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AN INFLUXDATA CASE STUDY

Gotion's Electric Vehicle Battery Management Systems Rely on InfluxDB

Gotion

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Gotion Collects Battery Sensor Data To Develop Safer, More Efficient Batteries

Company in brief

Gotion is an energy solutions company focused on battery technology. In its offices around the world, it works on a wide variety of projects including electronics, battery packs, and large-scale energy storage. The California office focuses on Battery Management Systems (BMS) for electric vehicles (EVs). EVs are becoming increasingly important as the word transitions to more sustainable transportation. The batteries that power them need to be well designed and monitored for safety and efficiency. A BMS is built into electric vehicles and monitors battery status. It keeps track of battery metrics to let drivers know battery usage, remaining mileage, and more. It can even detect safety issues such as overheating and warn drivers before the situation becomes dangerous. Gotion's batteries are used in many vehicles around the world, with an especially high market in China.

Case overview

Gotion handles huge volumes of data from BMSs. Some important metrics to monitor for safety include temperature, voltage, and current. Gotion uses that data to help design better batteries and to ensure safety while batteries are in use. The majority of the data the Gotion team collects is time series data, and they've chosen to use InfluxDB to store it. InfluxDB allows them to use an algorithm they've developed on large datasets to detect temperature anomalies before they become dangerous. They also collect data on battery usage in order to recycle batteries. The engineers working on developing new batteries found InfluxDB simple to learn. They use client libraries so they can code in the same language their algorithms are written in.

Technologies used: InfluxDB, Apache Airflow, Grafana, MATLAB, PostgreSQL, Python, scikit-learn, TensorFlow

The business challenge

The batteries Gotion works with have three levels. The basic unit is a cell, which is often similar in size to an iPad. Collections of cells make up modules, which have built-in monitoring components. Groups of modules make up packs. There are hundreds of cells in most packs and a BMS has to monitor data output from all of them. The majority of the data Gotion collects are time series, which is what led them to InfluxDB.

Each pack can include hundreds of measurements of battery voltage, around a dozen temperature sensors, and at least one current sensor. Gotion's BMS collects all these metrics on different timescales. A typical BMS collects voltage every 50 milliseconds, current every 10 milliseconds, and temperature every second. The Gotion team needs a database that can store and handle these different time resolutions.

