# IOT Enabled smart charging station for electrical vehicle

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**Abstract—**
**The demand for charging infrastructure, including charging stations in parking structures and garages is more important as the EVs on the road multiply. For long distance commuters, an available charging station may be a critical requirement to ensure the ability to finish the round trip and make it home. Even when charging is not critical, many EV drivers may plug in to alleviate range anxiety or to shorten the charge discharge cycle and decrease battery wear. A scarcity of charging stations may make EVs less convenient and contribute to range anxiety resulting in less people embracing the use of electric vehicles.[1] One solution is charging stations that service multiple vehicles at the same time with a given infrastructure. Multiple parts of the infrastructure need to be shared in order for a charging station to truly service multiple vehicles simultaneously.[1 Internet of Things (IoT) based Smart Electric Vehicle (EV)is a brilliant electric vehicle charging framework that has been constructed and is at present in operation. It is a product and system based EV charging framework outlined and worked around the thoughts of smart charge planning, multiplexing (interfacing various vehicles to each circuit) and adaptability.[2]**

**Index Terms—, Electric Vehicle (EV), Internet of Things (IoT), Charging Smart Grid**

## I. Introduction

Plug-in Electric Vehicles (PEVs) play a pivotal role in transportation electrification. The exible nature of PEVs'charging demand can be utilized for reducing charging cost as well as optimizing the operating cost of power and transportation networks. Utilizing charging flexibility of geographically spread PEVs requires design and implementation of efficient optimization algorithms.[3] To support the widespread application of the AVs in near future, various infrastructures have to be developed to access and provide autonomous services. The autonomous services can be realized by autonomous data acquisition and exchange based on machine-to-machine (M2M) communication. The idea of using a vehicle to initiate a transaction has been proposed to turn the vehicle itself into the payment mechanism and autonomously connect to bank's payment network and pay for its own services [4]. One solution is charging stations that service multiple vehicles at the same time with a given infrastructure. Multiple parts of the infrastructure need to be shared in order for a charging station to truly service multiple vehicles simultaneously. The charging system needs to share the plug port by safely plugging in multiple vehicles at once, it needs to share the circuit by rationing the available power in order to not overload the circuit, and it needs to share the grid capacity by intelligently scheduling charging in order to avoid peak consumption. To meet this demand, an EV charging system has been developed that safely multiplies the number of EVs that can be connected to a circuit by rationing the power allotted to each EV.[1] Current EV charging frameworks incorporate charging systems, for example, DBT, Charge Point and ECOtality. These EV charging systems concentrate on furnishing EV chargers with the capacity to distinguish clients and take instalments for open charging. Astutely sharing matrix framework assets has not been accentuated in these systems. Work has been done in algorithm and modelling for shrewd EV systems. Moving past displaying, IoT based Smart EV is a showing EV charging system at present in operation. It is a product and system based EV charging framework planned and worked around the thoughts of smart charge booking, multiplexing (interfacing different vehicles to each circuit) and adaptability. The framework is impartial about the equipment, the control focus and system that interconnect it with every one of the parts of the framework. A significant part of the plan for the framework has been depicted [2]

## II COMMUNICATION FRAMEWORK OF HYBRID CHARING/REFUELING STATIONS

Generally AVs have to install communication units to communicate with everything to assure the driving safety, known as vehicle-to-everything (V2X) [13].V2X mainly includes vehicle-to-vehicle (V2V) for information exchange between vehicles and vehicle-to-infrastructure (V2I) to communicate with road side units, for information exchange of vehicle location, road condition and drivers behaviors. Meanwhile, in order to achieve sustainable transportation based on autonomous vehicles, it is significant to find when/where the AVs can be charged efficiently, especially for time-consuming charging of electric vehicles. Therefore, the communication between autonomous vehicles and charging stations is indispensable, and belongs to vehicle-to grid (V2G) . Figure 1 shows the above mentioned V2V, V2I and V2G communication network. standards, the information models for electric vehicles and charging stations, have been discussed in reference. Whatever the communication approaches are, it is significant to figure out the phases of communication between AVs and HCSs and their exchanged information [4]

