Opportunity Open Source Conference 3.0

Sep 5 – 7, 2025

BeST SENSOR

OOSC at IIT in Kanpur 06.09.2025
https://events.canonical.com/event/134/contributions/727/

How we built a pump monitoring system for Deutsche Bahn with wireless sensors using Zephyr RTOS

Oliver Völckers, BeST Berliner Sensortechnik GmbH

Monitoring Wastewater Tanks

ICE = Intercity Express,
German High-speed railway

Toilets and on-board bistros discharge waste water into tanks

Tanks must be emptied regularly

Pumps are connected via hoses

Disposal process approx. 1-3min

Uneven flow of waste water

Existing System

Trains in the depot

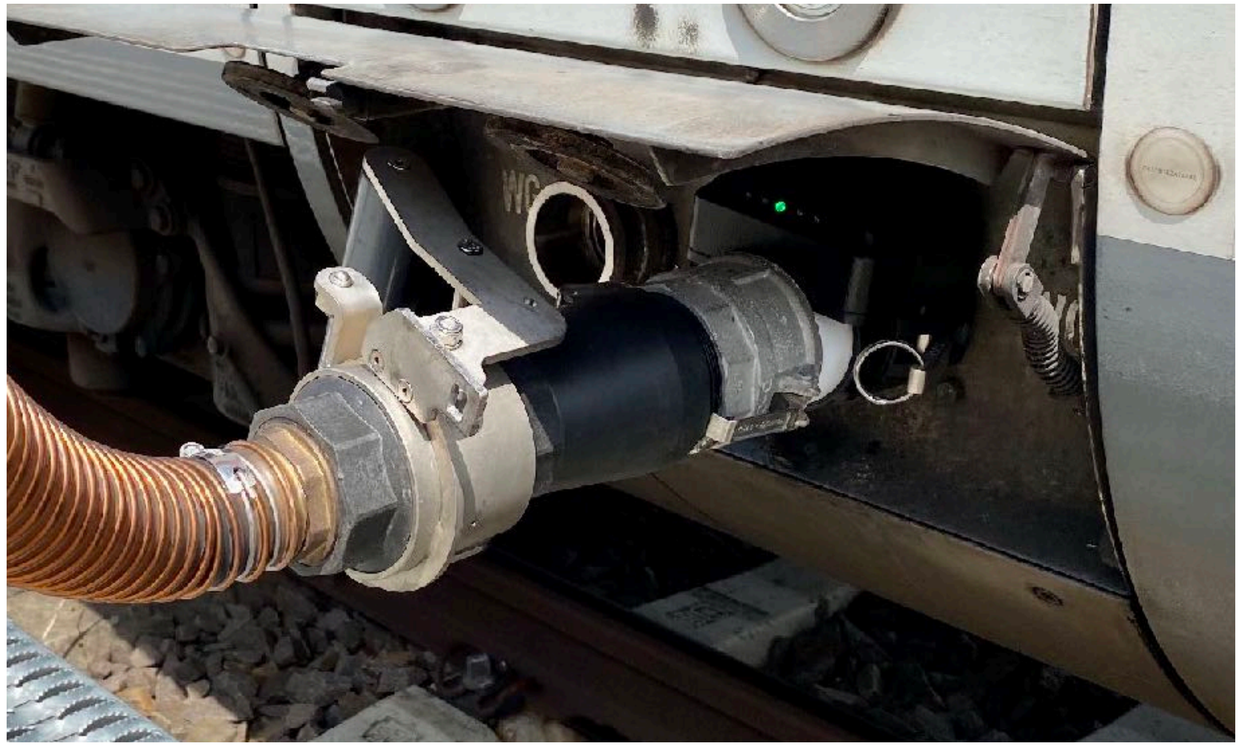
Analog wastewater monitoring

No digital overview of faults

Reporting via forms

Failure possible from:

- Train schedule
- Personnel
- Valves
- Pump



BeST Module analyses Pumping Process

Adapter on hose connection

Identification of the tanks via NFC tags

Faults are automatically detected and reported immediately

Battery operation, mobile network, connection to railroad IT

Development period 2020-23

Deutsche Bahn video:

https://www.deutschebahn.com/en/Digitalization/startups/db_startups/BeST-SENSOR-Berlin-sensor-technology--6935406

Adapter using Zephyr RTOS

Requirements:

- no new approval for trains or pumps
- Electrical safety
- without power supply and data connection
- Secure data transmission
- Must not disrupt work processes
- Automatic system for monitoring and logging
- No operating elements

Why use Zephyr for Wastewater Monitoring

- Technical parameters
  - Multitasking of peripherals
  - Real-time operation
  - Energy saving
- Economic reasons
  - Long-term serviceability
  - 100% control over source code
  - increased safety

https://www.zephyrproject.org/products-running-zephyr/

Signal Evaluation

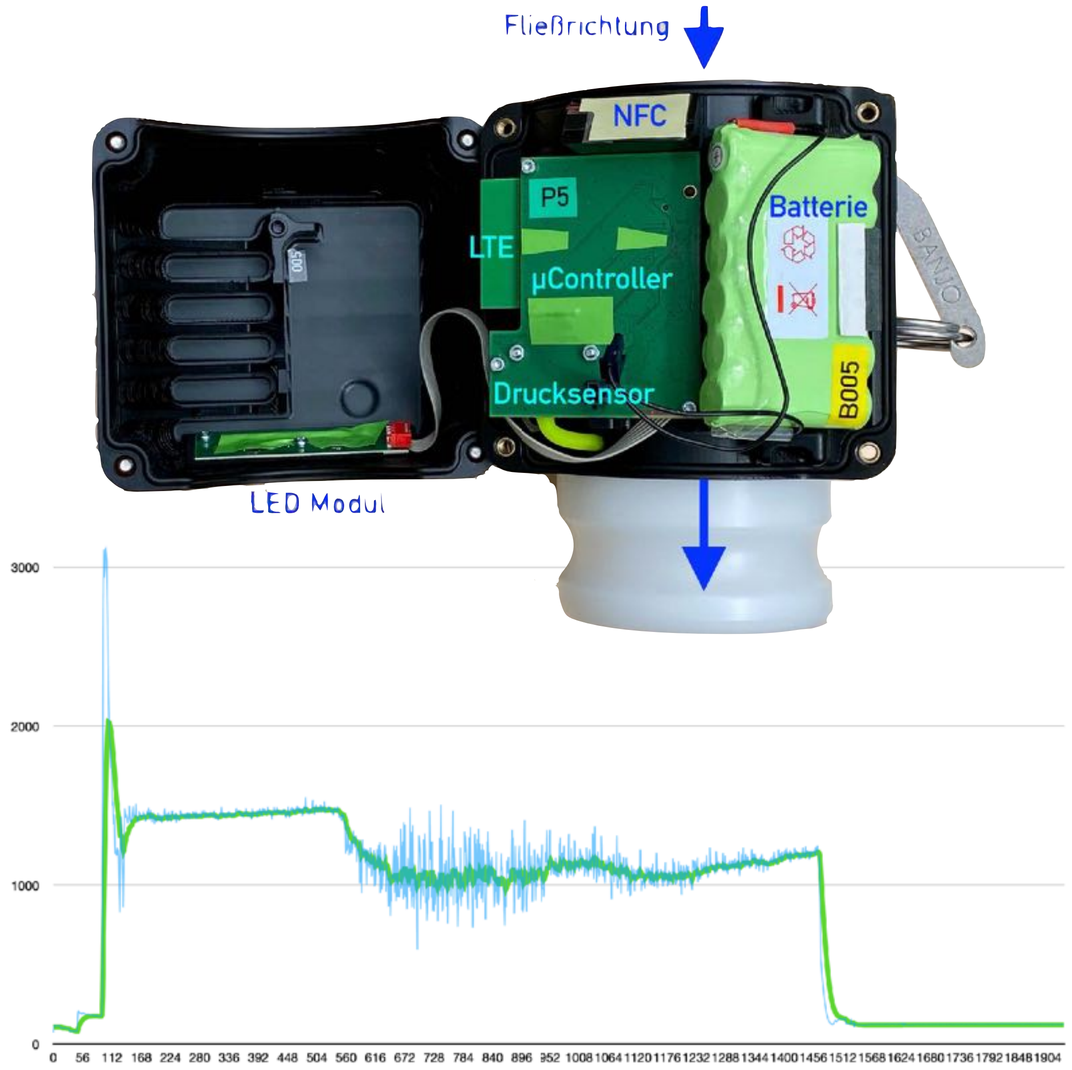
Sensor in adapter monitors wastewater flow

