WHITE PAPER: EV CHARGING DATA AGGREGATION PROJECT

or: What happens if very large EV fleets start to share EV charging data within a collaborative shared-data framework to solve today's infrastructure challenges.

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Status Report: EV Charging

Vehicle Charge Event Data Aggregation Project

Content

About COVESA

COVESA is an open, collaborative and impactful technology alliance, accelerating the full potential of connected vehicles. Working together, COVESA is a force multiplier, creating a more diverse, sustainable and integrated mobility ecosystem.

The Vehicle Signal Specification (VSS) is an initiative by COVESA to define a syntax and a catalog for vehicle signals.

Abstract

The automotive industry is at a pivoting point where software and electrification are defining the future of the vehicle. Disruptions are coming from many different industry segments and non-traditional automotive players. Looking at the charging infrastructure and stakeholder landscape, fragmentation in this area hugely impacts customer experiences. We have several thousand Charge Point Operators (CPOs) in Europe today. Many rely on other platforms and backend solutions, given the need for more technical knowledge and expertise to offer their services. On-top the industry is just starting to focus on a few key standardized and/or open protocols to harmonize data and communications around charging. However, today especially, the data related to chargers is still heavily prone to error, handled across multiple interfaces - a single source of truth does not exist. This results in inconsistencies, data gaps, or simply outdated data. From a customer's perspective, it can result in frustrating experiences, for example, unprecise POI locations of chargers, arriving at broken chargers, closed spaces, queues, or simply poor charger performance, to name a few. The industry is trying to counteract – e.g., many 3rd party applications are aggregating data, leveraging customer feedback loops, incentivizing customer ratings and continuously trying to improve the quality of existing data on charging sites in this very dynamic environment as the infrastructure scales up further and becomes even more complex and fragmented. As we move from early adopters to the mainstream market customer, data reliability is key to driving broader acceptance and a seamless experience for all EV customers, no matter what brand or charging provider is used. It is crucial for electric vehicle success. This white paper gives a technical perspective on how an open data model such as COVESA's VSS within a neutral server approach can help overcome some challenges while leveraging the connected vehicle to describe the charging event.
More specifically – what happens if a very large brand-agnostic EV fleet starts sharing charging related data amongst each other along their individual routes?

Project Overview

To deliver great EV charging experiences for everyone, standardized, shared big data must be leveraged at scale. Data and APIs must be standardized and shared to create scale greater than a single OEM or supplier can provide through proprietary solutions. Standardization and sharing of specific data are imperative to enable scale as well as opportunities for growth in EV charging that eventually will result in greater value for the individual market player as well.

The EV Charging Event Data Aggregation Project is chartered to

- develop a data model as a logical extension of Vehicle Signal Specification (VSS) to represent charging data and events
- leverage digital.auto to visualize the flow and logic of the targeted data

- demonstrate via proof of concept that charging data and events can be gathered and off-boarded at scale by more than two participants in a collective manner that will result in better experiences for all customers based on big data and insights
- The charge point network is highly fragmented and data from the CPOs (Charge Point Operators) is unreliable (e.g., location of chargers, occupancy, broken chargers, actual power, ...), these all lead to typical customer paint points that stop us from delivering world-class charging experiences
- Vehicles would be able to very easily crowd-sourced data themselves and off-board them
- vehicles or small fleets aggregating this data by themselves have much less scale. Algorithms (typically OEM IP or OEM's supplier IP) can only work with lots of reliable data in this regard to build statistical/predictions models
- Harvesting & sharing vehicle charging data at a large scale will add significant value to power new experiences at a large scale that has not been possible before

Vision

- Leverage "vehicle as a sensor" during charge events
- Establish a standard data model to represent three areas of interest: charge location, event and bidirectional charging as a sub-tree
- Crowd source data within a collaborative community, start a PoC
- Key (anonymized) data points could be, for example

  Step 1

  - exact GPS location of charge event
  - Chargepoint ID
  - key figures of current charging process
    - average charge power
    - max power charge power
    - time to complete