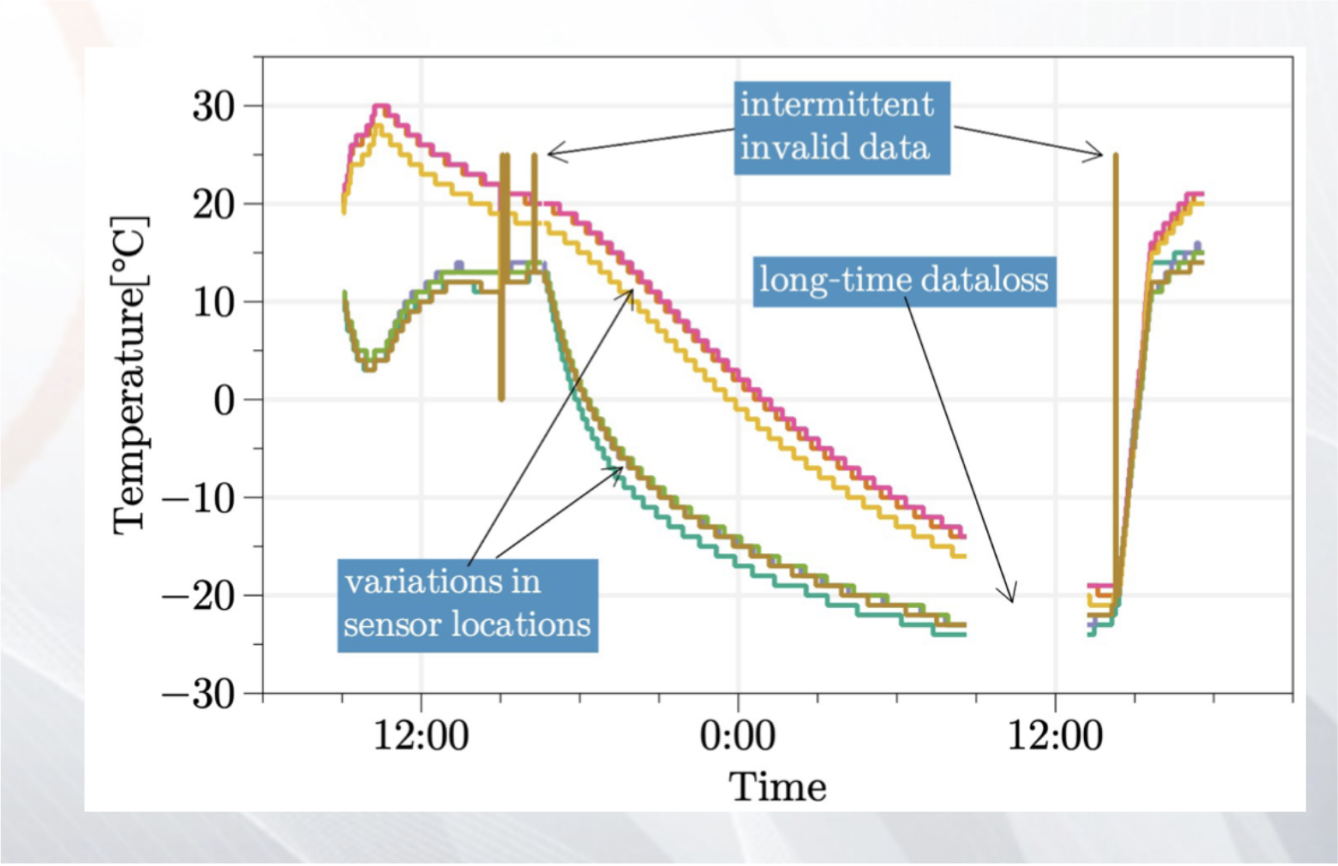
In addition to having a huge volume of data to manage, the Gotion team has to handle several different formats. The testing center sends data in text files or CSVs. Vehicles also send GPS and speed information, as well as charger and motor data. Gotion needs a system to store this data in a uniform way so its analytics team and the algorithm they've developed can easily access it.

This data can also help trace and determine the source of errors. Different companies manufacture cells, modules, and vehicles. Knowing where anomalies originate also helps them develop better algorithms. The better the algorithms are, the safer electric batteries become.

The technical challenge

One major Gotion project is an algorithm for thermal anomaly detection. Thermal runaway is a major problem and safety hazard for EVs, and detecting anomalies in temperature can prevent it. The causes vary from mechanical issues to electrical issues to batteries becoming overheated in extreme temperatures. Unchecked thermal runaway can lead to dangerous and difficult-to-put-out battery fires. Predicting thermal runaway and giving customers early warnings and alerts are key aspects of designing safe batteries.