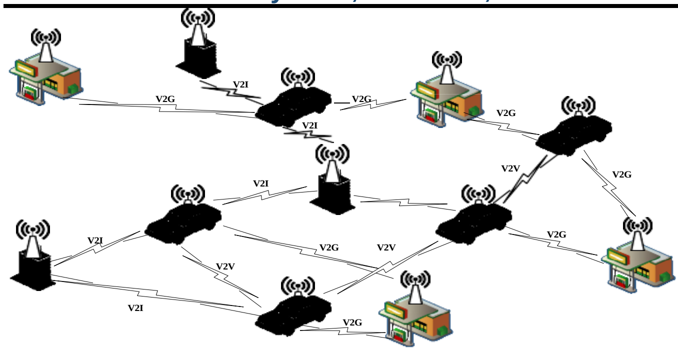



Table II Information provided by EVs in the request service phase'

| Information | Description |
|---|---|
| Vehicles ID | Vehicle identification number |
| Type of vehicles | Emergency vehicles, Normal Vehicles |
| Operation Mode | Fueled vehicles, Electric Vehicles |
| Type of Fuels | Regular Gasoline 87, Midgrade (Plus) Gasoline 89, Premium Gasoline 93, Diesel |
| Battery capacity (kWh) | 14,20,81 etc. |
| State of Charge | Percent of remaining battery Capacity |
| Required capacity | Percent of battery capacity required by the electric vehicles |
| Power acceptance rate (kW) | Slow. Power acceptance rate >3kW and it will take 6-8 hours for full charge.<br>Fast. Power acceptance rate 7-22 kW and it will take 3-4 hours for full charge.<br>Rapid. Power acceptance rate >43 kW (AC) and >50 (DC) and it will take 0.5 hours for full charge.<br>Ultra-rapid. Power acceptance rate 50-400 kW and it will take 0.25 hours for full charge. |
| Arrival time | Arrival time of the vehicles |

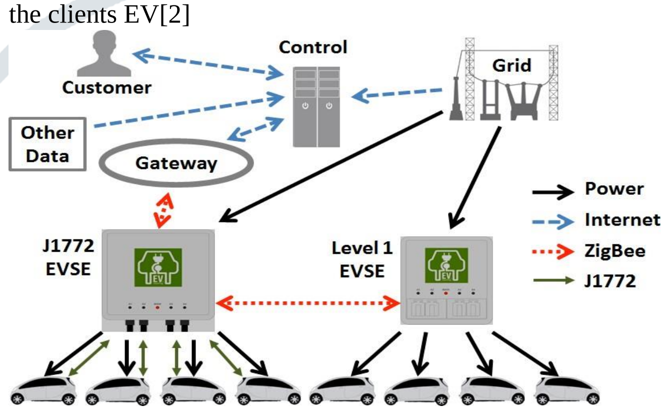
## III CONTROL SYSTEM

### A CONTROL SYSTEM OVERVIEW

To get the full advantages of astute EV charge planning, choices should be made at a focal area that will upgrade the general framework. Different choices may should be made locally, without a server hold up time, for example, when wellbeing is a worry. A product based framework will enable the insight to be updated (as required) and the framework incorporated with different gadgets and systems as system of gadgets as in Figure 1. The server may speak with any element inspired by the charging of EVs, including the client, the vehicle, the EVSE (Electric Vehicle Supply Equipment), network gadgets, and applicable outer elements. The information may incorporate basic data required for introducing the charging procedure, for example, the client/vehicle account ID, instalment data, and the port or gadget where the EV is associated. Information may likewise incorporate data that is not basic to charge introduction but rather might be useful to trickle line the charge booking, for example, the condition of charge of the battery, the power accessibility, climate and power utilization estimates, state of the power transformer utilized by an EV charger, and request reaction or value signals from the network[2] The EV charging systems software based controls may be in the cloud, or on a specific server with internet access. The system is network neutral, it can communicate with the routers that control the EVSEs through Ethernet, WiFi or cell phone data network such as 3G. The router communicates with the relays through Zigbee so that only one router can control multiple charge boxes. The J1772 EVSE device communicates with the EV through the charge cable. The user and vehicle identification are communicated through an internet enable device such as a smart-phone. It is also able to connect other devices to the network in order to accomplish tasks such as inputting user/vehicle ID and charge port ID through RFID or other type of scan and communication systems. The central controller for the current implementation of this system is located on a server connected to the internet. Users communicate with the system through internet connected devices such as a smartphone or computer. The EVSEs also communicate with the server through the internet. This deployment has devices connected directly to the internet through Ethernet, Wi-Fi, and 3G. It also has devices that connect to the internet through local communication to other devices with direct internet connections. The local communication systems in this deployment include Wi-Fi, Zigbee and PLC (Power Line Communication).[1]