  In the future

  - failures/connection errors
  - vehicle/trailer dimensions during the charging event
  - Suitable for trailers
  - Illuminated during the night
  - occupancy (+ planned occupancy along the tip)

- extend the existing VSS model to drive unique connected experiences

The 10% vs. 10x bold approach- focuses on 10x growth and not 10% improvements. This thinking can be applied here. As data fragmentation regarding charge points, backend players and aggregators will most likely continue, it needs a different approach that goes beyond simple patching of the existing data (refer to figure 1 as reference). With the vehicle being the "eyes and ears" of the charging event, it knows precisely where it is, when it will leave, when it is at the next charger, and how reliable the charging event is. It is the perfect sensor to neutrally characterize its' environment fully automated by adopting an open data model and communicating with other fleet participants to start leveraging charging data at scale. This opens many new opportunities that benefit not only each contributor but the entire industry and, in the end, all EV customers, boosting infrastructure reliability/availability.

The technology vision we are proposing in this white paper is leveraging an extended VSS model that has been defined in the charging data expert group within COVESA. With the help of digital.auto, we are simulating a complex environment of multi-brand vehicles, sharing charging event data in an open-source framework as they travel within a defined grid, using publicly available navigation APIs and charger POI data. We are making the hypothesis that in such an environment, the overall travel time and charger utilization is naturally optimized due to the inherent knowledge of this big data. It can subsequently be used to determine from each vehicle's point-of-view what the ideal route is, resulting in optimized charge stops as every participant reacts to a dynamic ecosystem. We also hypothesize that the penetration rate of participants sharing data only needs to be a fraction of the entire system to positively affect the journey.

With this example, it shall become clear that only by leveraging an open data model in a neutral server-shared approach, a much bigger value arises that can ultimately result in even more differentiated experiences we would not have imagined before. This still protects the individual IP of the contributors but enhances significantly the entire eco-system and ultimately boost the acceptance of E-mobility as it contributes to the future of a reliable and flexible charging infrastructure.

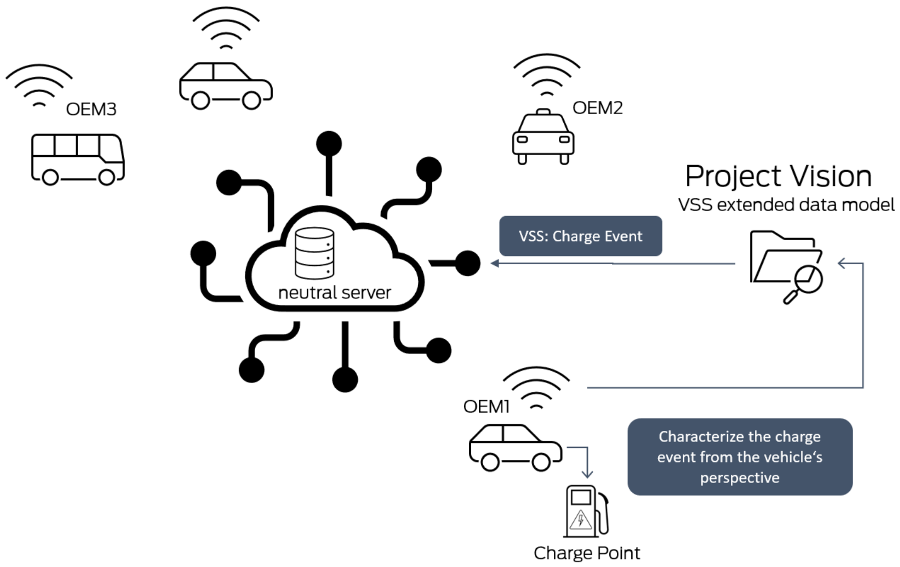


Figure 1: VSS extended data model applied to charging data aggregation

Data is heavily prone to error as it is being handled across multiple interfaces and protocols. No single source of truth exists, which results in inconsistencies, gaps and outdated information – as shown in Figure 2 below.

