management System



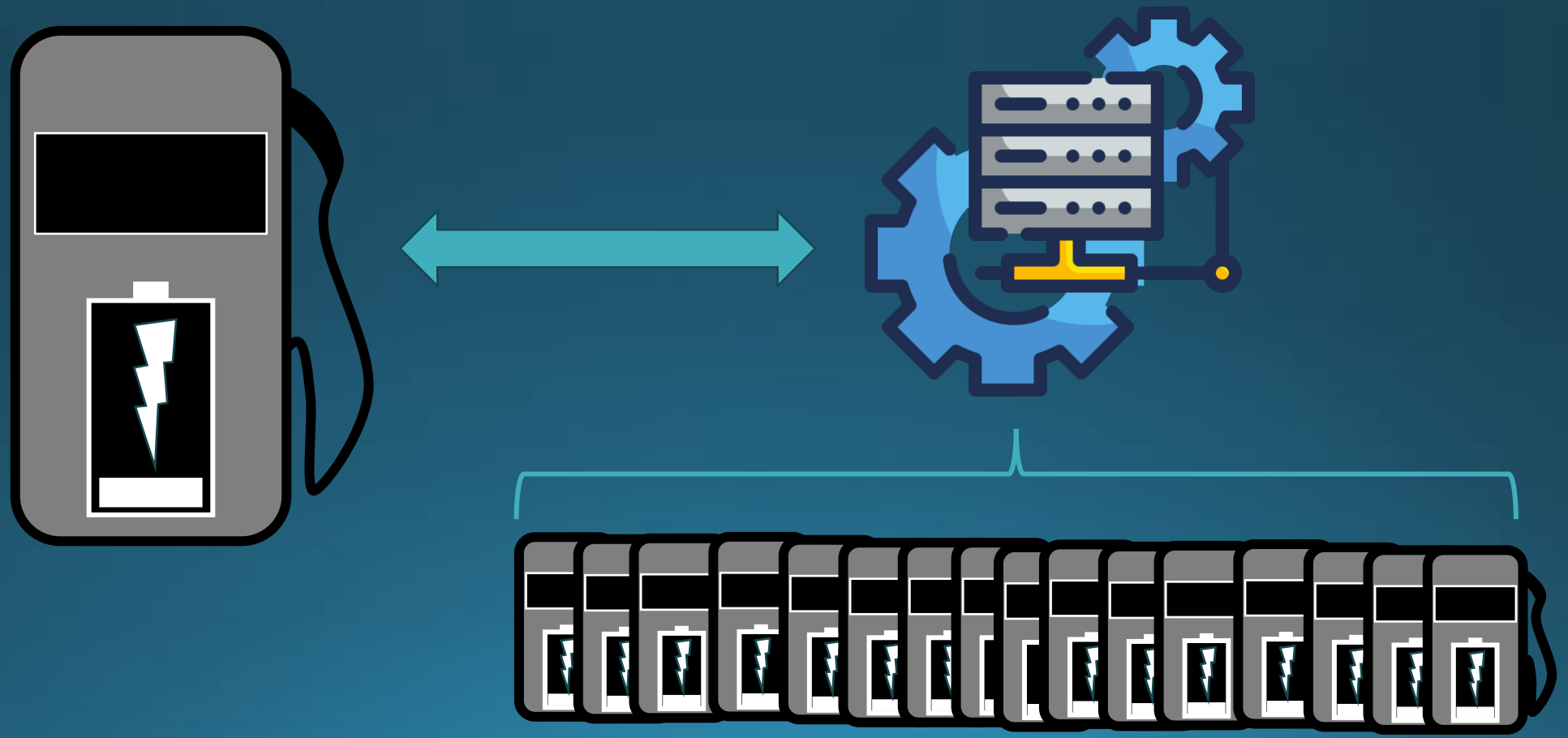
A router (hardware on-site, either integrated into the EVSE or embedded into a cabinet) communicates with the Central Management System.

This is accomplished via Wi-Fi (wireless fidelity), LTE (long-term evolution), or in some cases Ethernet – typically through a protocol called "Open Charge Point Protocol" (OCPP).

Backend Communication

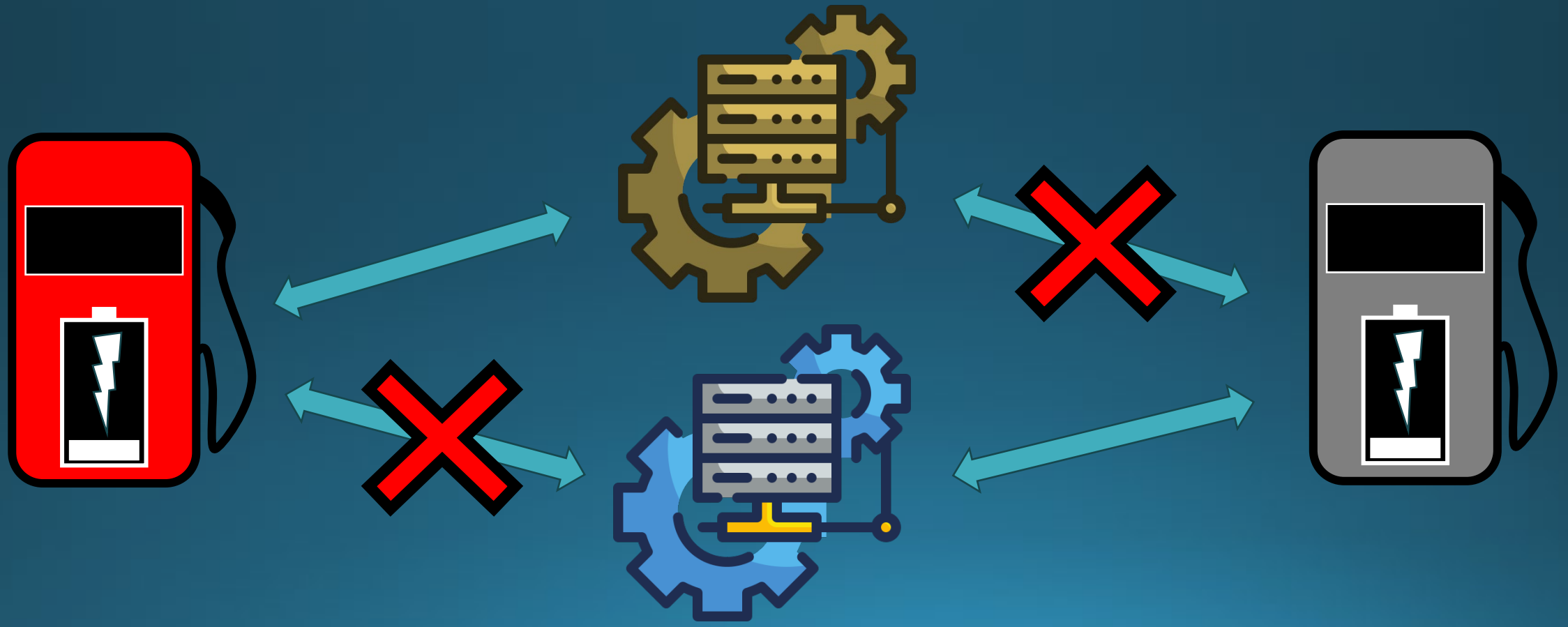
What is Open Charge Point Protocol (OCPP)?

Let's say that "Company A" has manufactured a device and a Central Management System (which is a software platform). Their charging "network" (all the devices they have designed to work with that management system) can communicate with their Central Management System in their unique "language" (Company A's communication protocol).

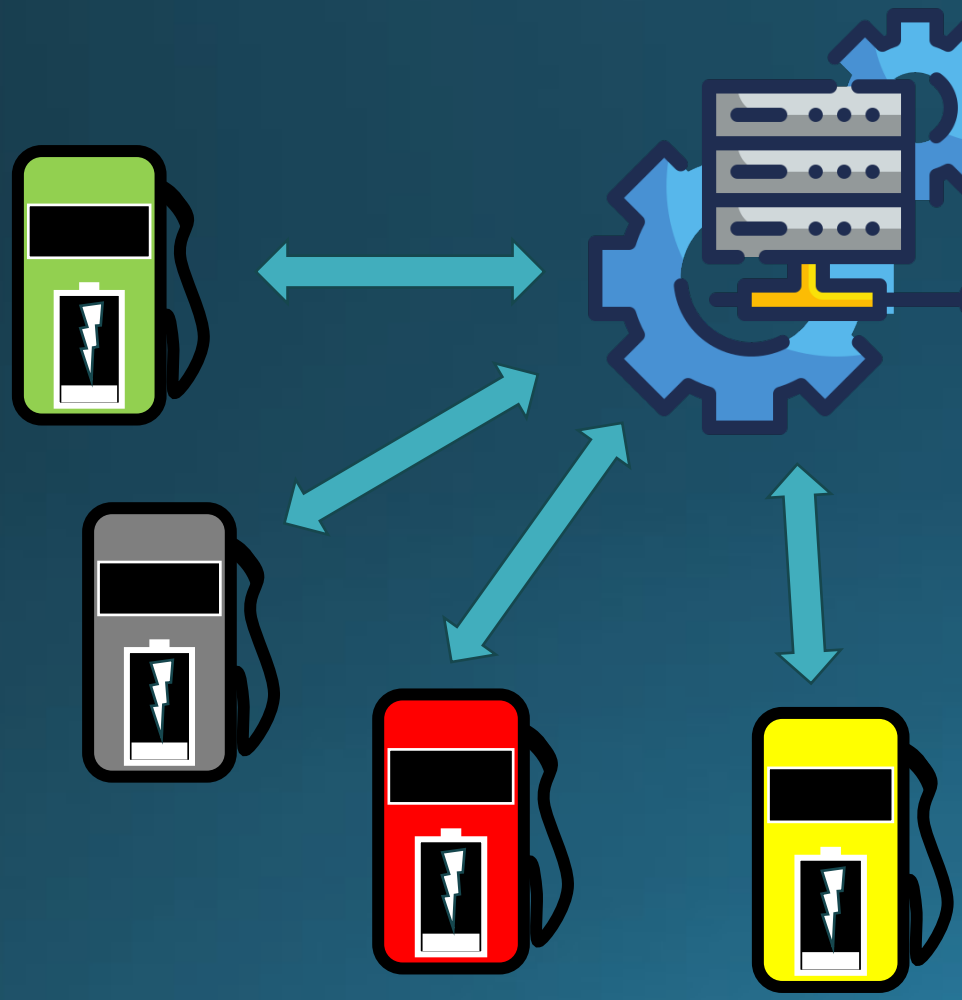


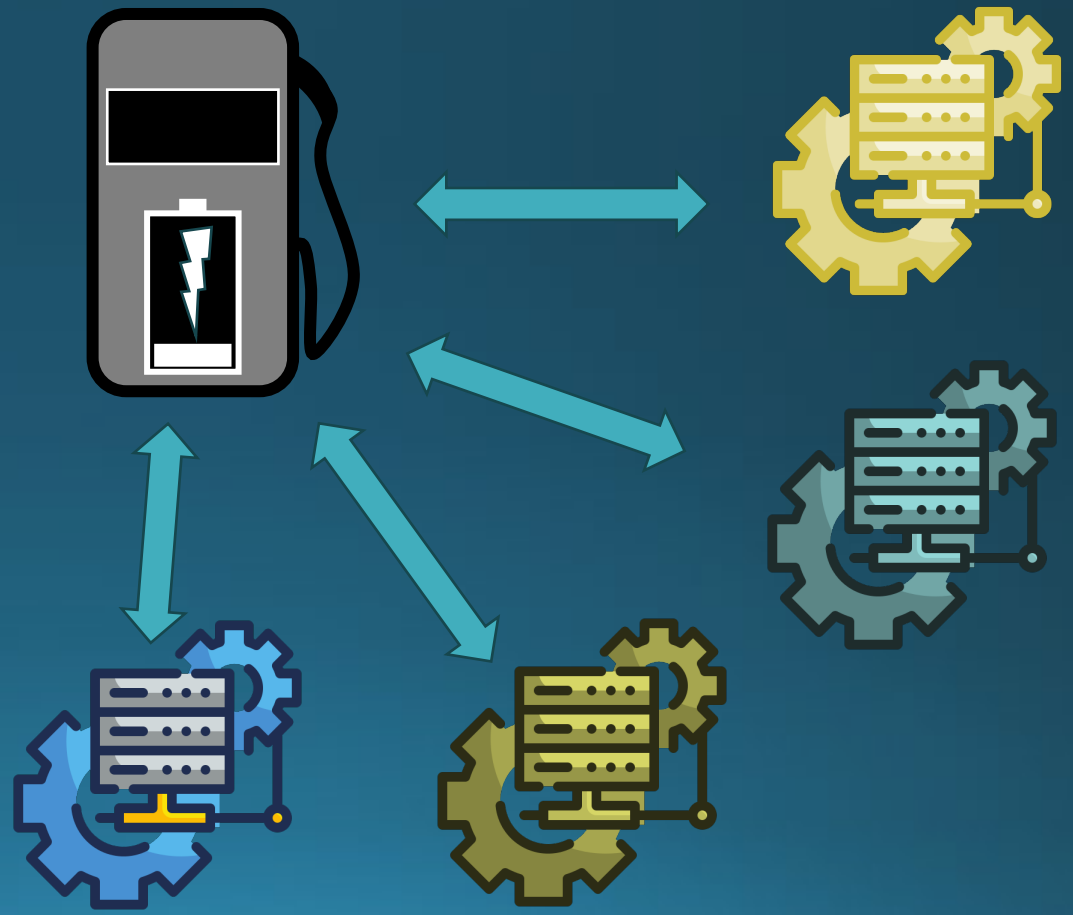
Without Open Charge Point Protocol (OCPP)

“Company B” has done the same thing – meaning that EVSE manufactured by “Company A” will not be able to communicate with the Central Management System of “Company B” and vice versa.



