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Smart Electric Vehicle Charging Station:Open Charge Point Protocol with Advanced Management

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Abstract— The growth of electric vehicles (EVs) has increased the need for efficient, smart and efficient vehicles. Managing the relationship between the end user, the electric car and the payment center during the charging process is important for the popularity of electric cars. It offers an extension of the Open Charge Point Protocol (OCPP) standard. The charging station is designed to accommodate vehicle-to-grid (V2G) technology, which provides bi-directional power between the electric vehicle and the grid. Many grid-connected charging systems are being installed that can follow a standard design such as those proposed by the charging point (CS), Open Charging Point Protocol (OCPP). The latest version of the standard is 2.0.1 and includes new security measures at the device and communication level to address security issues identified in previous versions. The user discusses the refund with the central station and offers his preferences and flexibility. The system is hosted on the Amazon Web Services (AWS) cloud.The application simplifies the experience for electric vehicle (EV) owners easily find charging stations, initiate and manage charging, receive status updates and access charging information. The operation of Vehicle to Grid and Grid to Vehicle are performed by the MATLAB simulation.

Keywords— Open Charge Point Protocol 2.0.1, Charging Station, Central Management System, V2G and Solar Panel System, Energy Storage System.

Introduction

The term 'Smart Charging' describes the colorful generalities and ways used to control the EVs ' charging process. There must be communication between the EV, the charging station, and the grid to control the electricity an EV draws from a charging station. OCPP is a communication protocol between an EV charging station and the reverse- endsystems. The rearmost interpretation, OCPP2.0.1, enables the requested energy quantum to be transferred from an EV at a charging station to the central charging system. While OCPP and ISO 15118 are distinct norms, they can work together to enable advanced functionalities in EV charging structure. Through the OCPP protocol, the charging stations can communicate with the CSMS system via websockets.Charging station operation software(CSMS) frequently uses the open charge point protocol(OCPP) to control the charging process ever. AWS offers colorful database services like AWS DynamoDB, AWS Lambda that can be used to store and manage charging session data, stoner biographies, and other affiliated information. These databases give scalable and dependable storehouse for the data generated by the charging station. In this paper, we address the a grid- tied charging station, which is connected to a solar PV system. In the proposed frame, EV motorists can make reservations via a mobile operation by specifying parameters, similar as the starting time, the duration, the asked charging power, and the type of electrical current they bear(AC or DC). The EV motorist confirms or cancels the reservation. Our CSMS result is grounded on the OCPP protocol to manage the charging station according to the verified schedules.

Background–

The 21st century has witnessed a paradigm shift in the global approach to transportation, driven by the pressing need to address environmental enterprises and reduce dependence on fossil energies. Electric vehicles(EVs) have surfaced as a potent result to combat air pollution, hothouse gas emigrations, and resource reduction. The wide relinquishment of EVs, still, hinges on the vacuity of a flawless and effective electric vehicle charging structure. To meet this demand,
Advanced Electric Vehicle Charging Stations (AEVCS) have evolved to offer high- speed charging capabilities and stone centric services. In tandem with the development of AEVCS, the elaboration of technology has introduced new confines to the charging geography. The emergence of pall computing, AWS Cloud and standardized communication protocols has opened avenues to enhance the functionality, effectiveness, and scalability of EV charging systems. One similar pivotal protocol is the Open Charge Point Protocol(OCPP), which establishes a standardized frame for communication between EV charging stations and central operation systems.

A. Open Charge Point Protocol

OCCP defines how charge stations and central management systems transmit commands like start and stop power, as well as diagnostic data such as how much power is being consumed or if there are any errors.OCPP supports various types of EV charging stations, including AC and DC chargers, and different charging power levels.The OCPP's role is to make any EV charging station work in a compatible way with any charger management software. OCPP and ISO 15118 are distinct standards , they can work together to enable advanced functionalities in EV charging infrastructure.