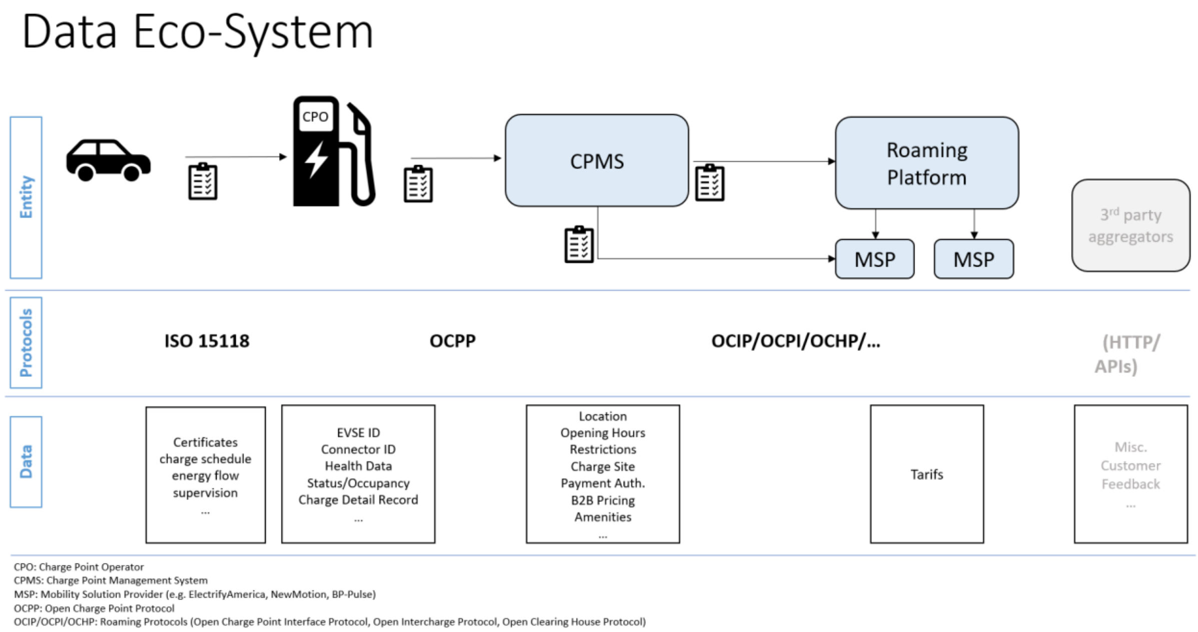


Figure 2: Overview of charging data eco-systems

Getting Started: EV Fleet Simulation

In order to validate the approach taken in general for this project, the required data and COVESA VSS APIs in particular, an EV Fleet Simulation was created. This simulation utilizes the digital.auto playground to manage VSS and required ad-hoc extensions, as well as building the dashboard for the simulation. In the background, a new, dedicated EV Fleet Sim server has been made, designed to support the goals of this project.

Fleet Perspective

The following outlines the Fleet Perspective in the EV Fleet Simulation. The goal is to make this a proper, brand-agnostic fleet perspective. This will start on the simulation level, later potentially augmented with accurate fleet data.

User perspective

The driver wishes a charge point recommendation that fits his preferences best. For example, a driver carrying a trailer needs a long charging space, whereas a big family might look for a playground for the kids. Therefore, the data tree proposed in COVESA also proposes standardizing infrastructure data. To deliver a satisfying charging user experience, the prediction of charge point occupation might be based on crowd-sourced data provided by a multi-OEM EV fleet. Figure 3 is shown how the user journey is linked to the data journey.