The intention of Open Charge Point Protocol (OCPP) is to act like a universal "language" which enables any EVSE manufacture's devices (hardware) to communicate with any Central Management Software.





EVSE Communication

Communication between the vehicle and EVSE.

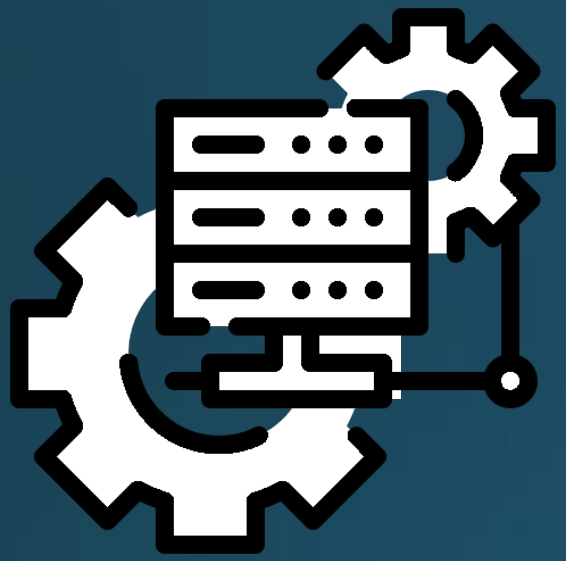
Operations and network management.

Central Management System

What about payment verification, price determination, invoicing…?

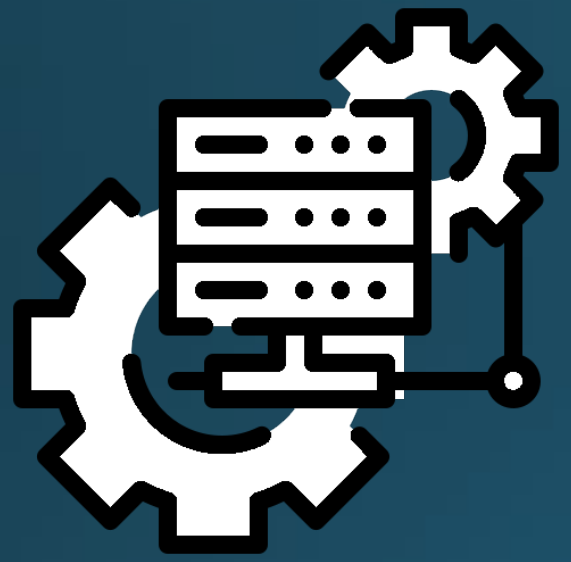
Frontend Communication

Backend Communication



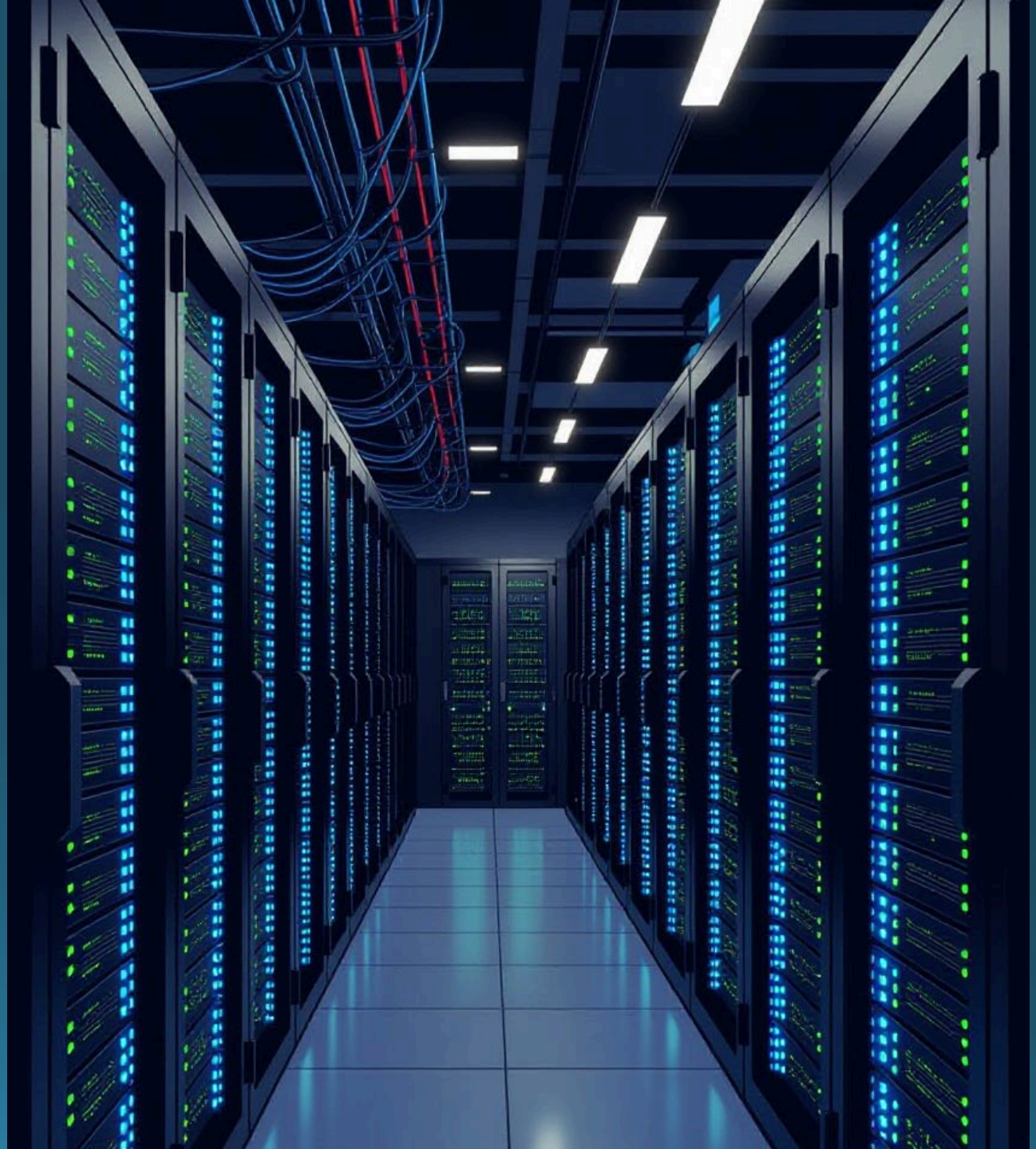
Customer Management System
(aka Customer Relationship Management)
[CRM]

- Software platform (runs on servers)
- Integration between charging system (Backend) and end user (consumer).
- An “app” is an example of a user-friendly interface for the Customer Management System on a phone.
- Customer management
  - User registration
  - Associated vehicles
  - Preferences
- Billing Management
  - Payment Methods
  - Identification of pricing
  - Transaction processing
    - Facilitated by a third-party payment processor.
  - Recorded representations and
  - History



Customer Management System
(aka Customer Relationship Management)
[CRM]

Runs on servers

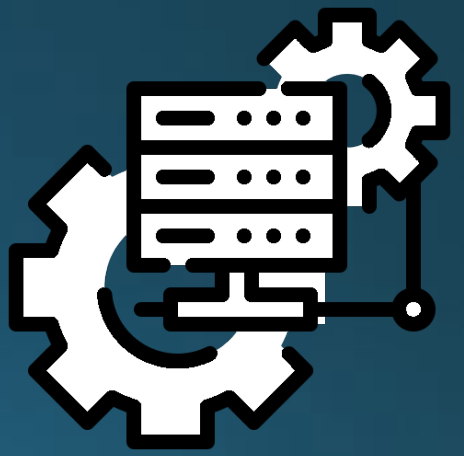


EVSE Communication

Central Management System

Customer Management System

The Central Management System and Customer Management system communicate through an Application Programming Interface (API) [communication protocols]



Examples include:

- Open Clearing House Protocol-Direct (OCHP-Direct)
- Open Charge Point Interface (OCPI)

Backend Communication

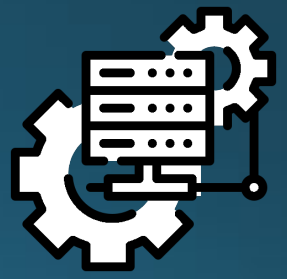
EVSE Communication

Communication between the vehicle and EVSE.

Operations and network management.

Customer and billing management (app interface).

Central Management System



Customer Management System

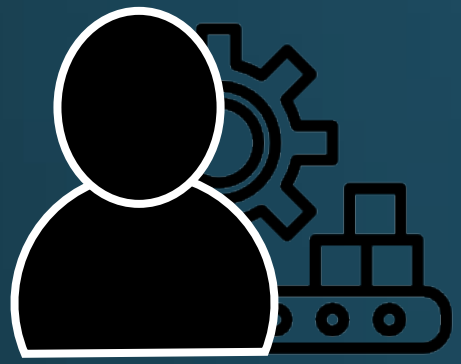
Frontend Communication

Backend Communication

Parties Associated with

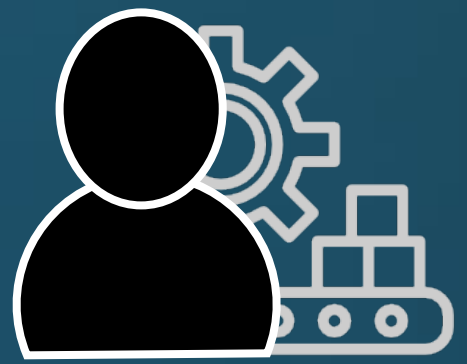
EVSE Infrastructure

EVSE Manufacturer



- Manufactures EVSE
- Original Equipment Manufacturer (OEM)

White-Label Retailer/Distributor



- Has an agreement with an OEM to re-label devices with their own information.
- Must be done through type evaluation process for the devices to be used commercially.

Device Owner

- Owns the EVSE
- May also be the CPO
- May also be the site owner (host).

Service Agency

- Installs and repairs devices used for commercial purposes.
- Must be familiar with the laws and regulations applicable to the commercial devices they service.

Charge Point Operator (CPO)

- Manages, operates, and maintains EVSE.
- Associated with the Central Management System (aka "Backend")

e-Mobility Service Provider (eMSP)

- Provides consumer access to charging networks through digital platforms.
- Associated with the Customer Management System.

Electric Vehicle Service Provider (EVSP)

- Provides end-to-end service
- A CPO who is also an eMSP
- Associated with both the Central Management System and Customer Management System.

Clearinghouse

- Facilitates the exchange of information between different parties.
- The concept is to allow drivers to use a single account to access chargers of different networks.

