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## D5.4 Undergraduate/Master Curricula Implemented

### Title of Course

# Internet of Things for Electric Vehicle

### Title of the presentation

# Electric Vehicles Charging Interconnected Communication Protocols


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**Partnership for Promotion and Popularization of Electrical Mobility through Transformation and Modernization of WB HEIs Study Programs/PELMOB**

Call: ERASMUS-EDU-2022-CBHE-STRAND-2

Project Number: 101082860

# Internet of Things for Electric Vehicle Electric Vehicles Charging Interconnected Communication Protocols

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# Internet of Things for Electric Vehicle

# Electric Vehicles Charging Interconnected Communication Protocols

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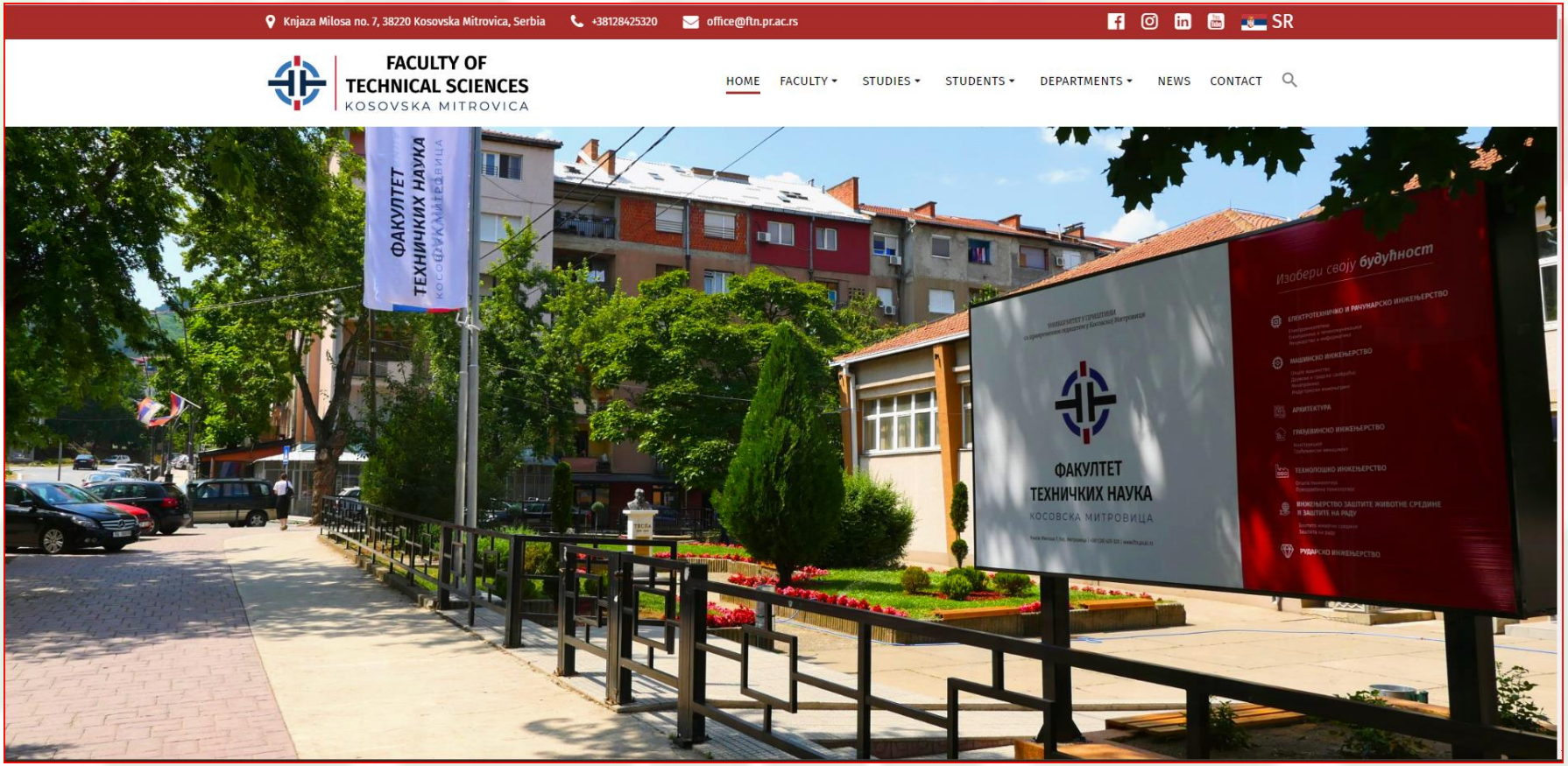

