Biodiversity

UKCEH Biodiversity: science, data and tools

Cecily Goodwin

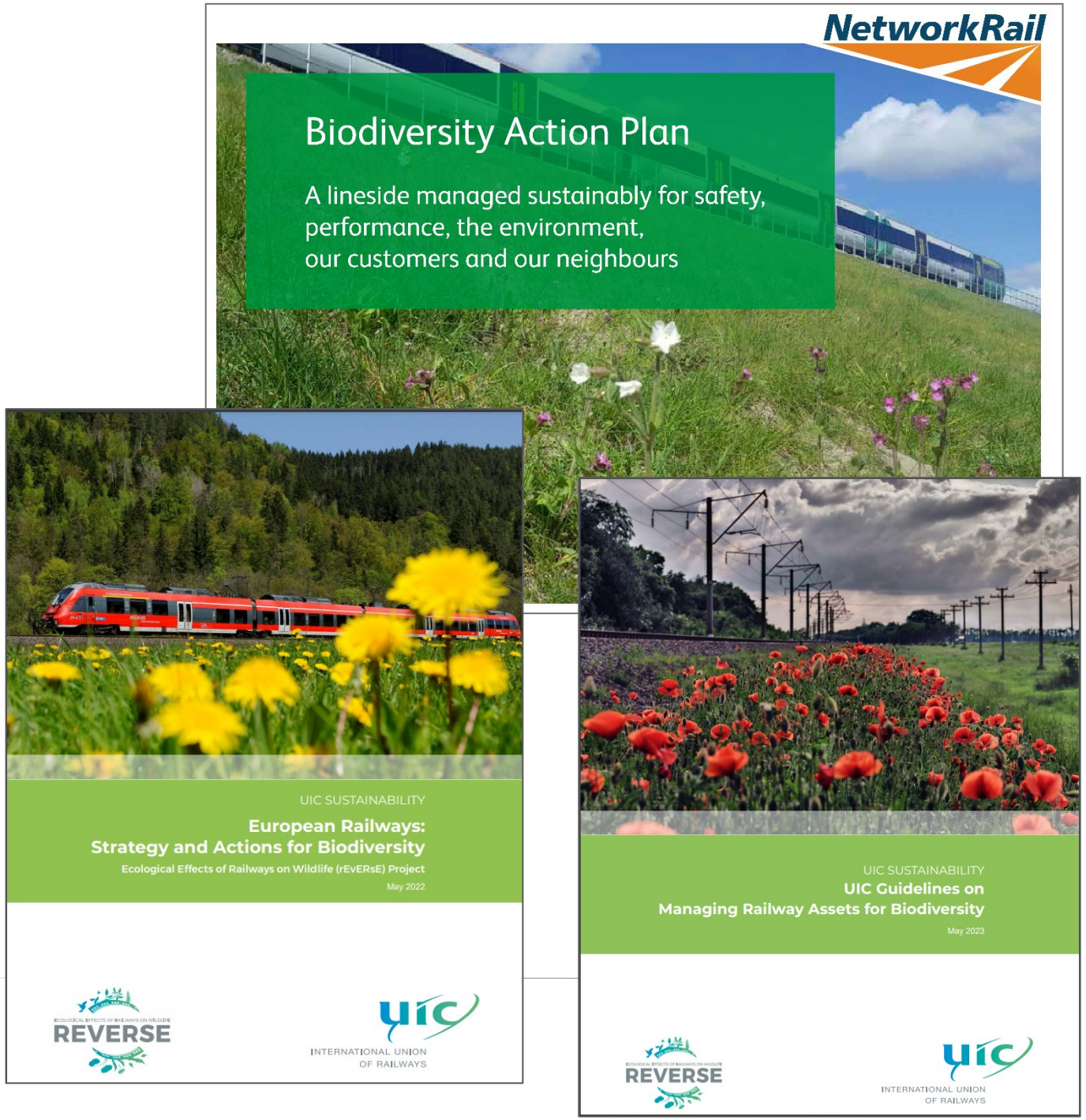
Richard Pywell, Helen Coskeran, John Redhead

Gary Powney, Lucy Ridding, Tom August

UK Centre for Ecology & Hydrology

Track record: transport infrastructure

- **Network Rail:**
  - *Biodiversity Action Plan*
  - *Biodiversity Baseline*
  - *Lineside 2035*
- **International Union of Railways:**
  - *European Railways: Strategy & Actions for Biodiversity*
  - *Guidelines for Managing Railway Assets for Biodiversity*
- **Kier Highways**
  - *Improving habitat connectivity in Devon and Cornwall*



UK Centre for Ecology & Hydrology

Land cover and habitat assessment

- **Integration** of high-resolution **satellite** sensors, **contextual** data and **ground** survey

- Detailed maps of **habitat type and condition** with estimates of **accuracy**

- **Reproducible** and able to **detect change**

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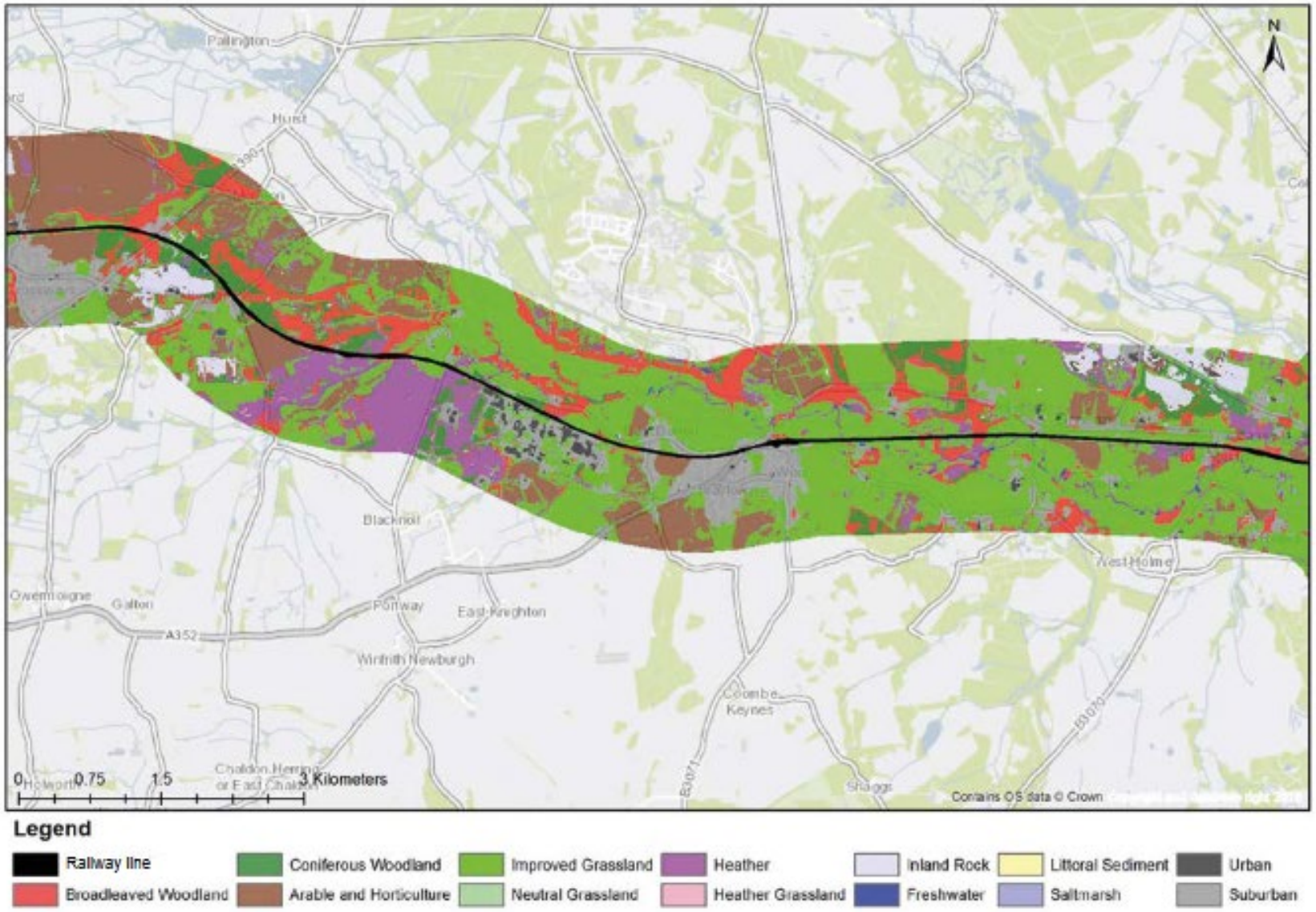
Land cover & habitats

3m and 10m UK habitat mapping

- Land Cover Map produced every year
- Maps going back >30 years
- New capability in 1m to 3m habitat mapping



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Monitoring and assessing biodiversity

- Assessment and validation of **structured recording schemes** and **citizen science records**
- Production of headline biodiversity **indicators, trends and benchmarks**
- Forms the basis of many models of **species relationship to habitats** and landscape

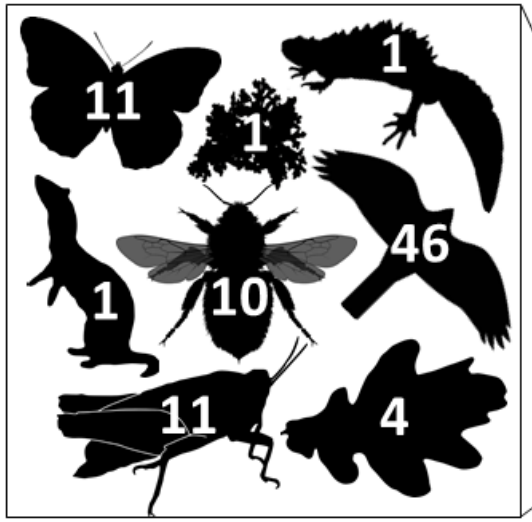
UK Centre for Ecology & Hydrology JNCC Biological Records Centre

Biodiversity

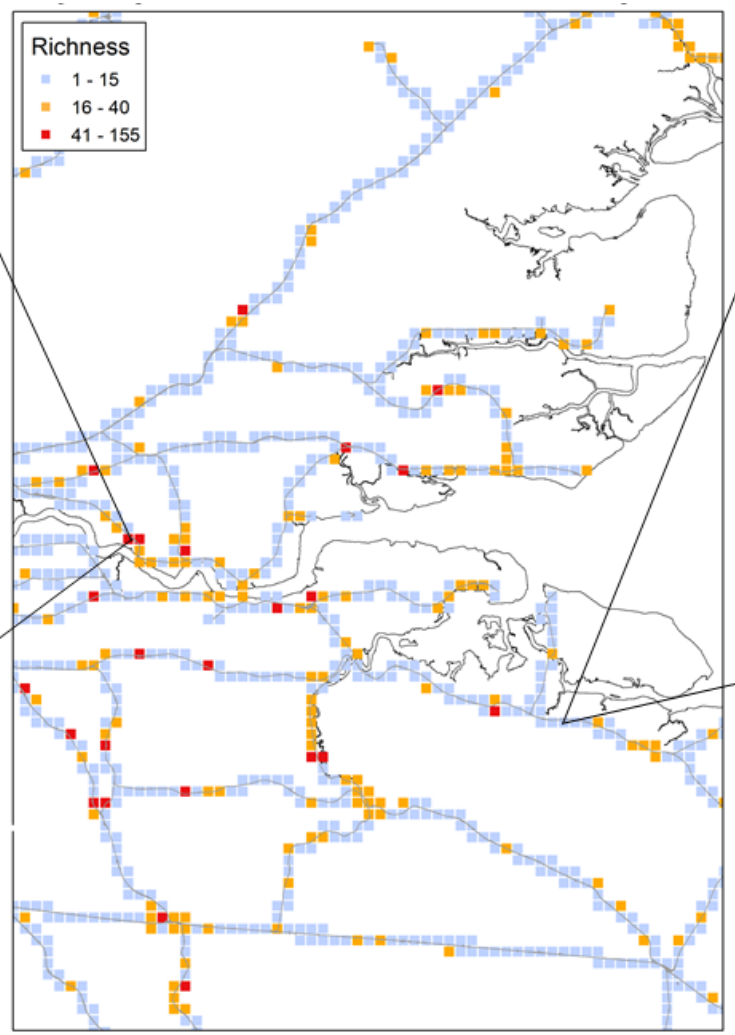
Rare species diversity per 1km

Biodiversity hotspot mapping for the Essex rail region

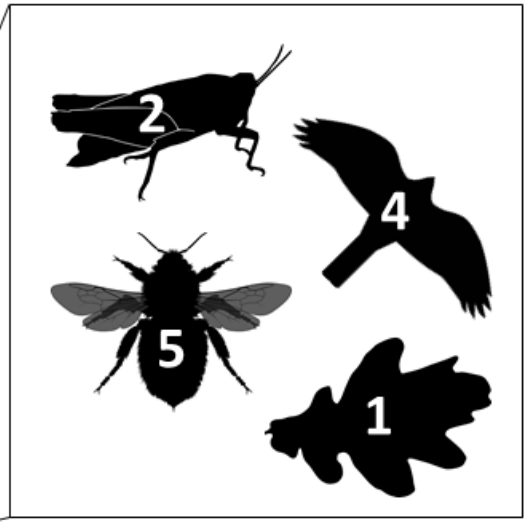
Cell TQ5479:
85 Priority species recorded



Group	Richness
Plants	4
Lichens	1
Butterflies + Moths	11
Bees	10
Other invertebrates	11
Birds	46
Mammals	1
Herptiles	1



