EV Charger Draft

Version-1.0
Date- 04/02/2019

CPO = Charge Point Operator

DSO = Distributed System Operator

eMIP = eMobility Protocol Inter-Operation

eMSP = e-Mobility Service Provider

EV = Electric Vehicle

EVSE = Electric Vehicle Supply Equipment

IEC = International Electrotechnical Commission

ISO = International Organization for Standardization

OCHP = Open Clearing House Protocol

OCPI = Open Charge Point Interface

OCPP = Open Charge Point Protocol

OICP = Open InterCharge Protocol

OpenADR = Open Active Demand Response

OSCP = Open Smart Charging Protocol

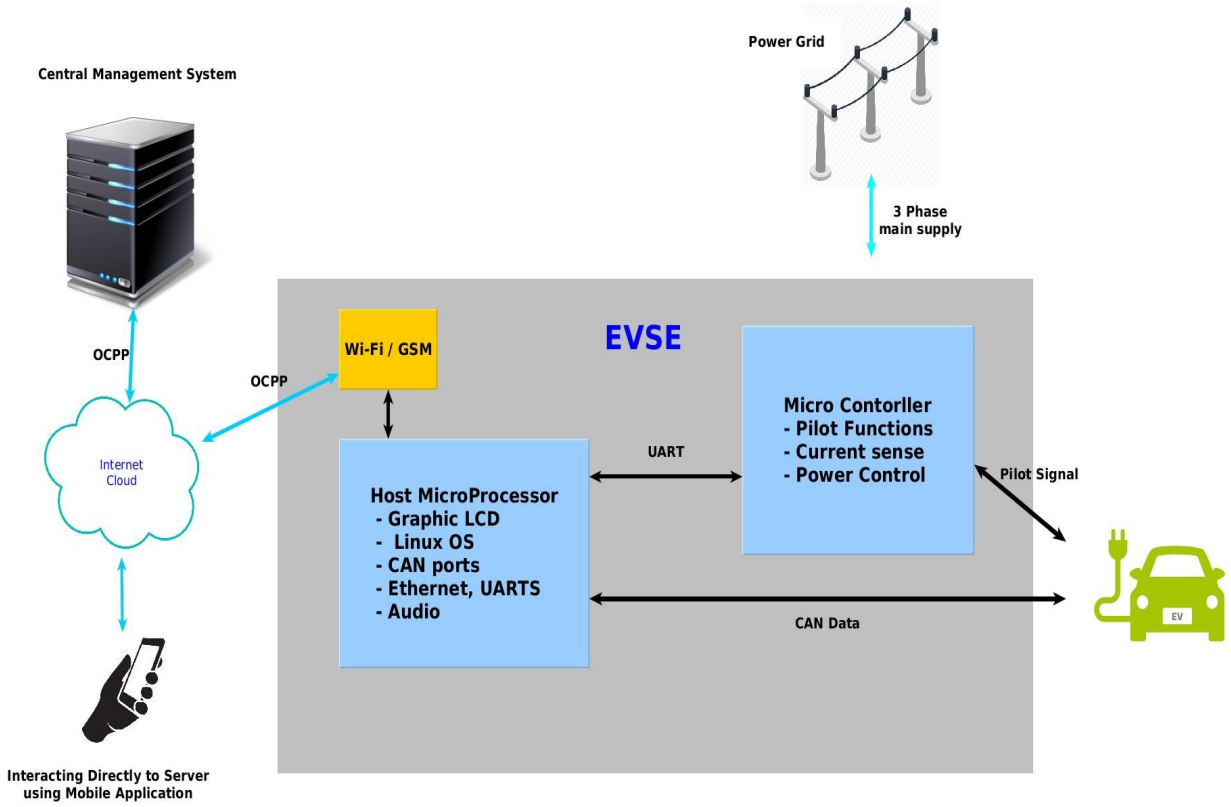
An EV charger, also called Electric Vehicle Supply Equipment (EVSE) is an element in EV infrastructure that supplies electric energy for recharging the electric vehicles. Deployment of EV charging stations is challenging, but it also introduces new opportunities.