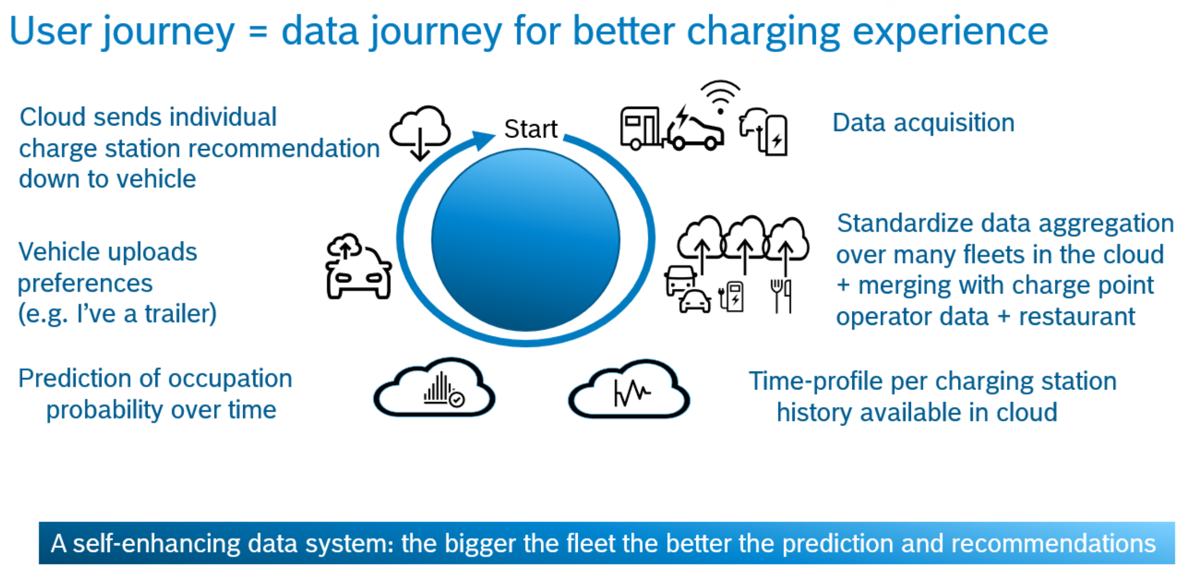
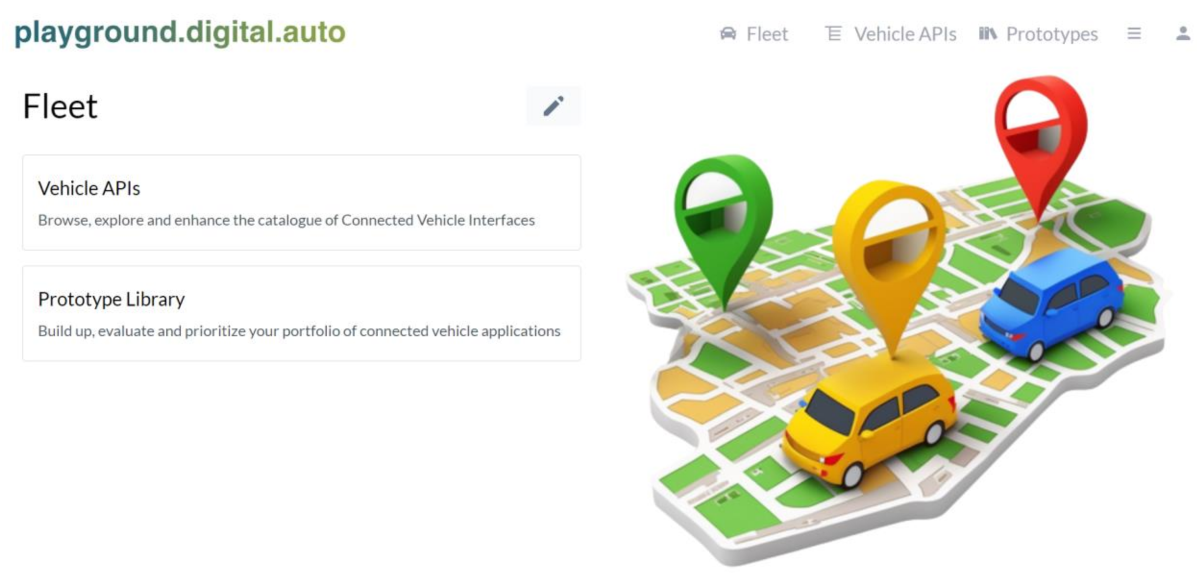