Cell TQ9263:
12 Priority species recorded



Group	Richness
Plants	1
Bees	5
Other invertebrates	2
Birds	4

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Biological Records Centre

JNCC

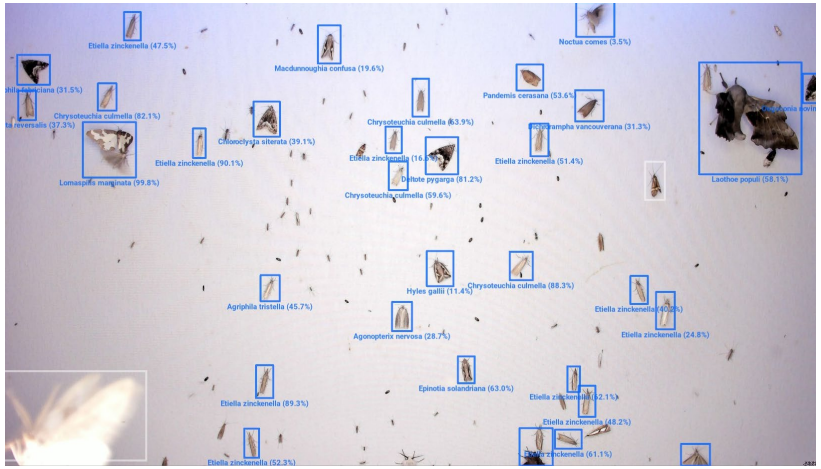
NetworkRail

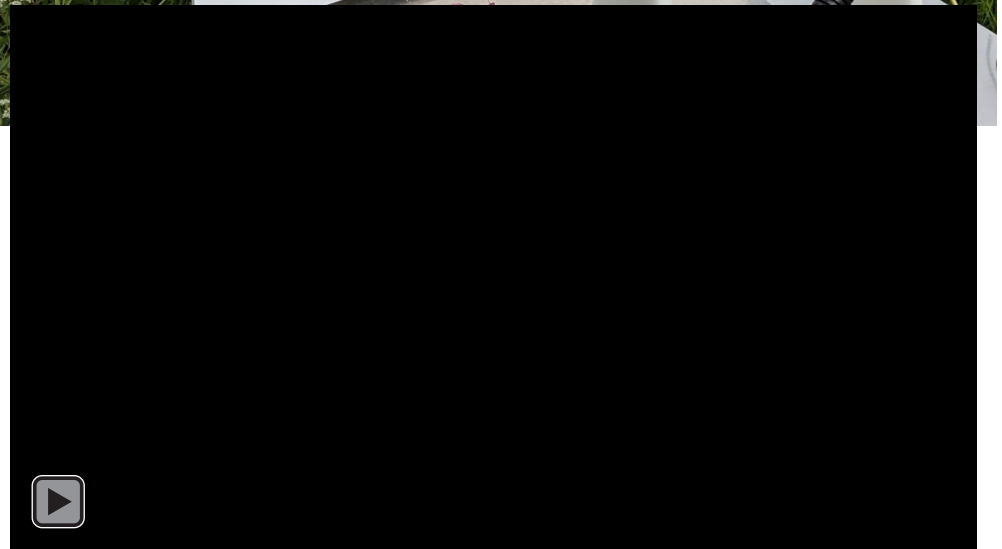
Biodiversity

Autonomous biodiversity monitoring

- Combines **computer vision** and **eco-acoustics** to provide continuous and standardised monitoring of key indicator species – moths, bats, birds amphibians and crickets

- Validated against traditional recording methods





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Biodiversity opportunities

- High quality data on the type, condition and location of environmental assets can be used to **identify opportunities for ecosystem protection and restoration**

- **Online tools** can make this process accessible

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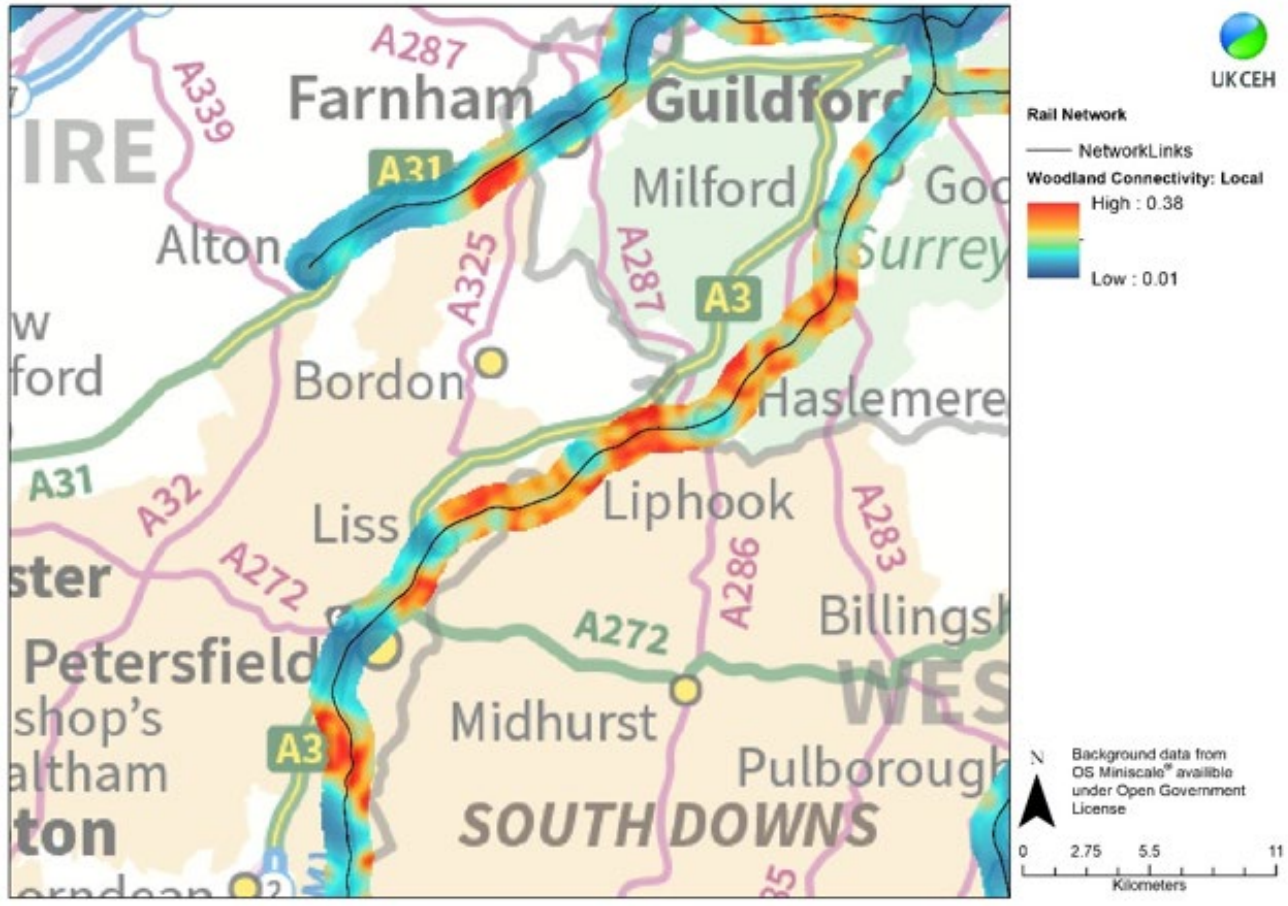
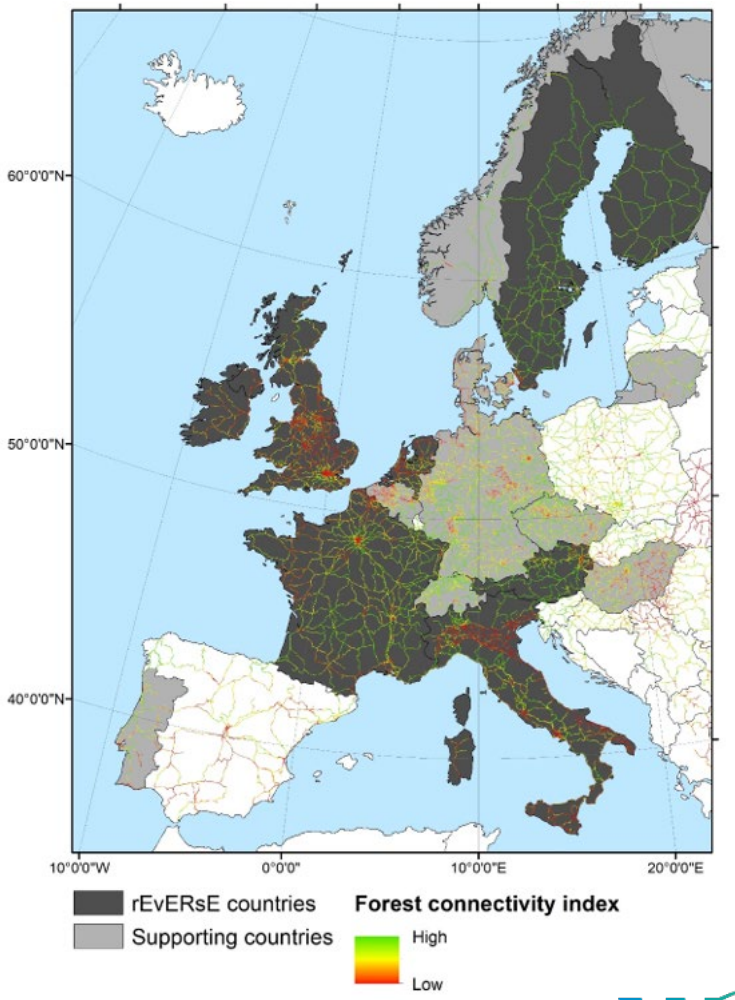
Biodiversity opportunities

Habitat connectivity along railways





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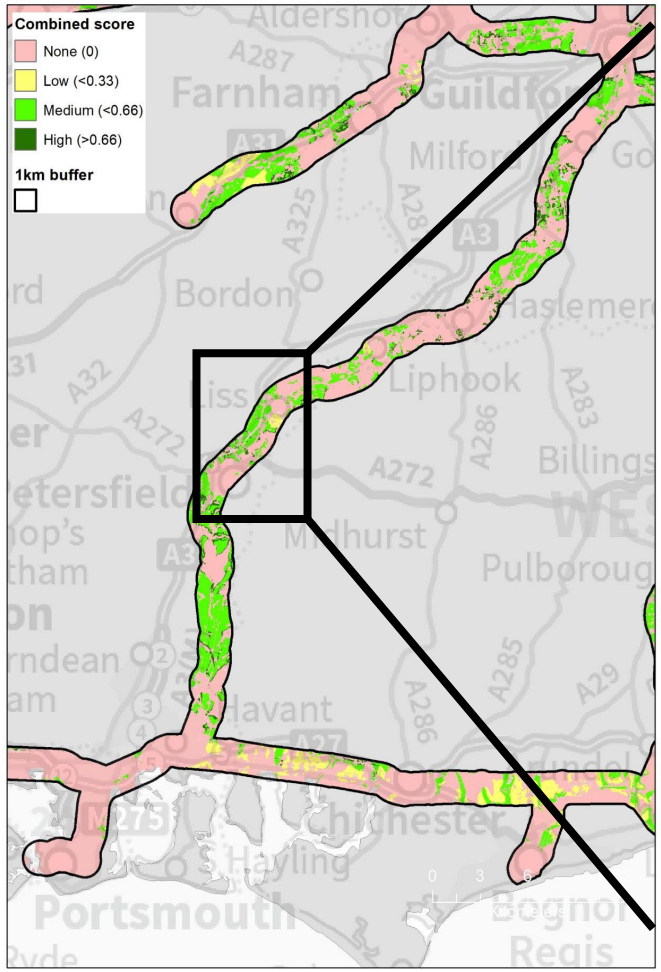
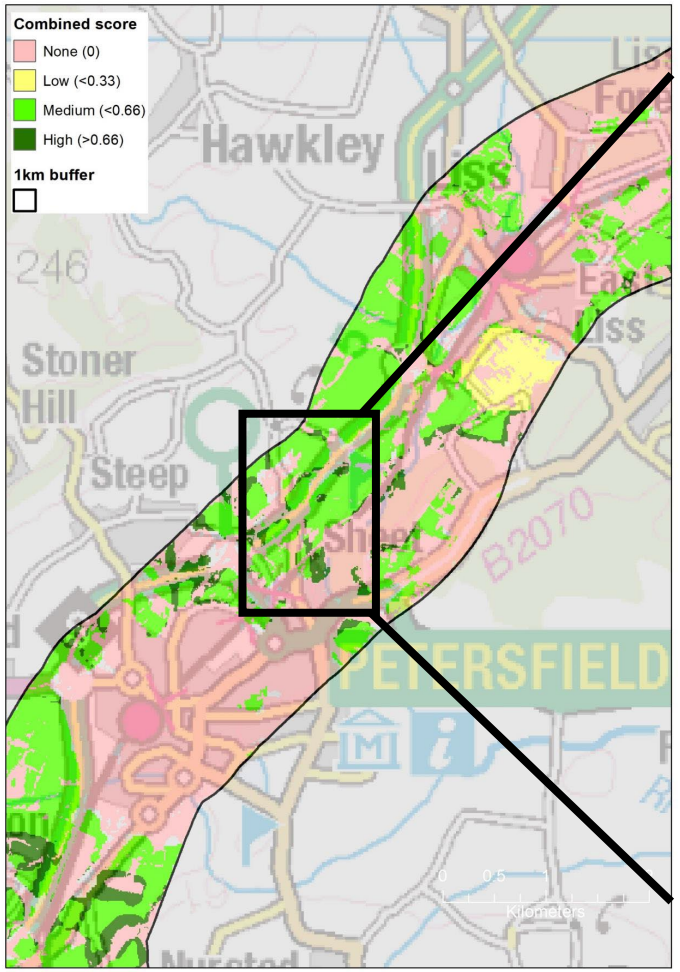
NetworkRail

INTERNATIONAL UNION OF RAILWAYS

Biodiversity opportunities

Opportunities for habitat restoration





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e-planner

Summary

1. Experience of monitoring, managing and restoring biodiversity in linear infrastructure
2. Use of advanced sensor technology:
    - Reproducible, validated maps of habitat type and condition from high resolution satellite data
    - Computer vision & eco-acoustic monitoring using AI
3. Modelling of biodiversity data to provide indicators, metrics and trends
4. Proven tools and models to identify opportunities for biodiversity restoration

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Thank you & Questions

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UK Centre for Ecology & Hydrology

Europe's Rail

NOISE AND VIBRATIONS

Laboratoire de Mécanique et d'Acoustique

Régis COTTEREAU

Aix Marseille Univ, CNRS, Centrale Marseille, LMA UMR7031, France

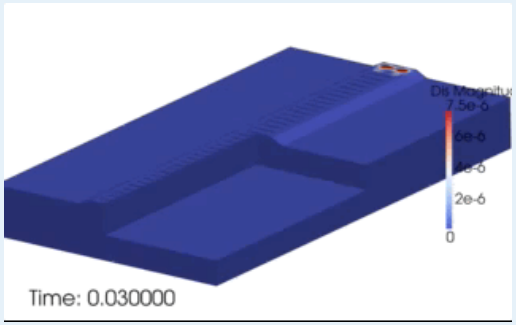
Ground Vibrations Prediction Tool : possible contribution

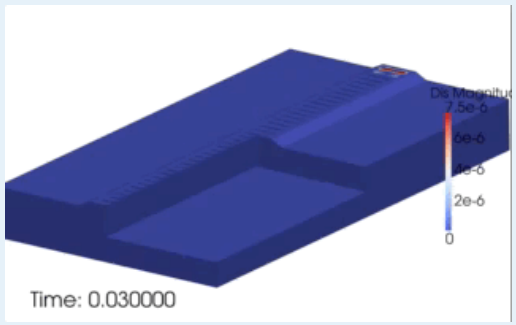
SEM3D : time-domain 3D wave propagation (spectral elements)