Challenge involves deploying a charging infrastructure that not only supports today's use cases of mostly short local trips, but also supports faster charging compared to home-based chargers to ease concerns about charge time on today's larger battery packs.

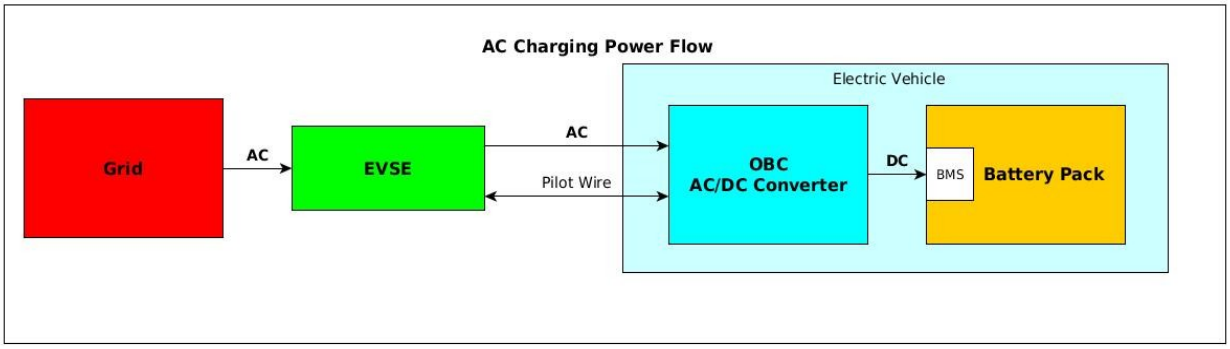
Growth of this magnitude is sure to incentivize innovation in the design of charging stations and accelerate the deployment of a comprehensive EV support infrastructure.

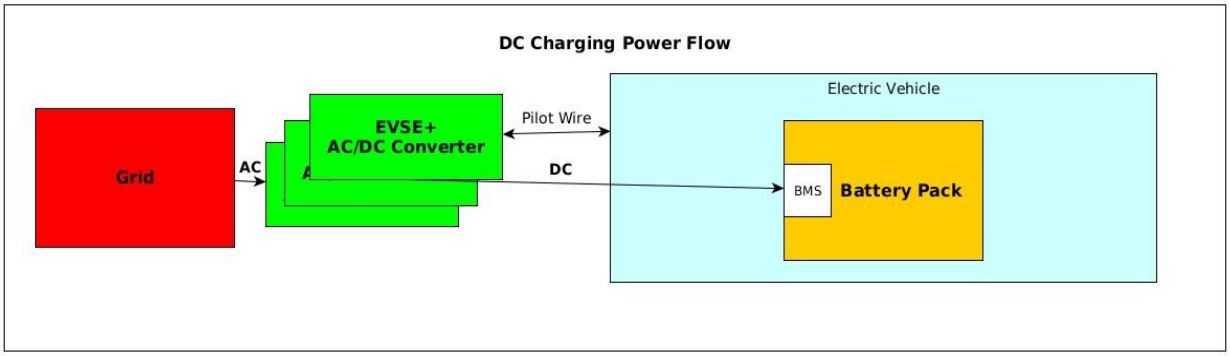
Residential homes, public parking lots adjacent to a restaurant or office building, or commercial outlets like a convenience store.

EV Charging Infrastructure:



EV Charger types:





According to Bharat EV Charger specifications below are the charger types and its specifications.

AC Chargers are classified as follows:

1. **AC slow charging:**
   Charging with 230 V, 1 Phase, 15 A Outlet with connector IEC 60309 and related safety interlocks

2. **AC fast charging:**
   Charging with 415 V, 3 Phase, 63 A Outlet with connector IEC 62196 and related safety interlocks.