B. V2G Standard (ISO 15118)

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Table 1 EV Charging and V2G Standard

	Standard	Uni-directional EV Charging	V2G
Communication Standards	IEC 61851	Active	N/A
	CHAdeMO	Active	Active
	ISO 15118	N/A	*Under Development*
Hardware Standards	CHAdeMO DC	Active	Active
	CCS DC (IEC 62196)	Active	*To be enabled by ISO 15118*
	Type 2 AC (IEC 62196)	Active	

C. Charging Station Work

This is a table of chargers type, charging time and EV battery capacity. There are both type of EV chargers AC and DC with there charging power. AC chargers has charging power of 7KW, 11KW and 22 KW and DC chargers has 50KW, 120KW, 150KW, 240KW etc. They are also called DC fast chargers. Here, to deliver the charging power of the chargers are depend on the EV battery capacity and the charging time is also depend on the EV battery capacity.

As the charging power increases, the EV charging time decreases and as the EV battery capacity increases, the charging time is also increases.

Table 2Chargers Type, Charging Time and EV Battery Capacity

	BATTERY SIZE kWh			
	25kW	50KW	75KW	100KW
NORMAL 'SLOW' EV CHARGING				
2.3kW AC	10hr 30min	24hr 30min	32hr 45min	43hr 30min
FAST EV CHARGING				
7.4kW AC	3hr 45min	7hr 45min	10hr 00min	13hr 30min
11kW AC	2hr 00min	5hr 15min	6hr 45min	9hr 00min
22kW AC	1hr 00min	3hr 00min	4hr 30min	6hr 00min
RAPID EV CHARGING				
50kW DC	36min	53min	1hr 20min	1hr 48min
120kW DC	11min	22min	33min	44min
150kW DC	10min	18min	27min	36min
240kW DC	6min	12min	17min	22min

D. Central Management System

This is the central and most important part of the charging station. Here, the control center which take server from the cloud and have two management systems :

a. Charging Station Management System
b. Energy Management System

Fig. 1 Central Management System

II. METHODOLOGY

A. System architecture and design

The system developed, shown in Figure, consists of the Charging Station Management System, the OCPP Gateway, the Solar Panel, the Grid Devices, the Energy Storage System, the AWS Cloud, the Charging Station and the Electric Vehicle (EV).

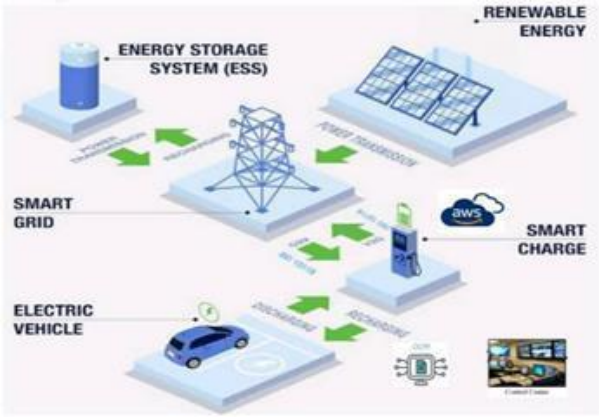

Fig. 2 Block Diagram of OCPP compliant EV charging station

a.OCPP Communication : Implement OCPP communication between charging stations and AWS Cloud.

b. AWS Cloud : Set up an AWS account and create a cloud environment, which provide servers for all the devices of the charging station.

c. V2G System : OCPP Compliant smart EV charging station, integration of V2G systems involves enabling not just the charging of EVs but also allowing these vehicles to discharge electricityback into the grid.

d. Solar Panel Integration : If using, integrate solar panels with the charging stations. Implement a system to switch between grid and solar power based on availability and demand.

e. Central Management System (CMS) : Integration Develop or set up a CMS to manage charging stations. Ensure the CMS can communicate with AWS Cloud for data synchronization.

Ill. RESULT DISCUSSION

G2V and V2G Simulation Model :

The fig. 5 shows the simulation model of the G2V and V2G simulation operation. In G2V operation, the power from the

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grid is trabsferred to the charging station and the charger, which is used to charge the electric vehicle, is bidirectional and DC fast charger. Here the AC power is also converted into DC power and after conversion, it supplies to the EV battery.Similarly in case of V2G operation, the EV battery is discharge to the grid, at the time of, when there is a demand at the grid or overload. Here, display shows the SOC, voltage and current of EV battery. Two scopes, where first represent the battery SOC, Current and Volatge and other represent Grid and Inverter Voltage. The switch 1 shows the G2V and switch 2 shows the V2G operation activation.