# Internet of Things for Electric Vehicle Electric Vehicles Charging Interconnected Communication Protocols

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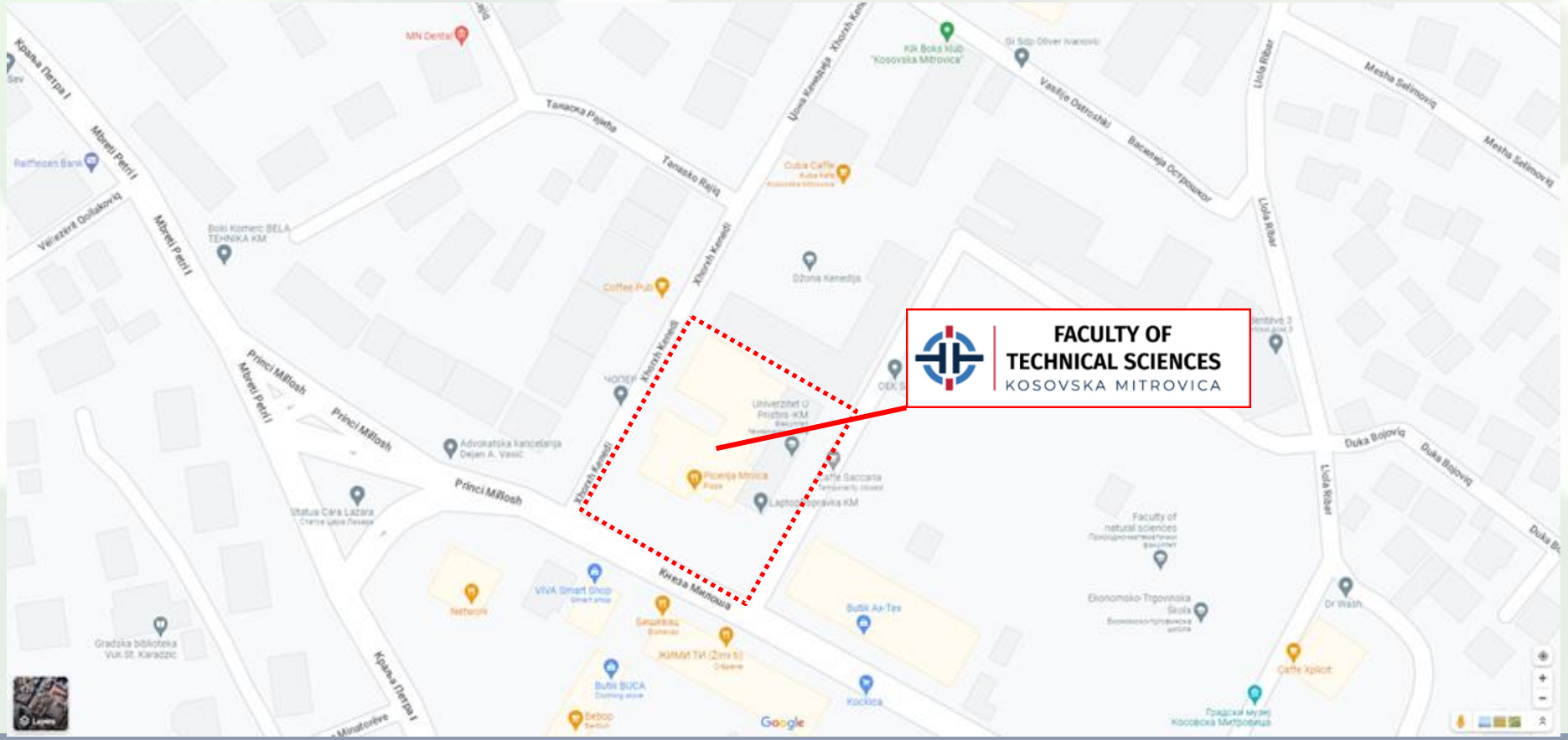

# Internet of Things for Electric Vehicle Electric Vehicles Charging Interconnected Communication Protocols

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# Internet of Things for Electric Vehicle

## Electric Vehicles Charging Interconnected Communication Protocols

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In the realm of Electric Vehicles (EVs) and Charging Stations, several IoT (Internet of Things) protocols are utilized to facilitate communication, data exchange, and management. These protocols ensure that EVs and charging infrastructure can interact efficiently, securely, and reliably.

The choice of IoT protocol in EV and charging station applications depends on the specific use case, required features, and existing infrastructure. OCPP and ISO 15118 are particularly prominent in the EV charging ecosystem, while protocols like MQTT, HTTP/HTTPS, and CAN are widely used for various communication needs within the IoT landscape of electric vehicles and charging infrastructure.

# Internet of Things for Electric Vehicle

# Electric Vehicles Charging Interconnected Communication Protocols

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The **Open Smart Charging Protocol (OSCP)**, **Open Charge Point Protocol (OCPP)**, and **ISO/IEC 15118** are interconnected protocols that collectively enable **smart charging**, **grid integration**, and **advanced communication** in the EV charging ecosystem.

1. **Open Smart Charging Protocol (OSCP)**

- **Purpose**: OSCP enables communication between charging stations and grid operators to optimize energy usage and prevent grid overload.

- **Key Features**:
  - Provides real-time grid capacity information.
  - Supports dynamic load balancing and smart charging.
  - Enables integration with renewable energy sources.

- **Role**: Ensures that EV charging aligns with grid capacity and energy availability.

## 2. Open Charge Point Protocol (OCPP)

- **Purpose**: OCPP facilitates communication between charging stations and a central management system (CMS) for monitoring, control, and management of charging sessions.

- **Key Features**:
  - Supports remote monitoring, firmware updates, and smart charging.
  - Vendor-neutral and widely adopted.
  - Works with various charging standards and hardware.

- **Role**: Manages charging stations and enables smart charging features like load balancing and demand response.

## 3. ISO/IEC 15118

- **Purpose**: ISO/IEC 15118 is a standard for advanced communication between EVs and charging stations, enabling features like **Plug & Charge** and **Vehicle-to-Grid (V2G)**.

- **Key Features**:
  - Supports secure authentication and billing (Plug & Charge).
  - Enables bidirectional power flow (V2G).
  - Uses Power Line Communication (PLC) or Ethernet for data transfer.

- **Role**: Enhances the user experience and enables advanced smart charging and grid integration.

# Internet of Things for Electric Vehicle Electric Vehicles Charging Interconnected Communication Protocols

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## Summary of Connections

| Protocol | Role in EV Charging Ecosystem | Connection to Other Protocols |
|---|---|---|
| **OSCP** | Provides grid capacity data for smart charging | Sends data to OCPP for load balancing |
| **OCPP** | Manages charging stations and implements smart charging | Uses OSCP data; works with ISO/IEC 15118 for EV communication |
| **ISO/IEC 15118** | Enables advanced EV-charging station communication (Plug & Charge, V2G) | Complements OCPP for secure and smart charging |

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# Electric Vehicles Charging Interconnected Communication Protocols

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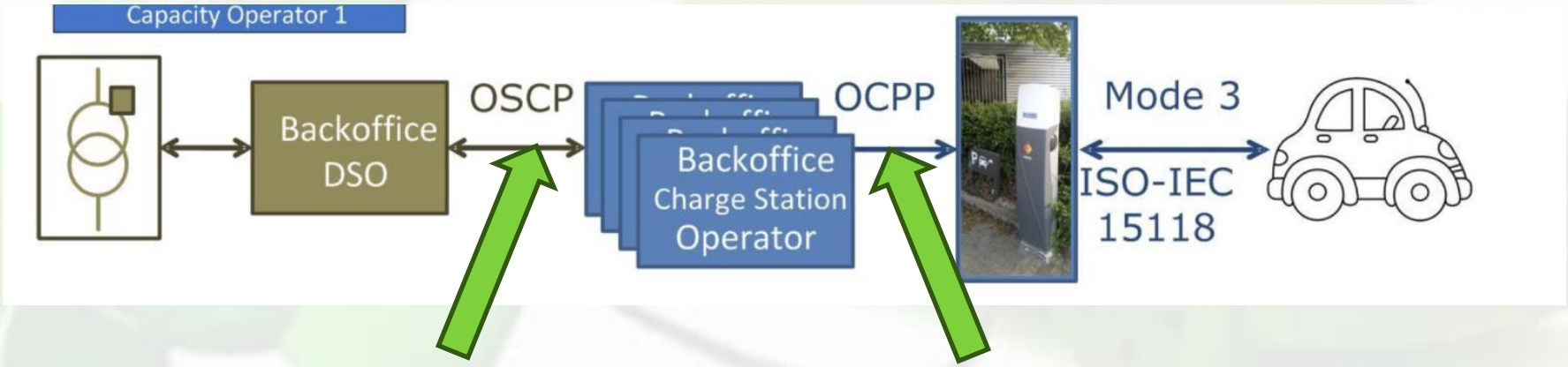



## Open Smart Charging Protocol (OSCP)

While **OSCP** is concerned with the dynamic management of grid capacity and energy distribution, OCPP focuses on the operational aspects of EV charging stations.