Figure 3: user journey = data journey

Entry Page

The entry page can be accessed here: [https://digitalauto.netlify.app/model/goWywBM5VPnC3voJycT7.](https://digitalauto.netlify.app/model/goWywBM5VPnC3voJycT7)



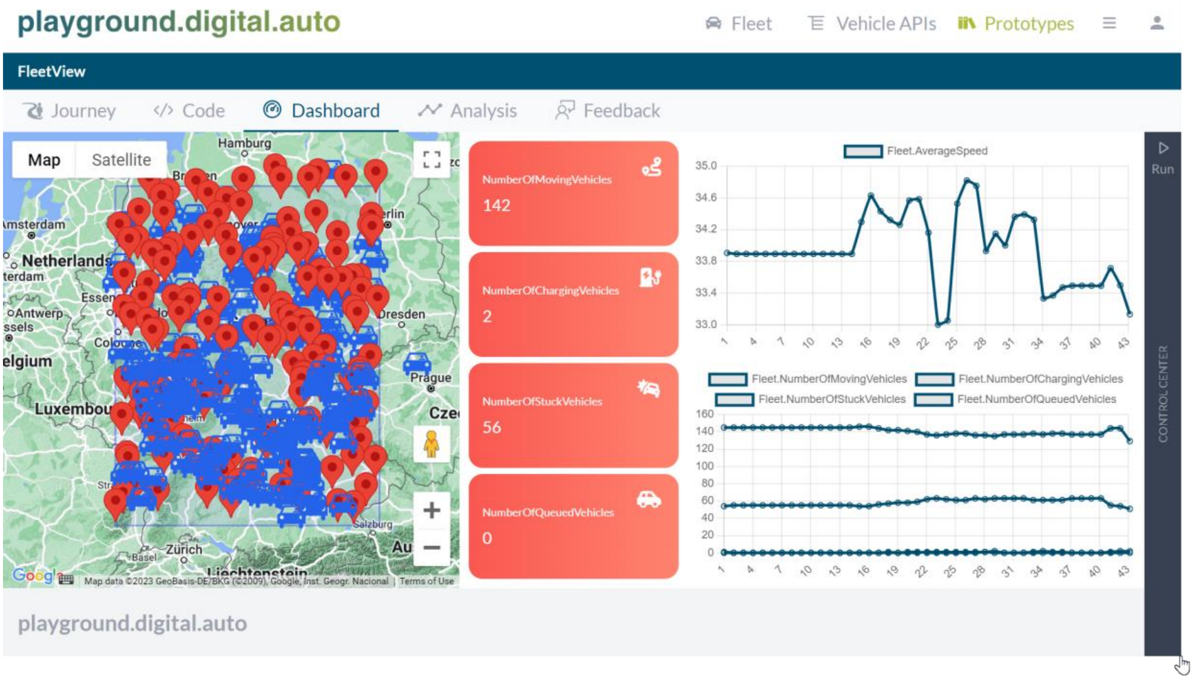
Fleet API

In order to provide a fleet dashboard in the digital.auto playground, a VSS syntax-compliant set of APIs for the fleet was defined. It remains to be seen if this is an ad-hoc technical solution or as something that should be developed further and even potentially standardized.

Fleet	BRANCH
Fleet.**NumberOfStuckVehicles** W	SENSOR
Fleet.**IteratorEnded** W	SENSOR
Fleet.**NumberOfMovingVehicles**	SENSOR
Fleet.**NumberOfChargingVehicles**	SENSOR
Fleet.**NumberOfParkingVehicles**	SENSOR
Fleet.**NumberOfQueuedVehicles**	SENSOR
Fleet.**AverageSpeed**	SENSOR

Fleet Dashboard

The fleet dashboard provides an overview of the fleet as a whole, currently including primary data about fleet statistics like moving vehicles, charging vehicles, and cars stopped due to empty batteries.

