

Foto: Adam Borkowski

Embever IoT Core

Cloud-based IoT platform for railway assets management

CONTENT

Challenges in Railway Maintenance	3
Embever IoT Core	4
Application Dimensions	5
Energy Consumption, Data Transfer Technology, Operational Scenarios, Adaptability and Versatility	
Architectural Overview	6
Embever Cloud, Embever Protocols and Embever OS	
Features	8
Integrations, Customization and Security	
Go-to-market timeline	9
Modes of Operation and Pricing	10
Case Study 1: Frost Protection with Deutsche Bahn	11
How to keep locomotives ready in winter times	
Case Study 2: Cloud-connected APS with PowerTech Converter	12
The new generation of PowerBrix	



1

Challenges

Keeping rolling stock in good conditions increases the lifetime of its components, decreases failure rates and downtimes. Reliable maintenance protocols are a key part of railway operational systems. For years, maintenance has been carried out on a time or mileage basis, which can lead to time-consuming and inefficient maintenance checks.

The mission of Embever is to bring mobility leaders towards more efficient and cost-effective predictive maintenance systems, with IoT. This cost-effective system allows railway operators and railway suppliers to have a better understanding of the behaviour of their railways and components and access their assets data remotely to prevent potential failures and to improve the development of their products. Gathering this data can also open new business opportunities and add new digital services to the company's product portfolio.

Embever connects leading mobility providers and OEMs to their assets and services by providing the latest cloud technology and a chipset that makes it easy to send data from devices to the cloud. Embever helps you develop new connected solutions and upgrade or retrofit electronic systems with direct connections to your business applications.



Asset Management

Get a comprehensive real-time picture of all your assets at a glance. Massively improve management efficiency.



Process Automation

Issuing automatic alerts before errors occur in your devices helps you maintain a constant and efficient workflow.



Digital Twin

Own a virtual model of your devices to understand their performance and needs.



Data Collection

Access your assets' data remotely - from anywhere at anytime. Know immediately, act fast, reduce maintenance costs.

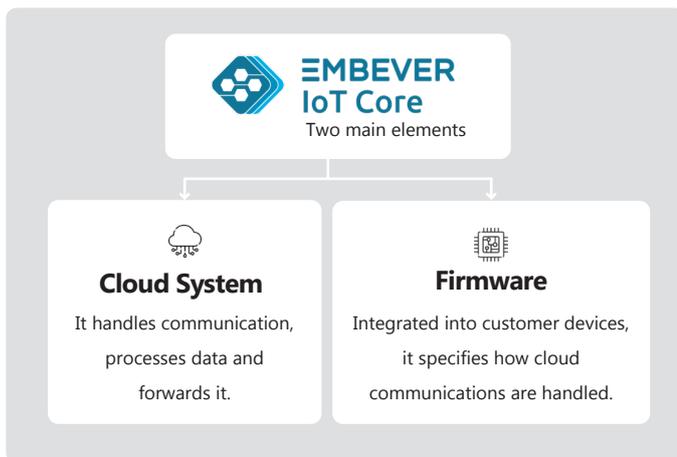
Aprox. **30%**
of rolling stock
lifecycle costs*
are related to maintenance

* Calculation based on our last projects

2

Embever IoT Core

Embever IoT Core is a connectivity platform that manages the data transfer between assets and the cloud. This platform simplifies the development of IoT products by providing a state-of-the-art connectivity solution to bridge devices to the cloud, allowing smooth communication between them.



It relieves developers of many time-consuming steps in the development process for an IoT product. Embever runs this innovative software service under a subscription or licensing model that adapts to the needs of each use case.

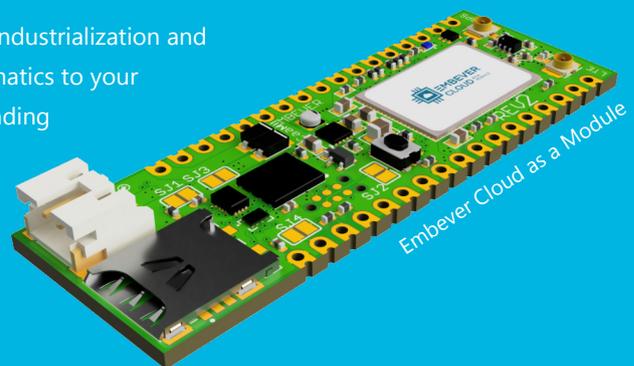
Aprox. **50%** of **warranty costs** can be reduced*

* Calculation based on our last projects

How to connect your electronic systems to the Cloud?