Parties Associated with EVFS Infrastructure

EVFS Manufacturer

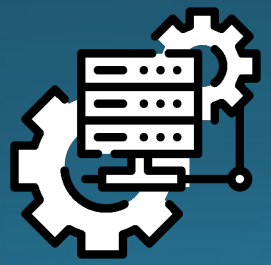
Charge Point Operator (CPO)

e-Mobility Service Provider (eMSP)

Device Owner

Service Agency

Central Management System (CMS aka Backend)



Customer Management System

Company A

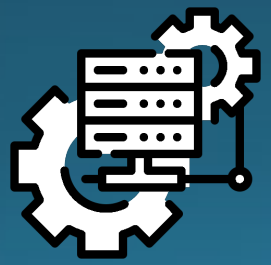
EVFS Manufacturer

Electric Vehicle Service Provider (EVSP)

Device Owner

Service Agency

Central Management System (CMS aka Backend)



Customer Management System

Company A

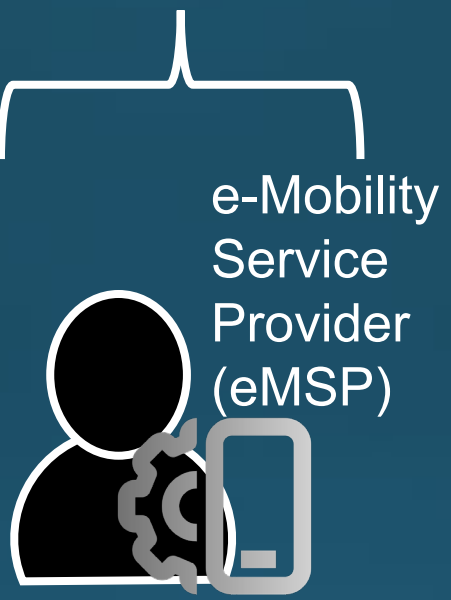
EVFS Manufacturer

Company B

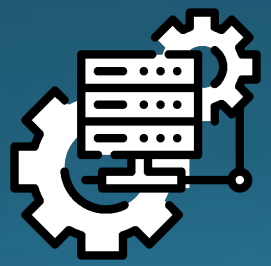
Charge Point Operator (CPO)

Central Management System (CMS aka Backend)

Company C



e-Mobility Service Provider (eMSP)

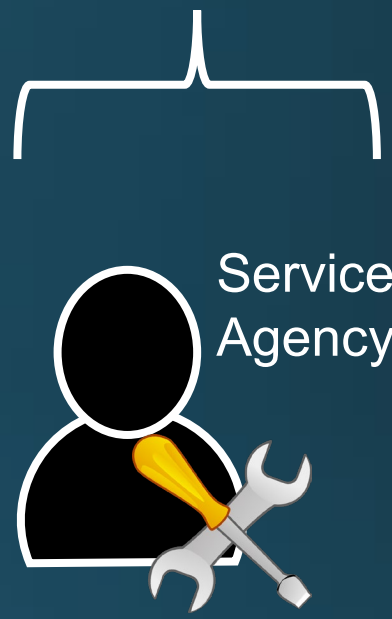


Customer Management System

Company D

Device Owner

Company E

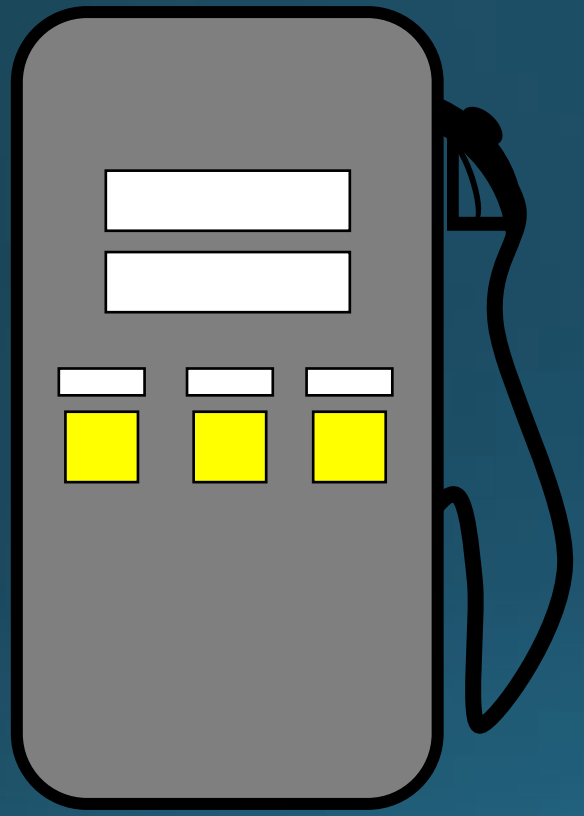


Service Agency

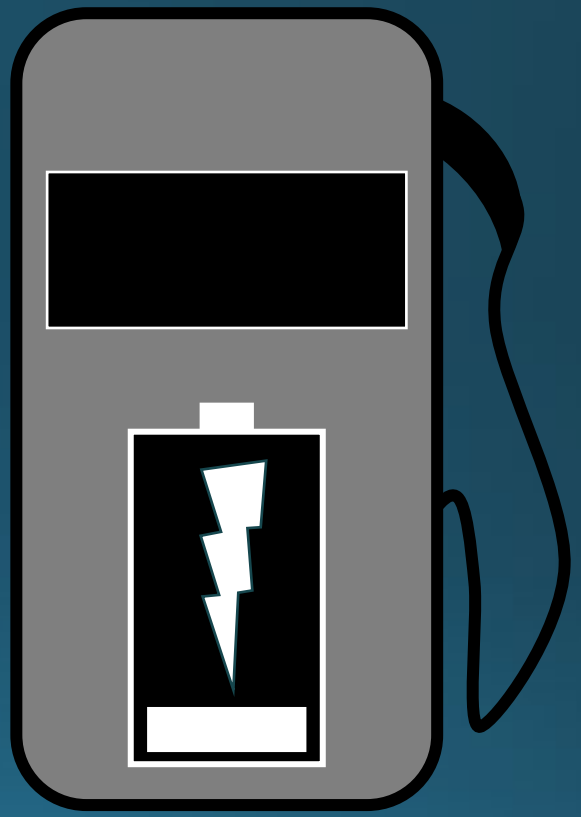
Conceptual Difference Between

RMFD & EVSE

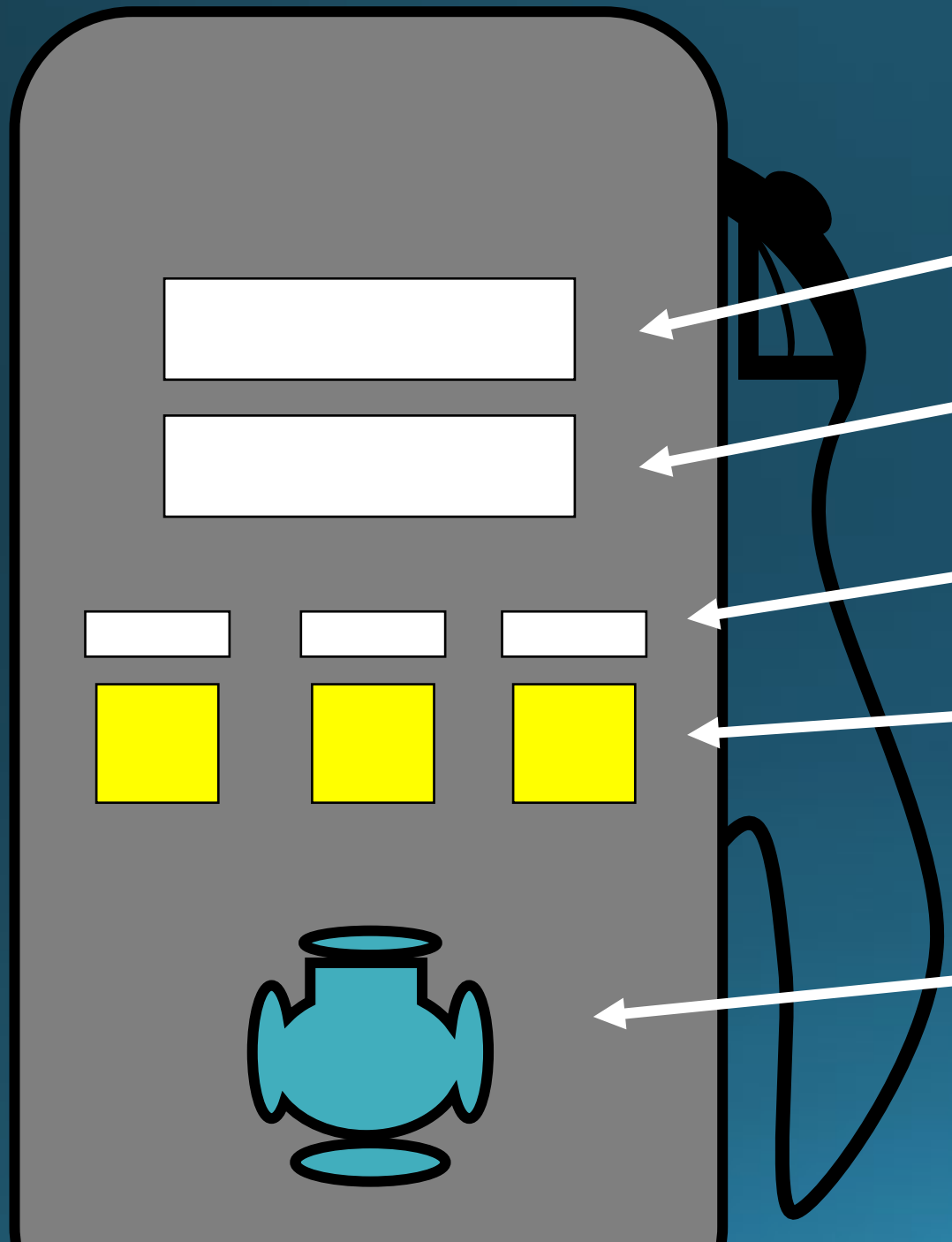
Fundamental Difference



Retail Motor Fuel Dispenser
(RMFD)



Electric Vehicle Supply Equipment
(EVSE)