- Parallel, efficient (even on **Amazon cloud**) ;
- no periodicity hypothesis (geometrical **uncertainties**), **curves**, non-linearities ;
- usable both for **noise (acoustics)** and **soil vibrations** ;
- **open source** and freely available `https://github.com/sem3d/SEM`

Good choice for reference simulations, or for a new generation of prediction tools (cloud-based, with a user-friendly interface to be developed)

Impact of heterogeneities of the ballast on ground vibrations [1]





1. L. DE ABREU CORRÊA et al. “Randomly-fluctuating heterogeneous continuum model of a granular medium”. In : *Comp. Mech.* 60.5 (2017), p. 845-861. DOI : 10.1007/s00466-017-1446-8

Other possible contributions

- **Modeling of track irregularities** and impact on train dynamic behavior [2]
- **Noise measurements** and state-of-the-art anechoic chambers
- Contact mechanics and fatigue at the track-rail interface

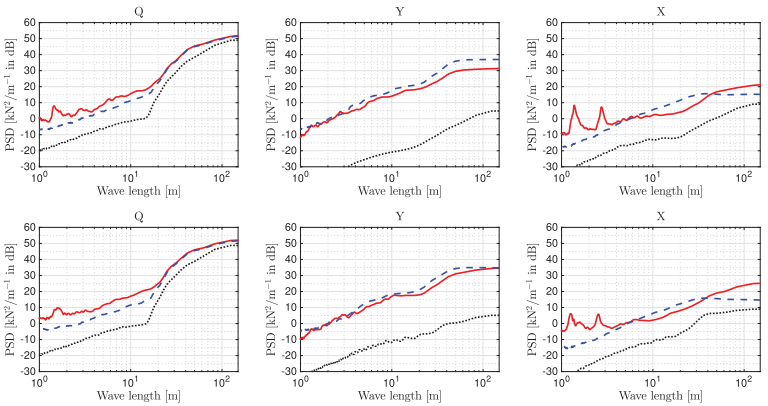
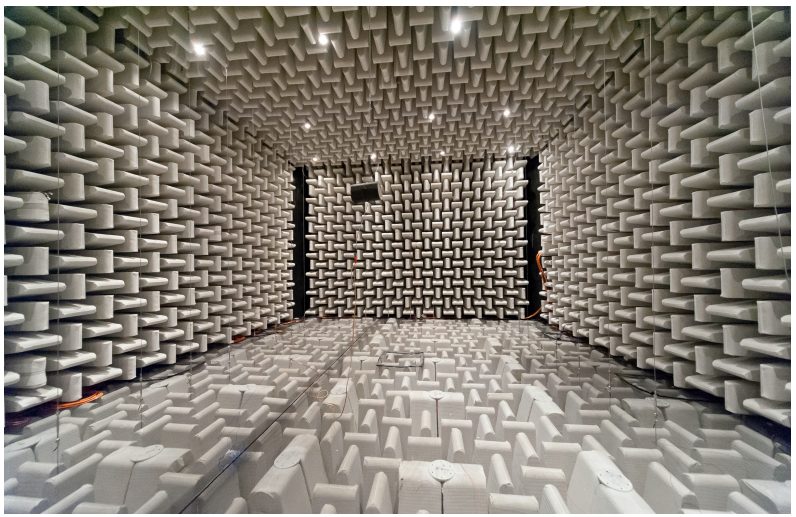


Figure 25. PSD of contact forces, front wheelset in alignment, variable velocity (first row acceleration, second row breaking). Experimental data (red line), numerical simulations with (dashed blue line) and without (dotted black line) irregularities.



2. A. Panunzio et al. “Construction of a stochastic model of track geometry irregularities and validation through experimental measurements of dynamic loading”. In : *Vehicle Syst. Dyn.* 55.3 (2017), p. 399-426. DOI : 10.1080/00423114.2016.1269935

Laboratoire de Mécanique et d'Acoustique

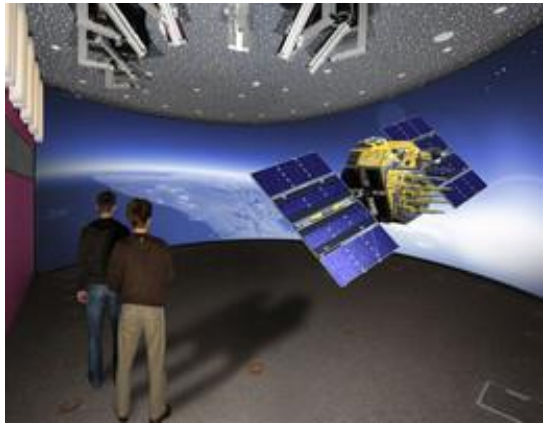
Régis COTTEREAU

Aix Marseille Univ, CNRS, Centrale Marseille, LMA UMR7031, France

Fraunhofer HHI

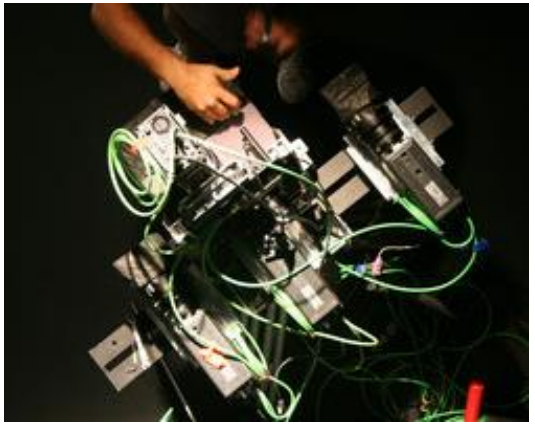
Audiovisual Simulations of Infrastructure for Planning and Communication

Capture & Display Systems Group at Fraunhofer HHI



Immersive Rooms &
Real-Time Interaction

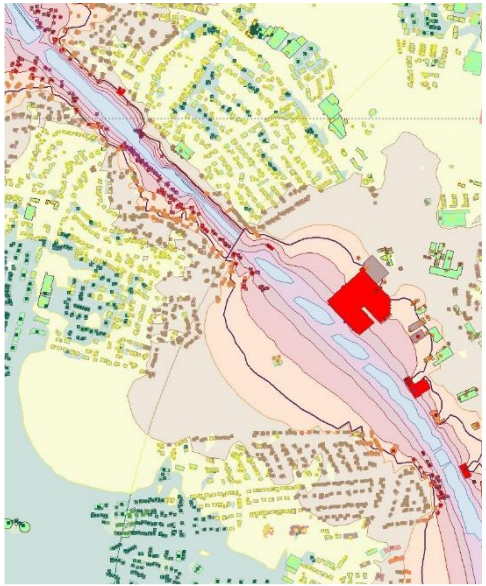
Audiovisual Simulations &
Remote Trainings



Multi Sensoric
Systems

Why acoustic simulations are necessary

- Infrastructure planning processes suffer from long delays, also due to public reservations regarding noise pollution
- Current communication of noise level predictions using isophones and average SPL not intuitively understandable for laymen



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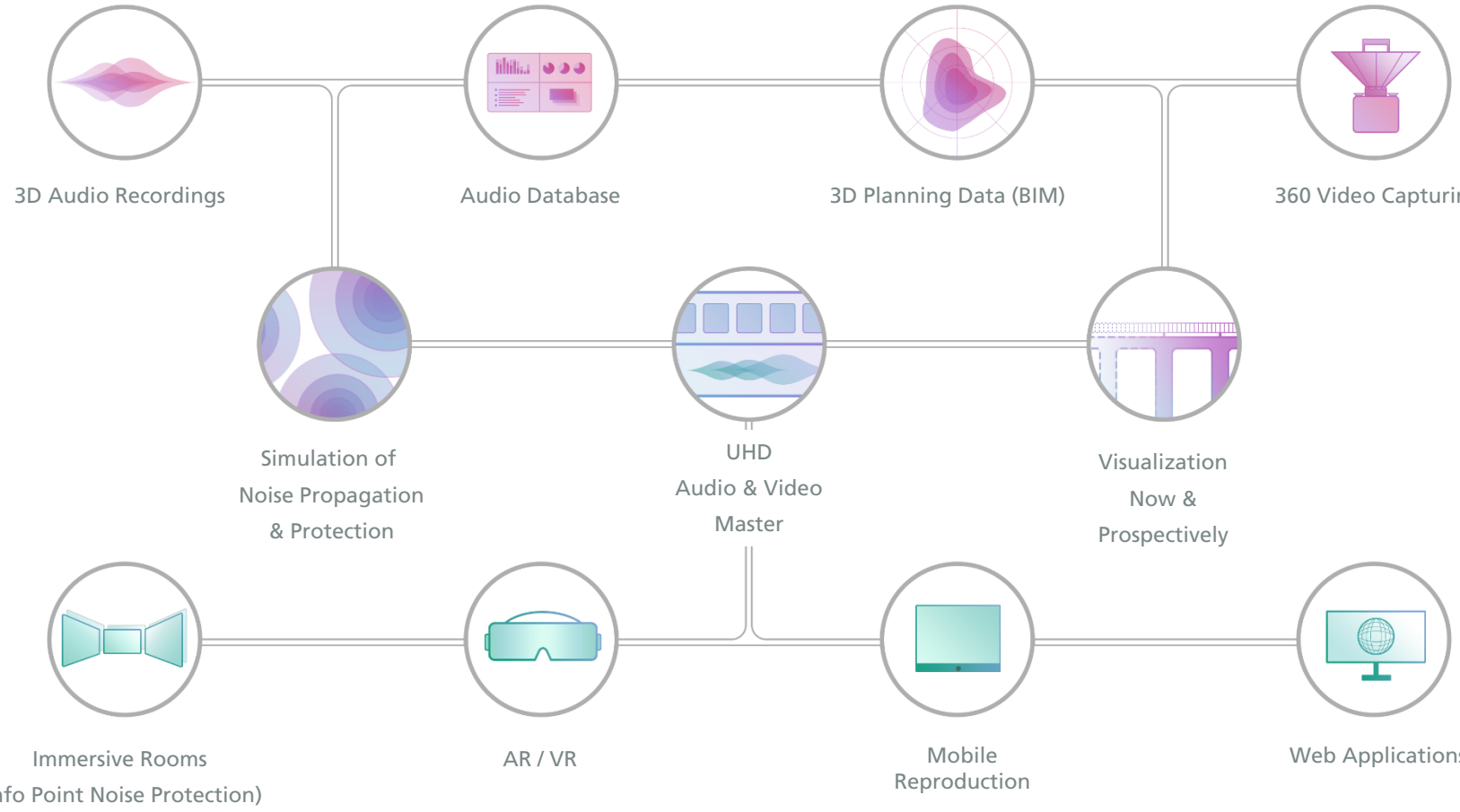
https://images.tagesschau.de/

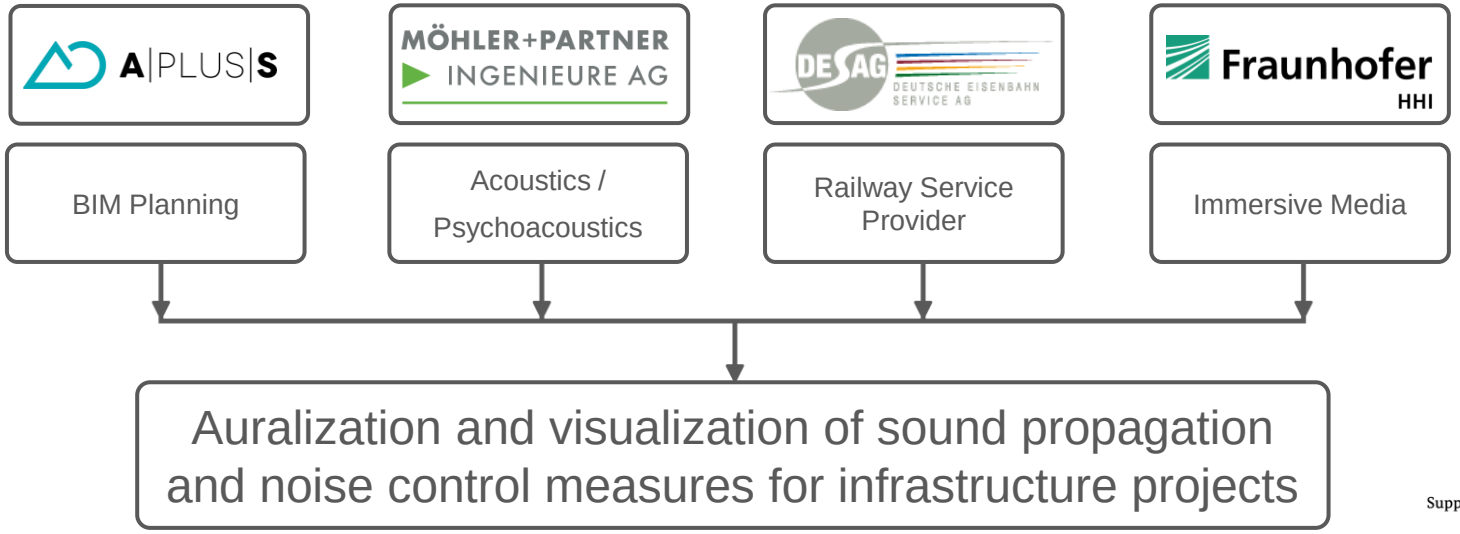

3D Audio Recordings
Audio Database
3D Planning Data (BIM)
360 Video Capturing
Simulation of
Noise Propagation
& Protection
UHD
Audio & Video
Master
Visualization
Now &
Prospectively
Immersive Rooms
(Info Point Noise Protection)
AR / VR
Mobile
Reproduction
Web Applications

State of the art of solutions

State of the art of solutions

State of the art of solutions

Project EAV-Infra

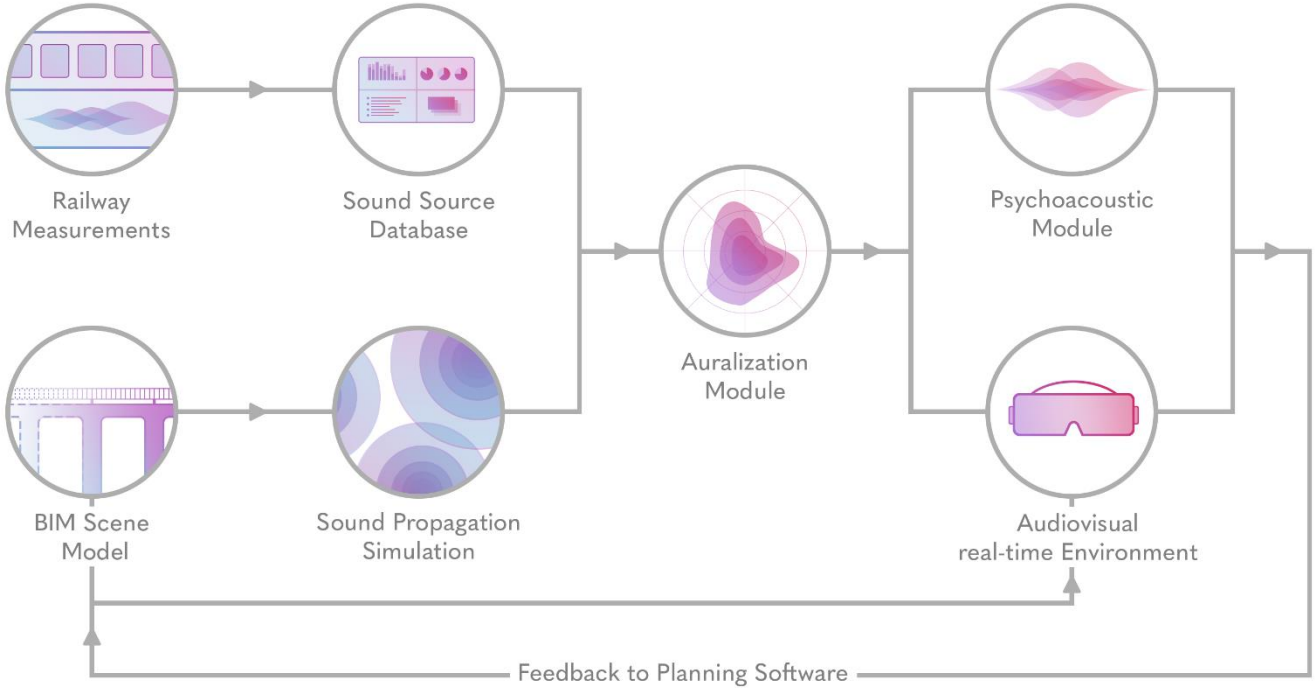


Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

Expected Results



Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI

WE PUT SCIENCE INTO ACTION.