To enable your devices to connect to Embever IoT Core, you need to upgrade them by adding a small piece of hardware. We currently offer two different possibilities:

- **Embever Cloud as a Module:** For companies that would like to develop a prototype in a fast and easy way, we offer Embever Cloud as a Module, a plug-and-play development kit that was developed to help companies easily overcome the multiple initial hurdles such as data management, protocols, operator selection, contract management, firmware updates, etc.
- **Schematics and own integration:** As soon as it comes to industrialization and certification, we provide you the connectivity module schematics to your engineering team to adapt the design of the module depending on your hardware requirements and constraints. This option is preferred by companies planning on taking the product into mass production.



3

Application Dimensions



Energy Consumption

In scenarios where a device needs to be independent of any constant power source and is powered by batteries, the system architecture can be built to be extremely energy-efficient. In this case, the IoT devices do not have to be permanently in a state of readiness to receive or send data. Flexible settings allow our customers to decide how often the devices should “wake up” to optimize energy consumption.



Data Transfer Technology

The tool that we use comes with several cellular technologies that support different applications. For example, NB-IoT is supported for use cases in which better coverage at a higher latency is required and the size of the data is small. Other cases in which a higher amount of data needs to be transferred at a lower latency can also be supported by technology like Cat-M1.



Operational Scenarios

This new IoT product generation uses cellular communication independently of routers, so that IoT devices are independent of any onsite setup to be activated. Devices running on Embever IoT Core work out of the box. They can work in almost any country in the world without extra effort. Any time-consuming installation effort is eliminated.



Adaptability

What makes Embever IoT Core unique is the agnosticism of the infrastructure it runs on and its adaptability. This is achieved using infrastructure as code approach, using Terraform, which only utilizes non-proprietary infrastructure elements. This ensures that IoT Core can run on any Infrastructure as a Service (IaaS) provider (like AWS or Google Cloud Platform) but also on-premise.



Versatility

The versatility of this platform supports a full range of applications, regardless of their nature: power source, connectivity technology or data transfer capacity. The system adapts to the different customer parameters to exactly meet each use case.

4

Architectural Overview

Three innovations make Embever IoT Core the optimal choice to easily adapt to each use case. The System comprises three main components that operate on cloud, transmission and firmware levels: Embever Cloud, Embever Protocols and Embever OS.

Embever Cloud

API

Embever Cloud enables users to manage and control IoT devices. Using a standardized HTTP REST API, the users are able to:

- Create or modify devices in the Cloud
- Group devices into different groups (Applications) to restrict access to certain devices
- Trigger remote procedure calls
- Read events data from devices
- Create and manage Over-the-Air Firmware deployments
- Define webhooks that are used to distribute information about certain events to own or third party applications

The API is designed to act as a single interface to communicate with the devices.

Messaging System

Embever Cloud handles sending and receiving device messages. It automatically encodes messages into a specific format, as defined by Embever Protocol and sends them to the devices. Messages sent by devices to the cloud are automatically decoded and further distributed by the Data Distribution System.

Data Distribution System

By using a webhook system, Embever Cloud can distribute device data and status updates to third party systems. Webhooks can be defined to distribute a single event to several systems at once.

VPN Integration

Embever IoT Core Cloud comes with Integrations to Mobile Network Operators (MNOs). Data transfer is tunneled through a VPN between Embever IoT Core and the MNO. Therefore, any data connection between your devices and Embever IoT Cloud is encrypted automatically.