Total Price

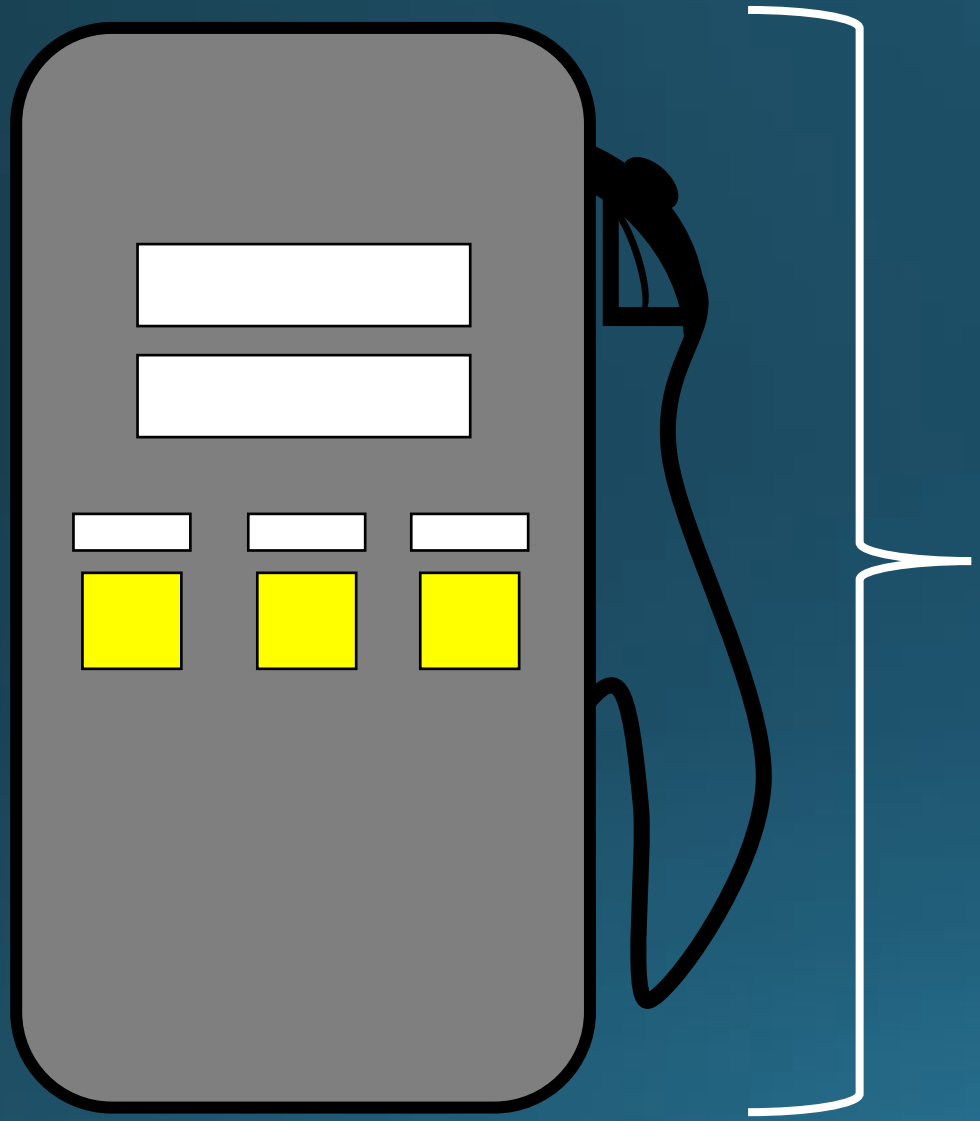
Total Gallons

Price per Gallon

Grade Selection

Meter

Retail Motor Fuel Dispenser

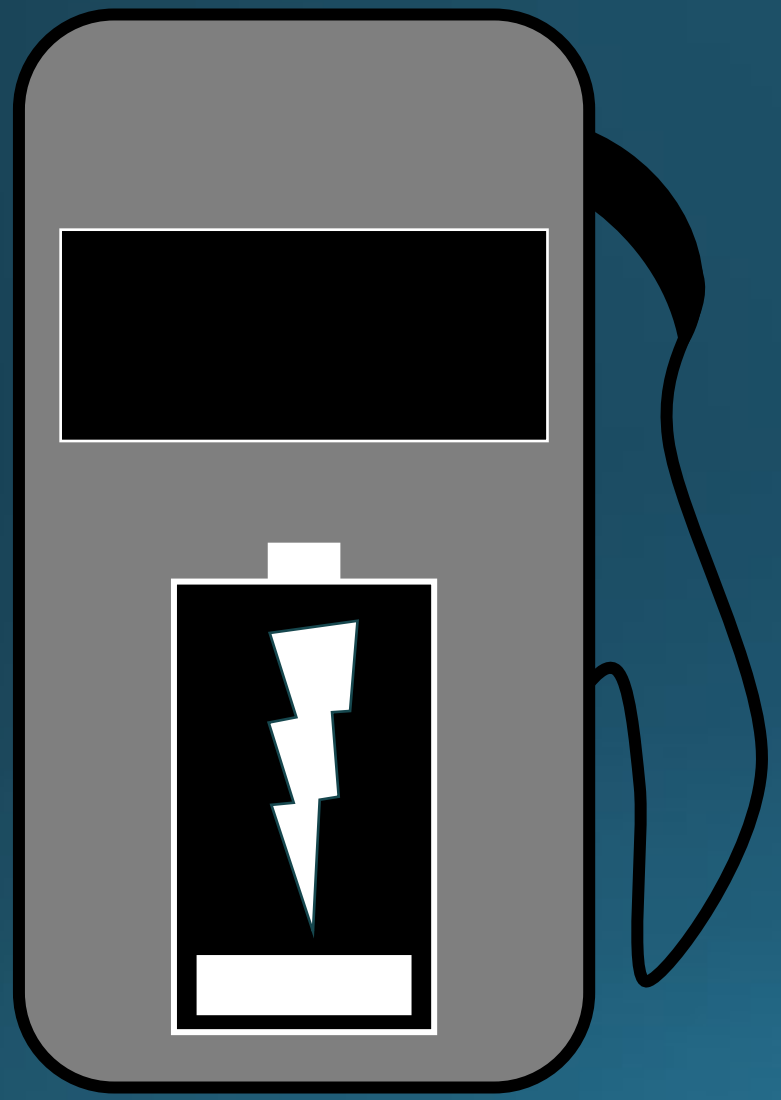


Retail Motor Fuel Dispenser

When we think about RMFD, many times we think about:

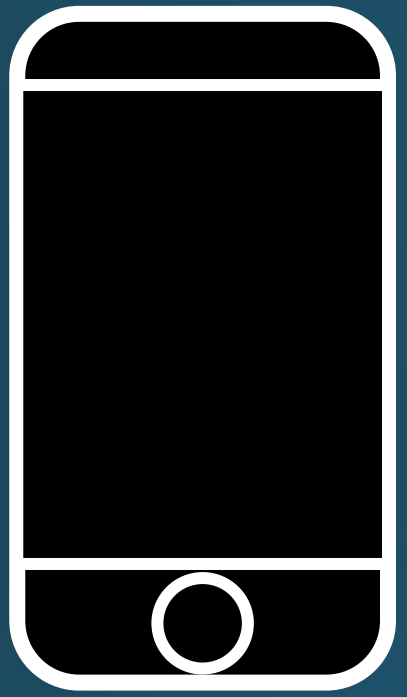
- price selection
- measurement
- total gallon representation, and
- total price calculation

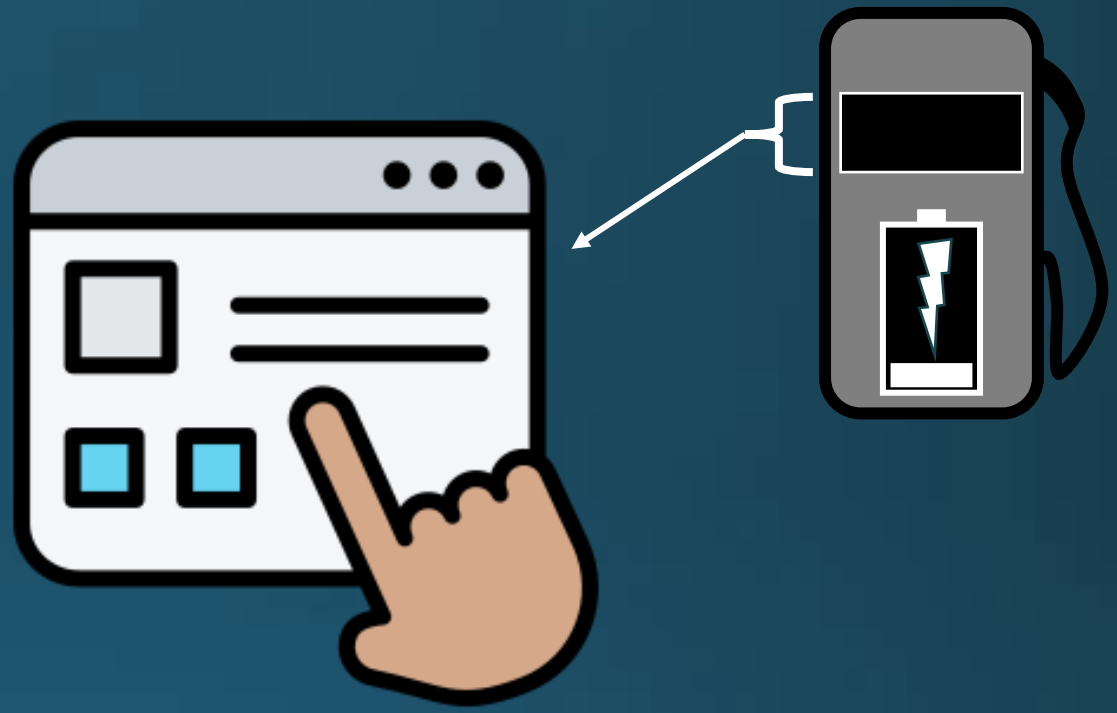
all being achieved within the same dispenser “body”.



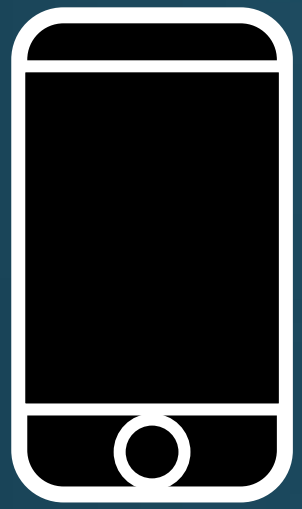
Electric Vehicle Supply Equipment

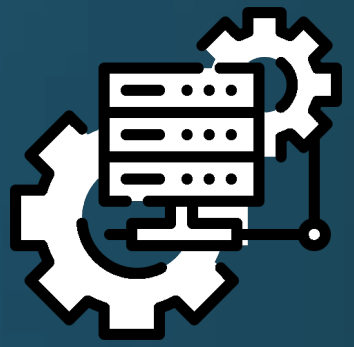
A similar process occurs for EVSE, however, how it is achieved is significantly different.





A price per kWh is determined and the device is activated whether through an “app”, a kiosk, a user interface on the EVSE itself, etc.

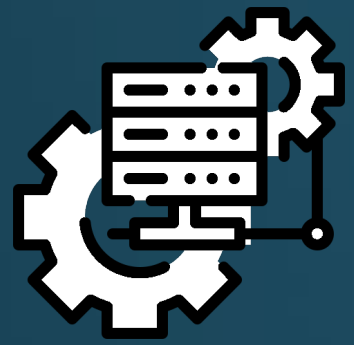




Customer Management System

The price per kWh information and activation request do not go directly to the EVSE, they go first to the Customer Management System which verifies a payment method.

Note: This is an example of an app being used as the user interface. A user interface embedded into the EVSE operates similarly depending on whether it is controlled by the Customer Management System or Backend Management System.

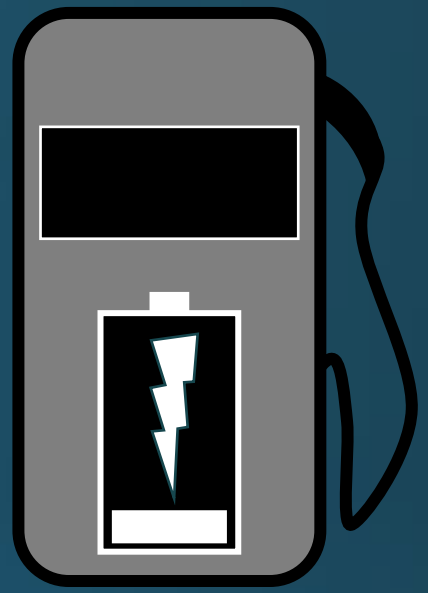


Customer Management System

Backend Management System

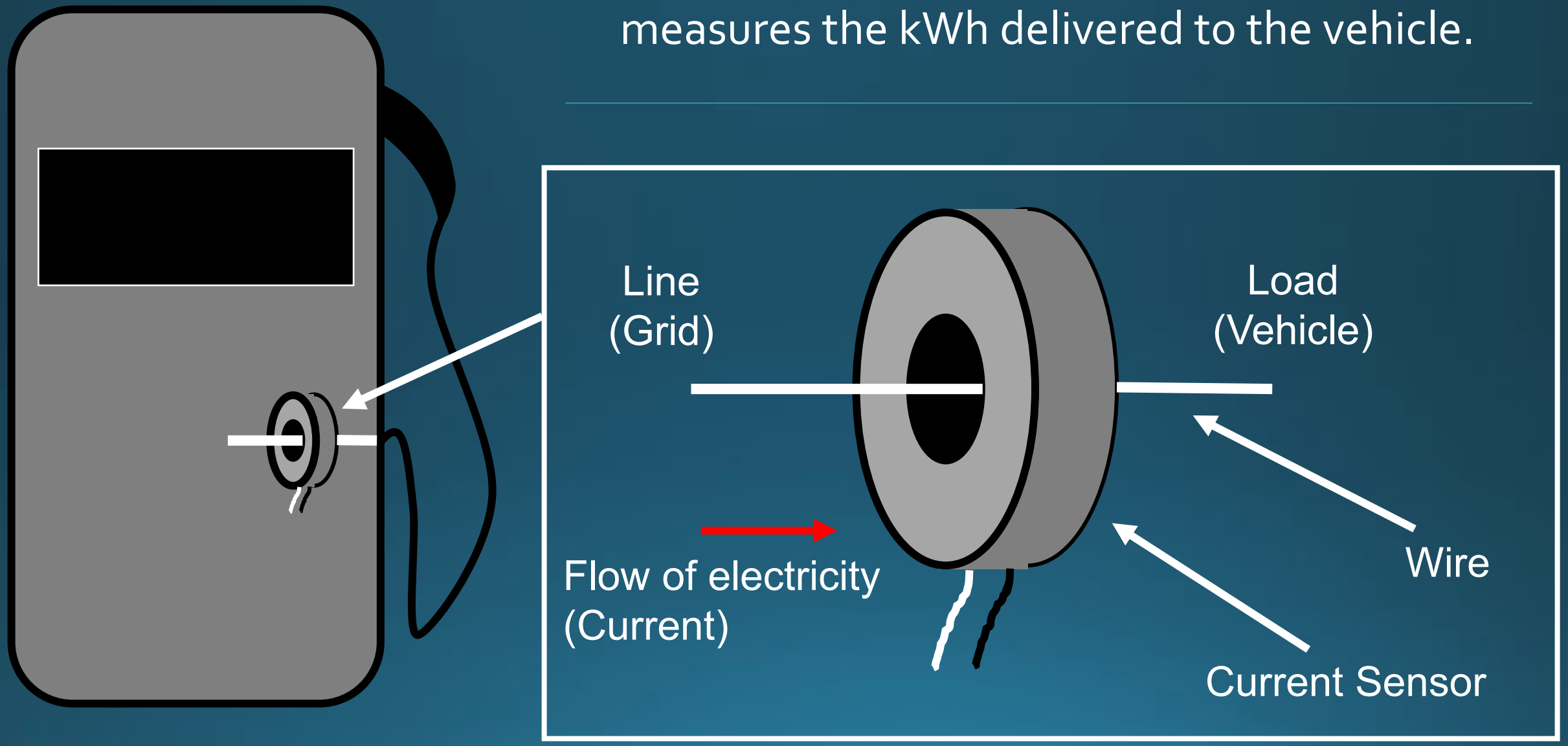
The Customer Management System then sends a signal to the Backend Management System that a request to begin a charging session has been received, payment has been verified, and to start the charging session.

Backend Management System

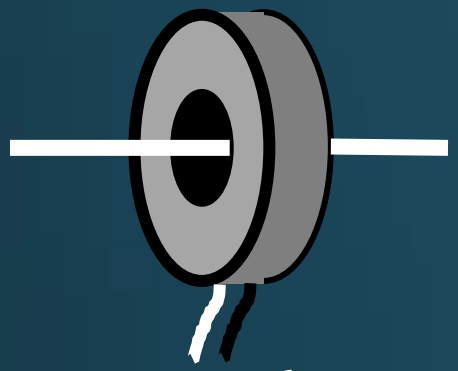


The Backend Management System then sends a signal to the EVSE to begin the charging session.

Inside of the EVSE, there is a meter which measures the kWh delivered to the vehicle.



Note: This is a simplified example to provide reference, not how all EVSE are designed.