DC Chargers are classified as follows:

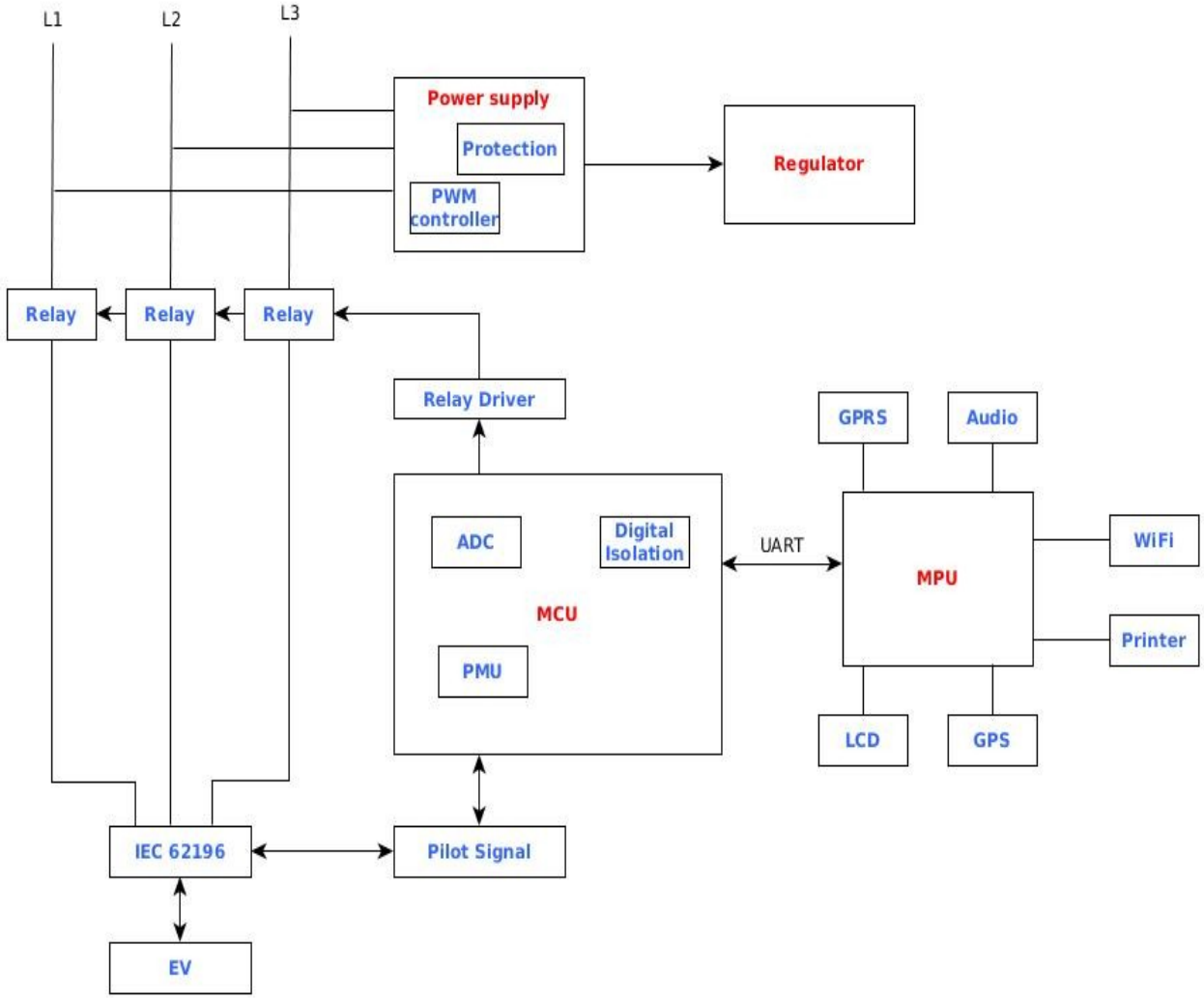
1. **Level 1 DC Chargers:**
   Public off-board DC Chargers at output voltage of 48V / 72V, with power outputs of 10 kW / 15 kW with maximum current of up to 200A. Connector is GB/T.