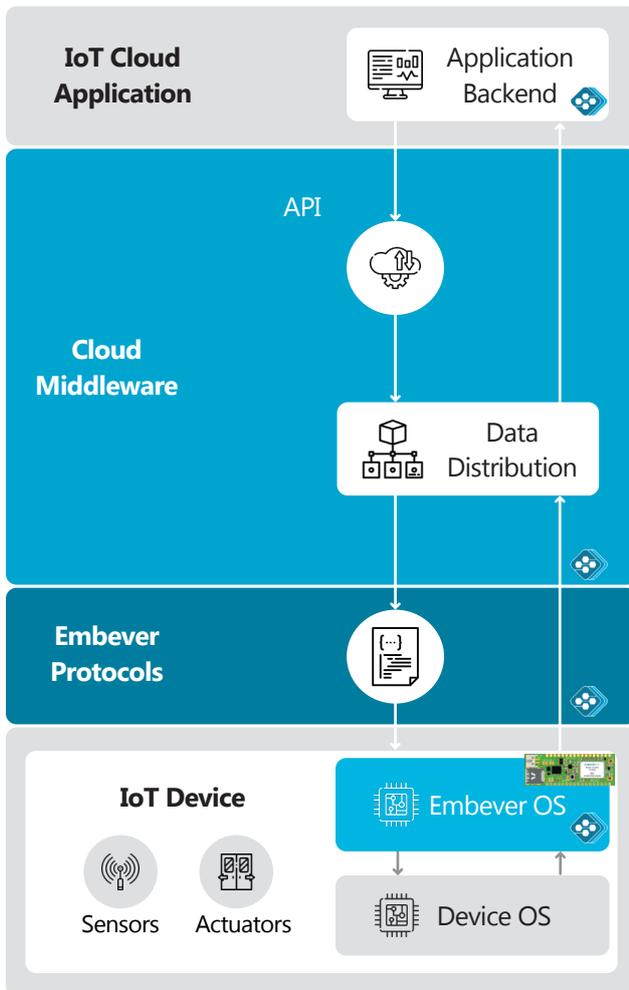


EMBEVER
IoT Core

- ✓ Implementation Support
- ✓ IoT Best Practices
- ✓ Full Documentation
- ✓ Embever Cloud Access
- ✓ MNO integrations
- ✓ Network of experts

4

Architectural Overview



Embever Protocols

Embever IoT Core employs protocols that have specifically been designed for a reliable and easy-to-maintain cloud-device data transfer.

The Embever Messaging Protocol is embedded in Embever OS and makes the devices interact seamlessly with Embever Cloud.

The Embever File Transfer Protocol is used to transfer files over congested networks. The protocol also considers the limitations of new technologies like LTE Cat.-NB1 (NB-IoT), where long delays in communication are common.

Embever Operating System

Embever OS is an embedded operating system integrated into a cellular modem that offers a serial interface that makes it very easy to exchange data with the Cloud. It includes an implementation of Embever Protocol, so that an efficient device-cloud data transfer can be automatically achieved. Developers don't have to deal with AT commands and they don't have to think about developing protocols.

The capabilities of Embever OS are easy to extend using its hardware driver architecture. This allows us to easily add support for new radio modules.

Additionally, it supports the interaction with external processors using standard serial interfaces. In this way, a clear separation (at the hardware level) between device-cloud communication protocol and business logic can be achieved. This makes the further development and update of different components not dependent on each other.

Integrated into Embever OS are over-the-air updates of application code, and of the operating system itself.

5

Features

Embever IoT Core offers the possibility of being integrated with external ERP and CRM systems of your choice to make better use of the data generated.

The availability of this data in a familiar interface can lead to better and more informed-based decisions. For example, a company that is used to working with Salesforce or SAP can integrate the data provided by the devices connected to Embever IoT Core with a few clicks.

Integration to external systems



Devices can be connected to the Embever Cloud either via public Internet or within a closed network (VPN).

Embever maintains virtual private networks with different MNOs so that the data sent from the device to the cloud is secure and remains within the private cloud.



Secure Cloud

Customized dashboard



If your company doesn't have a unified CRM or ERP system, we can provide a customized dashboard tailored to your needs. We can design how the information is displayed and establish actions that would trigger alarms or notifications.

For example, if the temperature of the locomotive where your asset is located reaches a certain degree, specific people will be notified immediately to take the appropriate action. As administrator, you can also grant access to specific people in your team to determine the information they are allowed to see. This dashboard can be accessed from any computer, tablet or smartphone with Internet access.



Data Diode

Our team is aware of the importance given to security when it comes to public transportation and railway. Embever IoT Core can be setup to enable either unidirectional or bidirectional communications.

In a unidirectional mode, only devices can send data to the Cloud and not vice-versa. Companies that are a target for cyberattacks prefer this option to prevent any potential asset manipulation by intruders.

6

Go-to-market timeline

Initial Business Workshop

In an initial workshop, we jointly define the goals and requirements for developing a prototype or a Minimum Viable Product.

Prototype Development

We help you integrate our connectivity module into your hardware by offering a development kit (Embever Cloud as a Module) or its schematics.

Integrations and Certifications

If any software integration with external systems like CRM or ERP is needed, we offer integration support. Our certification partners can help you get all certifications required.

Production

After a successful testing phase, the new Cloud-connected generation of the product is ready to be brought into production. With our expertise, we support you in developing a go-to-market and production strategy.