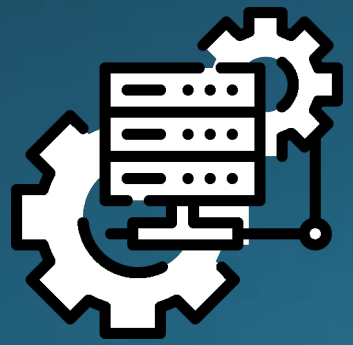


Information regarding the quantity of kWh delivered is sent to the backend management system.

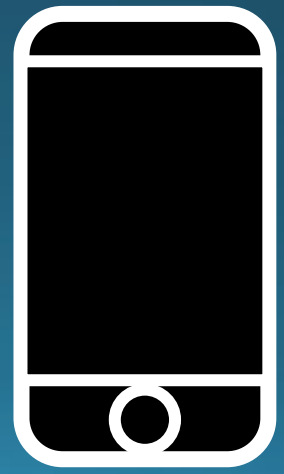
The backend management system then forwards this information to the customer management system.

Backend Management System

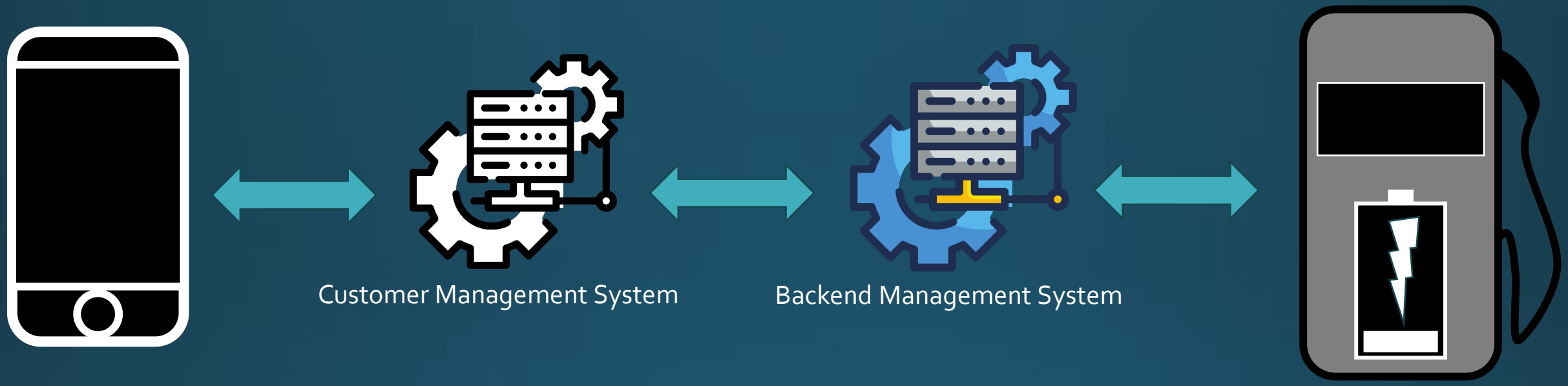
The customer management system then applies the price per kWh, preforms the total price calculation, and displays this information on the app and/or indication/user interface on the EVSE, etc.



Customer Management System



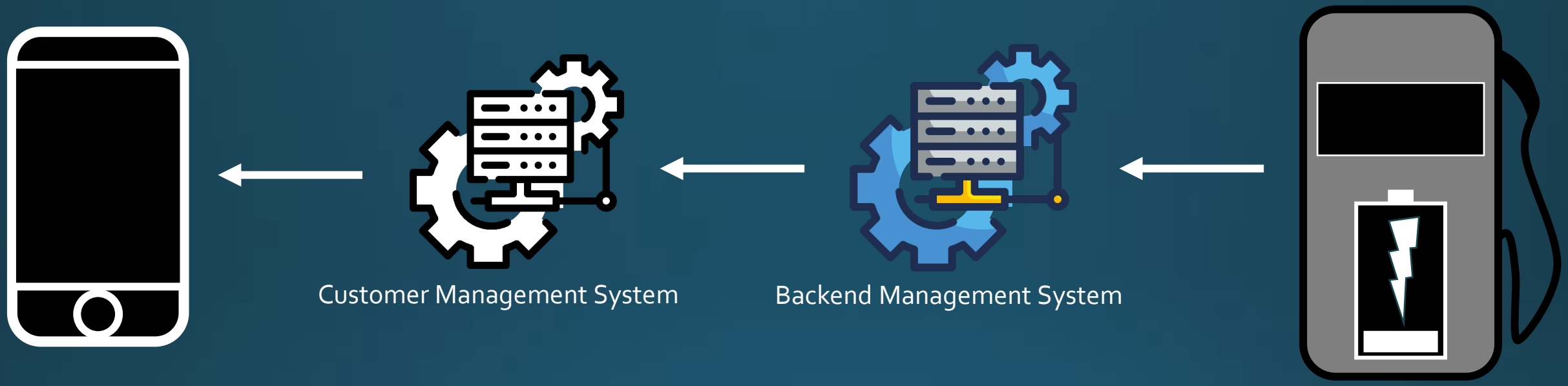
Throughout the Charging Session



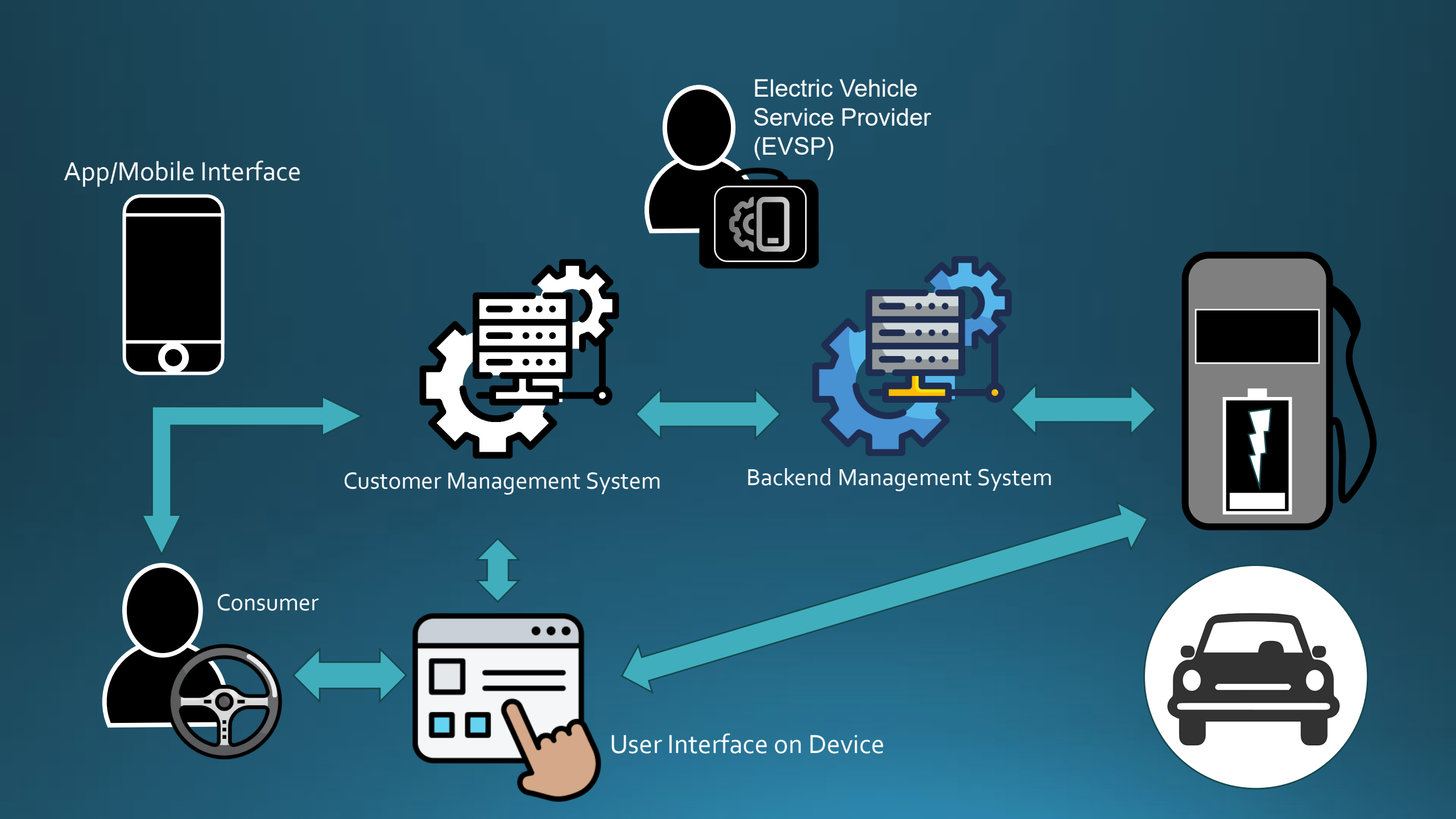
There is now constant communication (typically in approximately 30-second intervals) between the EVSE, Backend Management System, and Customer Management System.

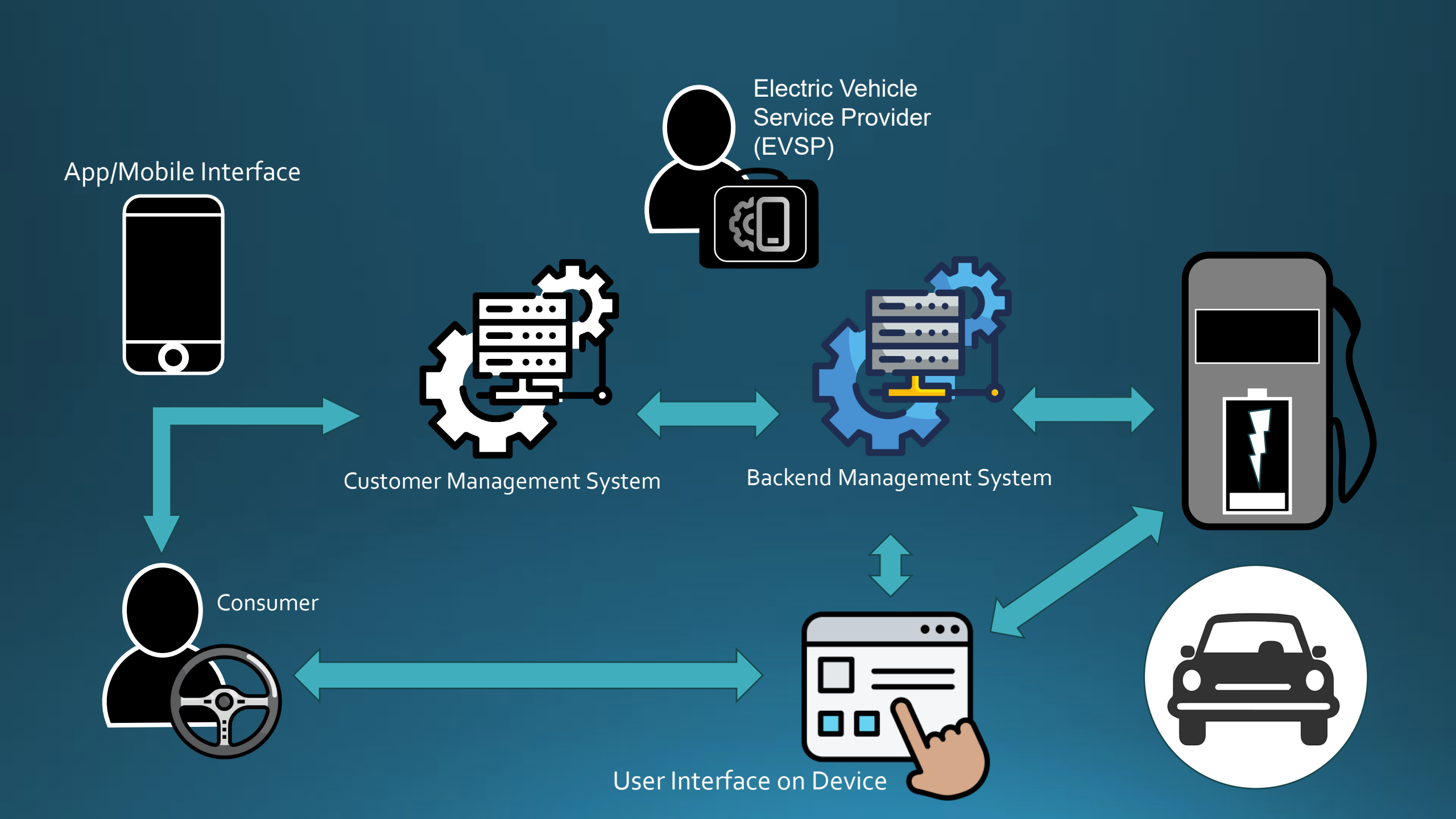
- The EVSE "tells" the Backend MS about energy delivered, status, etc.
- The Backend MS forwards usage information and manages the charging session.
- The Customer MS takes the data, performs calculations, and displays applicable values on the app and/or user interface on the EVSE itself.

