DMrail - Digitalisering av underhåll för en hållbar transportinfrastruktur

20 oktober inom

InfraSweden2030s projekt- och resultatkonferens

Project's Goals and Purpose

***Improve** current maintenance systems to **increase uptime** for the railway infrastructure*

Predictive maintenance with innovative methods

Project Duration: June 2019 – August 2022
Coordinator: RISE Research Institutes of Sweden AB
Partners: Bombardier Transportation Sweden, Ekkono Solutions, Järnvägsklustret, RISE Research Institutes of Sweden, and KTH Royal Institute of Technology.

Project Website:
https://www.infrasweden2030.se/project/dmrail

The DMrail project is carried out within the strategic innovation program InfraSweden2030, a joint venture by Vinnova, Formas and the Swedish Energy Agency.

ALSTOM · mobility by nature ·
JÄRNVÄGSKLUSTRET RAILWAY CLUSTER of SWEDEN
RI. SE
KTH VETENSKAP OCH KONST
EKKONO .AI
Infra Sweden

Problem statement and motives

DMrail - Innovation

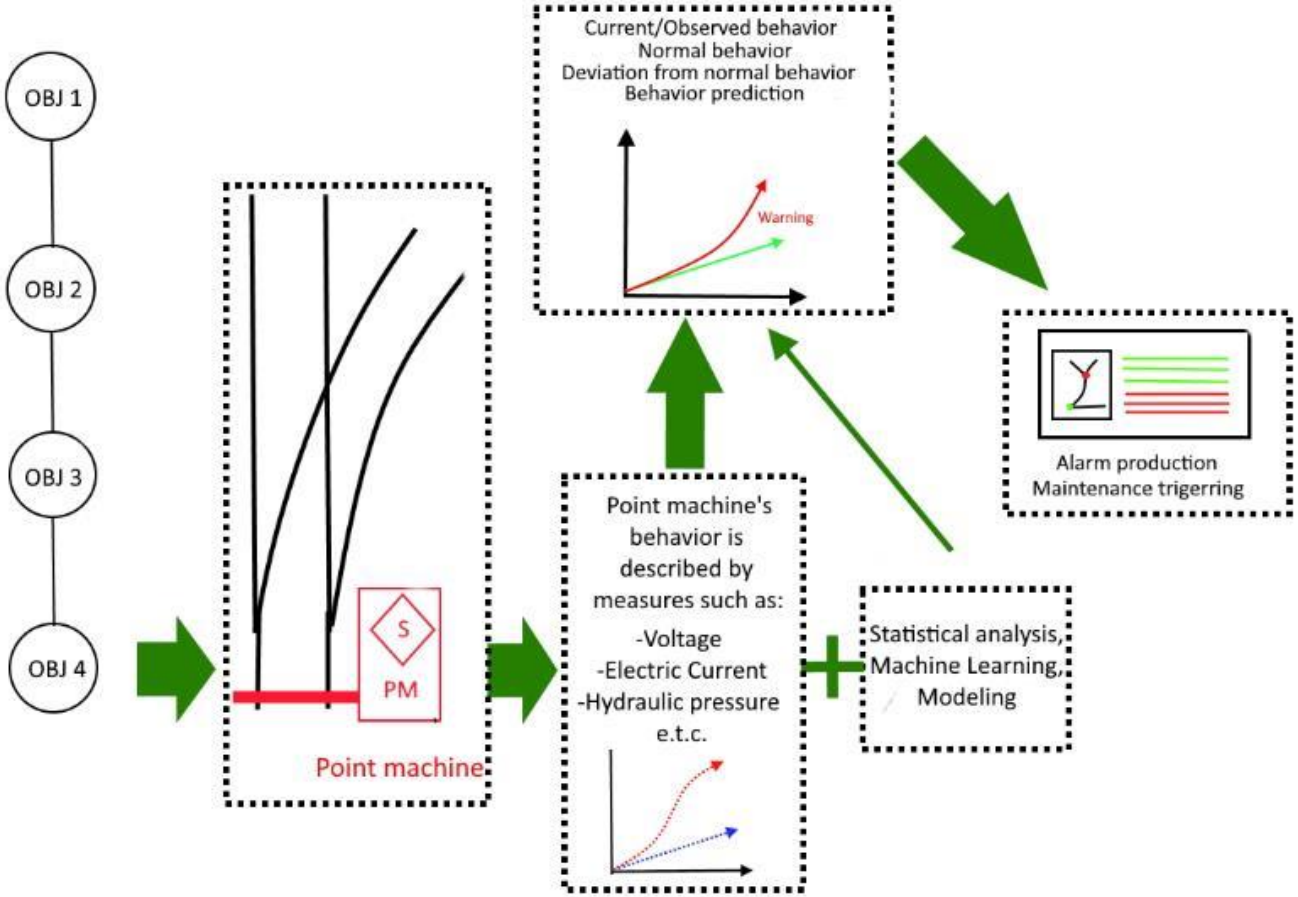
Own editing

innovation potential is based on:

- creating simple **innovative measuring methods**
- trouble-free installation
- rational (dynamic) data transfer → sufficient for an **automated remote condition diagnostics and analysis** → **trigger maintenance activities** as needed
- the guiding vision of DMrail is “Easy to install, simple to use”