**OSCP 1.0 -** SOAP,
**OSCP 2.0** JSON/REST

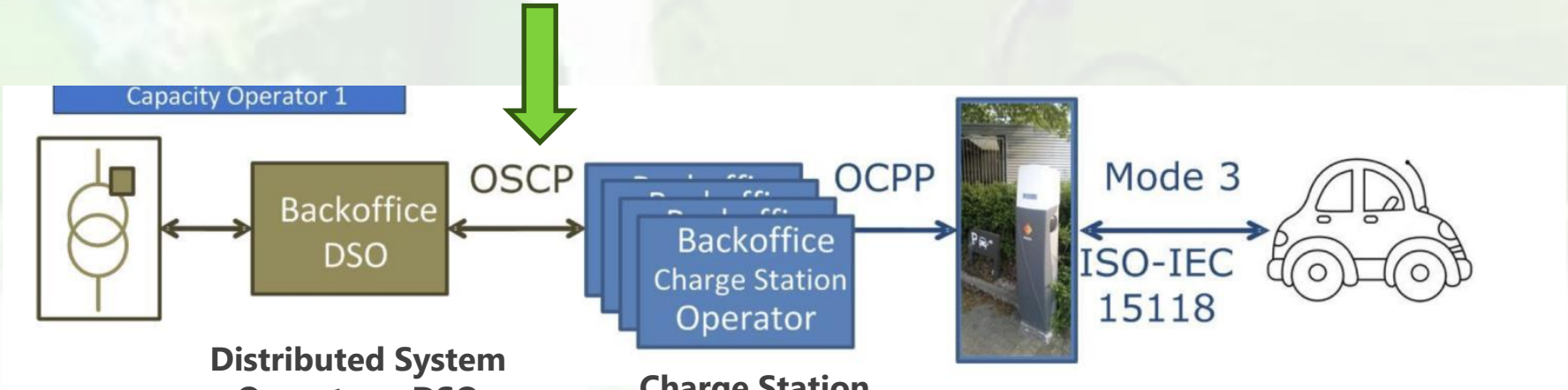
## Open Charge Point Protocol (OCPP)

**OCPP** allows charge points to communicate with central systems, providing data on the status of the charger, managing user sessions, and handling transactions and payments.

**WebSocket, SOAP, or HTTP/REST technologies**

https://evboosters.com/ev-charging-academy/articles-blogs/oscp-explained/

## Benefits and impact of Open Smart Charging Protocol (OSCP)




OSCP enables communication between charging stations and grid operators to optimize energy usage and prevent grid overload.

## Open Smart Charging Protocol (OSCP)

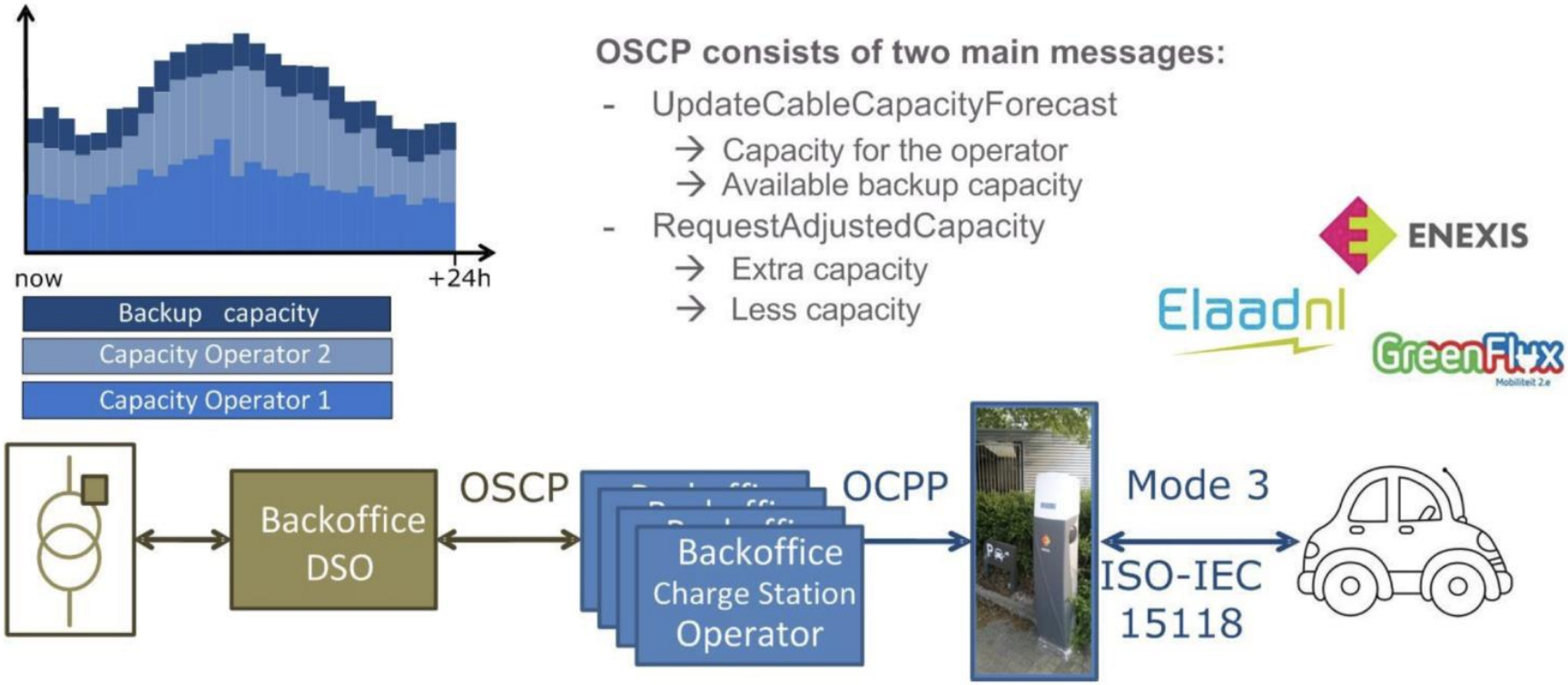



**Fig 7: Depiction of the Open Smart Charging Protocol (OSCP)**

https://evboosters.com/ev-charging-academy/articles-blogs/oscp-explained/

## Benefits and impact of Open Smart Charging Protocol (OSCP)

### 1. Grid Stability and Load Balancing

•**Benefit:** OSCP allows grid operators to send real-time signals to charging stations about available grid capacity.