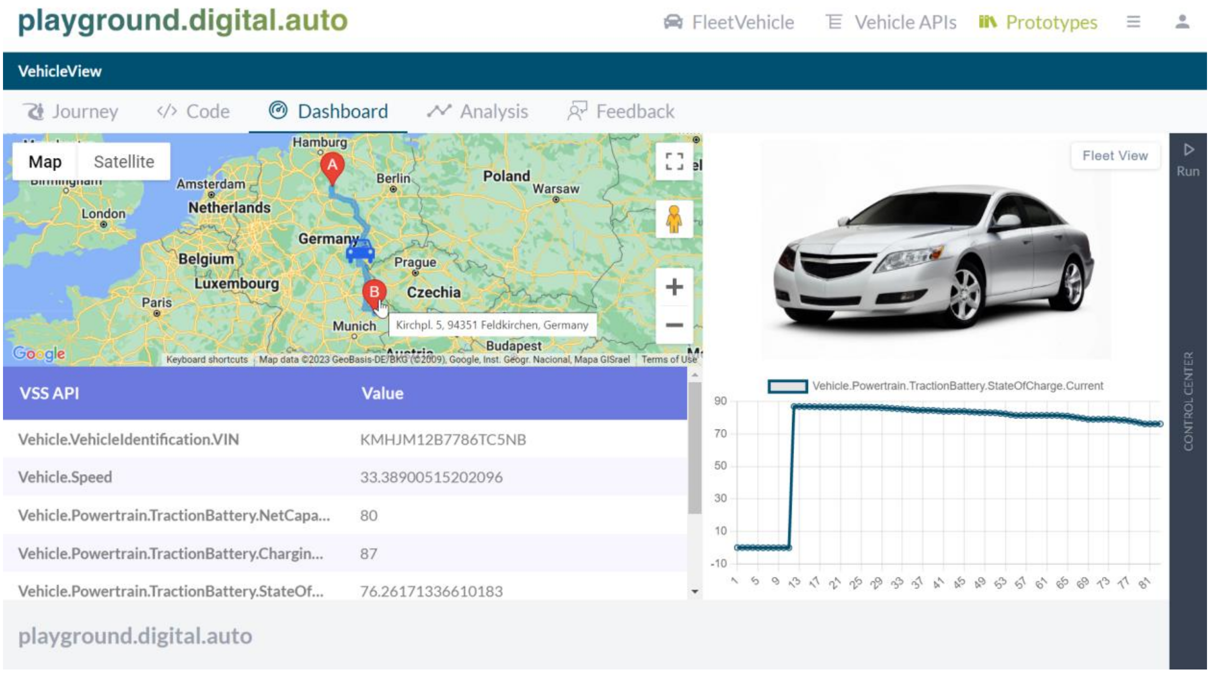


BEV Perspective

The BEV perspective provides details about the individual vehicles, including vehicle movements and critical readings of VSS sensors.