Infra Sweden

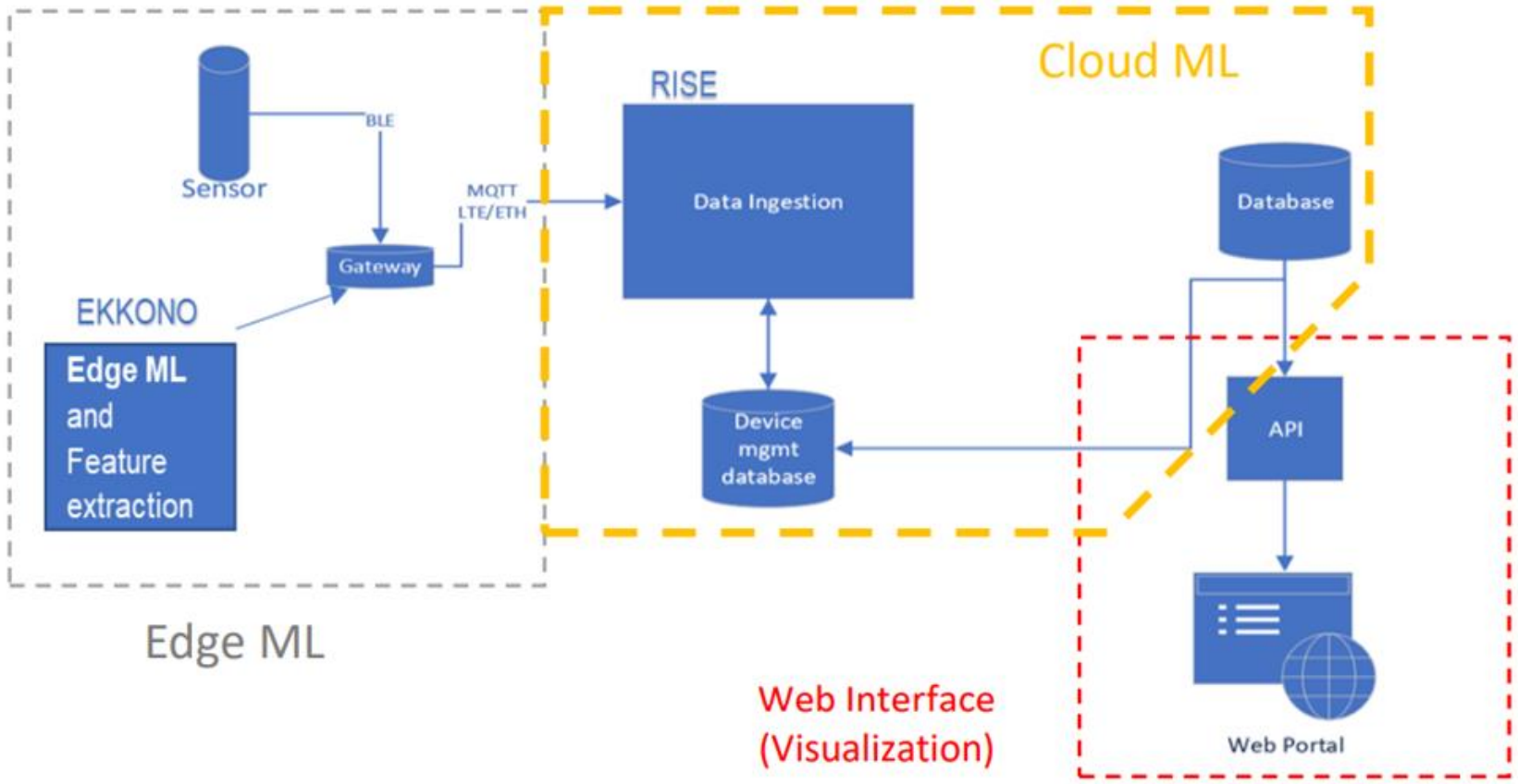
Implementation



Infra Sweden

Implementation

Data connectivity architecture



Infra Sweden

Project's three most important results

- The validation of project results was key driver
  - Real Bombardier data sets have been used for assessing the validity of the solutions including Cloud and Edge ML anomaly detections
- We also received access to Trafikverket's Ofelia database, which allowed us to analyze actual faults and compare them with our predictive algorithms
- DMrail has boosted innovations for predictive maintenance systems though emerging Cloud and Edge technologies:
  - Cloud ML including (i) 30 different anomaly detection methods to detect the anomalies related to obstacle and electrical resistance and (ii) approach for detecting degradation trends in the cloud using the EIM data only
  - Edge ML to detect anomalies on the point machine at the edge, by analysing the curve data collected at the sensors using unsupervised machine learning techniques

Infra Sweden

Trafikverket´s Ofelia database and reclassification

- TRV's system - report of failures and associated measures
  - Contains failures by time, place, cause of failure, as well as measures taken to remedy a failure
- Purpose of Ofelia in DMrail:
  - verify the findings of ML analysis and modelling
  - relate current curve from sensors and turnout number with failure occurred as some point
  - establish a precedent regarding how the data processing from the Ofelia database is performed

- Ofelia database reclassification process gave some interesting and insightful results, e.g.:
  - Extended variation of failures and their causes was observed even amongst the same parts of the turnout
  - Most of failures occurring in turnouts are mainly related to point machines, obstacles of any kind, problems with the switching mechanism, absence of lubrication, as well as weather related phenomena (ice and snow)

Infra Sweden

Cloud ML -GBG

