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IOT integration of electric vehicle charging infrastructure

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Abstract

All across the world, the electrification of road vehicles is growing quickly. With EV sales shooting up, there is a greater need to develop a robust charging infrastructure. More than just installing charging points, the bigger challenge lies in managing a large fleet of devices dispersed across geographic locations. There are challenges in developing the EV ecosystem, including infrastructure management, addressing customer experience, profitability, maintenance, monitoring, energy management, and ultimately, how to create a universal ecosystem that works for everyone. IoT technology is a promising player in bringing it all together. In this paper, through a specific case study, is pointed out the importance of IoT integration in the EV ecosystem, as one of the key management factors. By monitoring the charging network, it is possible to independently manage the power and its distribution and obtain real time reports on charging behavior and data on vehicle models. IoT usage enables CPOs to remotely monitor and manage operations and quickly resolve issues by presenting real-time insights into usage and device performance, including charger availability, fault monitoring, and troubleshooting – all of which help enormously when it comes to predictive maintenance and reducing downtime. In conclusion are identified the new benefits of IoT integration of the EV infrastructure.

Introduction

According to McKinsey, over 40% of the Internet of Thing's economic value will be contributed by operations optimization and account for $1.3 trillion by 2030. With EV sales shooting up, there is a greater need to develop a robust charging infrastructure. More than just installing charging points, the bigger challenge lies in managing a large fleet of devices dispersed across geographic locations. Unlike the non-networked gasoline fuel stations, the EV charging stations are connected devices and integrated with various third-party service providers such as energy suppliers, e-MSPs, and charge point operators [1-2]. The transition to electric mobility is a promising global strategy for decarbonizing the transport sector by hybrid energy system [3].

They use various protocols & connectivity options and back-end cloud infrastructure to ensure seamless charging operations such as payment processing, software updates, scheduling, predictive maintenance, and usage analytics. Besides all the factors favoring EV adoption, the key to success lies in the development of robust charging infrastructure [4]. The real challenge is not about installing a large number of charging stations, but the ability to remotely manage and smoothly operate dispersed devices. IoT has the potential to resolve the problems of the EV charging industry and enhance the overall adoption of EVs. The paper presents a network of electric chargers integrated in IoT [4-5], for managing the charging network and monitoring power and its distribution. It is also presented dynamic energy management, to utilize the maximum energy potential, where the whole process is achieved through special IOT communication protocols, as illustrated in Figure 1:

Figure 1. Implementation of IoT architecture

Electric vehicle charging station

An electric vehicle charging station connects an electric vehicle (EV) to a source of electricity to recharge electric cars, neighborhood electric vehicles and plug-in hybrids [1]. Some charging stations have advanced features such as smart metering, cellular capability and network connectivity, while others are more basic [2,4]. Charging stations are also called electric vehicle supply equipment (EVSE) and are provided in municipal parking locations by electric utility companies or at retail shopping centers by private companies.

These stations provide special connectors that conform to the variety of electric charging connector standards. There are three categories or types of charging: Trickle Charge, AC Charge and DC Charge. The slowest method of charging your EV at home, using a standard (three-prong) 220V plug.

IOT in ev charging

In simple terms, the IoT can be viewed as a convergence of OT (Operational Technology) and IT (Information Technology) [1]. While OT deals with the operations of physical properties such as devices, sensors, and connectivity, IT focuses on the digital transformation aspects. In the view of EV charging, IoT comprises three major elements charging equipment, mobile app, and charging management platform [2].

IoT in EV charging enables continuous monitoring and presenting data in form of reports & dashboards. It also helps in notifying users in the event of critical failures or important updates. Charge point operators can remotely troubleshoot devices without a physical visit. Network operators can enhance roaming services for their charging network as illustrated in Figure 2:

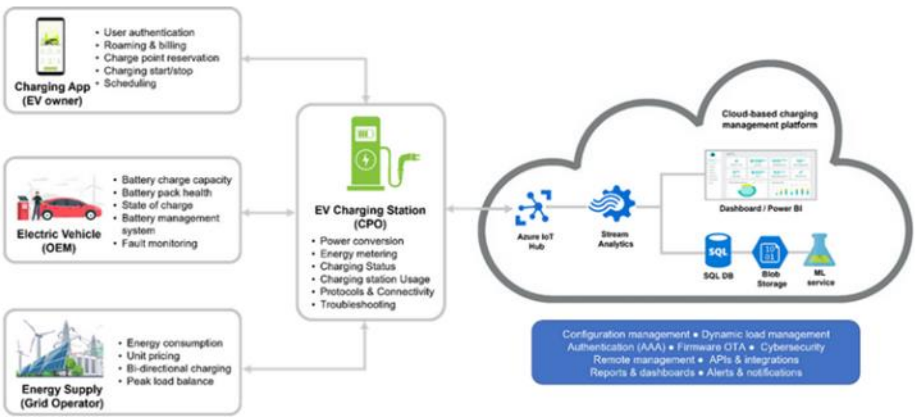

Figure Error! No text of specified style in document.**2.** Diagram of IoT in EV charging