•**Impact:**

- Prevents grid overload during peak demand.
- Enables dynamic load balancing by adjusting charging speeds or delaying non-urgent charging sessions.

### 2. Support for Renewable Energy Integration

•**Benefit:** OSCP enables charging stations to align EV charging with renewable energy generation (e.g., solar or wind).

•**Impact:**

- Reduces reliance on fossil fuels.
- Maximizes the use of clean energy, lowering the carbon footprint of EV charging.

## Benefits and impact of Open Smart Charging Protocol (OSCP)

### 3. Cost Optimization

•**Benefit:** By aligning charging with periods of low energy demand or high renewable energy availability, OSCP helps reduce energy costs.

•**Impact:**

- Lower electricity bills for EV owners and charging station operators.
- More efficient use of energy resources.

### 4. Scalability

•**Benefit:** OSCP is designed to support large-scale deployment of EV charging infrastructure.

•**Impact:**

- Facilitates the integration of thousands of charging stations into the grid.
- Ensures compatibility with future expansions in EV adoption.

# Benefits and impact of Open Smart Charging Protocol (OSCP)

## 5. Interoperability

•**Benefit:** OSCP is an open standard, ensuring compatibility between different charging stations, grid operators, and energy management systems.

•**Impact:**

- Reduces reliance on proprietary systems.
- Promotes collaboration between stakeholders in the EV ecosystem.

## 6. Real-Time Communication

•**Benefit:** OSCP enables real-time data exchange between grid operators and charging stations.

•**Impact:**

- Allows for immediate adjustments to charging schedules based on grid conditions.
- Enhances responsiveness to fluctuations in energy supply and demand.

# Benefits and impact of Open Smart Charging Protocol (OSCP)

## 7. Support for Smart Charging

•**Benefit:** OSCP enables advanced smart charging features, such as dynamic power allocation and time-of-use optimization.

•**Impact:**

- Improves the efficiency of charging infrastructure.
- Enhances the user experience by ensuring reliable and optimized charging.

## 8. Future-Proofing

•**Benefit:** OSCP is designed to support emerging technologies like **Vehicle-to-Grid (V2G)** and **autonomous charging**.

•**Impact:**

- Prepares the grid and charging infrastructure for future advancements.
- Enables bidirectional energy flow, allowing EVs to supply power back to the grid.

# Benefits and impact of Open Smart Charging Protocol (OSCP)

## 9. Reduced Infrastructure Costs

•**Benefit:** By optimizing energy usage and preventing grid overload, OSCP reduces the need for costly grid upgrades.

•**Impact:**

- Lowers capital expenditure for grid operators.
- Delays or eliminates the need for additional power generation capacity.

## 10. Enhanced User Experience

•**Benefit:** OSCP ensures that EV charging is reliable, efficient, and aligned with user preferences.

•**Impact:**

- Reduces the risk of charging interruptions due to grid constraints.
- Provides a seamless charging experience for EV owners.

# Benefits and impact of Open Smart Charging Protocol (OSCP)

## 11. Environmental Benefits

•**Benefit:** By optimizing energy usage and integrating renewable energy, OSCP contributes to a reduction in greenhouse gas emissions.

•**Impact:**

- Supports global sustainability goals.
- Promotes the adoption of clean energy solutions.

## 12. Regulatory Compliance

•**Benefit:** OSCP helps grid operators and charging station operators comply with regulations related to energy management and grid stability.

•**Impact:**

- Reduces the risk of penalties or fines.
- Ensures adherence to industry standards and best practices.

