



BUSINESS CASE

SMART SENSORS FOR FROST PROTECTION

PREDICTIVE MAINTENANCE ON THE TRACKS



EMBEVER <>



INTRODUCTION

Embever has participated in the DB mindbox 2019 startup support program and is currently working together with Deutsche Bahn to keep locomotives with smart sensors always ready for operation in winter.

Locomotives of the **class 101** pull IC trains across the country. To ensure that the vehicles are **always ready** for operation **even at low temperatures**, they remain under power in the winter months even when not in operation. As a protective mechanism against voltage variations, the locomotive can disarm itself, i.e. take the pantograph off the grid. If the starter battery is then subsequently discharged by the idle consumption of the stationary locomotive, it can happen that the locomotive cannot be started for its next operation: this would cause delays in train traffic.

This is where **Embever's smart IoT technology** comes into play. Wireless, battery-operated sensors continuously check the voltage of the starter battery and inform the responsible control center directly in case of failures. The locomotives always ready for operation, which improves punctuality and reduces the time-consuming manual checks called "Frostwache".

DEUTSCHE BAHN

Deutsche Bahn (DB) is one of the world's leading mobility and logistics companies and employs more than 330,000 people worldwide - around 210,000 of them in Germany. **DB** designs and **operates** the **transport networks of the future**.

Through the integrated operation of transport and railroad infrastructure and the economically and ecologically intelligent linking of all modes of transport, the Group moves people and goods.

THE PROBLEM

Locomotives are continuously connected to the grid with their pantographs for stationery supply, even before they start operating. This is especially important in winter, as the heating system must be operated continuously if there is a certain probability of frost. This ensures that the systems do not freeze. It can happen that, **due to voltage fluctuations or power failures, locomotives will disconnect themselves from the overhead power supply** and the internal battery for heating the systems will be activated automatically. Their capacity is designed for a maximum power period of two to six hours, depending on the locomotive series.

Locomotives of older series do not yet have a system that informs the control centers when a pantograph is no longer connected to the grid. **If the battery is completely discharged, some of the locomotive's systems can literally freeze and can no longer be started.** As a result, delays in train traffic can occur. Deutsche Bahn currently has 145 class 101 locomotives in service, the first one has been in operation since 1996. These high-performance universal locomotives have proven their reliability in everyday operation and are used, for example, as Intercity locomotives.

HEROES OF THE NIGHT

One of the reasons why the IC trains can start on time in the morning is the "Frostwache". This group of **locomotive drivers and suppliers check on site every two to six hours** whether the locomotives are still connected to the grid. The frequency of the inspection interval depends on the type of locomotive or the capacity of the battery installed.

Their activities ensure the energy supply of the vehicle and increase the punctuality of the trains. This **preventive process** can be automated by IoT technology and reduce the workload of the *heroes of the night*.



WHAT TO DO

Since the locomotives are in service throughout Germany, a **complex deployment management system** is behind the guarantee of operational capability. The **objective** is to develop an **automated solution** for the Frostwache in order to relieve the personnel of the operations control centers at certain points.

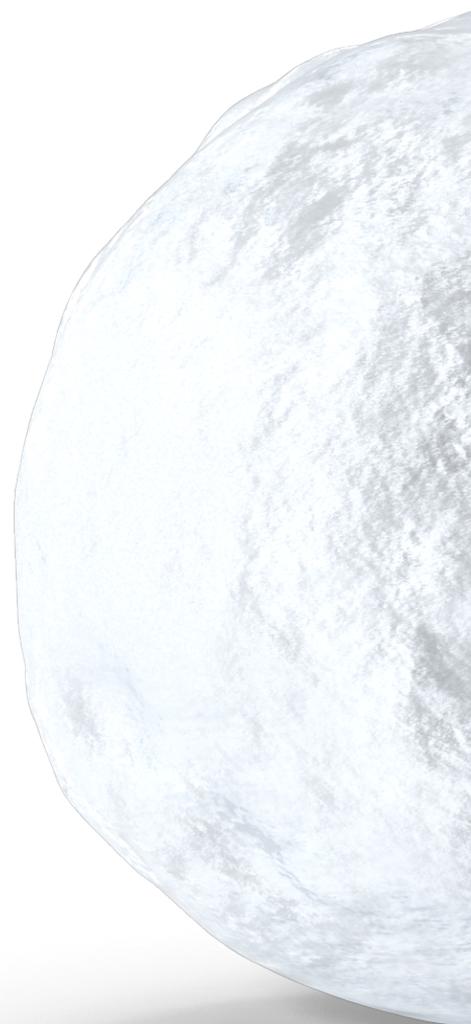
ADDED VALUE CREATED

Deutsche Bahn has taken a promising step with the **digitization of the Frostwache**. Thanks to the IoT solution, employees will be able to **reduce night-time operations to a minimum**. Many night shifts can thus be avoided in the future. With the help of the innovative IoT technology, the Deutsche Bahn is preparing to reduce train delays even further in the future.

PARTNERSHIP AND FURTHER DEVELOPMENT

Embever GmbH has convinced Deutsche Bahn in the **DB mindbox startup support program** with its solution. During the 100 day program a prototype was developed. A battery-powered gateway is using wireless sensors to determine whether the locomotive is connected to the power supply of the power grid.

In this way, it can be determined at any time whether the parked locomotive is supplied with power. Following the successful completion of the prototype phase, **Embever** has been engaged as an **IoT communications expert** since early 2020 to **develop a system for monitoring the locomotives**. For communication, Embever is using a self-developed NB-IoT-Gateway, which can build a local mesh network with wireless sensors.



The system can be extended by adding further wireless sensors as required. To ensure that the device always communicates with the correct control center, it has been equipped with GPS functionality. **Embever IoT Core is used for data transmission.** This consists of a complex interaction of embedded firmware, protocols and a sophisticated cloud architecture to ensure **reliable communication between locomotives and control centers.** The system is ideally suited for low-power IoT applications.



Picture 1: Visual representation of IoT application - Railway sector. Source: Own creation

RETHINKING PROCESSES

IoT technology can play a significant role in increasing efficiency, transparency and agility of processes. More and more companies are therefore turning to **Embever's 100-day program** to develop a proof of concept at a fixed price.

This reduces the risk of developing the wrong product and paves the way for **redesigning outdated processes** with higher added value.

Are you also interested in developing a smart product?
We are looking forward to your inquiry