Aprox. 9 months*

* Calculation based on our last projects

7

Mode of Operation

Platform as a Service

Embever IoT Core uses a **Platform-as-a-Service** approach. This model of technology delivery is offered under a subscription fee based on the number of devices that are to be connected per month.

One of the biggest advantages of running your devices on our platform is fast time-to-market. The maintenance of the Cloud platform is responsibility of Embever when it is run on a Platform-as-a-Service.

- Fast time-to-market
- Grow-as-you-grow
- Reduce risks
- Focus on your business application
- **Subscription model**

Private Cloud

Customers can also acquire a **licence** to run an owned version on their own as a Private Cloud. For companies predicting an increasing growth in the number of devices, we recommend buying a licence that will reduce costs in the long term. This option should be considered if the company has the capacity to manage and maintain its own version of this platform by itself.

The biggest advantage of this option is the full control and independence over your system as the Cloud runs on your own servers.

- Full control over your Cloud
- Licence for unlimited time
- For high number of devices
- **Licencing model**



Frost Protection

Class 101 locomotives pull IC trains across Germany. To ensure that the vehicles are ready for operation at all times, even in low temperatures, they remain under power during the winter months. Voltage fluctuations can lead to the connection to the overhead line being interrupted, the starter battery discharging and the locomotive not being ready for use on time.

Wireless, battery-powered sensors continuously check the voltage of the starter battery and inform the responsible control centre directly in case of problems. The vehicles can be used immediately, which improves punctuality and reduces the time-consuming manual control rounds called "Frostwache". Deutsche Bahn plans to save 9000 working hours a year with this solution.

Challenge

Deutsche Bahn monitors these locomotives with a workforce called "Frostwache". This group of locomotive drivers and technicians check on-site every two to six hours whether the locomotives are still connected to the grid. The complexity and inconveniences of this preventive process (night shifts, overtime working hours) can be reduced with IoT technology.

Solution

After a successful prototype phase, a certified system has been developed and installed in the first locomotive. A battery-powered gateway uses wireless sensors to determine whether the locomotive is connected to the power supply of the power grid.

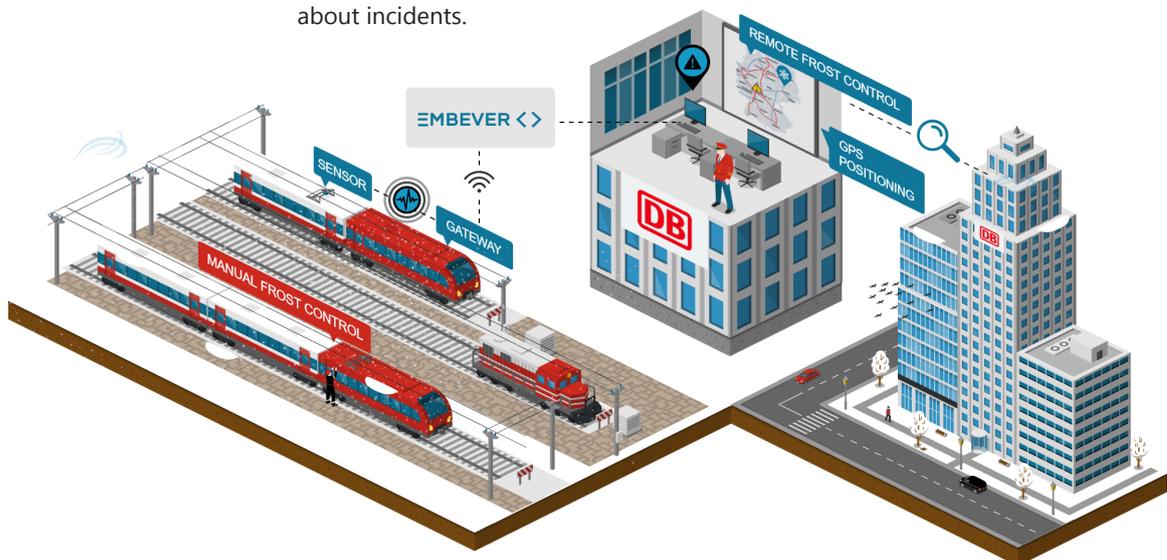
Its highlight is that this network can be expanded to include any sensors and that the gateway is equipped with a GPS function. An alert system has been configured to inform specific personnel about incidents.

9000 hours
of work a year will
the Deutsche Bahn
save implementing
this IoT solution*

* Calculation made during the implementation of this project with Deutsche Bahn

Timeline

- February 2019: Participation in DB Mindbox
- July 2019: Development of a prototype
- January-August 2020: Development of product
- September 2020: Railway Certifications
- November 2020: First installation of 120 IoT devices in locomotives of type 101.