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Fraunhofer HHI

Norwegian centre for railway sound & vibration

Anja Diez
SINTEF Acoustics

Technology for a better society

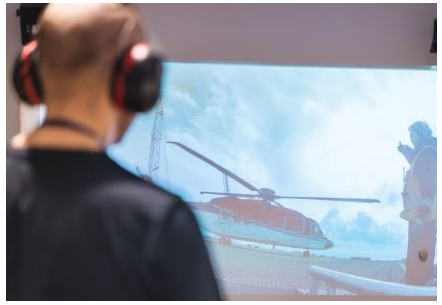
SINTEF acoustics

Industrial

- ultrasound
- transducer design
- signal analysis
- non-linear responses
- defects in concrete

Environmental

- noise propagation
- numerical modelling (e.g., CNOSSOS)
- noise classification machine learning
- impact & annoyance



Communication

- Audiology
- Technology for hearing preservation
- Binaural technologies
- Speech processing

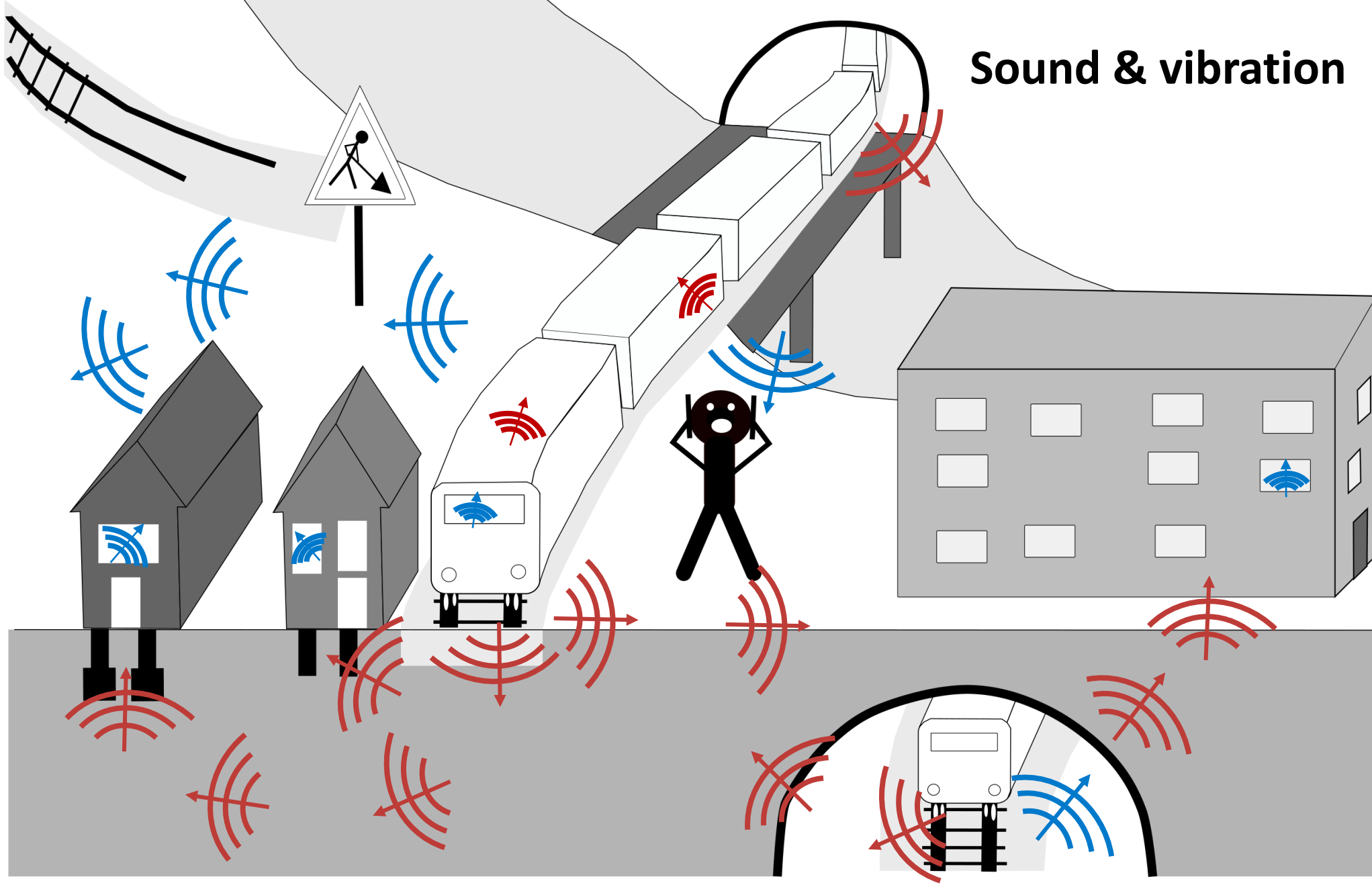
Sound & vibration

Challenges:
- noise
- vibrations
- structural vibrations

- infrastructure damage
- human health

- description of source
- coupling of waves

Use:
- condition monitoring (track, train, infrastructure, geology)
- warning systems

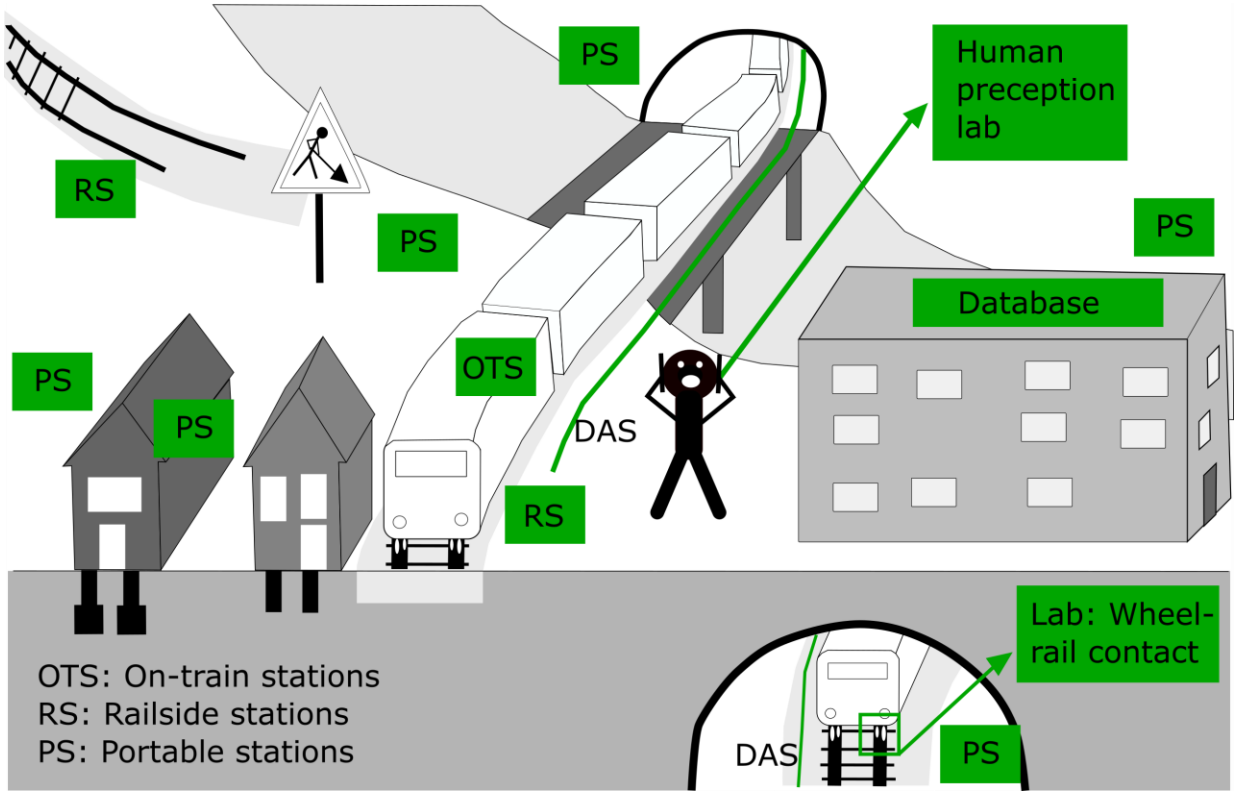


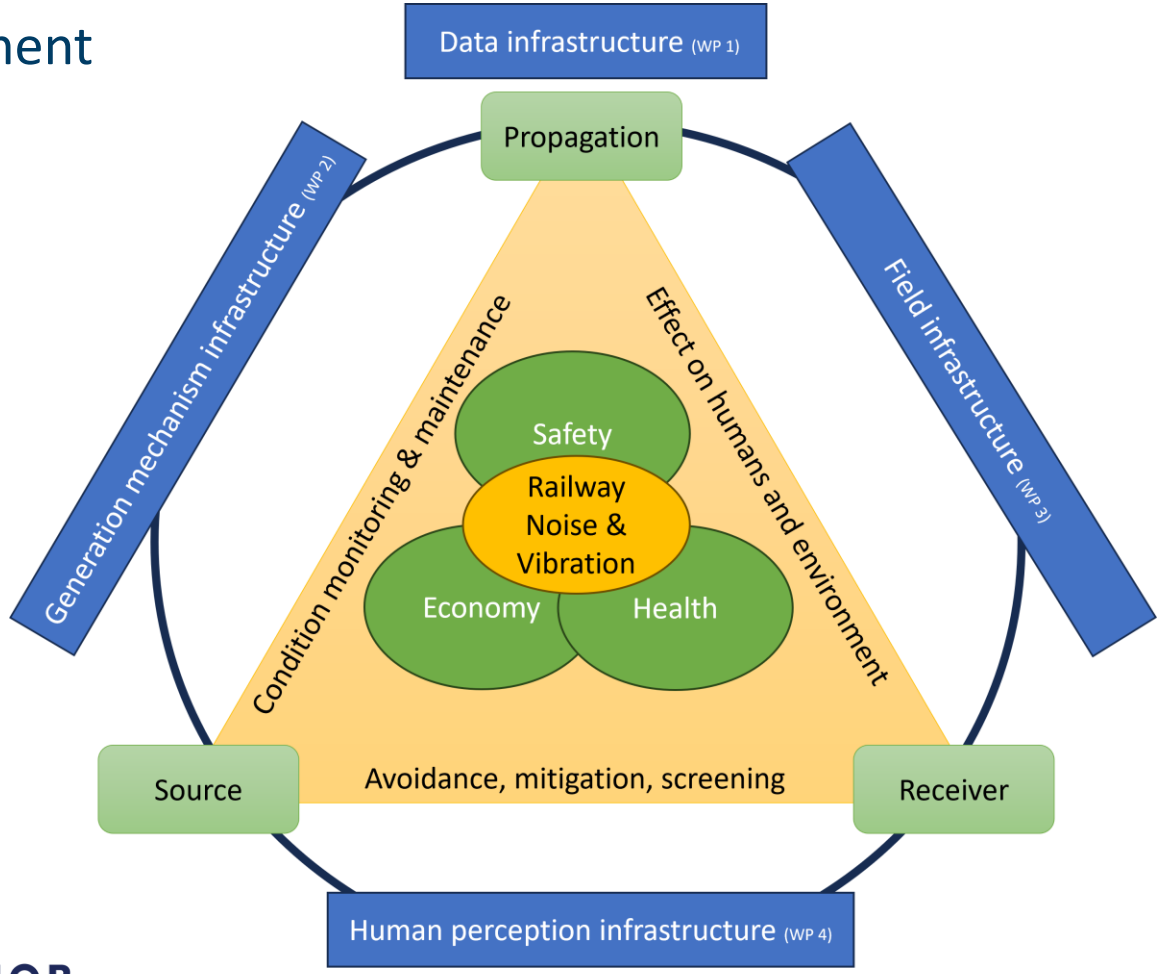
Increase in train traffic

Increase of noise & vibration

Norwegian centre for railway sound & vibration

1 Database + 2 Labs + 3 Test sides -> moveable equipment





SINTEF Digital Narvik Industry NGI NORSAR NTNU BANE NOR

Technology for a better society

Research interests –> possible applications

- Application possibilities of this infrastructure in international projects

Specific interests SINTEF acoustics:

- source
  - better classification of the source,
  - better description of the source for modelling
- coupling between sound and vibrations
- condition monitoring of infrastructure
  - early damage detection
  - non-linearity -> early crack detection
- understanding of mitigation measures