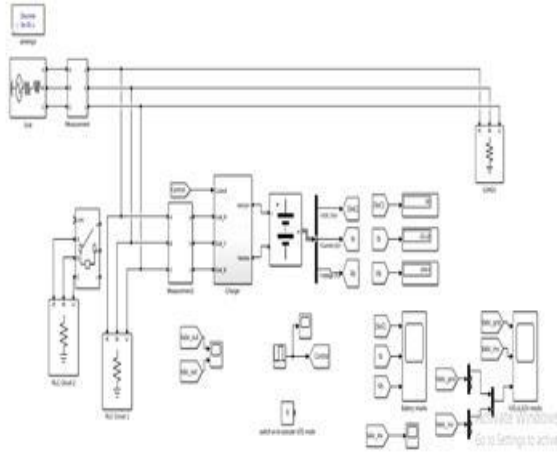

Fig. 3 G2V and V2G Simulation Operation

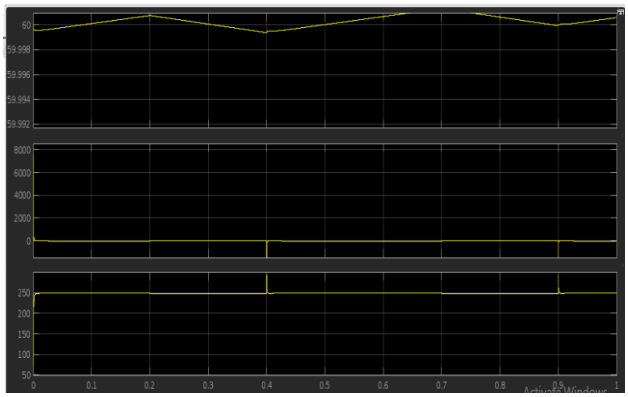

Fig.4 Battery (SOC, Current and Voltage)

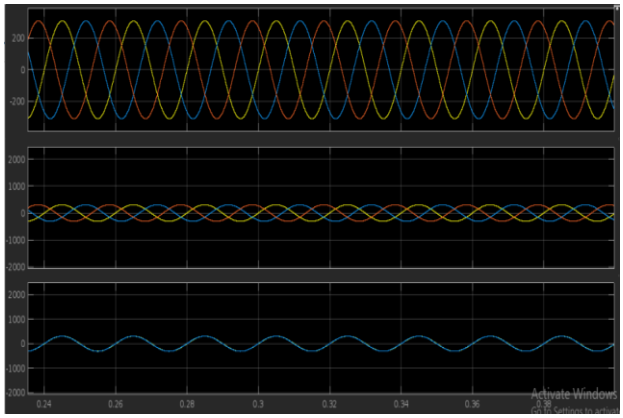

Fig. 5 Grid and Inverter VoltageG2V and V2G Operation Parameters :

Table 3G2V and V2G Operation Parameters

Parameter	Value
Voltage (Grid)	380 V
Power (Charger)	50 KW
Voltage (Battery)	400 V
Capacity (Battery)	75 KWh
SOC (Initial)	60 %

IV. CONCLUSION

This paper has delved into the comprehensive design and implementation of an OCPP-compliant smart EV charging station integrated with a sophisticated Charging Station Management System (CSMS), Energy Management System (EMS), mobile application, and seamless integration with grid devices. The incorporation of optional solar panels further enhances the sustainability of the system, ensuring uninterrupted charging even during grid overloads or interferences. Leveraging the power of AWS Cloud network infrastructure, this solution offers scalability, security, and realtime data management, making it a robust and future-proof choice for the electric vehicle ecosystem. The inclusion of a camera and penalty system enhances security and accountability. This research bridges the gap between advanced EV infrastructure and the growing demand for sustainable energy solutions. It not only provides a detailed blueprint for the implementation of a state-of-the-art smart charging station but also underscores its significance in advancing the adoption of electric vehicles and renewable energy sources. As the world transitions toward sustainable transportation results, this design paves the way for a future where EV charging is both environmentally friendly and technologically advanced.

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