### B CHARGING SYSTEM COMMUNICATION REQUIRED

In a keenly controlled EV charging framework, the controller must get essential data to settle on choices and satisfy the required undertakings, for example, track clients, line charging, take instalment, track control utilization, dispense assets, and so forth. The main bit of information that the control focus requires to start a charge arrangement is client/vehicle ID and the charge point that the EV is associated with. Revise mapping of every client/vehicle ID with the ID of the charge point it is associated with, is basic. This guarantees the best possible charge point is stimulated and gives energy to the clients EV[2]




SAE J1772 is a North American standard for connecting EVSEs to EVs. This standard includes the cables, the communication interface and the safety system requirements. The communication between the EVSE and the EV through the J1772 system is limited to the state of cable connection, whether devices are ready to power up, the electric voltage and current available to the vehicle to charge. No vehicle ID or battery charge information is communicated through the J1772 cable. In order to obtain a vehicle ID or battery state of charge, other communication channels must be implemented. Once the control server has the vehicle/user ID and the ID of the charge port the vehicle is connected to, the server can put the vehicle into the charging queue and initiate charging as appropriate. The charge sequence and queuing will depend on the algorithms implemented in the server. How the EVSE reacts to charge instructions depends on the type of EVSE. There are two types of EVSEs in the deployed charging system. The first is a level 1 only, trickle charge device that that turns 120V household outlets on and off while allowing the 120V EV cable provided with each EV to fulfill all the J1772 communication protocols and safety requirements regarding EV charging. The second is a level 1 or 2 box that uses J1772 cables to connect directly with the EVs. This EVSE fulfills all the standard J1772 communication and safety requirements.

## IV EVSE DEVICE

Trickle Charge, EVSE

The level 1, trickle charge, EVSE does not connect or communicate with the EV directly. Each EV comes with the portable, 120V, trickle-charge cable that plugs into standard household 120V plug (NEMA 5-15). The other end of the trickle charge cable has a standard EV charging plug (SAE 1772) plug that connects to the EV. The other end of the trickle charge cable has a standard EV charging plug (SAE 1772) plug that connects to the EV. On the cable, in between these two plugs, is a box that contains the electronics required to communicate with the EV and initiate the charging protocol. The electronics in the cable box automatically initializes the charging protocol whenever power is provided to the 120V plug, and disengages when power is removed. Therefore, the action of this cable can be ignored and when power is provided to the cable, it can be considered provided directly to the EV.[1]

The level 1 multiplexing EVSE for current execution comprises of a box with 4 outlets joined to the outside where clients can connect to the 120V EV versatile stream charge link. Over each of 4 outlets there is a pointer light that shows which outlet is given power. There is a fifth light that shows regardless of whether the charging enclose has control and is benefit. Inside the container, there are 4 transfers with metering capacity that both kill the power on and to every outlet and measure the current to guarantee that the gadget is really off. A switch inside the container conveys between relay/meters and the control server.[2]

The fundamental capacity of multiplexing is to share the accessible power among various EVs. Since the level one box does not discuss specifically with the EV, the measure of energy that an EV pulls can't be controlled. Along these lines, to guarantee that the circuit does not over-burden, the control calculations direct that just a single EV (at any given moment) can charge per circuit. A repetitive framework initially kills the ability to any charging EV, and afterward checks the present coursing through each relay to guarantee that no current is streaming before continuing to draw in energy to the following EV in the line. This excess framework guarantees that the circuit is never over-burden. Since programming controls the killing and on the charging, various calculations can be investigated for planning the EV charging. These calculations can consider time of landing, condition of charge, end charge time, network soundness, cost and whatever other factor applicable to EV charge booking.[2]

J1172 EVES

The multiplexing J1772 EVSE must incorporate all the J1772 standards, cables, and protocols. In addition, it must connect multiple EVs at once and safely provide optimal charging. the J1772 charging device incorporates all of the capabilities of the trickle charger including the communication router, 4 relays for control power and electrical metering . Furthermore, it includes systems that communicate with the EV to let the EV know it is connected and how much power is available, shut power off if the cable is disconnected and provide ground fault protection (GFCI) capabilities that shut power off if a fault is detected.[1] A pilot signal is used to allow communication between the EV and EVSE. The pilot signal is in the form of a PWM signal created by the EVSE. Both the EV and the EVSE can detect changes in the pilot signal. When no EV is connected to the EVSE, the EVSE detects no changes to the pilot signal. When the J1772 cable is plugged into the EV, a circuit in the EV creates a resistance between the pilot signal and ground that changes the amplitude of the square wave. This change in amplitude signals to the EVSE that an EV is present. In order to begin charging, the EVSE energizes the charge cable and changes the duty cycle of the PWM signal to indicate to the EV the amount of power available. Only once the EV receives this information, does it activate its charging equipment to begin charging[2]