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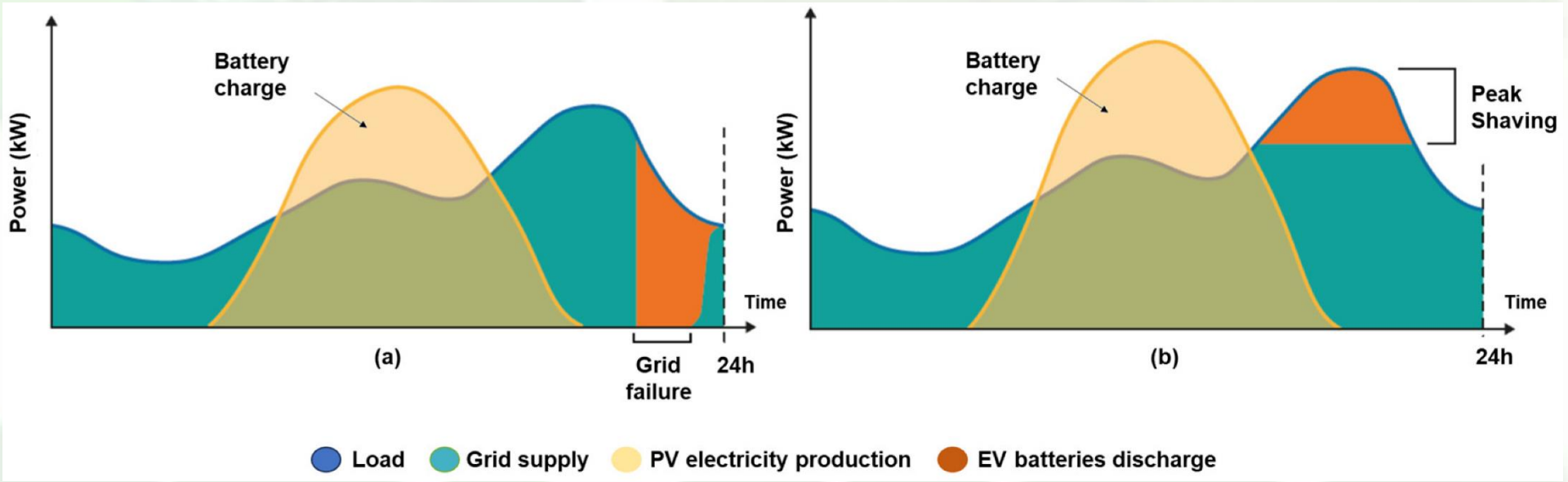
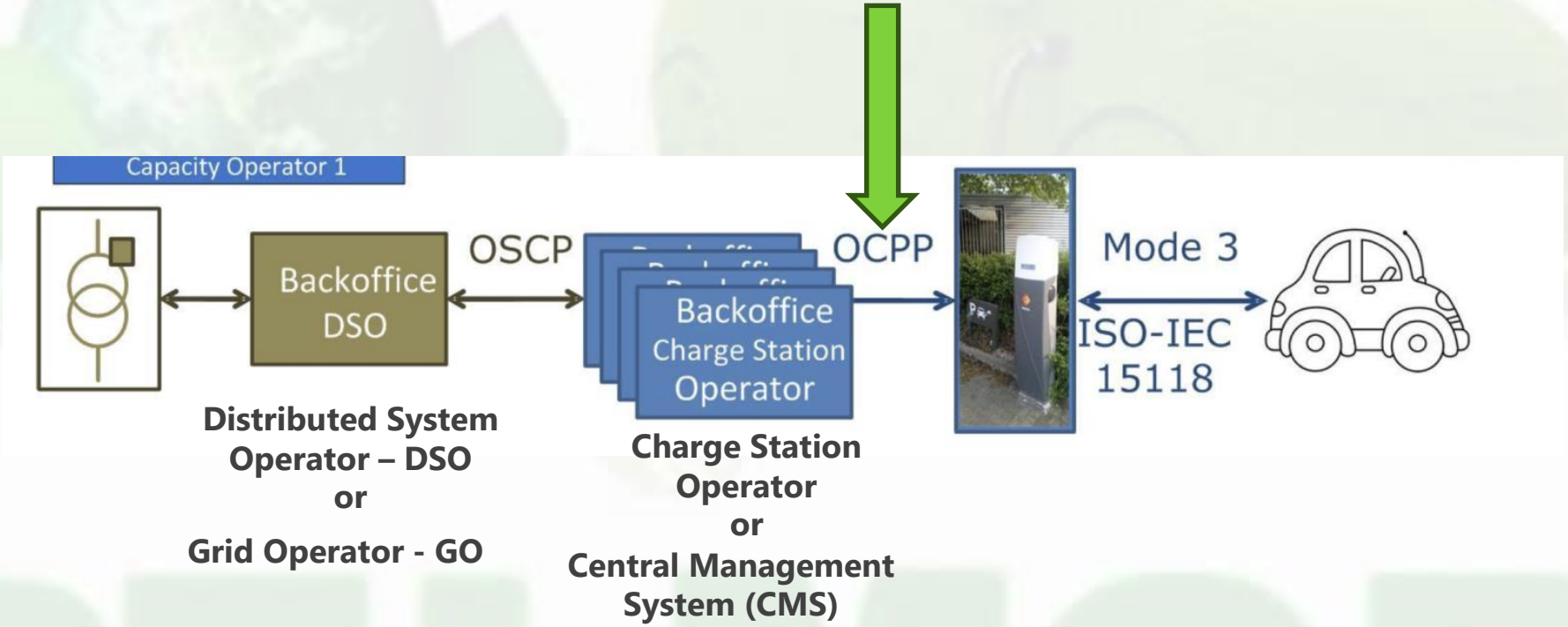
Examples of EV batteries used as (**a**) back-up for the grid and (**b**) peak shaving



## OCPP (Open Charge Point Protocol)




**OCPP** facilitates communication between charging stations and a central management system (CMS) for monitoring, control, and management of charging sessions.

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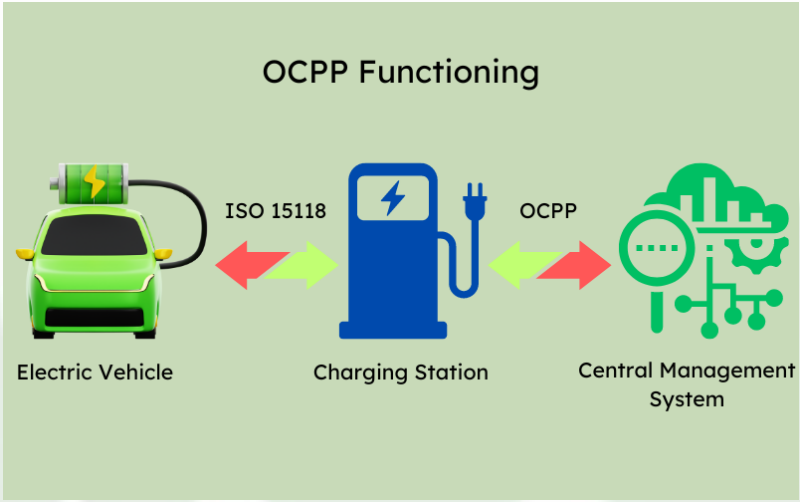
## OCPP (Open Charge Point Protocol)

•**Purpose:** OCPP is a widely adopted protocol for communication between EV charging stations and central management systems (CSMS). It allows for remote management, monitoring, and control of charging stations.

•**Versions:** OCPP 1.6, OCPP 2.0, and OCPP 2.0.1 are commonly used.

•**Features:** Supports features like remote start/stop of charging sessions, firmware updates, transaction handling, and diagnostics.

## Benefits of OCPP Protocol In EV Charging App:

•**Reservation Facility:** The owners or the drivers of E-Vehicle would have the advantage of reserving the place even before they reach the station just by using their mobile app.

•**Diagnosis of Vehicle:** It can also scan problems related to or interrupting the charging process, and can provide some tips and tricks to solve those problems yourself and quickly.

•**Smart or AI charging:** The charging station app can automatically decrease or increase the power being supplied to the vehicle to increase its performance.

•**Data transfer:** OCPP system supports different types of data transfers between mobile apps being used by the customers and EV charging stations.

•**Remote Feature:** EV charging App partners can manage the functionality of EV charging App remotely.

•**Reports:** OCPP can be used to gather complete information regarding the charging station, its current state and can report these to the system administrator.

