Expanding Existing V2X Communication to Transmit Electric Vehicle Data to District Energy Management Systems

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Abstract

In order to use the flexibility offered by large energy storages like pooled electric vehicles (EV) in districts and neighborhoods, novel options of energy management between vehicle and buildings have to be developed. The primary goal is to prevent the existing electrical infrastructure from overcharging and to maximize locally generated renewable energy consumption. Therefore, the EVs have to communicate their remaining storage capacity, destination, distance to the charging infrastructure, state of health and other parameters to the district energy management (DEM), to enable the DEM to decide on optimal energy flows. This paper depicts the procedure that was developed to facilitate communication between an EV and a DEM with the aim of enhancing flexibility in the energy use. A controller area network (CAN) reader was used to extract sensor data via the on-board diagnostics (OBD) interface, and to convert the data flow to a JSON format. A vehicle-to-everything (V2X) capable communication device was used to transmit this data via Message Queuing Telemetry Transport (MQTT) protocol to an InfluxDB time-series database for access by the DEM. A communication architecture and message format to transmit data between EV and DEM based on V2X-Facility messages is eventually proposed.

Introduction and Motivation

The integration of renewable energy generation, required to mitigate climate change, brings two main challenges: the volatility of energy resources, and the timing mismatch with energy demands. As weather amplifies the effect on power generation, it has been estimated that an additional 9.6 GW of flexible power generation in Germany might be needed during extreme weather years by 2050 [1]. One solution for these challenges is through sector coupling, where the available infrastructures that contain energy resources can be utilised by integrating electricity, heat and transport sectors [2]. Using electric vehicles is a potential option for this integration [3, 4]. This paper focuses on the use of a fuel cell electric vehicle (FCEV) as a stand-in for a battery electric vehicle (BEV) for supplying electricity and heat to a local energy system with the aim of increased flexibility. The use of sensors, software, communication procedures, measurement modules, and Vehicle-to-everything (V2X) capable devices has been presented.

Applied Method

The proposed communication architecture between the vehicle and the building can be seen in Figure 1. An FCEV was employed and modified to include an external heat exchanger (EHE) and an electrical coupling for heat and electricity provision to the building. Temperature (T1, T2, T3, T4) and flow (F) measurements from sensors in the EHE were sampled to the Data Acquisition Module (DAQ) 1, while the DAQ 2 sampled signals from the vehicle's electronic control unit (ECU). CAN and MQTT communication protocols, and a Cohda V2X capable device were used to send data to the DEM. InfluxDB was used as the DEM database.

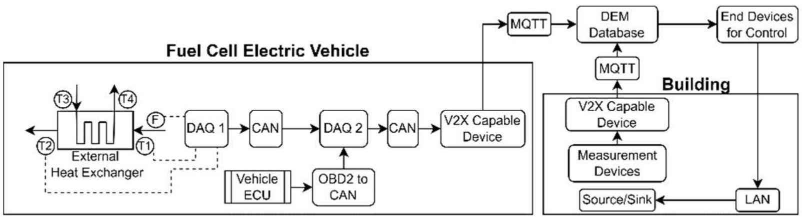

Figure 1. Planned, installed, and tested interface for communication between the vehicle and the building.

Results

Sample measurements obtained on October 17th, 2024 from the temperature sensors at the EHE are shown in Figure 2.

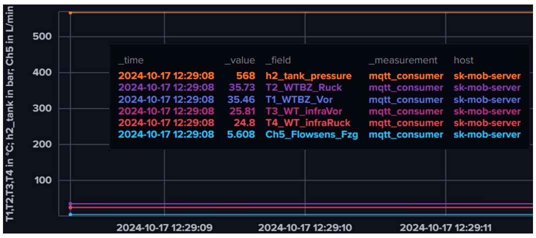

Figure 2. Measurements of temperatures, flow (Ch5), and hydrogen pressure (h2_tank) directly from InfluxDB.

Conclusions

The proposed communication scheme enables the transfer of real time data from the vehicle to the building. The use of V2X devices and a DEM facilitated the integration.

References

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