IOT integration case study

The charging network system that is considered in this study consists of KemPower Satellite electric chargers, where each charger has Charging Power Unit (CPU) [6]. Each CPU cabinet provides up to 200 kW of charging power from four power modules into one or up to eight charging plugs on Satellite posts. Charging stations are geographically dispersed, making it challenging and expensive to manage 'onsite'. IoT enables CPOs to remotely monitor and manage operations and quickly resolve issues by presenting real-time insights into usage and device performance, including charger availability, fault monitoring, and troubleshooting – all of which help enormously when it comes to predictive maintenance and reducing downtime.

Additionally, as charging station buildouts increase, data on existing deployments will help operators more accurately plan locations for new stations. Data can also be used to optimize charger utilization, identify areas for improvement, and track trends over time. In the Figure 3, the location of each charger is shown, which is continuously viewed in the system.

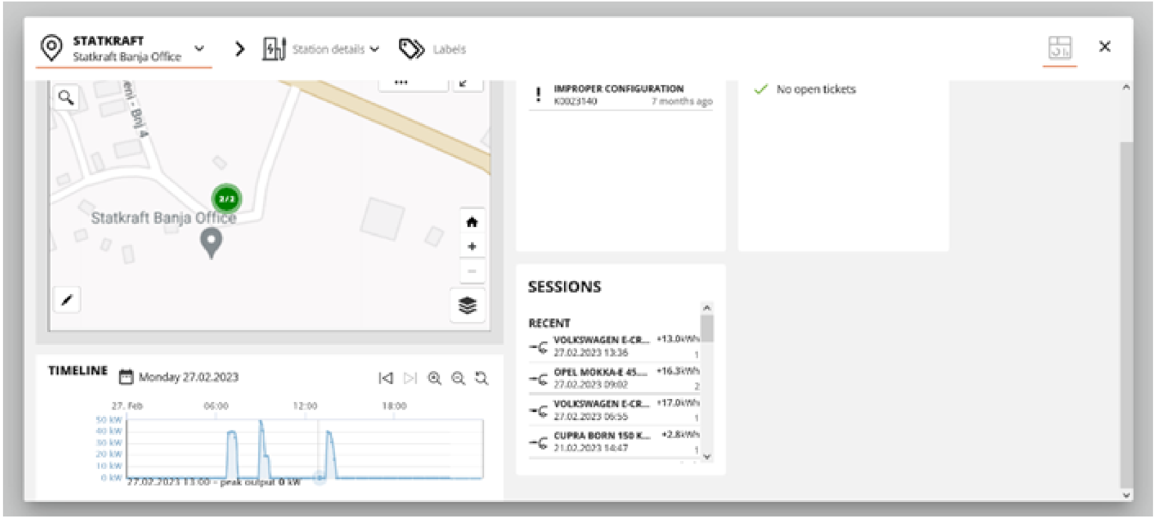

Figure 3. Geolocation of the charger

Each Charging Power Unit (CPU) consist of 1-12 power modules, with 2 independent power channels on each module and optional dynamic module that can route the power channels in any order to a maximum of eight charging outputs. To utilize full potential of each DC charger, dynamic power management is one of the key elements on Adaptive EV charging.

Compared to the traditional static charging, Adaptive EV charging can benefit from re- routing the power channels even during each charging session. It enables true flexibility to DC charging and improved OPEX as charging service power levels can also be adjusted to match with real-time energy price level as well as to eliminate possible power peaks in advance.

The Figure 4 shows in real time the power received by the cars, its distribution as well as the model of the car being charged. There are also errors in the system that may have occurred during charging.