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Signalton Technology

Digital Signal Processing Solutions for Smart Sensor Systems

Smart Home, Building, City, Transportation, Industry, Energy and Environment

Nail Çadallı, Ph.D.
Founder and CEO/CTO

Ankara, Turkey
www.signalton.com.tr

October 2023

About Signalton Technology

Vision

State-of-the-Art DSP Techniques and Algorithms for Real-World Problems

Expertise

Signal Analysis (Acoustic/Audio, Vibration)

Control

Image Processing / Computer Vision

AI / Machine Learning

Electronic Design

Embedded Systems

Algorithms and Software

Experience

130+ Years (Team's total in academy and industry)

Focus

Wireless Sensor Networks

Custom DSP Systems

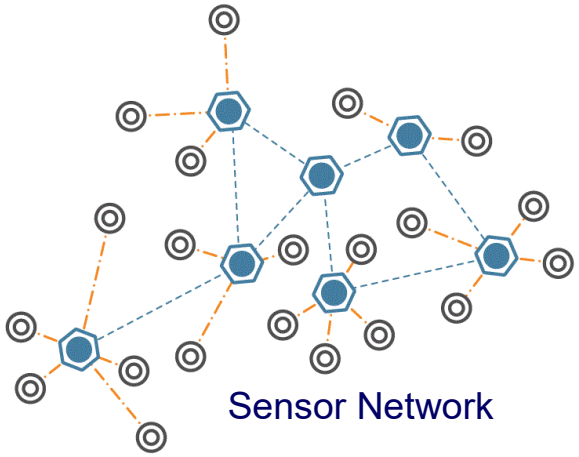
IoT

Edge/Cloud Computing

Smart System Applications

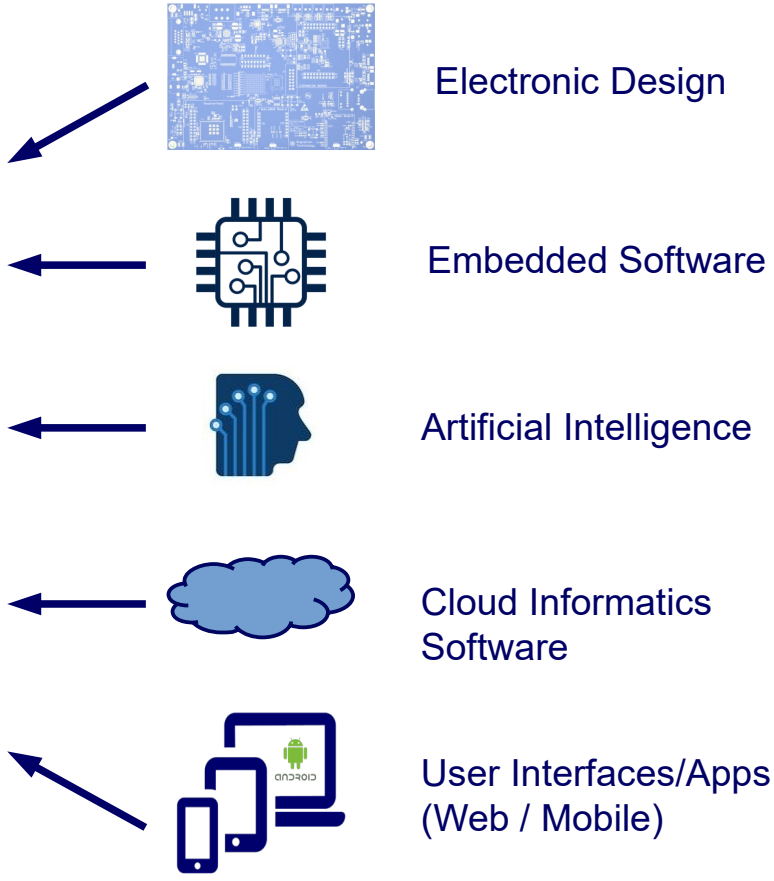
Informatics

Edge Computing and IoT Systems



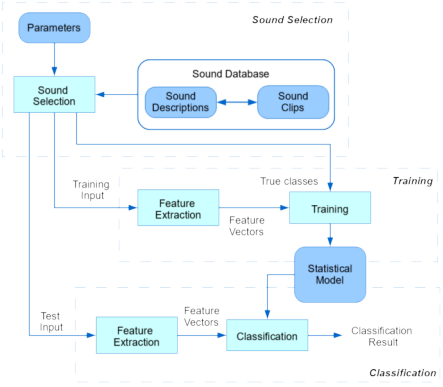
Sensor Network

- Smart home, building, city, transportation, industry, energy and environment
- Real-time sensing and actuation.
- High-speed wireless connectivity.
- Artificial intelligence (AI) at the edge or cloud.
- Rapid customization (size, function, cost).

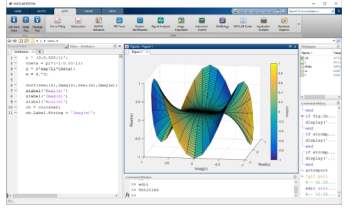


All components developed in-house by Signalton.

Real-Time AI Signal Analysis (edge/cloud)



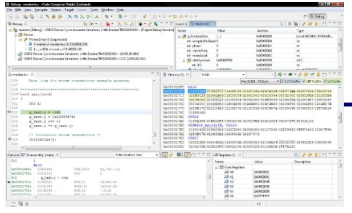
Signal Classification based on machine learning



Matlab/Octave suite (signal analysis, training, and performance evaluation)

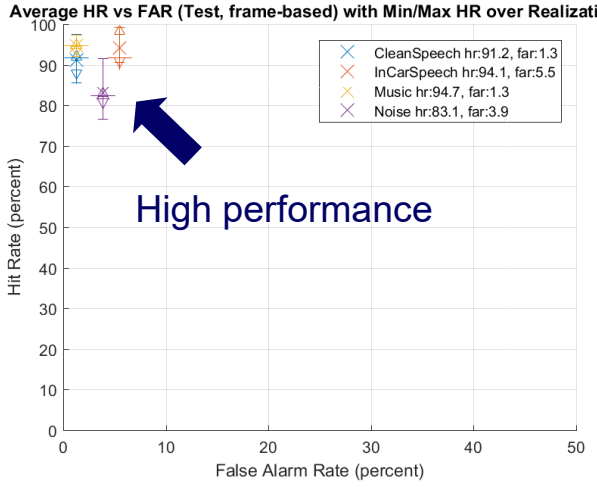
Cloud

Server Code



Embedded Code

Acoustic environment classification



High performance

Real-time processing

SigMote

Tested successfully for

- Acoustic environment classification
- Acoustic fault detection of electric motors
- Speech detection
- Voice activity detection
- Face detection (image/video)
- Face recognition
- Object detection and tracking
- Predictive/Preventive maintenance
- Vibration analysis
- IoT data collection

- Rapid customization to any signal database
- Option to run at the edge or on the cloud
- System-wide performance optimization given any use case

AI-Based Edge Computing and IoT Applications

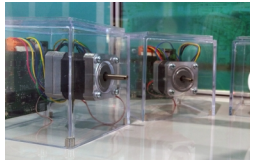
SigMote

DataMote

DSAR
Disaster Search and Rescue, survivor detection
(Smart City, Resilience)

AQNS
Air Quality and Noise Sensing
(Smart city, transportation, environment)

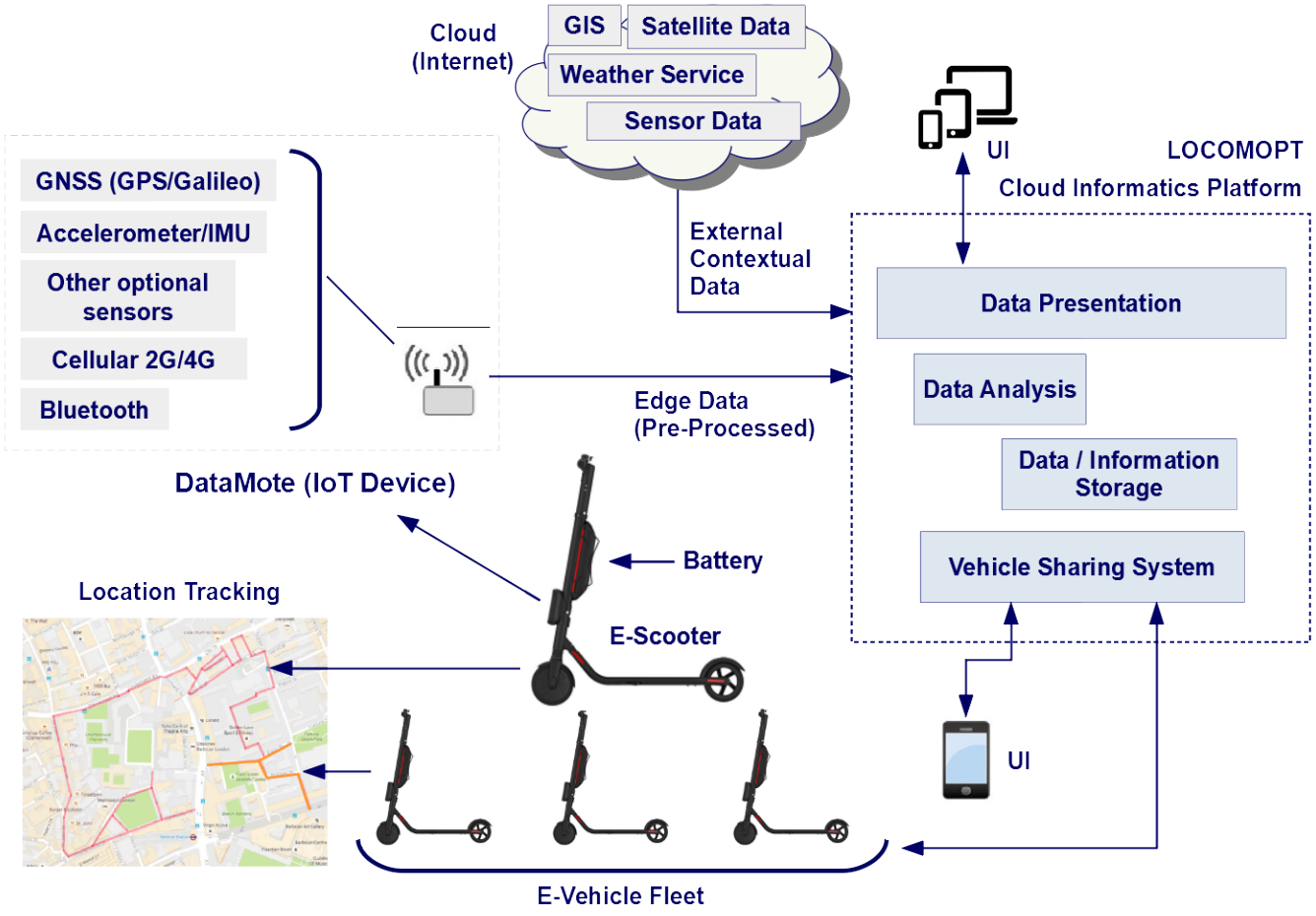
Locomopt
Micromobility Vehicle Tracking and Control
(Smart City, Transportation)



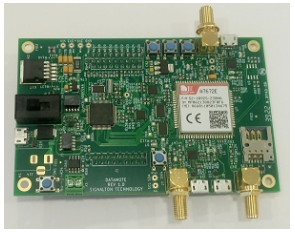
Acoustic/Vibration Analysis, Anomaly Detection,
Preventive/Predictive Maintenance
(Industry 4.0, Smart Manufacturing, Energy)

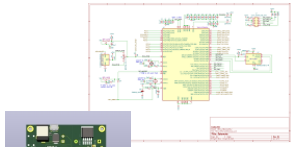
Image/Video Object Identification,
Process Control, Automation, Workforce Safety and Health
(Industry 4.0, Smart Manufacturing)

Locomopt Micromobility System



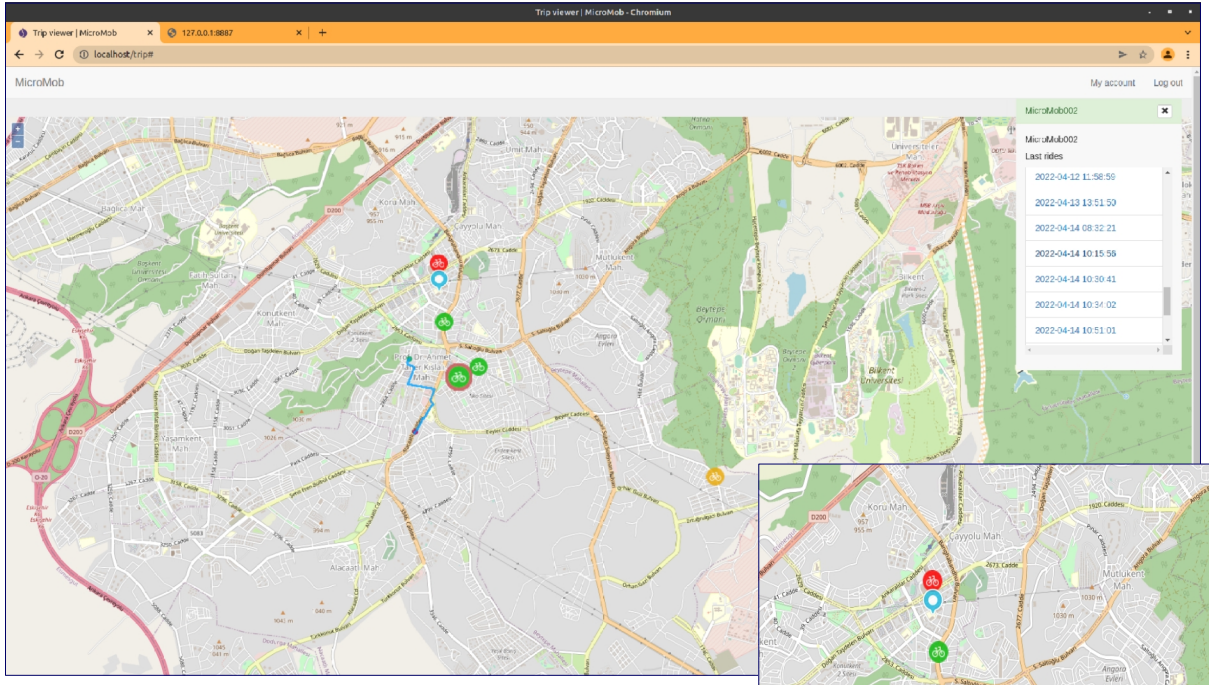
DataMote

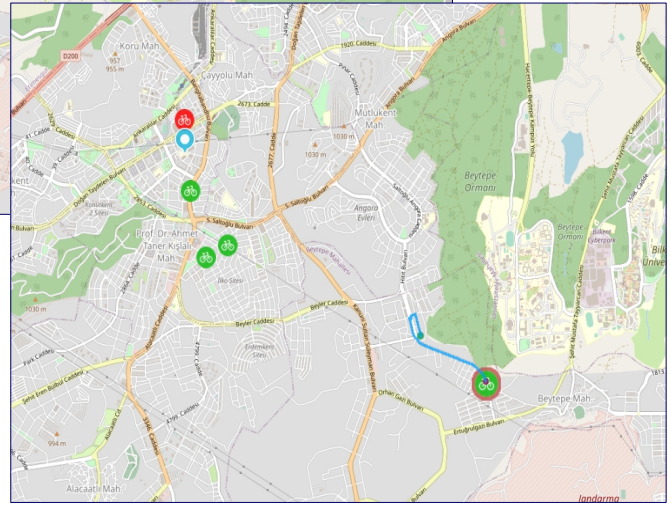




- Micromobility + general IoT applications.
- ARM processor.
- Real-time operation (TI-RTOS)
- Long-range connectivity: 4G/LTE
- Location: GNSS (GPS)
- Short-range connectivity: Bluetooth
- Vibration sensor with fall/motion detection.