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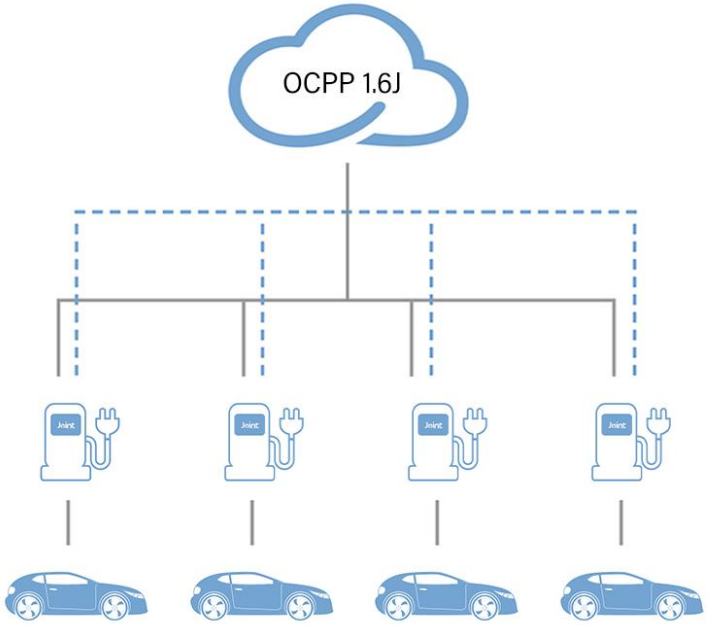
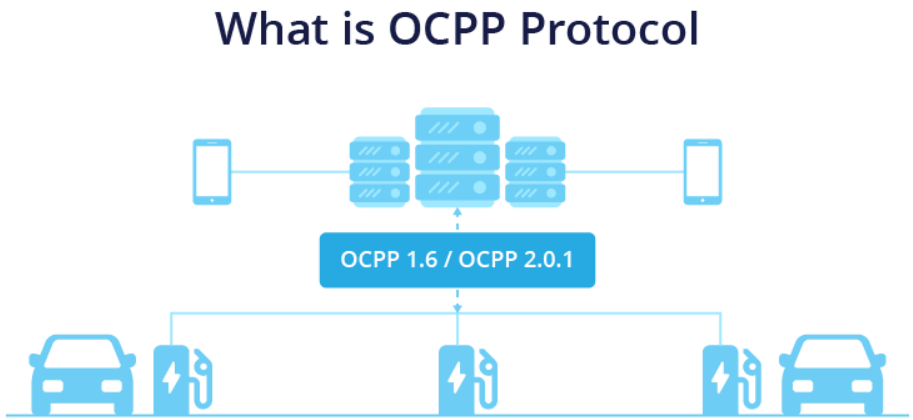
**The Open Charge Point Protocol (OCPP) is an open-source communication protocol that aims to establish a standard language between different EV chargers and their software.**




**This protocol enables any charger to work with any management software, regardless of the manufacturer or developer's location.**

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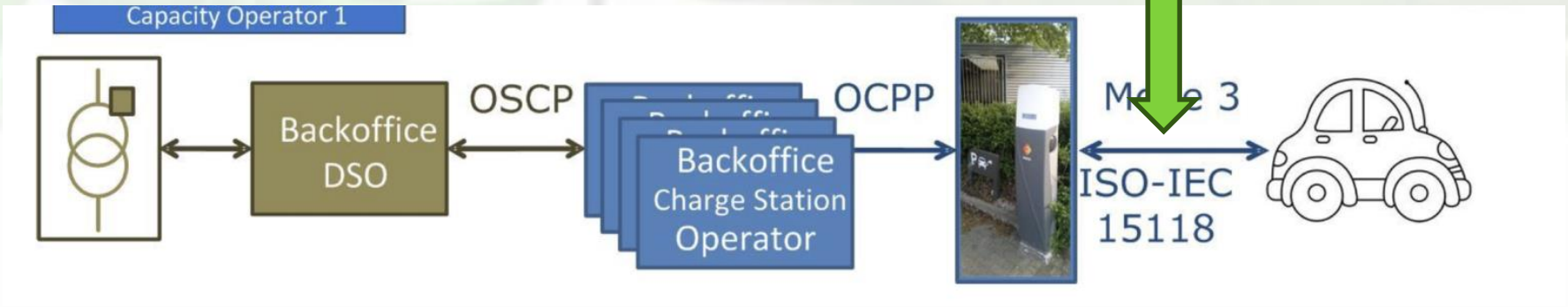
## Communication Standard

**ISO 15118**



## ISO 15118

•**Purpose:** ISO 15118 is a standard that defines the communication between EVs and charging stations, particularly for Plug & Charge functionality, which allows for automatic authentication and billing.

•**Features:** Supports both wired (PLC - Power Line Communication) and wireless (Wi-Fi, cellular) communication. It also enables smart charging and Vehicle-to-Grid (V2G) communication.

The ISO 15118 standard, is known as "Communication interface between the vehicle and the electrical grid. Part 1: General information and definition of use cases." This standard aims to improve communications between charging points, electric vehicles, and the electrical grid.

ISO 15118 is not an **IoT protocol**. Instead, it is a **communication standard** specifically designed for the interaction between Electric Vehicles (EVs) and Electric Vehicle Supply Equipment (EVSE), commonly known as charging stations.

## ISO 15118 in the IoT Ecosystem

ISO 15118 plays a specialized role within the broader IoT ecosystem:

- It handles the **local communication** between the EV and the charging station.

- IoT protocols handle the **wider communication** between the charging station, cloud platforms, and other systems (e.g., energy grids, fleet management systems).

## How ISO 15118 Relates to IoT

While ISO 15118 is not an IoT protocol, it can be integrated with IoT systems to enable advanced functionalities in the EV charging ecosystem. For example:

**1.IoT Integration:**

- IoT protocols like **MQTT** or **HTTP/HTTPS** can be used to send data from charging stations (which use ISO 15118) to cloud platforms for monitoring and analytics.

**2.Smart Charging:**

- IoT-enabled charging stations can use ISO 15118 for secure communication with EVs while leveraging IoT protocols for grid integration and energy management.

**3.Remote Monitoring:**

- Data collected via ISO 15118 (e.g., charging session details) can be transmitted to IoT platforms for real-time monitoring and control.