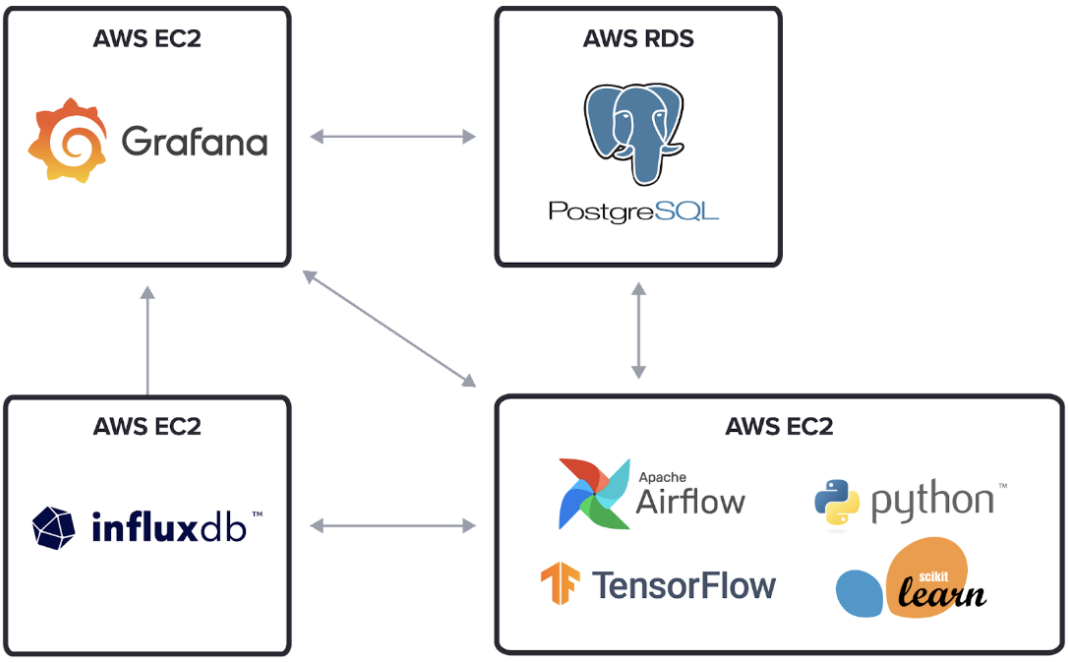
The data the Gotion team works with often has periods of invalid or missing data. Wireless transmission problems or simply turning off EVs can cause this. Often the source of an issue is unknown. With this kind of data, it's difficult to manually trigger warnings or base warnings on set thresholds. This led the Gotion team to develop an algorithm to detect anomalies.



Example of Gotion's challenges with their data. Source: Gotion

The basic way the algorithm works is by grouping data at regular time intervals based on shape. Each car has many temperature sensors, so by comparing them all, the algorithm can determine if one sensor's temperature data follows a different pattern. Battery cell designers set safe temperature limits based on tests in the lab. Catching when the shape of the data starts to change rather than when the temperature reaches a certain threshold allows Gotion to identify anomalies earlier. They've published a paper that includes further details on their algorithm.

The solution



The algorithm the Gotion team developed works on large sets of data. They created a framework that gets the data from vehicles to InfluxDB so it's ready for analysis. To upload data to InfluxDB, they often manually upload CSVs and text files to a website. They use Airflow to transmit the data, and then aggregate it with functions built into InfluxDB. Alternatively, some of their customers have wireless transmission modules within a BMS that sends data to a local gateway before it hits Gotion's system.

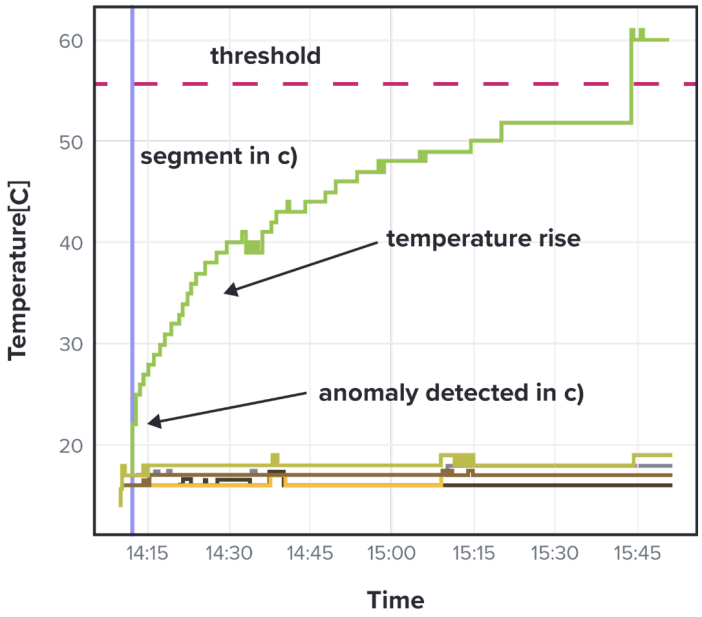
For their main application, Gotion uses Grafana for displays and dashboards. Users can select what time windows they want to focus on and what kind of data they want to apply the algorithm to. They can also customize their display with filters such as testing method, battery capacity, and chemistry type, and then view the corresponding time series. Gotion uses Airflow as a go-between tool. It gets commands from Grafana and selects data from InfluxDB. They also use Airflow to send the results of the algorithm back to InfluxDB. They store metadata on the analysis in PostgreSQL.