2. **Level 2 DC Chargers:**
   Public off-board DC Chargers at output voltage up to 1000V, with power outputs of 30 kW / 150 kW.

AC Fast Charging Station:

The electric vehicle service equipment for most modern EVs is a simple system that monitors and controls the high voltage power path from the grid to the vehicle. The actual AC/DC conversion and charging is all handled within the vehicle. The fast charger uses 415V up to 63A. The Bharat EV AC fast charger (BEVC-AC001) specifies plug standard as IEC 62196.

Block Diagram:



Components of AC Fast Charger:

Micro controller Unit (MCU) will communicate with the vehicle over the pilot line to determine when to open and close power relays. The MCU can also integrate HMI and communications functions if needed.

In fact, MCU with their integrated analog-to-digital converters (ADCs), and advanced pulse width modulator (PWM) hardware have already been extensively adopted in a number of EVs as a crucial control processor in battery-management applications.

Pilot Signal Function

The J1772 Pilot is 1khz +12V to-12V square wave, the voltage define the state. The EV adds resistance pilot to ground to vary the voltage. The EVSE reads the voltage and changes state accordingly.

Below are the steps for pilot Function:

1. The EV is plugged in, at this point there is no AC/DC output to the vehicle.
2. EVSE signals its availability with +12V on the pilot line, and a proximity circuit in the plug handle.
3. The EV places a resistor on the pilot line, dropping it to 9V, which the EVSE uses to detect the EV's presence.
4. The EVSE will start a PWM signal on the pilot line, with a PWM related to the available current.
5. The EV changes the load resistance, and the pilot voltage drops to 6V to finish the handshake.
6. The EVSE will then turn on the AC/DC power, and the EV will begin charging. Charging continues until the EV is done and stops drawing power, an error is signaled and the EVSE cuts power, or the handle is unplugged and the EVSE cuts power.

Below are the Pilot Function States:

State	Pilot High	Pilot Low	Frequency	EV Resistance	Description
State A	+12V	N/A	DC	N/A	Not Connected
State B	+9V	-12V	1000hz	2.74k	EV Connected (Ready)
State C	+6V	-12V	1000hz	882	EV Charge
State D	+3V	-12V	1000hz	246	EV Charge Vent. Required
State E	0V	0V	N/A		Error
State F	N/A	-12V	N/A		Unknown/Error

Power Measuring Unit (PMU) for current sensing to enable real time power usage monitoring.

Relay Driver is used to control the high power relays or contactors that will enable power flow to the vehicle.

Regulator is used to provide multiple power domains for MCU, Pilot signal and Relays

IEC 62196 Connector Which includes the high voltage power lines, and a low voltage communication signal called the pilot line. This pilot line signals to the car the available current of the charger, and the car will respond with a charging status.