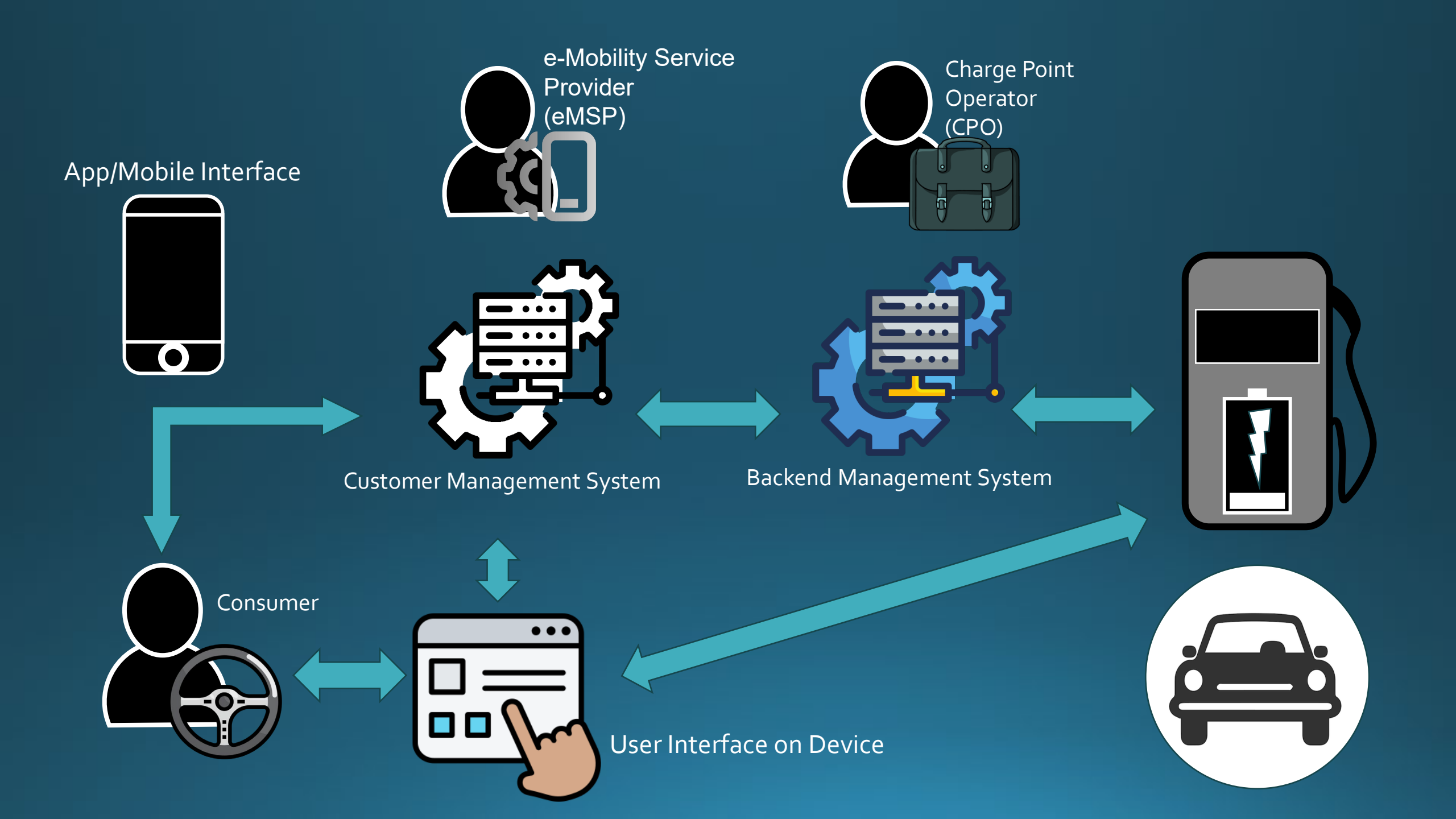
At the end of a Charging Session

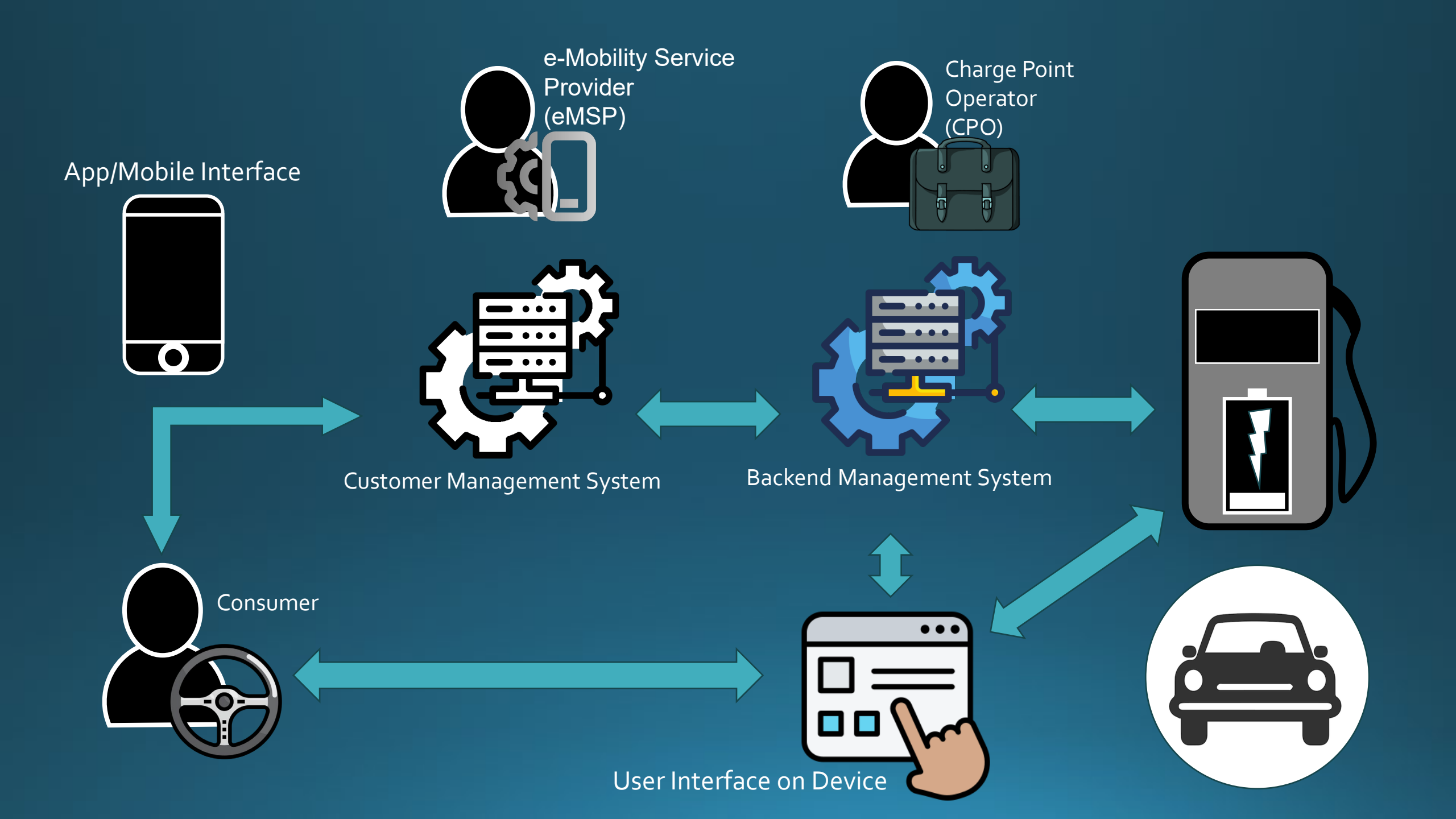


- At the end of the charging session, the EVSE sends a message to the Backend MS that the transaction has ended and provides the total energy delivered in kWh.
- The Backend MS then forwards this value to the Customer MS.
- The Customer MS takes this value, calculates the total dollar value, processes the payment, then displays the total values and creates a recorded representation.

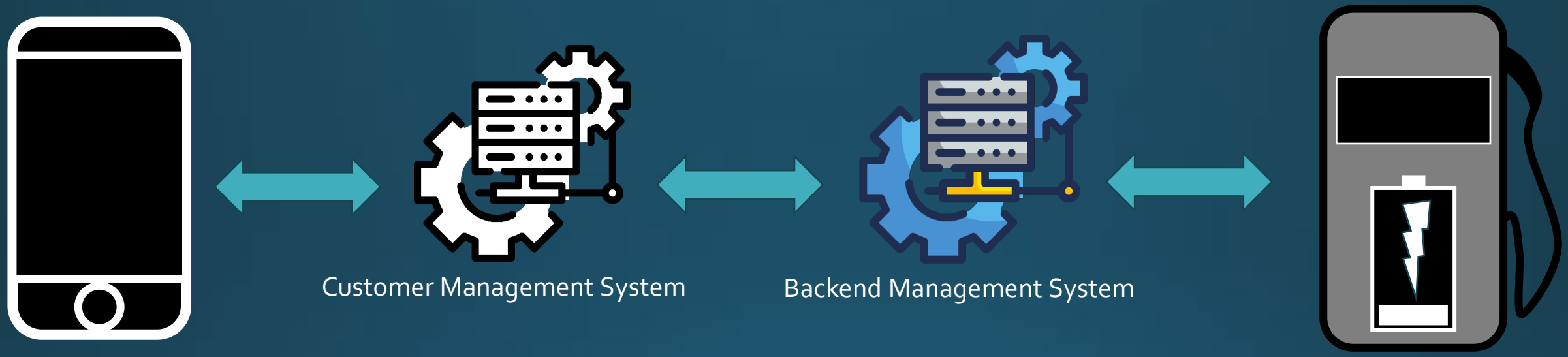

Electric Vehicle
Service Provider
(EVSP)
App/Mobile Interface
Customer Management System
Backend Management System
Consumer
User Interface on Device


Electric Vehicle
Service Provider
(EVSP)
App/Mobile Interface
Customer Management System
Backend Management System
Consumer
User Interface on Device


e-Mobility Service Provider (eMSP)
Charge Point Operator (CPO)
App/Mobile Interface
Customer Management System
Backend Management System
Consumer
User Interface on Device

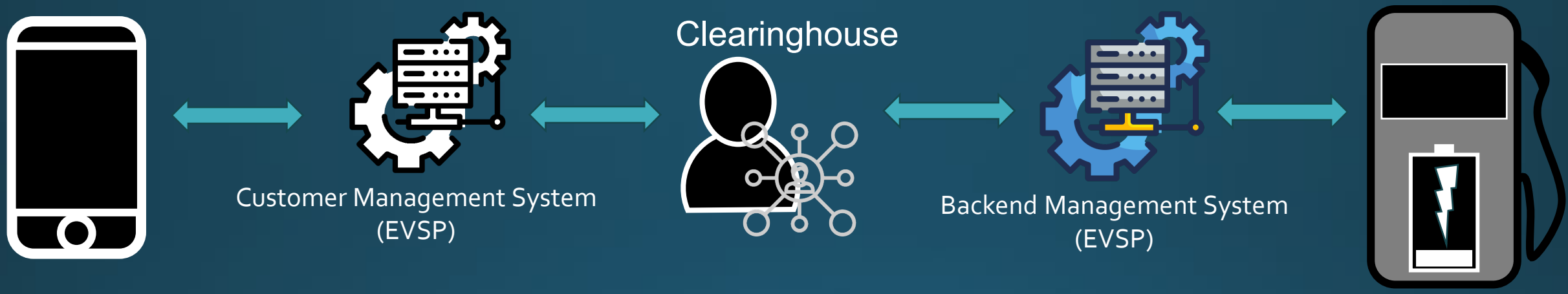

e-Mobility Service Provider (eMSP)
Charge Point Operator (CPO)
App/Mobile Interface
Customer Management System
Backend Management System
Consumer
User Interface on Device

“Direct Customer” Transactions



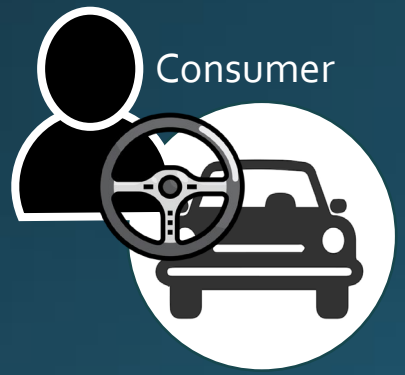
When the parties responsible for the Customer Management System and Backend Management System have an agreement with each other, they communicate directly with each other as described in the previous slides.

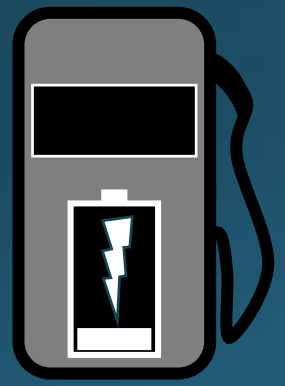
“Roaming” Transactions



When the parties responsible for the Customer Management System and Backend Management System do not have an agreement with each other but want to offer charging services together, they utilize a “Clearinghouse” which facilitates the exchange of information, verification of payment, etc.