PowerBriX Cloud

Embever has partnered with PowerTech Converter to develop a Digital Twin of their product. The Auxiliary Power Unit (APU) converts the power from the power grid into train voltage and supplies all the train's electronic components outside the traction unit.

The software of PowerBriX already collects extensive data within the unit on, for instance, the energy consumption of the train's auxiliary units, the power network as well as the battery health. The operating status of the vehicle, the outside and inside temperature of the APU and commands from the control systems are also registered.

Maintenance costs decreased around **30-50%** with a Digital Twin*

* Calculation made for this project with PowerTech Converter

Challenge

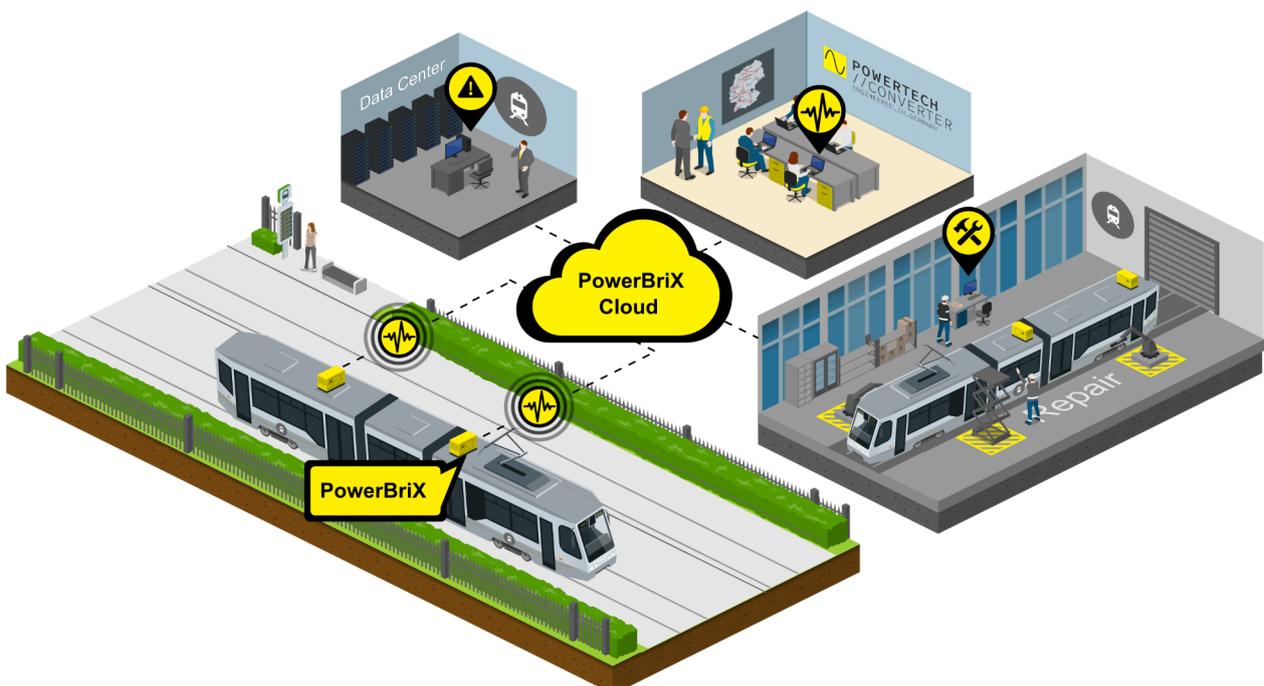
This valuable data was only stored locally and couldn't be accessed remotely. A designated technician had to be sent to the location of the PowerBriX device in order to collect the data generated or to fix any technical incident.

Solution

PowerTech Converter is now taking the next logical step bringing PowerBriX to the Cloud. This operational data, which is used to make maintenance predictions and analyze service events, can be now recorded, accessed and evaluated remotely to ensure top-quality service.

Timeline

- February 2021: First business workshop
- July 2021: Development of a prototype
- January 2022: Start public presentations for business customers and go-to-market activities



EMBEVER <>

Do you want to bring your railway assets
to the Cloud?

Contact us at info@embever.com
or find more information at
www.embever.com

Carl-Miller-Strasse 6
39112 Magdeburg · Germany

Behlerstrasse 35
14467 Potsdam · Germany



Watch this video to understand how to
connect your devices with the Cloud