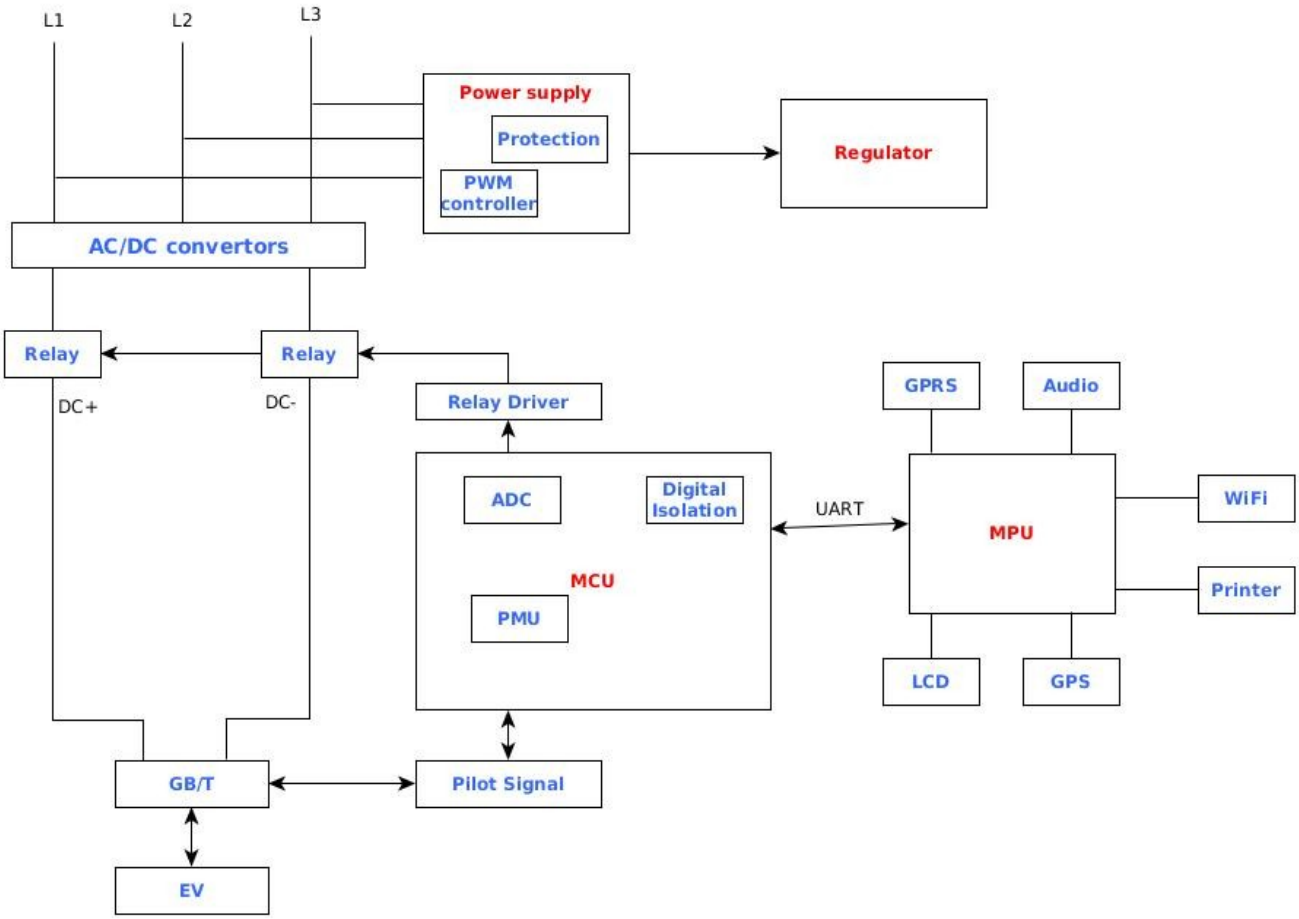
Micro Processor Unit (MPU**)** will communicate with MPU and show state of charging status on LCD. Using Graphical LCD user can select payment options. MPU will communicate to Central management system (CMS) using internet for grid related parameters, user authorization, billing and other information related to charging.