EVSE Communication





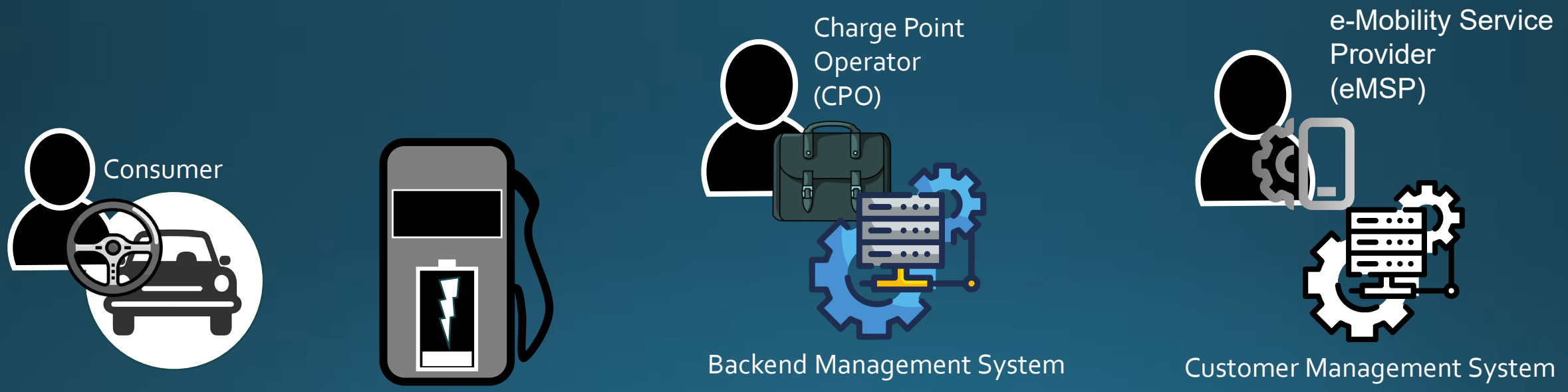
Backend Management System

Customer Management System

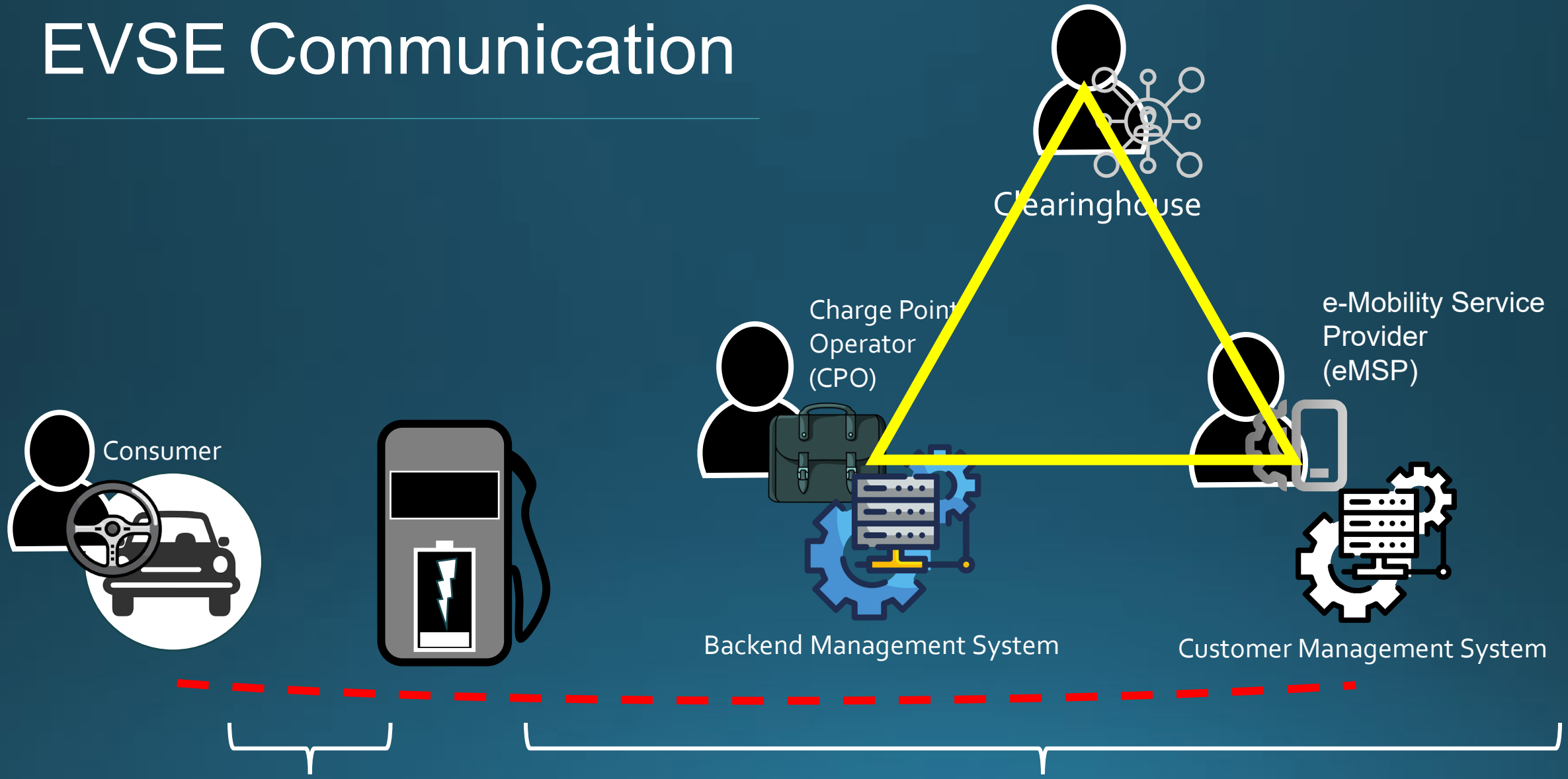
Frontend Communication

Backend Communication

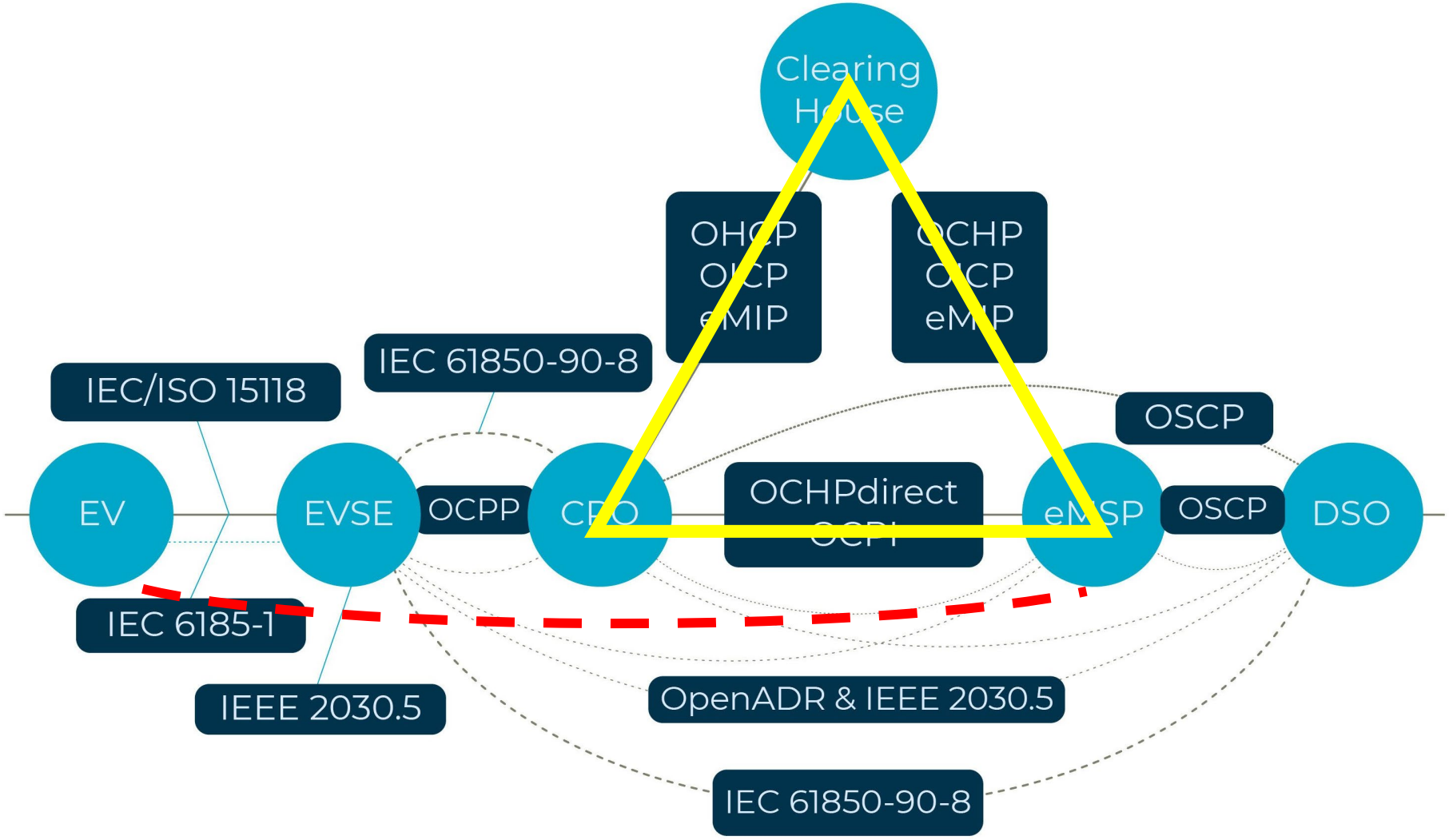
EVSE Communication



EVSE Communication

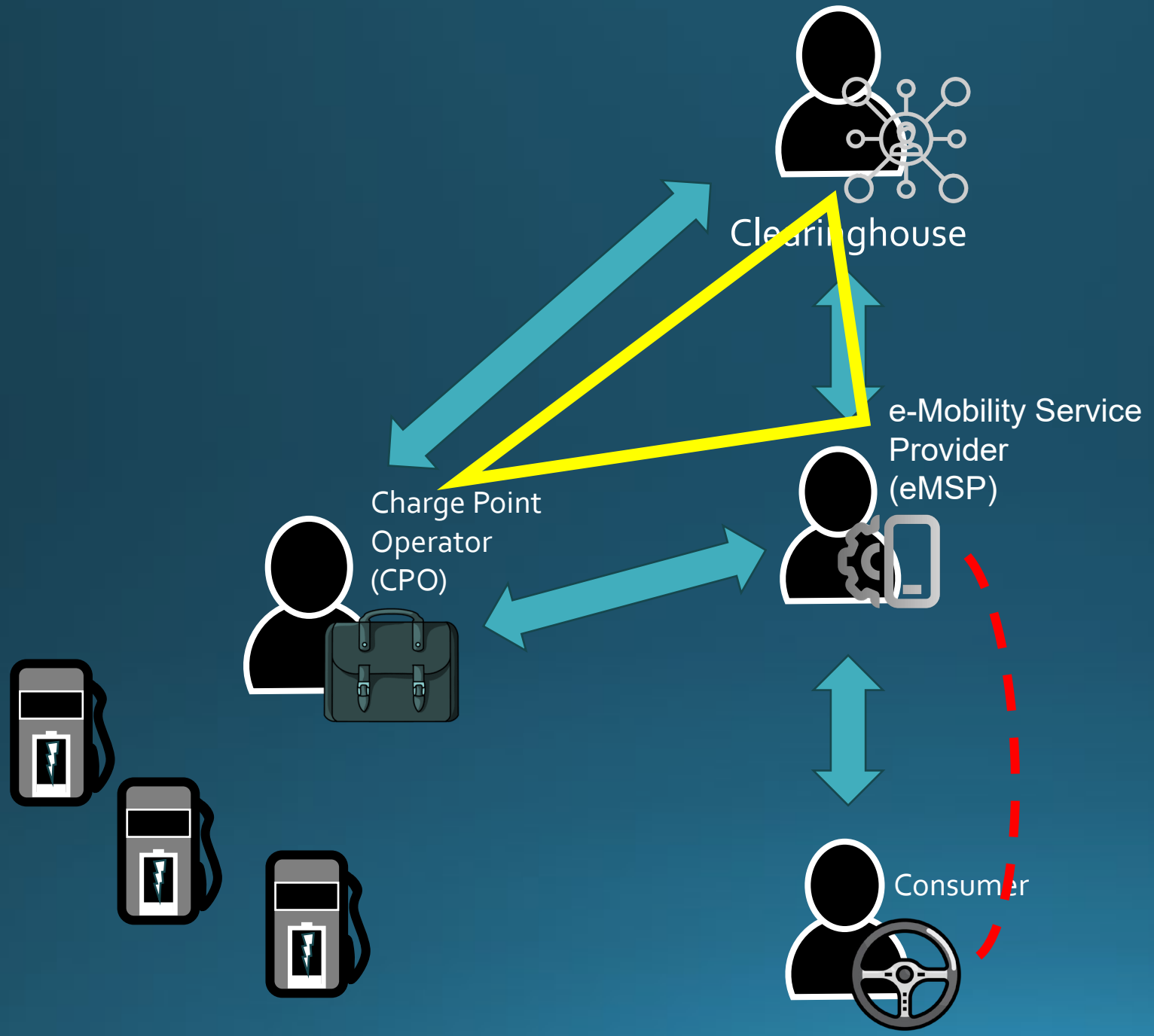


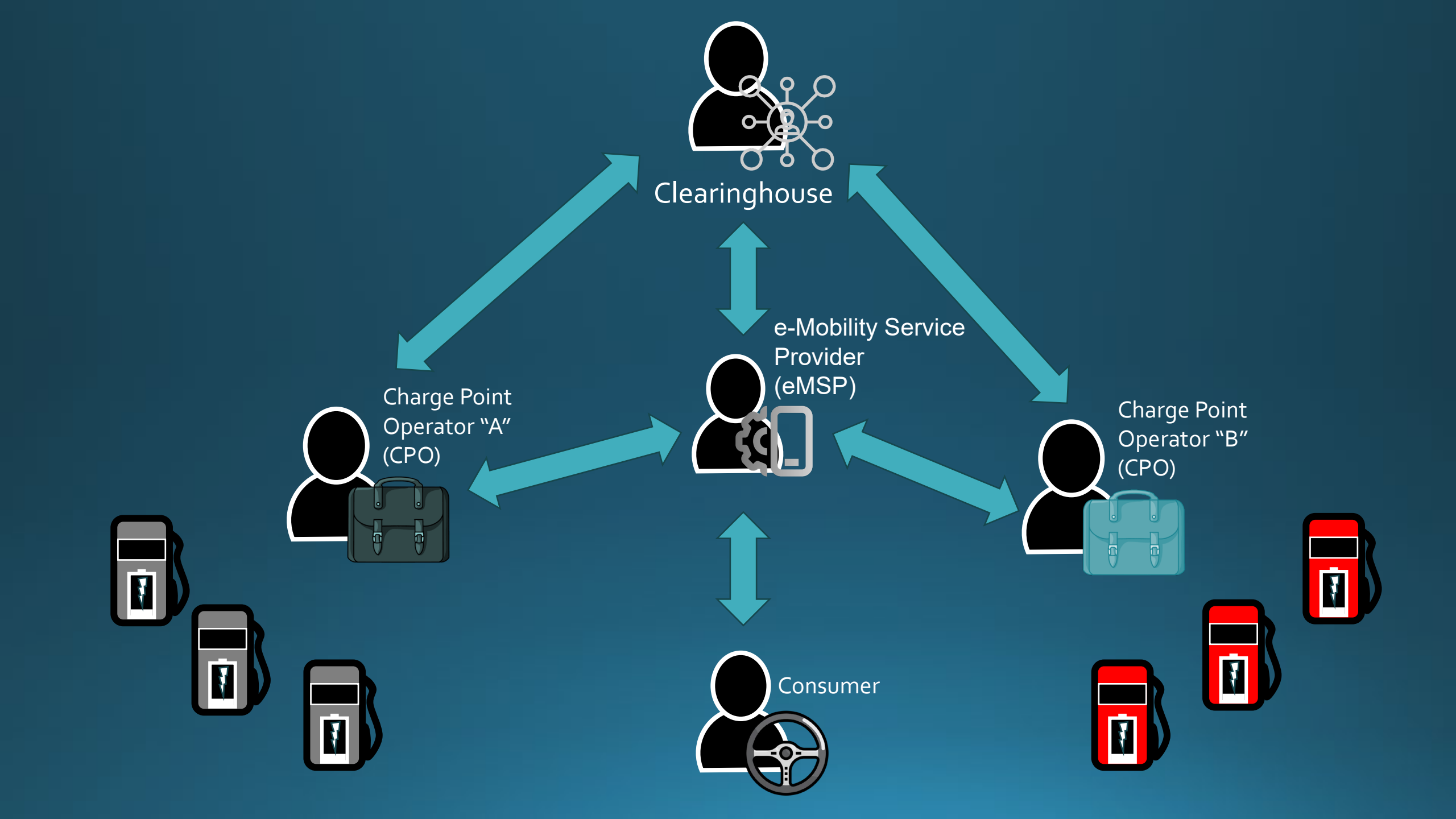
Schematic of charging communication

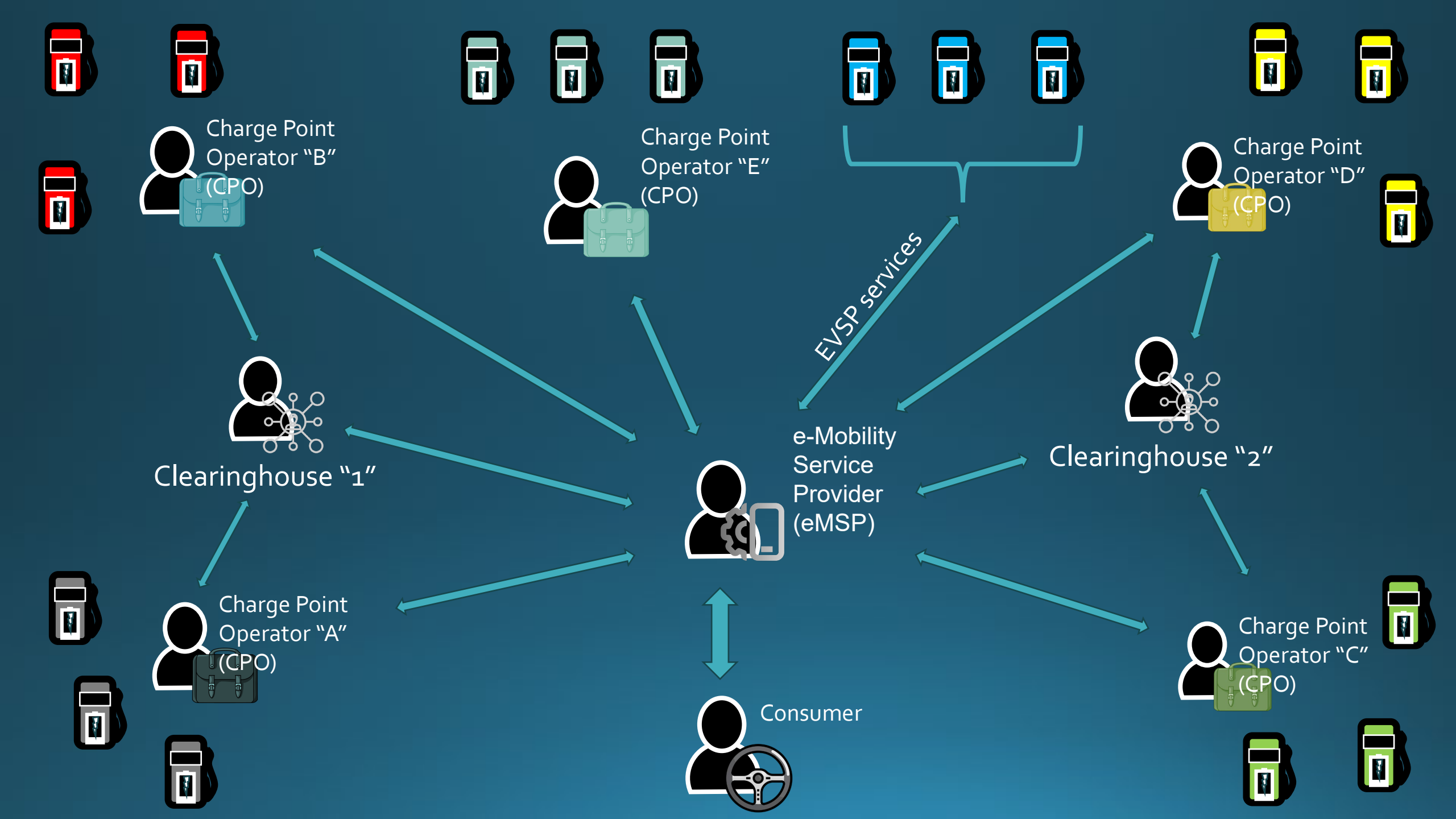


Legend

EV	EVs	EVSE	EVs Supply Equipment
CPO	Charge Point Operator	eMSP	E-Mobility service providers
DSO	Distribution System Operator		


Clearinghouse
e-Mobility Service Provider (eMSP)
Charge Point Operator (CPO)
Consumer

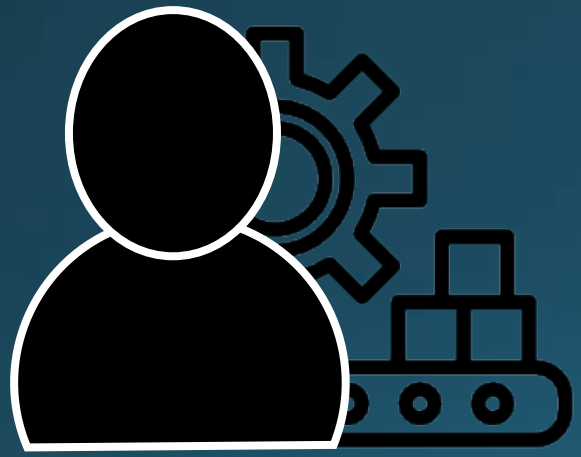

Clearinghouse
e-Mobility Service Provider (eMSP)
Charge Point Operator "A" (CPO)
Charge Point Operator "B" (CPO)
Consumer


Charge Point Operator "B" (CPO)
Charge Point Operator "E" (CPO)
Charge Point Operator "D" (CPO)
EVSP services
Clearinghouse "1"
e-Mobility Service Provider (eMSP)
Clearinghouse "2"
Charge Point Operator "A" (CPO)
Charge Point Operator "C" (CPO)
Consumer

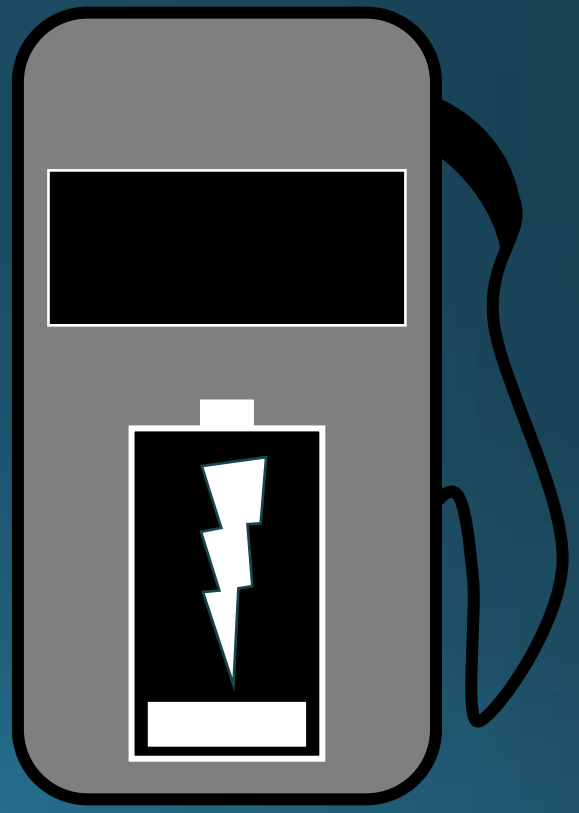
Type Evaluation Considerations

NTEP CC or CTEP COA

Manufacturer



EVSE



Hardware Type Evaluation Considerations

- EVSE hardware could be susceptible to calibration or configuration changes by the Backend Management System (an example is those that OCPP facilitates) – this needs to be addressed through the type evaluation process.
  - Firmware updates could be an example of this.
  - Specific questions about this can be addressed by a type evaluation expert during the type evaluation process.

Hardware Type Evaluation Considerations

As is the case with any device intended to be used for commercial purposes; a situation where a device is “white labeled”, or a distributor, subsidiary, “DBA”, etc. intends to alter the device from what was originally type evaluated – this must be addressed through the type evaluation process.

Software Type Evaluation Considerations

- It is common that EVSE are evaluated with a Management Software in conjunction with hardware as a system – the device may ONLY be used for commercial purposes with the Management Software(s) identified on the type evaluation certificate OR a Management Software which holds its own type evaluation certificate and lists that specific hardware.

- In some cases, a device is intended to be used with an "app" interface – the app needs to be evaluated in conjunction with EVSE hardware similar to the Management System software as identified above.


Questions?

Thank you, NCWM!

Matthew Douglas
Supervising Special Investigator
Device Enforcement
(714) 904 – 5309
Matthew.Douglas@cdfa.ca.gov

For more information about our programs, please visit:
https://www.cdfa.ca.gov/dms