Locomopt Cloud Informatics Platform





- Software developed in-house.
- Full customization for specific features and requirements.

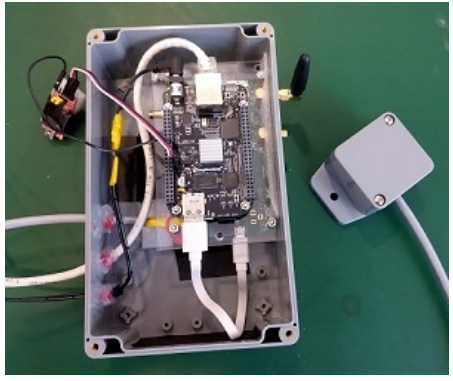
- E-vehicle tracking using location data from DataMote.
- Shared e-vehicles (fleet rentals).

Tire Failure Early Warning based on Vibration Analysis

Signalion Technology

Anomaly Detection and Early Warning System Based on Predictive/Preventive Maintenance with Application to Tire Failure

Tire Endurance Testing



End-to-end solution development for a strategic large-industry partner.

Data Collection Unit
(Based on DataMote and a high-accuracy vibration sensor).

System deployed and data collection started at the factory (April 2023).

Contact

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Founder, CEO/CTO

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Phone: +90-(533)-348-3873

UNIVERSITY OF TWENTE.

Expertise:

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- Michael Yang (UT-ITC-SU)
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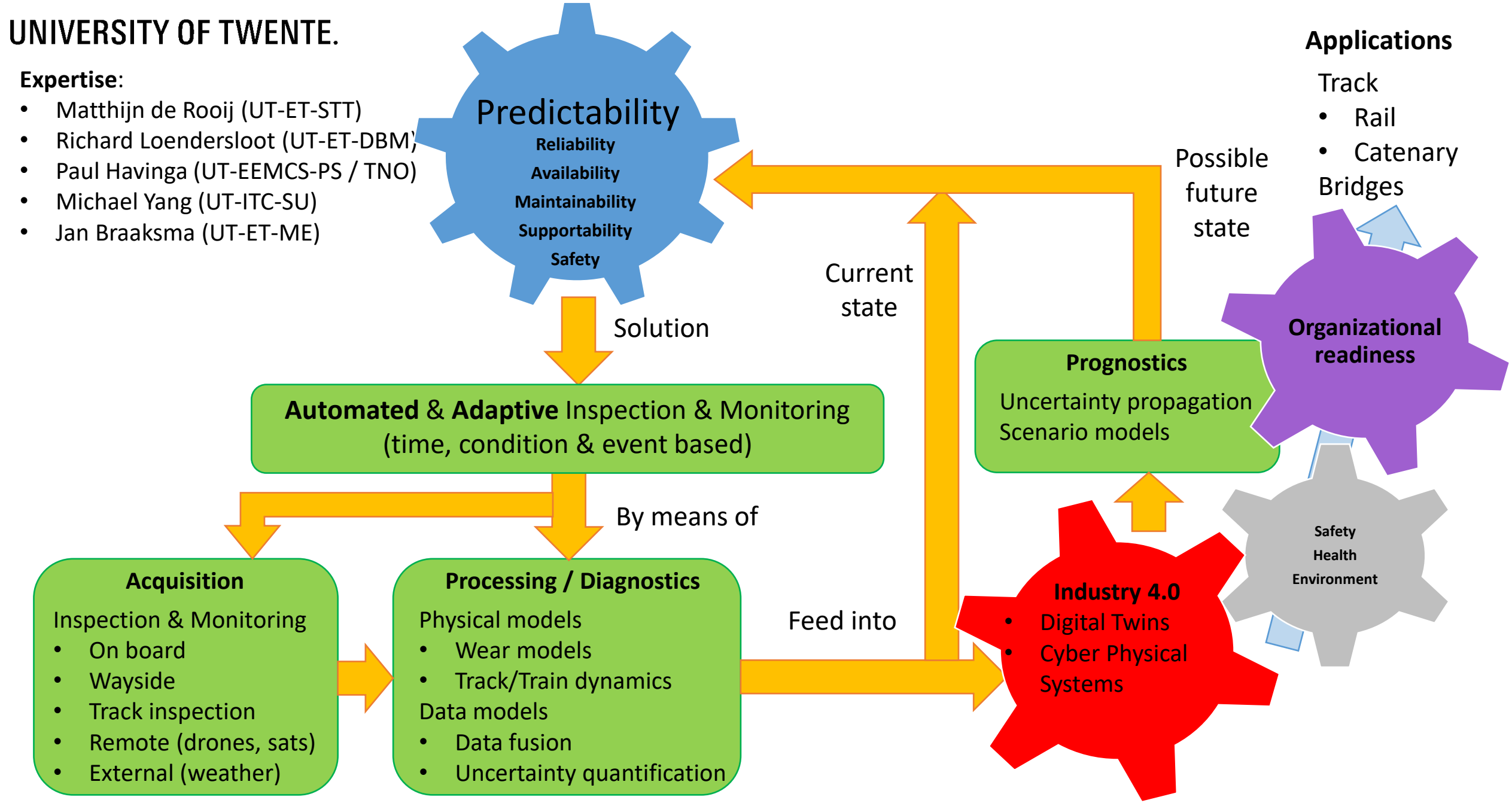

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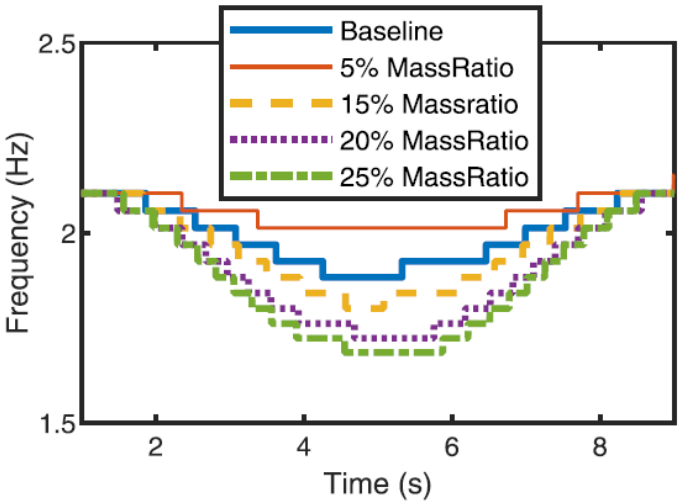
DYNAMICS BASED MAINTENANCE

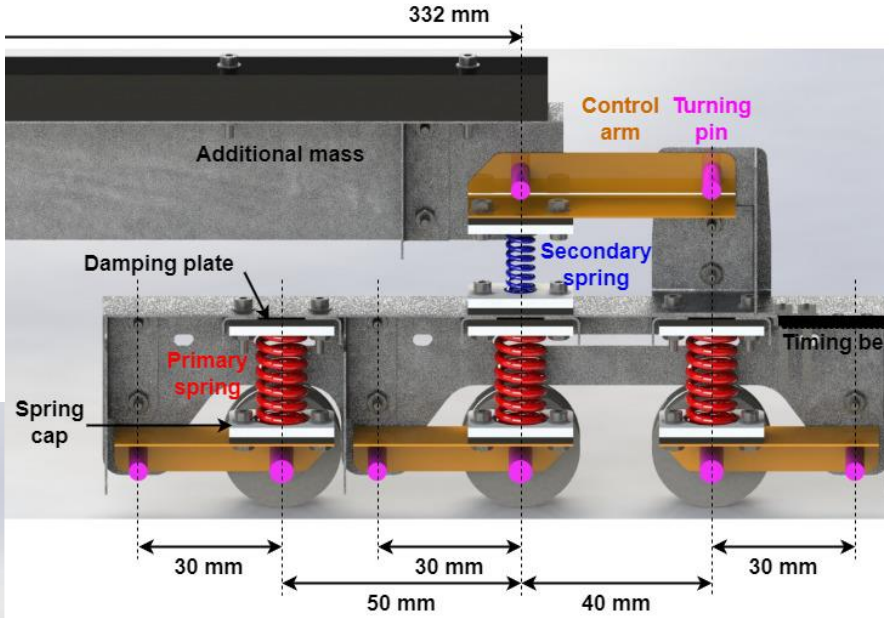
Railway Bridge Damage Detection

The research proposes a method to **identify damage** by observing the **change in the instantaneous frequency** using the **Wavelet Synchro-Squeezed Transformation (WSST)** during the traverse phase, which is when a train passes over the bridge.

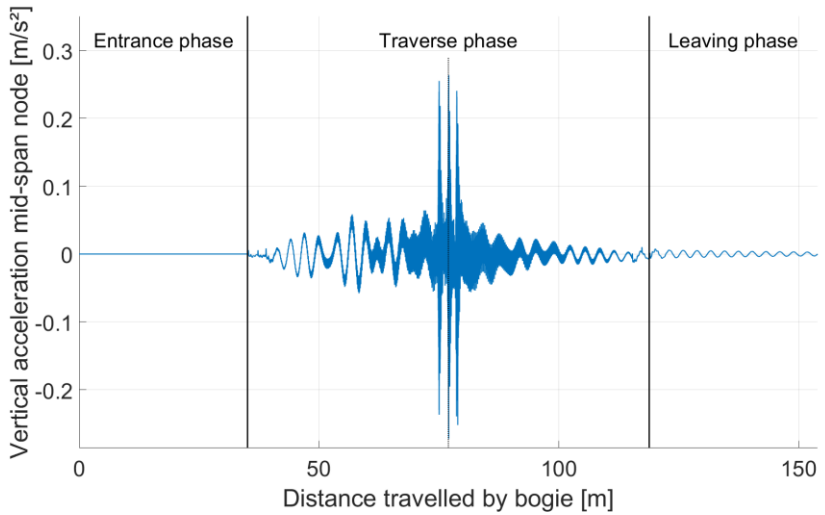
Boyne Viaduct in Drogheda, County Louth, Ireland

Mostafa N., et. al (2022)

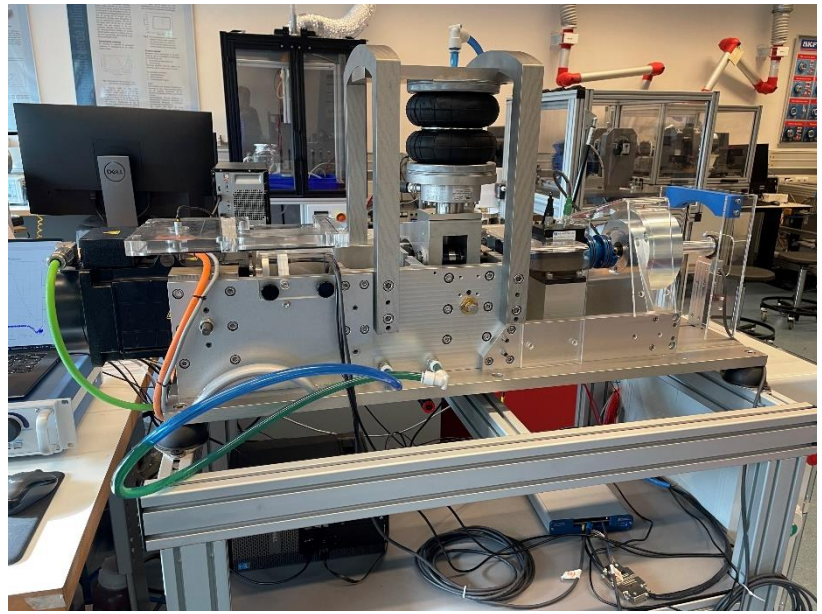




Experimental set-up (scaled) by Patrick Boersma



Surface Technology and Tribology Group (STT) Capabilities



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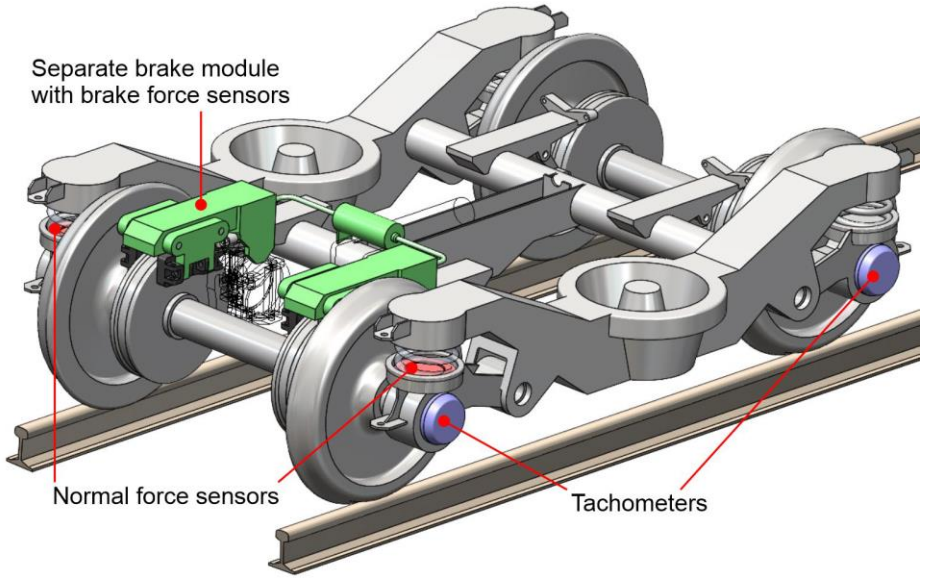

Prof.dr.ir. M.B. de Rooij
m.b.derooij@utwente.nl
UNIVERSITY OF TWENTE. | Surface Technology and Tribology

Surface Technology and Tribology and Dynamics Based Maintenance

Noise and Vibration

- Relation train dynamics / train-track interaction and surface interactions
- Lubrication and contact dynamics
- Traction / adhesion modelling & measurement

UT-WIDE EXPERTISE IN DISRUPTIVE ASSET MANAGEMENT

Prof.dr.ing. Sebastian Thiede full prof.