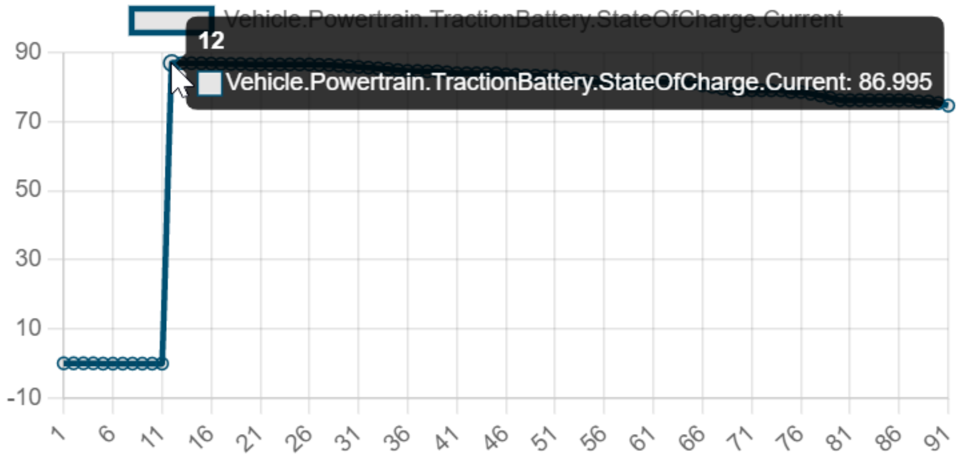
Dashboard

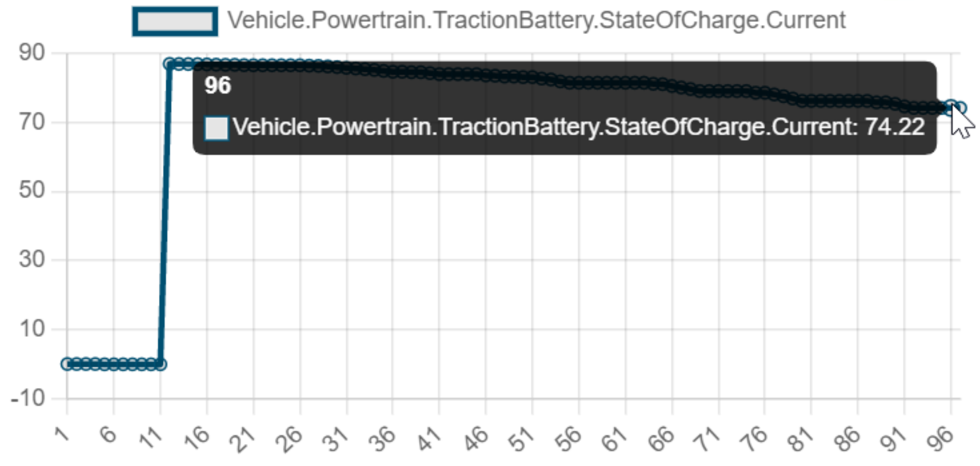
The dashboard provides an overview of the current state of the vehicle. The map shows the movement of the car in the simulator. Next, the VSS API table shows the current simulated values. Finally, the chart visualizes critical time series data – in the present instance, the state of charge.



EV StateOfCharge

The EV StateOfCharge is a crucial indicator for the range of the BEV, which is why it is included here. Primarily for use cases focusing on data related to range vs. next charge point available, this is important.