DC Charging Station:

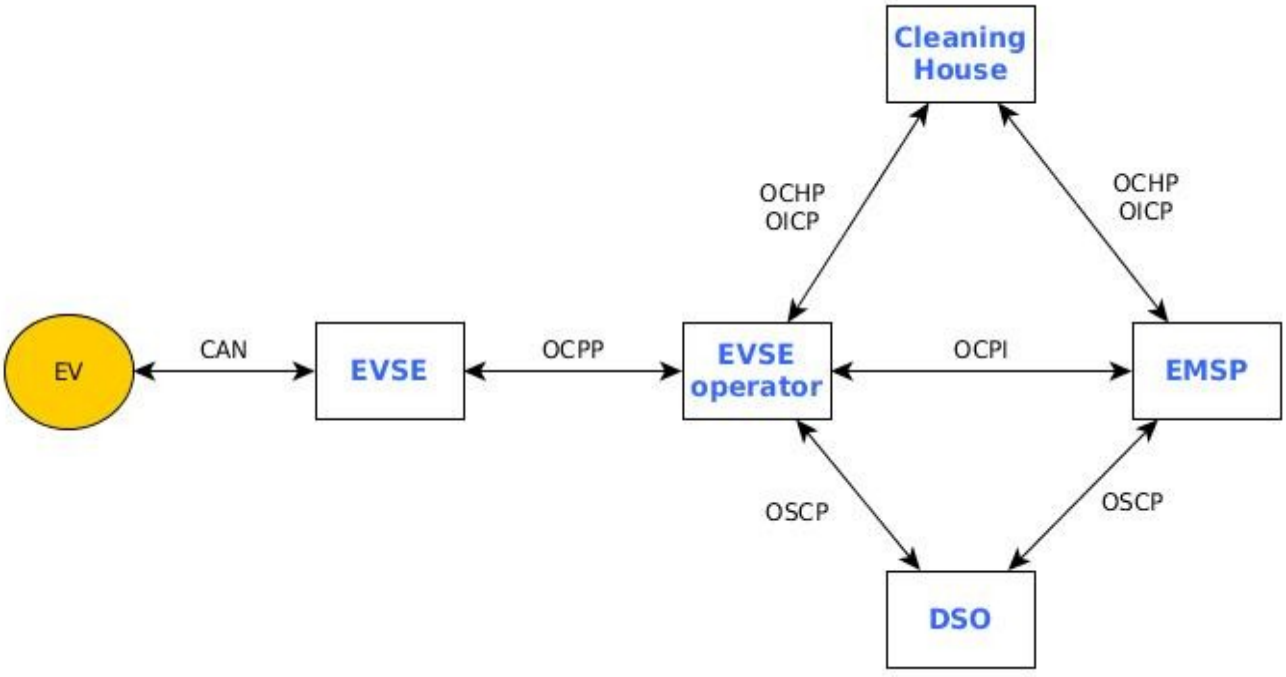
The main purpose of DC charging stations are reduce the charging time. Depending on the nature of battery and vehicles used, different sizes of higher capacity DC fast chargers are required. The method for charging an EV is to use an off- board charger for delivering direct current. These are typically on the order of 48V/72V, with power outputs of 10kW/15kW with maximum current of up to 200A. These will be called **Level 1 DC** chargers.

In this case the BMS must communicate with the charging station to control the voltage and current delivered to the battery. The vehicle tells the charging station through the CAN Bus, the battery capacity, and what level to set the voltage. Every 0.1 seconds the vehicle tells to the charging station how much current to deliver following a very specific CC/CV (constant current / constant voltage). Before start charging safety interlocks are managed by CAN Bus which test the charger circuit, battery condition.

Block Diagram:



Information flow in EV Charging System



Charge point operator(CPO) or EVSE operator:

Operates and maintains charge spots. CPOs play a important role in the EV market, the CPO also needs to have a communications link to a Distribution System Operator (DSO) which is responsible for operating and maintaining the electrical distribution grid.

E-Mobility Service Provider(EMSP):

The EMSP sells electricity to EV users for charging their car.The CPO and EMSP need to be in a contractual relationship so that the EMPS's customer can charge at a charging station operated by a CPO.

Distribution System Operator(DSO):

The DSO manages a regional electricity grid, and is responsible for a stable, reliable and well-functioning grid delivering electricity to consumers.