The J1772 charger must shutdown if a ground fault is detected. A ground fault is any stray current that is not passing through one of the power conductors. This current needs to ground somewhere; and potentially passing through a person poses a severe danger. Any difference in current through the two power conductors is a danger that is prevented by the ground fault circuit interrupter (GFCI) [1]. The GFCI recognizes a distinction in the two conductors and rapidly stop the power. This is expert in the TEXAS CC3200 box with a present transformer that yields a little voltage in extent to the present contrast in the two hot wires. The voltage is then opened up and used to close down the loop voltage to the power transfer, closing off power the EV [2]

EV CHARGING DEVICE COMMUNICATION

With the normal drive of 12.6 miles, and a Nissan Leaf getting 29kWh/100mi , the vitality required to energize the EV after the normal drive is 3.7kWh. A devoted, 30A (40A pinnacle), 240V circuit providing a level 2 charger can supply 7.2kW of energy, which will make an interpretation of into 6.6kW going into the battery after wastefulness misfortunes.[2]

Installations at malls or other public places where the commute may be longer than average and the EVs may be parked for shorter periods of time; sharing a 30A circuit may not fulfill the customer's requirements. If the level 2 EVSE has a 120A circuit, all 4 EVs can charge at full 30A each. If many chargers with this setup are connected to a single transformer, than the transformer could be a bottle neck. If each EV charges at 7.2kW, than a 100kVA transformer can handle a maximum of 13 of these. In this scenario, a group of 4 or more EVSEs, with 16 or more charge points can charge the first 13 EVs that arrive at maximum charging speed. The control system can run algorithms that limit the power consumed by the EVSEs as a group by putting the 14th EV into a queue or lower the power allotment for the other EVs to provide power to the 14th.[1]

On the off chance that splitting1.5kW (120V, 12.5A) 4 routes with the level 1 EVSE does not fulfil the given arrangement of energy prerequisites, at that point the EVSE can be designed to part 2 120V circuits between the 4 charge focuses. This leaves each circuit to be shared by just 2 plug focuses averaging 0.75kW each. On the off chance that a 1.5kW level 1 circuit is excessively control for 4 EVs, for example, at air terminal parking garages where EVs may remain for drawn out stretches of time, numerous EVSEs might be securely associated with one circuit. The normal charge required will decide the ideal number of EV plug focuses to circuit. A 1.5kW circuit can convey 36kWh/day and 252kWh/wk. .

SYSTEM NETWORK TOPOLOGY

These topologies may range from one central controller directly controlling all EVSEs, to local networks connected to a more centralized controllers that branch together making a tree like topology. The optimal topology depends on the goals of the system and how to best interact with the larger grid. There are some opposing motivations. A centralized controller may give the network more influence over the larger grid, making it a bigger asset in terms of DR and grid control. A centralized controller may not be as robust as more localized controllers. Furthermore, a localized controller that directly communicates with the local grid may better respond to the local needs of the grid in terms of power quality and response to local shortages and outages. The current setup uses one central server connected to a network and controls all the EVSEs on the network, regardless of where the EVSE is located.[1]

## V CONCLUSION

So as to address the issue of a consistently developing interest for EV charging framework, a product based EV charging framework has been manufactured. It can ideally plan charging with a specific end goal to securely expand the utilization accessible framework assets for charging EVs and along these lines augmenting the quantity of EVs that can be associated with the lattice while upgrading network steadiness. EVSEs enables different EVs to share a solitary circuit and accessible network limit. The control framework is both system and equipment unbiased and can interface with different gadgets and frameworks through the web for information social event and data trade. The charging system consists of a controller connected through the internet to purpose built EVSEs that multiplex electrical circuits. The EVSEs allows multiple EVs to share a single circuit and available grid capacity. The control system is both network and hardware neutral and can connect to other devices and systems through the internet for data gathering and information exchange. Because of this flexibility, the system can grow and change as technology changes.

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