Automatic evaluation in the module

Transmission of results by radio

Server software generates reports from the messages

Reports are sent to the railroad on a daily basis



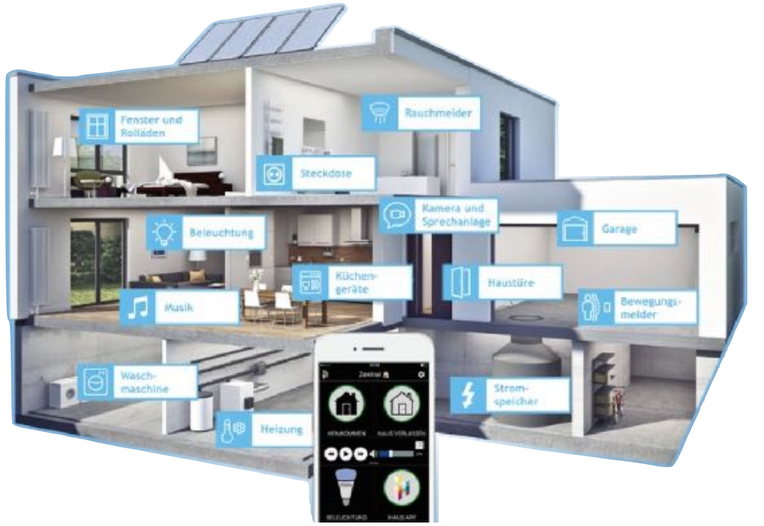
Analogy heating monitoring

Heating controller

Thermostat

Consumption meter per heating period

Real-time system with radio transmission



Economic efficiency:

better for larger systems

for new buildings today always

Source of pictures:
https://esa-tec.com/gebaeudeautomation-smarthome.html

https://www.talu.de/heizung-richtig-ablesen/

Current Status

Result now (Autumn 2025): Pre-series of 36 modules in continuous operation for over two years