Open Charge Point Protocol(OCPP):

The OCPP has been designed and developed to standardize the communications between an EV charging point and a central system, which is used for operating and managing charge points.
The high-level use cases as listed in below:

- Authorize charging session
- Billing
- Manage gird
- Operate charge point
- Reservation
- Smart charging

Operations Initiated by Charge Point:

1. Authorize

The Charge Point Shall only supply energy after authorization. A Charge Point may authorize identifier locally without involving the Central System, as described in Local Authorization List. If an idTag presented by the user is not present in the Local Authorization List, then the Charge Point shall send an Authorize request to the Central System to request authorization. Response from Central system indicate whether the idTag is accepted or not.

2. Boot Notification

The Charge Point shall send a BootNotification each time it boots or reboots, where Central System returns Accepted or Pending.When the Central System responds with a status Accepted, the Charge Point will adjust the heartbeat interval in accordance with the interval from the response. If the Central System returns the status Rejected, the Charge Point SHALL NOT send any OCPP message to the Central System until the aforementioned retry interval has expired.

3. Data Transfer

If a Charge Point needs to send information to the Central System for a function not supported by OCPP. If venderID not present response will be "UnknownVender", if messageId mismatch (if used) the recipient SHALL return status 'UnknownMessageId'.

4. Diagnostics Status Notification

Charge Point sends a notification(busy or has finished successfully or failed) to inform the Central System about the status.

5. Firmware Status Notification

The Charge Point shall send a Firmware Status Notification for informing the Central System about the progress of the downloading and installation of a firmware update.

6. Heartbeat

To let the Central System know that a Charge Point is still alivr, a Charge Point sends a heartbeat after a configurable time interval.

7. Meter Values

Meter values are sent at predefined intervals or when a trigger message is received. This message informs the how much power is being used by the charger.The nature of each sampledValue is determined by the optional measurand, context, location, unit, phase, and format fields.

8. Start Transaction

This message is sent when a car is connected and authorized. It is used to inform that Charging has started, and log billing relevant information to Central System.

9. Status Notification

A Charge Point sends a notification to the Central System to inform the Central System about a status change or an error within the Charge Point. As the status Occupied has been split into five new statuses (Preparing, Charging, SuspendedEV, SuspendedEVSE and Finishing), will be sent from Charge Point to the Central System.

10. Stop Transaction

When a transaction is stopped, the Charge Point shall send stop request to the Central System that the transaction has stopped. A StopTransaction request PDU may contain an optional TransactionData element to provide more details about transaction usage.

Operations Initiated by Central System:

1. Cancel Reservation

To cancel a reservation the Central System shall send an CancelReservation.req to the Charge Point. If the Charge Point has a reservation matching the reservationId in the request, it SHALL return status 'Accepted'. Otherwise it SHALL return 'Rejected'.

2. Change Availability

Central System can request a Charge Point to change its availability. A Charge Point is considered available (operative) when it is charging or ready for charging. A Charge Point is considered unavailable when it does not allow any charging. The Central System SHALL send a ChangeAvailability.req for requesting a Charge Point to change its availability. The Central System can change the availability to available or unavailable.

3. Change Configuration

Central System can request a Charge Point to change configuration parameters. To achieve this, Central System SHALL send a ChangeConfiguration.req. This request contains a key-value, where "key" is the name of the configuration setting to change and "value" contains the new setting for the configuration setting.

4. Clear Cache

Central System can request a Charge Point to clear its Authorization Cache. The Central System SHALL send a ClearCache.req for clearing the Charge Points Authorization Cache. The Charge Point SHALL respond with a ClearCache.conf. The re-

sponse SHALL indicate whether the Charge Point was able to clear its Authorization Cache.

5. Clear Charging Profile

If the Central System wishes to clear some or all of the charging profiles that were previously sent the Charge Point, it SHALL use the ClearChargingProfile.req. The Charge Point SHALL respond with a ClearChargingProfile.conf specifying whether it was able to process the request.