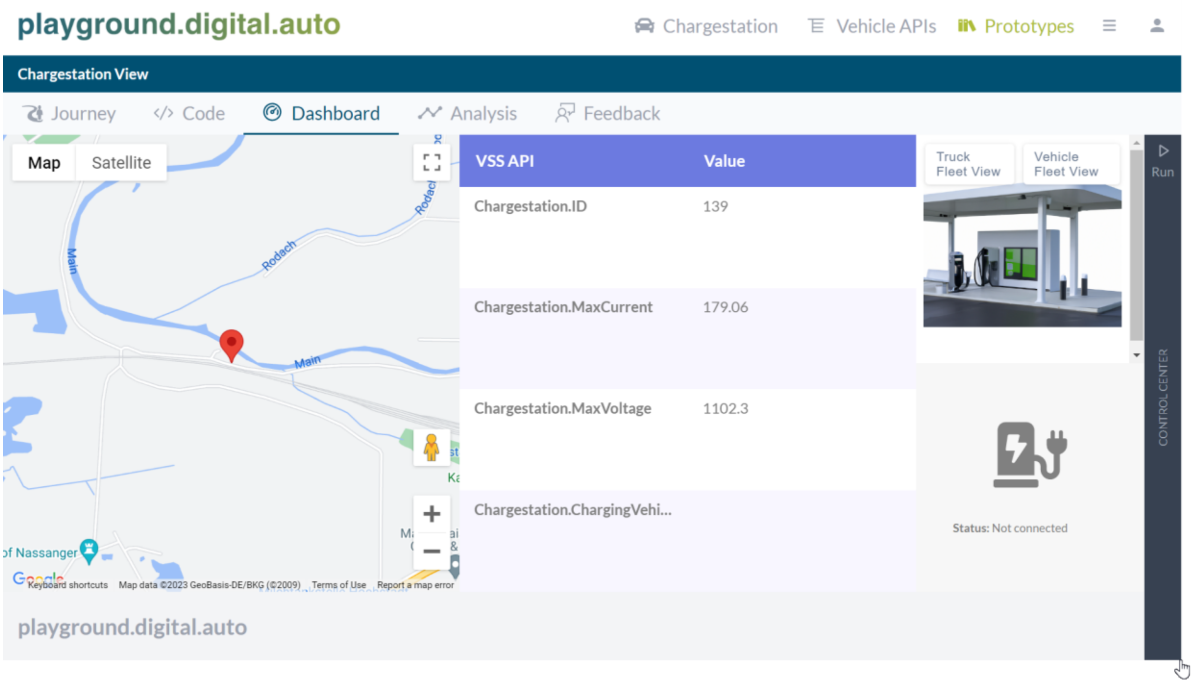
VSS

COVESA VSS exposes key vehicle data points from the simulator for further processing and analysis. This includes the random Vehicle Identification Numbers of the simulated vehicles, speed, net battery capacity, charge limit, the current state of charge, and battery range. In addition, key data related to the charging process itself includes "is charging" and "time to complete."

Vehicle.VehicleIdentification.VIN	KMHJM12B7786TC5NB
Vehicle.Speed	23.760415209480826
Vehicle.Powertrain.TractionBattery.NetCapacity	80
Vehicle.Powertrain.TractionBattery.Charging.ChargeLimit	87
Vehicle.Powertrain.TractionBattery.StateOfCharge.Current	81.52067813643326
Vehicle.Powertrain.TractionBattery.Range	326.082712545733
Vehicle.Powertrain.TractionBattery.Charging.IsCharging	false
Vehicle.Powertrain.TractionBattery.Charging.TimeToComplete	86.94461138882754

Charge Point Perspective

Finally, the charge point perspective can be used to visualize information about the charge point, including performance data (e.g., max. current and voltage) and any current vehicle attached to the charge at the charge point.



Next Steps

The working group has identified the following work packages to advance the mission of the project:

(1) Extension and refinement of the simulator`s behavior to support the project goals
(2) Improved analysis of simulation results to help validate the central project hypothesis
(3) Augmentation with and validation against real-world data, including vehicle and charge point data

Re (1), the simulator`s behavior to support the project goals should be extended and refined as follows:

- Improved vehicle performance simulation with the individual vehicle and driver profiles
- Improved vehicle charging simulation, with more realistic route and charge stop planning
- Include simulation of charge points with "bad quality of service."
- Testing of first collaborative charge point reservation algorithms to minimize wait times and maximize range

Re (2), the analysis of the simulation data should be extended to cover the following:

- How can the simulation data be used to improve
    - Insights on quality of charging services (i.e., identify aforementioned, simulated charge points with "bad quality of service")
    - Charging process improvements, e.g., reduced wait times
- Identify additional data demands (type of data, update frequency, average coverage) in order to improve the charging experience?

Re (3), the working group would like to augment and validate their approach against real-world data, including vehicle and charge point data. For this purpose, a scouting process is underway to identify interested OEMs and charge point operators.

Re (4), the data back-end might be extended to merge multi-OEM data sources with other service providers (e.g., POI-data-bases).

Re (5), based on historical time-series data per charging station, a prediction of the future (e.g., occupation probability) becomes possible. A multi-object optimization for the individual preference (e.g., kWh-pricing, occupation-probability, trailer-ready-flag) might provide an optimized charging user experience.

Please get in touch with the working group if you would like to contribute to any of these activities.