Over 50,000 disposals analyzed, clear detection, immediate reporting of faults

But: pre-series only allows random sampling

Missing disposals go unnoticed

NFC tag requires extra handling

Full transparency requires full roll-out

Web-Interface FlowNexus

Access from anywhere with any browser

Also from mobile devices

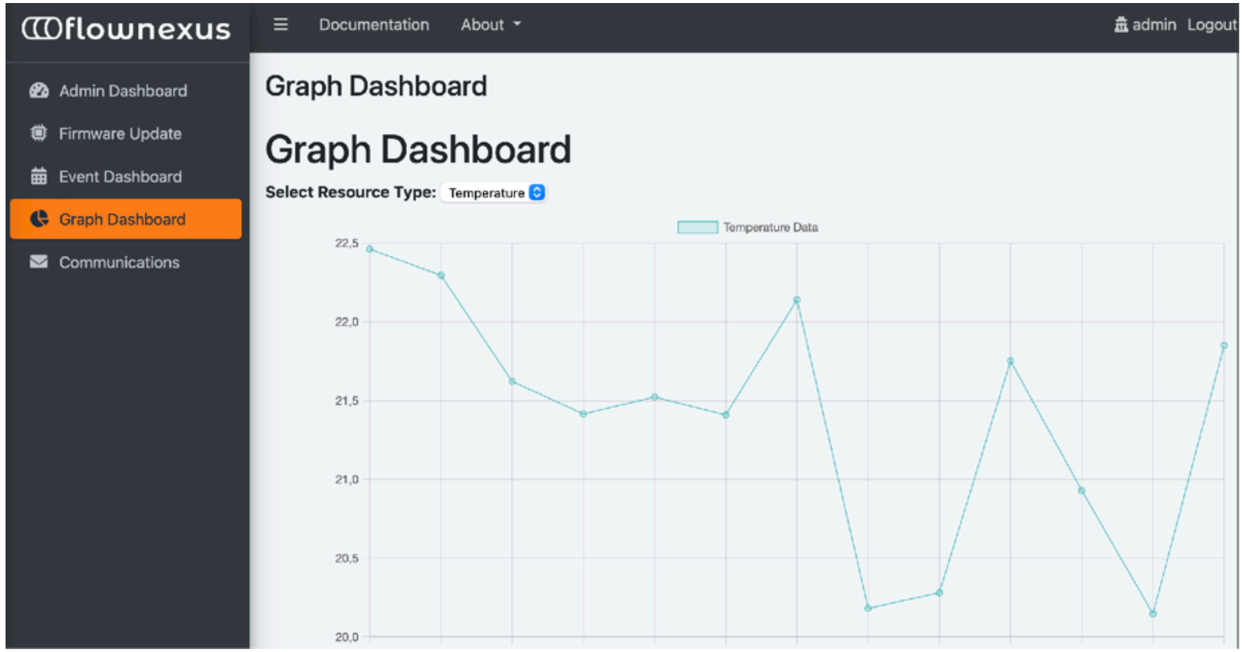
Graphical user interface

Access permissions

Customizable

From MQTT to LwM2M technology

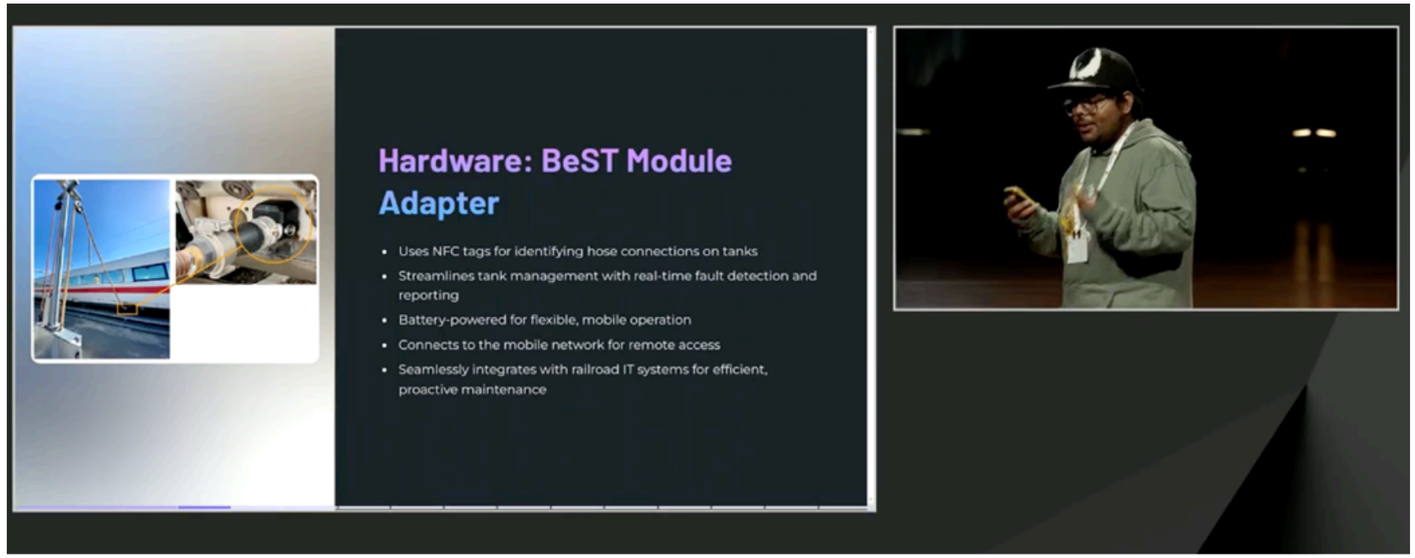
Open source



From BeST specifically for pump monitoring

Flownexus at Ubuntu Summit 2024, The Hague

- Akarshan Kapoor
- local server-based IoT system
- uses Lightweight Machine to Machine (LwM2M) protocol
- communicates between IoT devices running Zephyr OS and a backend server using Django, an open source web framework based on Python



Join the Flownexus project:

https://github.com/flownexus-lwm2m/flownexus

https://www.bestsensor.de/en/post/flownexus-software-presented-at-ubuntu-summit

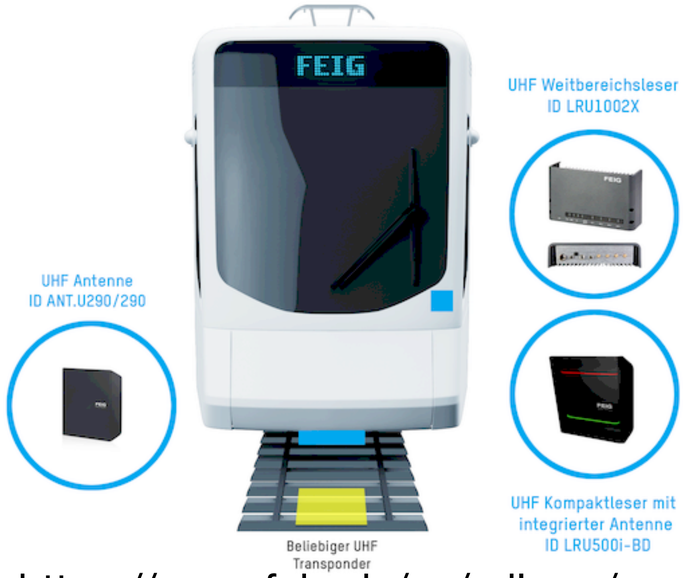
UHF-RFID instead of NFC

Ultra High Frequency Radio Frequency Identification instead of Near Field Communication

- Reading distance > 1m
- No direct contact necessary
- Automatic assignment upon entry

Next steps:

- Software associates wagons and tanks with waste disposal operations
- Interface to pump monitor



https://www.feig.de/en/railway/

Goal: complete monitoring system

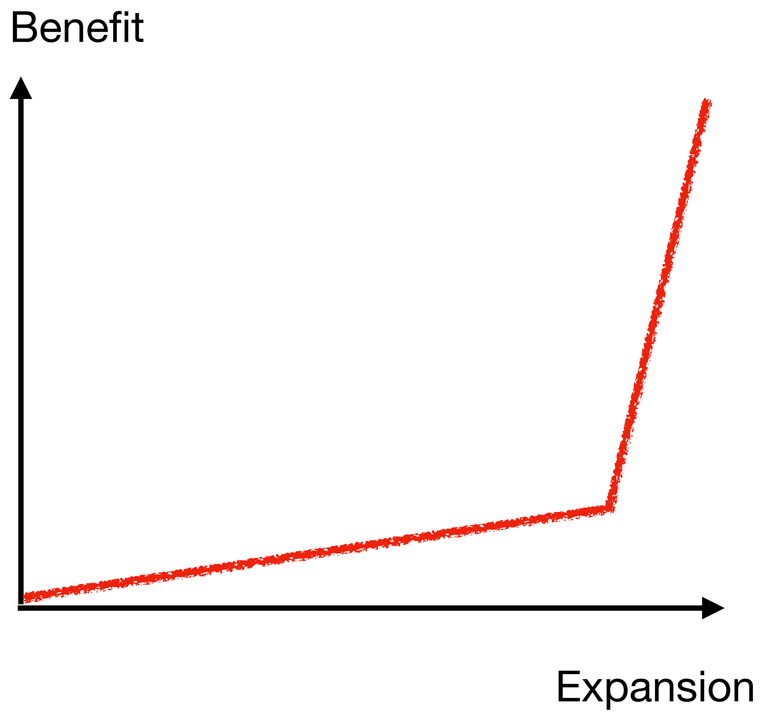
Overview of disposals at all times

Recognize anomalies in tanks, location, pump

NFC is replaced by RFID

Expansion: one location after another

Economical thanks to optimized disposal planning, saved energy, fewer breakdowns



Lessons learned

- agile project management can work with a huge organisation
- DB Mindbox, Deutsche Bahn's start-up program supported BeST
- open source community helped to meet seemingly impossible requirements
- how to keep customer happy and project within budget: focus on customer satisfaction

https://www.dbmindbox.com/

Thank you

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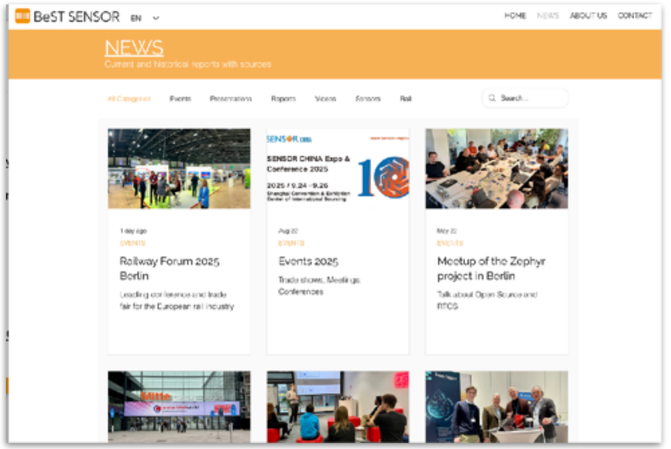

https://www.bestsensor.de/en/blog