6. Get Composite Schedule

The Central System MAY request the Charge Point to report the Composite Charging Schedule by sending a GetCompositeSchedule.req. Charge Point SHALL calculate the scheduled time intervals up to the Duration is met and send them to the central system.

7. Get Configuration

To retrieve the value of configuration settings from charge point. If the list of keys in the request is empty or missing, the Charge Point SHALL return a list of all configuration settings in GetConfiguration.conf. Otherwise Charge Point SHALL return a list of recognized keys and their corresponding values.

8. Get Diagnostics

Central System can request a Charge Point for diagnostic information.if diagnostics information is available then Charge Point SHALL respond with a GetDiagnostics.conf stating the name of the file containing the diagnostic information that will be uploaded.

9. Get Local List Version

In order to support synchronisation of the Local Authorization List, Central System can request a Charge Point for the version number of the Local Authorization List. Charge Point SHALL respond with a GetLocalListVersion.conf containing the version number of its Local Authorization List.

10. Remote Start Transaction

Central System can request RemoteStartTransaction.req. Charge Point receipt, a status indicating whether it is able to start a transaction or not.

11. Remote Stop Transaction

Central System can request a Charge Point to stop a transaction by sending a RemoteStopTransaction.req to Charge Point with the identifier of the transaction. Charge Point SHALL reply with RemoteStopTransaction.conf to indicate whether it is indeed able to stop the transaction.

12. Reserve Now

A Central System can issue a ReserveNow.req to a Charge Point to reserve a connector for use by a specific idTag.If the reservationId in the request matches a reservation in the Charge Point, then the Charge Point SHALL replace that reservation with the new reservation in the request. If the reservationId does not match any reservation in the Charge Point, then the Charge Point SHALL return the status value 'Accepted' if it succeeds in reserving a connector. The Charge Point SHALL return 'Occupied' if the Charge Point or the specified connector are occupied. The Charge Point SHALL also return 'Occupied' when the Charge Point or connector has been reserved for the same or another idTag. The Charge Point SHALL return 'Faulted' if the Charge Point or the connector are in the Faulted state.

13. Reset

Central System can request a hard or a soft reset. The Charge Point SHALL respond with a Reset.conf. The response SHALL include whether the Charge Point is will attempt to reset itself or not. If any transaction is in progress it SHALL be terminated normally, before the reset, as in Stop Transaction.

14. Send Local List

Central System can send a Local Authorization List that a Charge Point can use for authorization of idTags. The list MAY be either a full list to replace the current list in the Charge Point or it MAY be a differential list with updates to be applied to the current list in the Charge Point.

15. Set Charging Profile

A Central System can send a SetChargingProfile.req to a Charge Point, to set a charging profile. At the start of a transaction to set the charging profile for the transaction. In a RemoteStartTransaction request sent to a Charge Point During a transaction to change the active profile for the transaction. Outside the context of a transaction as a separate message to set a charging profile to a local controller, Charge Point, or a default charging profile to a connector.

16. Trigger Message

The TriggerMessage.req makes it possible for the Central System, to request the Charge Point, to send Charge Point-initiated messages. In the request the Central System indicates which message it wishes to receive.The Charge Point SHALL first send the TriggerMessage response, before sending the requested message.In the TriggerMessage.conf the Charge Point SHALL indicate whether it will send it or not, by returning ACCEPTED or REJECTED. It is up to the Charge Point if it accepts or rejects the request to send.

17. Unlock Connector

Central System can request a Charge Point to unlock a connector.The purpose of this message: Help EV drivers that have problems unplugging their cable from the Charge Point in case of malfunction of the Connector cable retention. The response PDU SHALL indicate whether the Charge Point was able to unlock its connector.

18. Update Firmware

Central System can notify a Charge Point that it needs to update its firmware. The request SHALL contain a date and time after which the Charge Point is allowed to retrieve the new firmware and the location from which the firmware can be downloaded. the Charge Point SHALL respond with a UpdateFirmware.conf.