The Gotion team chose InfluxDB because it's the leading time series database and is built to handle the kinds of metrics they're focused on. They found that Flux, InfluxDB's scripting language, is easy for their data scientists and engineers to learn. They use Grafana as their front-end tool and appreciate the easy integration InfluxDB has with it. Python and MATLAB are the two main languages Gotion uses for algorithms, and InfluxDB's corresponding client libraries are very helpful for algorithm development.

> *"Here is the reason we choose InfluxDB as our database. First of all, it's a dedicated time series database, so it is number one in the market. So we do have a high confidence it will be continuously updated in the future.*
>
> *It is very easy to implement on a cloud platform such as AWS. [...] Compared to Graphite, InfluxDB is relatively easy to get started with and has better API support.*
>
> **Tony Li, Ph.D.,** Manager Of Software And Data, Gotion

The results

The algorithm that the Gotion team developed is successful at detecting temperature anomalies. In one case, they had thirteen temperature measurements from an EV using their BMS. One of these measurements rose above the safety threshold, so it was classified as a system failure. They applied the algorithm to this same data set and found that it was able to detect an anomaly in the shape of the data an hour and a half before it passed the threshold.



Using Gotion's thermal anomaly detection algorithm,
the platform was able to discover the problem early and send an alert.

The team is working on developing other algorithms to improve battery performance in EVs. All of this work is based on time series data, and they plan to continue using InfluxDB as their datastore because of its high performance.

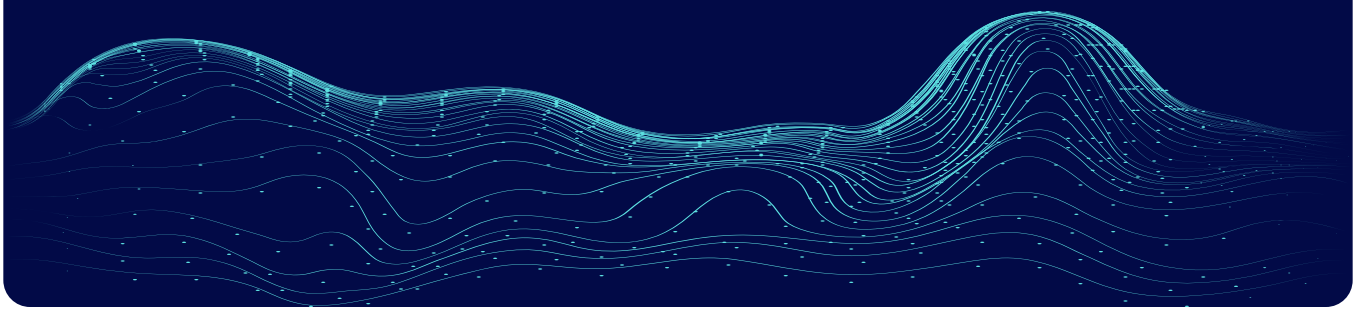
What's next

Future projects for the Gotion team include working on battery health, to give customers better estimates about battery lifespans. They also will work on battery quality management. They plan to use the data they're collecting to improve batteries so they last longer, as well as to recycle used batteries.

Batteries often include lithium and other parts which are mined in environmentally destructive ways, so recycling as many batteries as possible is important. To recycle a cell you need to know detailed data on its usage, which they have access to with InfluxDB. The data Gotion collects lets them monitor battery health based on how a driver is using a car. The team plans to utilize battery data to aid recycling and hopes to become ENERGY STAR certified.

About InfluxData

InfluxData is the creator of InfluxDB, the leading time series platform. We empower developers and organizations, such as Cisco, IBM, Lego, Siemens, and Tesla, to build transformative IoT, analytics and monitoring applications. Our technology is purpose-built to handle the massive volumes of time-stamped data produced by sensors, applications and computer infrastructure. Easy to start and scale, InfluxDB gives developers time to focus on the features and functionalities that give their apps a competitive edge. InfluxData is headquartered in San Francisco, with a workforce distributed throughout the U.S. and across Europe. For more information, visit influxdata.com and follow us @InfluxDB.



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