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## Key Differences Between ISO 15118 and IoT Protocols

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| Aspect | ISO 15118 | IoT Protocols |
|---|---|---|
| **Purpose** | Standardizes communication between EVs and charging stations. | Enables communication between IoT devices, sensors, and cloud platforms. |
| **Scope** | Focused on EV charging (e.g., authentication, billing, smart charging). | Broad scope, applicable to various industries (e.g., smart homes, healthcare). |
| **Communication Type** | Wired (Power Line Communication - PLC) and wireless (Wi-Fi, cellular). | Wireless (e.g., MQTT, CoAP, Zigbee, LoRaWAN) or wired (e.g., Modbus, Ethernet). |
| **Use Case** | Plug & Charge, Vehicle-to-Grid (V2G), smart charging. | General IoT applications like remote monitoring, automation, and data analytics. |
| **Security** | Uses TLS encryption and digital certificates for secure communication. | Security varies by protocol (e.g., TLS in MQTT, AES encryption in Zigbee). |
| **Interoperability** | Ensures compatibility between EVs and charging stations. | Ensures compatibility between diverse IoT devices and platforms. |

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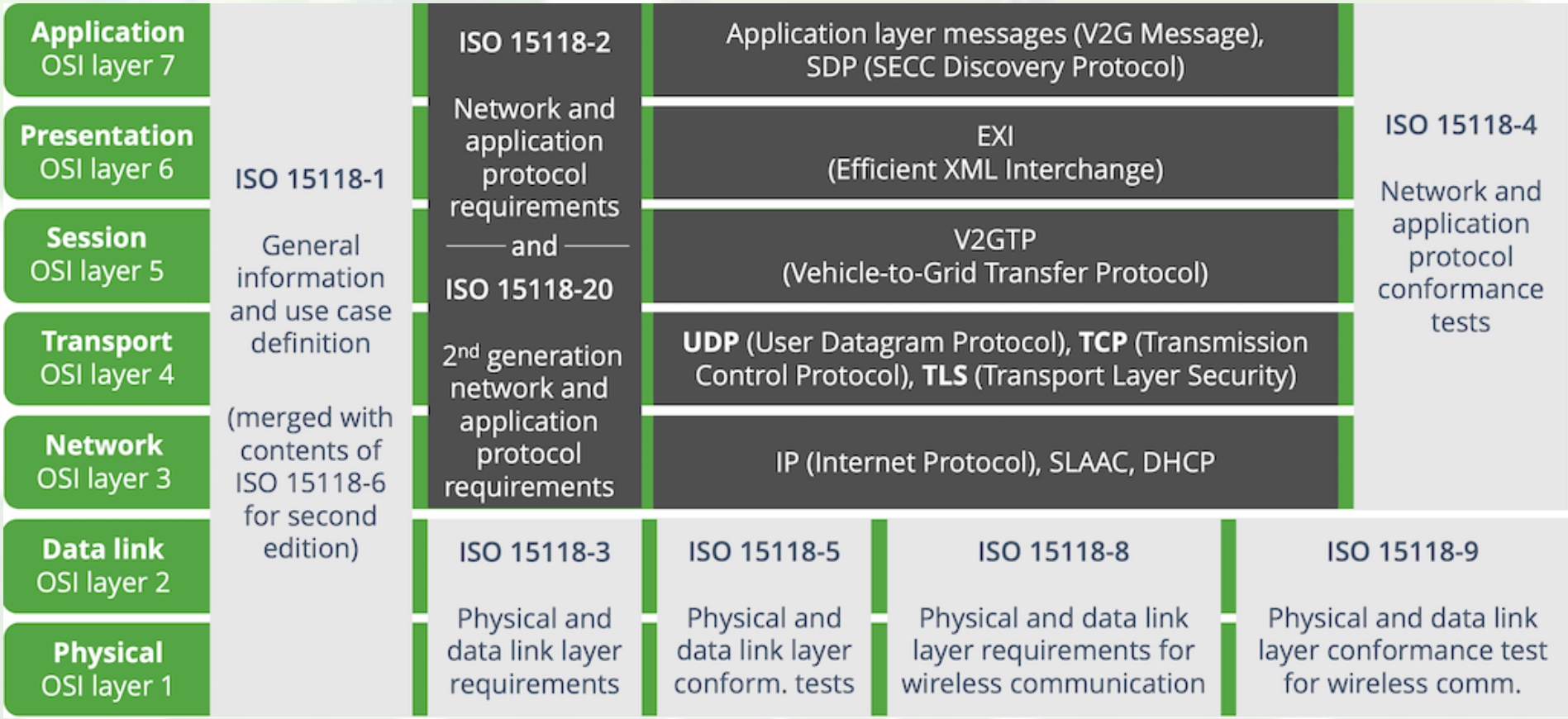
## ISO 15118



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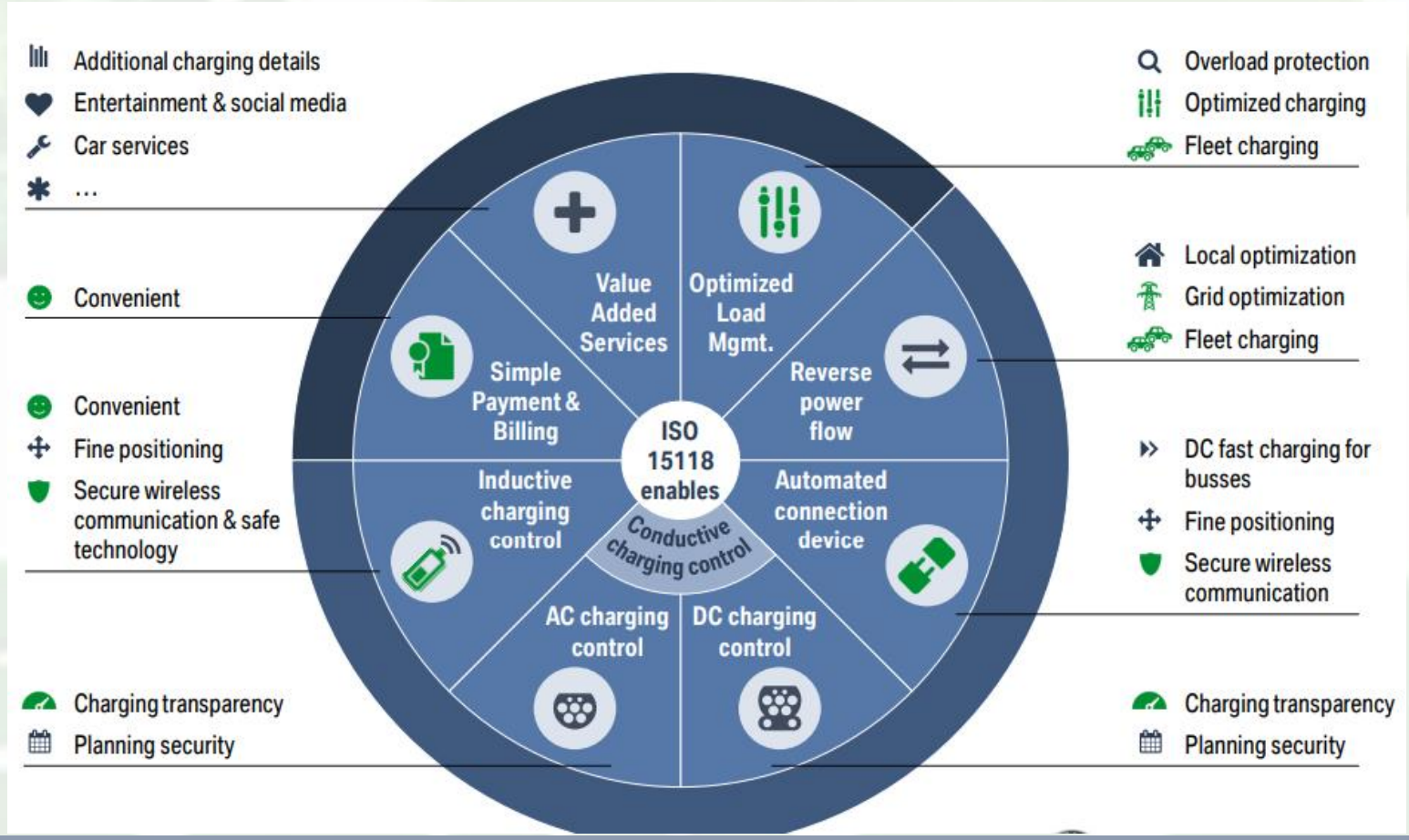
## ISO 15118