- Analyzing summary statistics to detect degradation trend
  - Useful for setting maintenance policies, negotiate contracts, and plan operations and procurement in the long term

Infra Sweden

Edge ML

- Generalizability
- Computing resources
- Updating and maintaining a decentralized solution
- Data privacy: no need to send all the data to the cloud
- More accurate: more fine-grained data and solution

- Goal?
  - Use ML techniques to learn the functioning of each point machine, to detect in advance when the point machine is not working as expected

Infra Sweden

Edge ML – GBG pilot

- Scenario:
  - Many point machines with only the current sensor available
  - Ofelia dataset with the maintenance logs

- Solution?
  - Unsupervised change detector, personalized per point machine
  - The change detector will detect malfunctioning point machines ahead of time
  - The solution is validated with the Ofelia maintenance logs

Infra Sweden

GBG Pilot data

- Extensive feature extraction
- Selection of the features that are the best predictors
- Change detector calibrated and run individually on each point machine. Output is a health score for the point machine

Infra Sweden

Conclusions and reflections

- **Reflections:**
  - Difficult and necessary to understand how data is collected – New sensors
  - Several competences to be combined – Common language needed
  - Good support from InfraSweden 2030 – Common events enabling cross-fertilization with other projects

- **Edge and Cloud ML**; a complementary combination
  - A combined Edge and Cloud ML solution benefits from not needing to send all the data to the cloud e.g. in terms of the amount of bandwidth saved
  - Important findings of the project are related to the comparison between the Cloud and Edge anomaly detections
- Societal digitalization & sustainability of the Swedish rail transportation system
- Utilize results to bring new products, services and railway infrastructure technology to the market

Infra Sweden