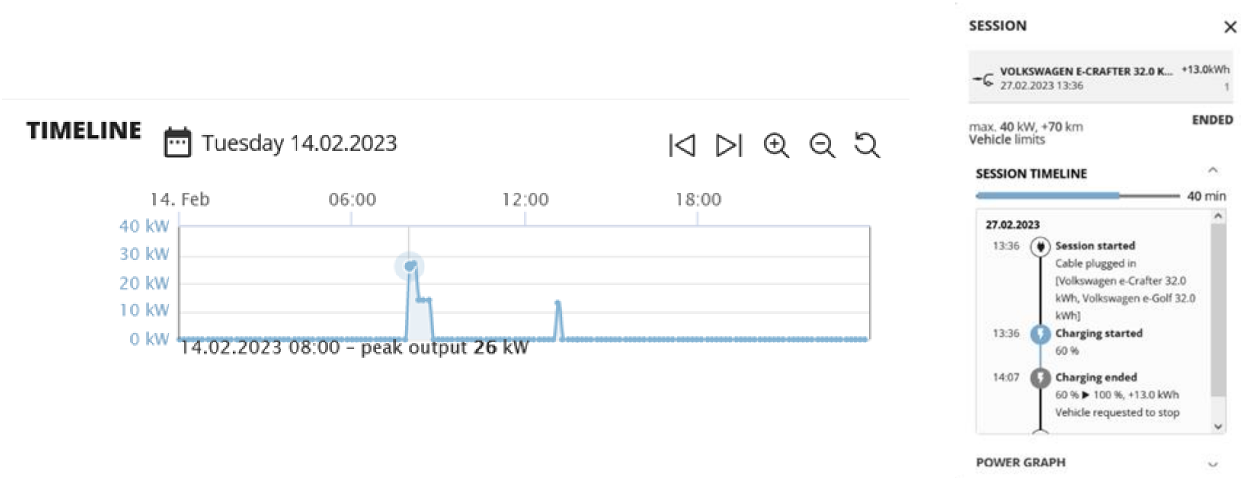

Figure 4. Data from the charging network in real time

In the democratic power management as illustrated in Figure 4, each charging output is granted with 25 or 50 kW from the beginning of each charging session, thus on an empty charging area, the first vehicle receives maximum power until next vehicle starts to charge. The starting power level is depending on the number of power modules versus number of charging outputs and their charging cable sizes.

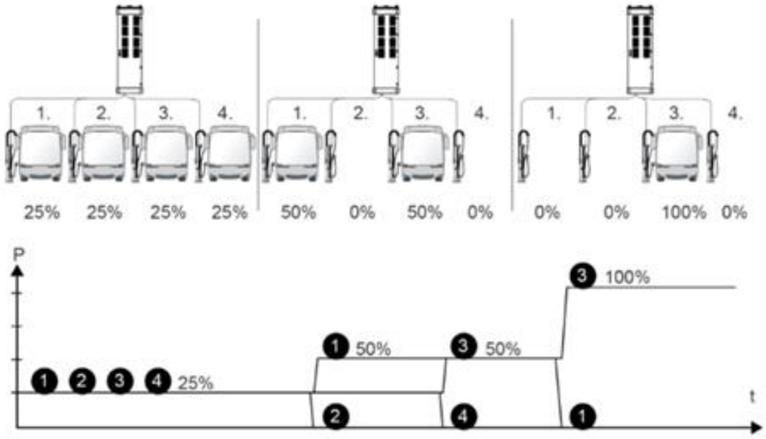

Figure 5. A simplified example of democratic power management

Results and conclusions

More than just remote monitoring, IoT is a fundamental block for developing next-gen applications such as smart charging and vehicle-to-grid. Not only for EV drivers, but IoT is also equally important and beneficial for everyone as it helps CPOs to prevent downtime, grid suppliers with energy management, and create a large roaming network for a seamless charging experience.

The case study of IoT integration of the KemPower chargers' network is presented and real-time data is obtained and analyzed . The main identified benefits:

- Improved Authentication

Before charging the EV, the users need to verify themselves with the help of smartphones or RFID tags for access. This high-end authentication ensures secure billing and transaction.

- EV Station Search

Finding an EV charging station in an unfamiliar area is hectic. With IoT, EV owners can easily find nearby stations by searching the application's location, checking availability, and reserving a slot in advance per the charging requirements.

- Smart Charging

With the help of IoT, the chargers can find the lowest rates available from the grid and start charging automatically. This facilitates the CPOs to manage the surge in energy demand and save costs.

- Remote Operation Management

IoT solutions have enabled the CPOs to take real-time device performance insight into account and quickly resolve the associated issues while remotely managing the other EV station operations.

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