Prof.dr.ir. Leentje Volker full prof.

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Dr. Engin Topan assistant prof.

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Augmented and Virtual Reality

Change Management/Org. behaviour

Risk and Safety Management

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Sensing and Networks

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Physics of Failure

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University of Twente Expertise

UNIVERSITY OF TWENTE.

DISRUPTIVE ASSETS MANAGEMENT SOLUTIONS, INCLUDING URBAN USE CASES

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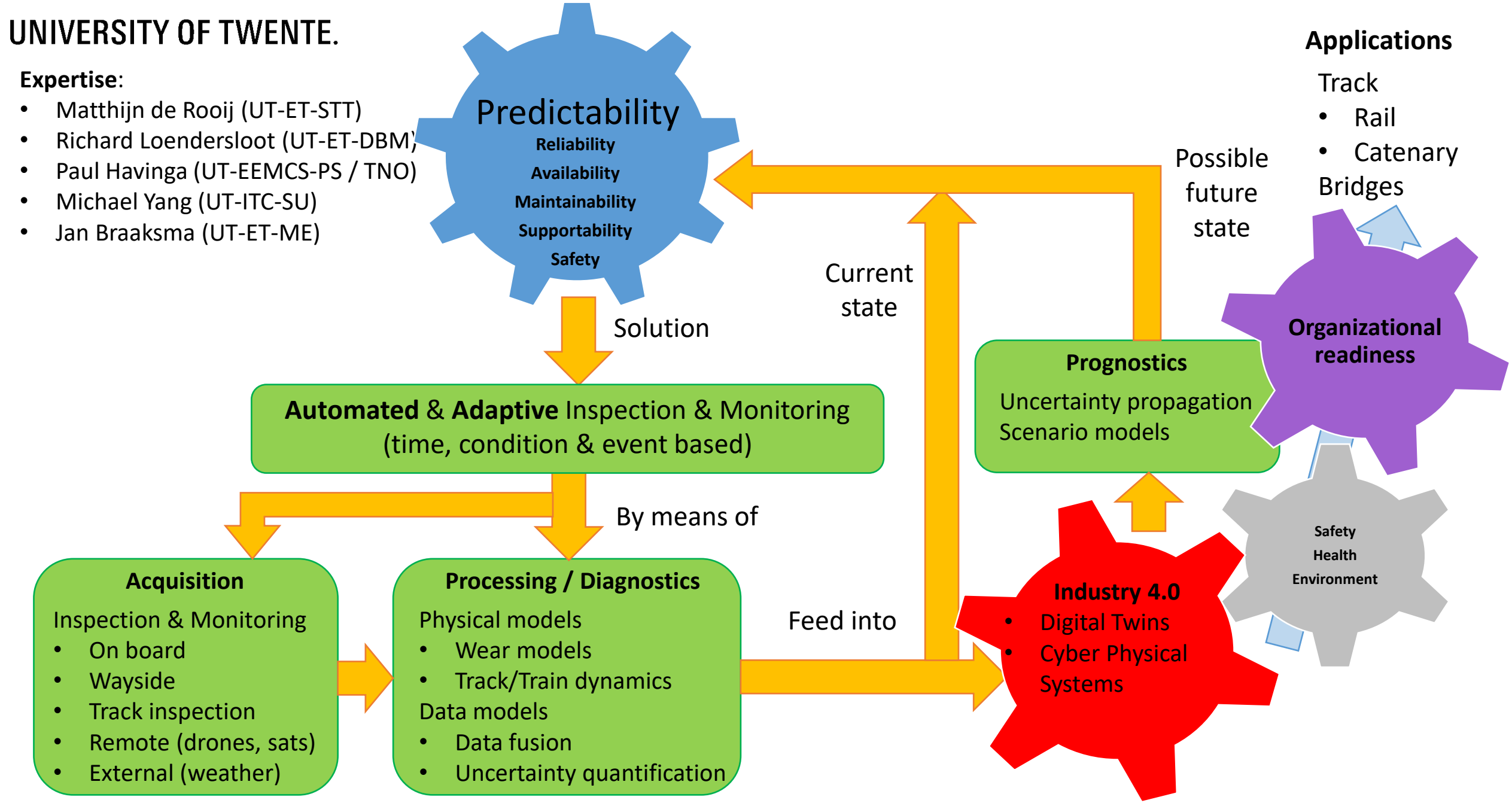

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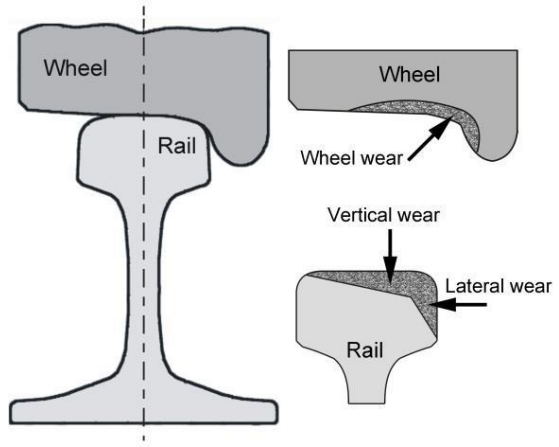
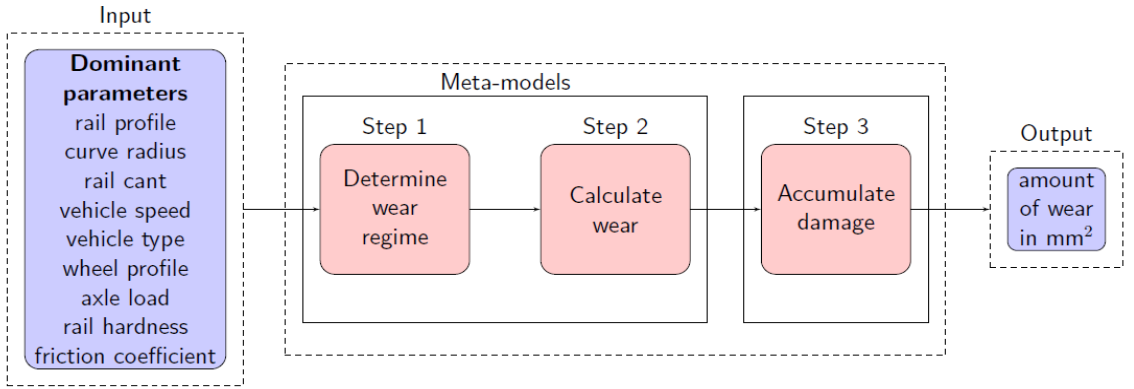
Predictive Maintenance



- **Prediction of rail wear using meta-models**
  - Rail wear prediction still based on linear extrapolation
  - Rails are operated in **highly demanding and varying conditions**
  - **Meta-models** for fast communication between autonomous sensor systems, users and infrastructure managers
  - Model simulates **scenarios** that have not occurred before
  - Model takes into account **uncertainty** to accurately predict RUL with **less computational effort**

Rolling Contact Fatigue (head checks)

- **Interaction of rail wear and rolling contact fatigue**
  - Rails are exposed to **multiple failure mechanisms**
  - Solve the challenge of interacting failure mechanisms through meta-models



Meghoe A., et. al (2019)

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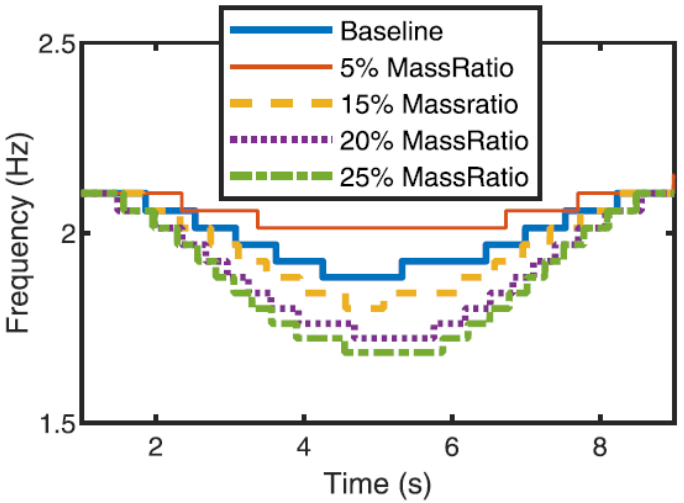

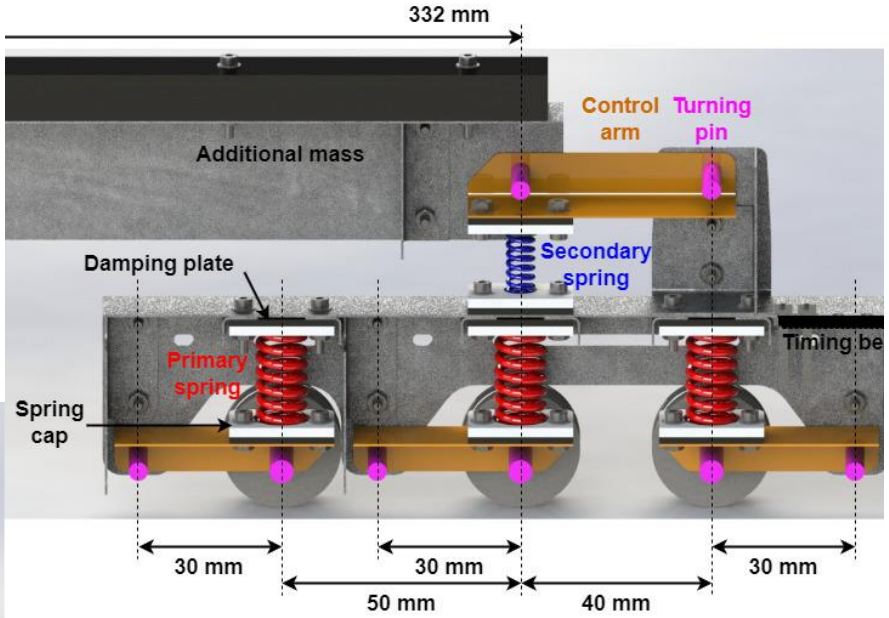

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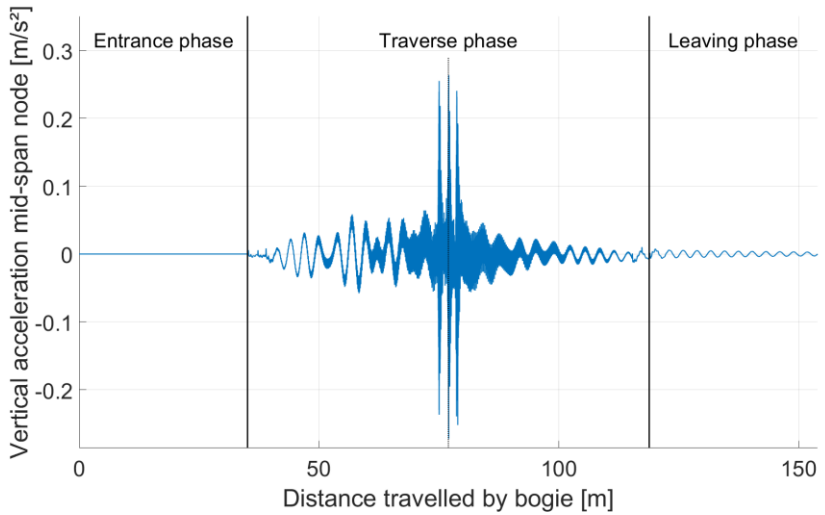

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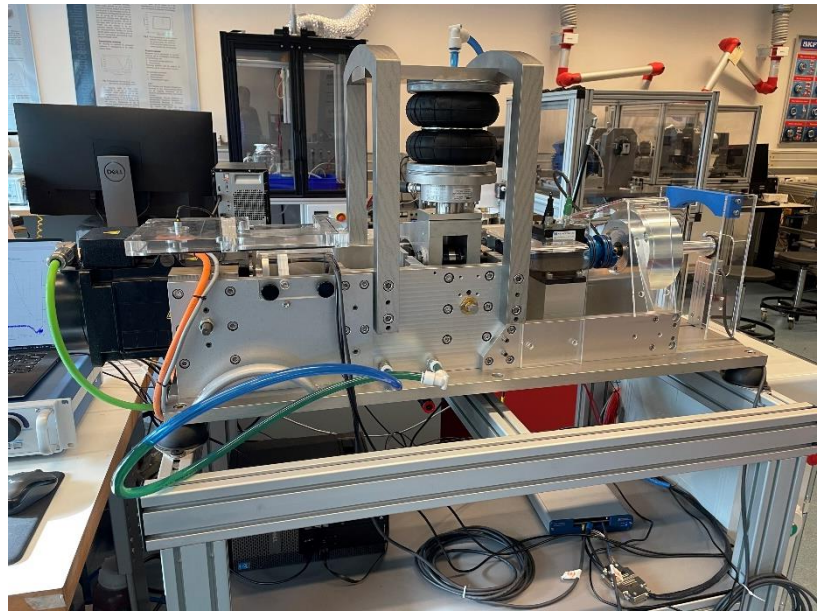

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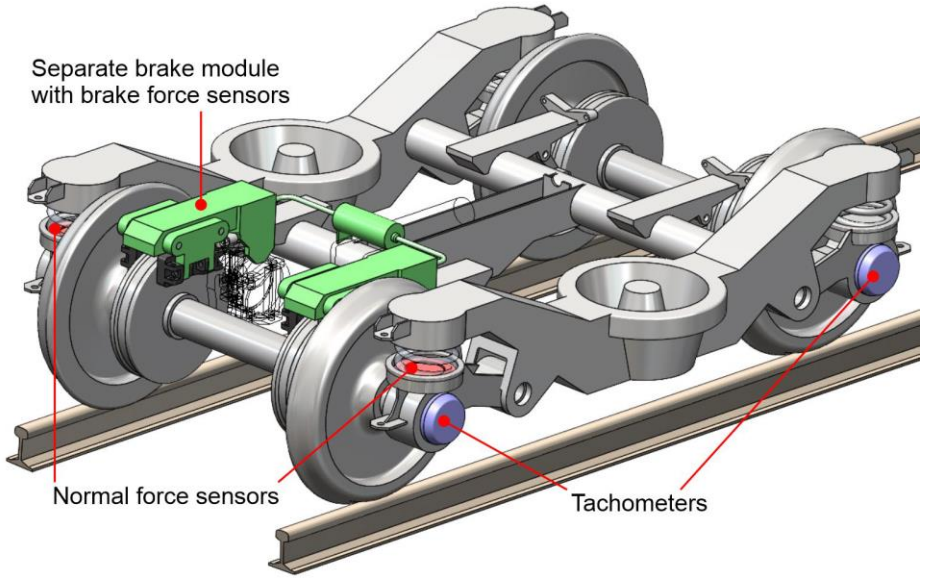