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## ISO 15118

**Vehicle-charger communication is divided into five stages – contact established, message exchange, isolation phase, precharge and charge.**


| CONTACT STABLISHED | MESSAGE EXCHANGE | ISOLATION PHASE | PRECHARGE | CHARGE |
|---|---|---|---|---|
| Connection of vehicle and charger deteted | Checking battery charge level | From charger and vehicle > 100 kOhm | Charger increasing the voltage required by the vehicle (> 20 Vdc) | Completed green light on |
| NO | NO | NO | NO | NO |
| > The pantograph has not connected to the hood<br>> Hose not connected<br>> Detection switch fault<br>> Rust on external connections | > The vehicle or charger does not receive the information or does not comunicate<br>> Timing not compliant with ISO or shorter or longer than expected | > Check vehicle and charger isolation | > Problem with the charger?<br>> Problem in timing? | > Vehicle stop: visible in the charger<br>> Charger stop: red alarm lights up<br>> Check grid availability |

https://www.jemaenergy.com/en/e-mobility/iso-15118-charging-process/

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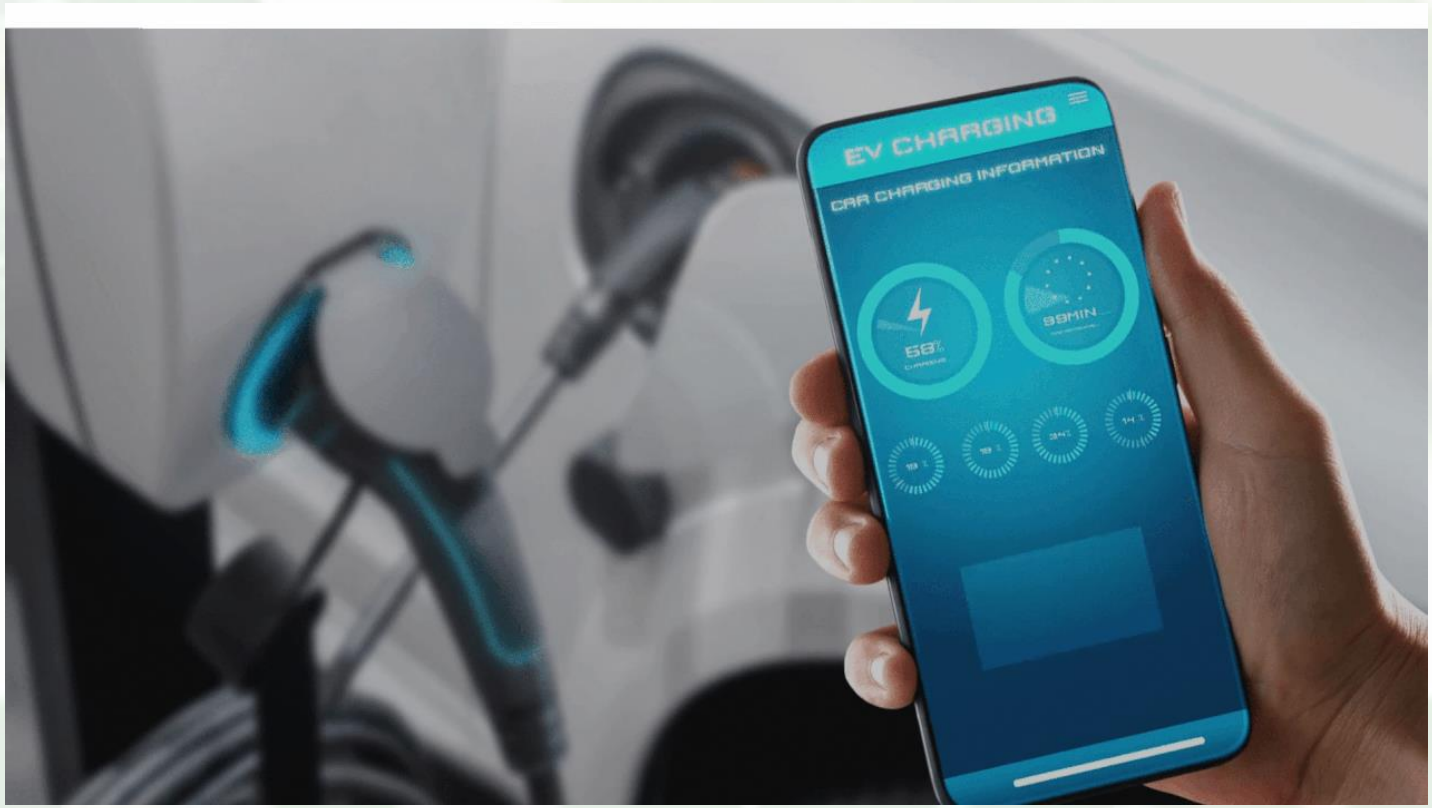


https://www.linkedin.com/pulse/role-iso-15118-ev-charger-conformance-testing-infinipower-qnhpc/?trackingId=FahG5pr69H5REzNtG8lYaw%3D%3D