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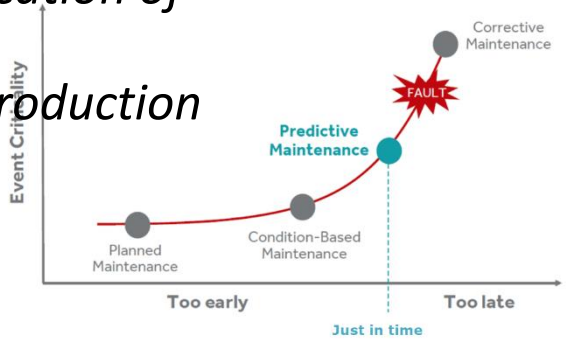
Asset Management & Maintenance Engineering

- *Research in close cooperation with industry*
- *Strong link with European and National Railway sector*
- *Expertise in rail sector with recent projects on:*
  - *Risk and introduction management, e.g.anti-fragility, resilience*
  - *Organizing predictive maintenance*
  - *Sustainable asset management (e.g. digitalisation/ eco-labeling)*
  - *Business case for Autonomous Transport Automation*
  - *Systems integration/systems thinking, IT/OT convergence/digitalisation, application of technologies in maintenance: augmented reality,*
  - *Coordination of interorganizatonal cooperation, knowledge management, introduction management)*
- *Link with World Class Maintenance*



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GS1 Switzerland

Discovery Service in Rail

ONS for Vehicle Visibility Events

Dominik Halbeisen, GS1 Switzerland

Who is GS1 (Global System One)

A worldwide, international association sans but lucratif (AISBL)

- Not-for-Profit
- International and locally
- Founded by companies to help companies
- Solves the neutral actor challenge for its members

150
Countries

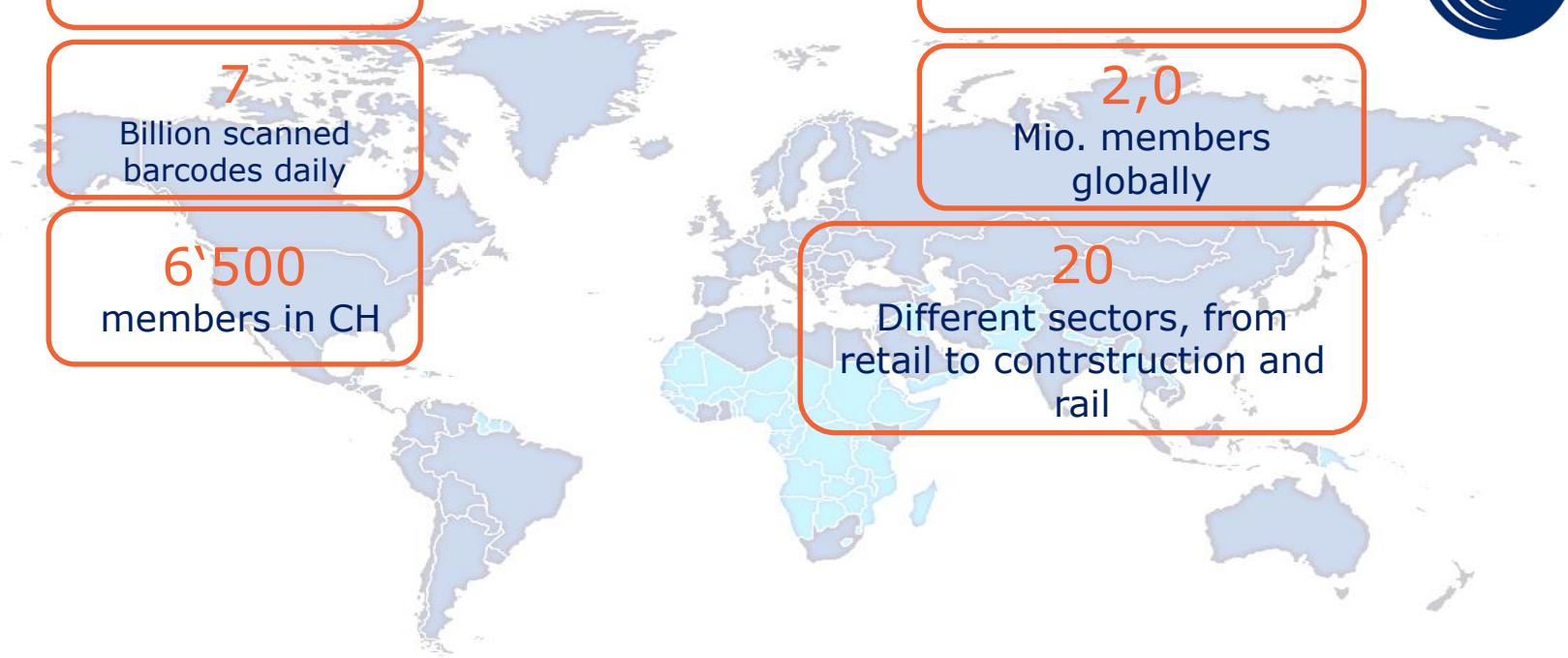
7
Billion scanned barcodes daily

6'500
members in CH

114
Local offices

2,0
Mio. members globally

20
Different sectors, from retail to contrstruction and rail



Countries with a GS1 office

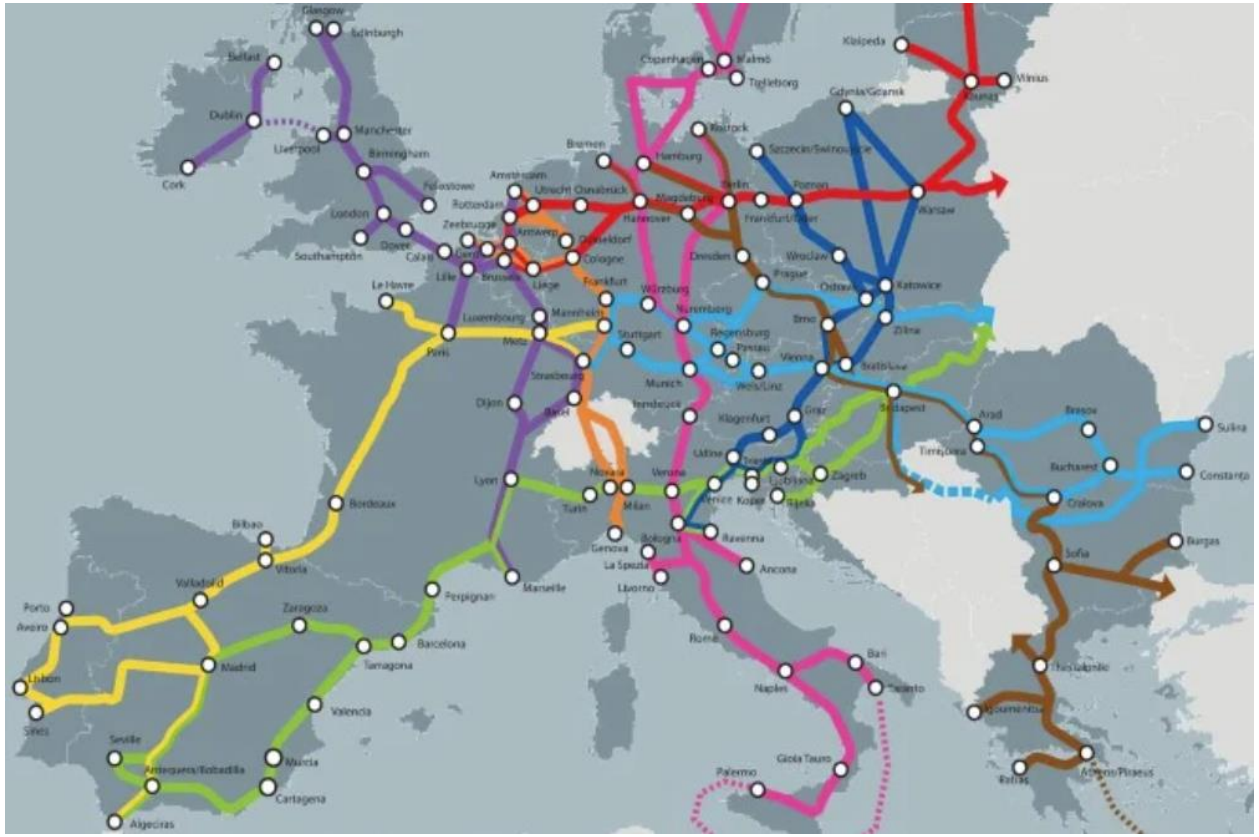
Countries served by the GS1 global office

European Rail Corridors

Main Challenges for Vehicle Owners and Operators

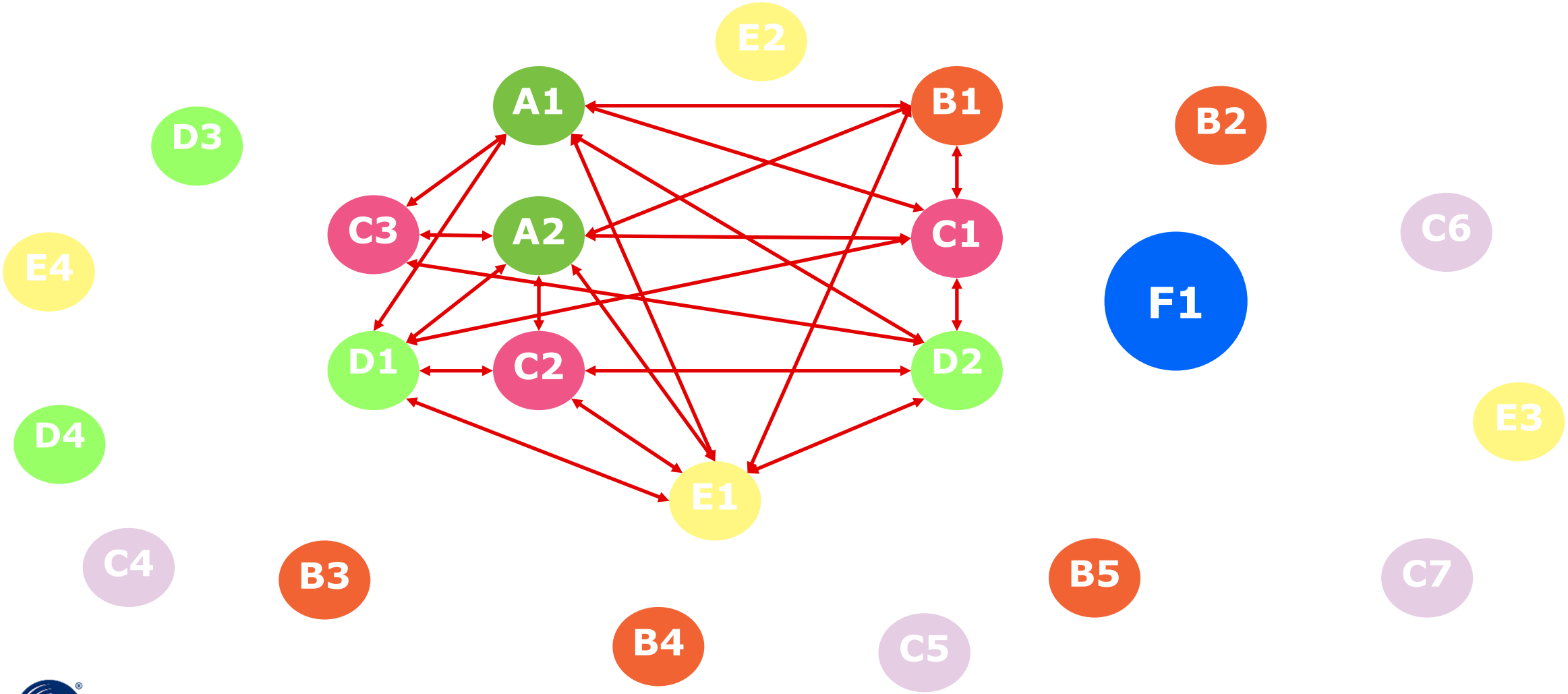
There is no common event repository to track a rail car journey across Europe for all parties involved.

- Vehicle owners and/or holders
- ECM maintainers
- Railway undertakers
- Railway infrastructure operators



Scaling is a challenge

The issue lies in the high number of parties and connection points



Standards already existing

To gradually solve this issue standards have been developed

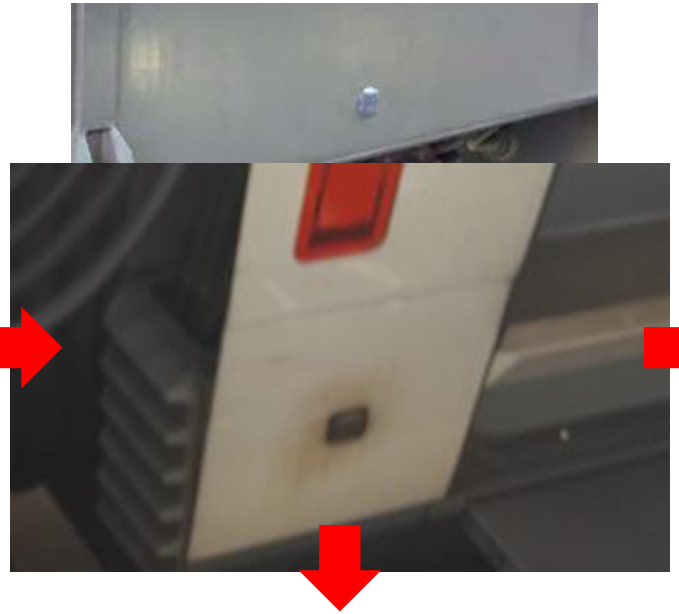
The Global Language of Business

Identification of Components and Parts in the Rail Industry - Application Standard

Rules on the use of the GS1 keys and attributes for the identification and marking of components and parts in the rail industry

Release 1.1, Ratified, Sep 2018

GIAI



EUROPEAN STANDARD **EN 17230**

NORME EUROPÉENNE

EUROPÄISCHE NORM November 2020

ICS 35.040.50; 35.240.60

English Version

Information technology - RFID in rail

Technologies de l'information - Identification par radiofréquence dans le secteur ferroviaire

Informationstechnik - RFID in Eisenbahnanwendungen

This European Standard was approved by CEN on 11 October 2020.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

Exchange of component/part lifecycle data in the rail industry Application Standard

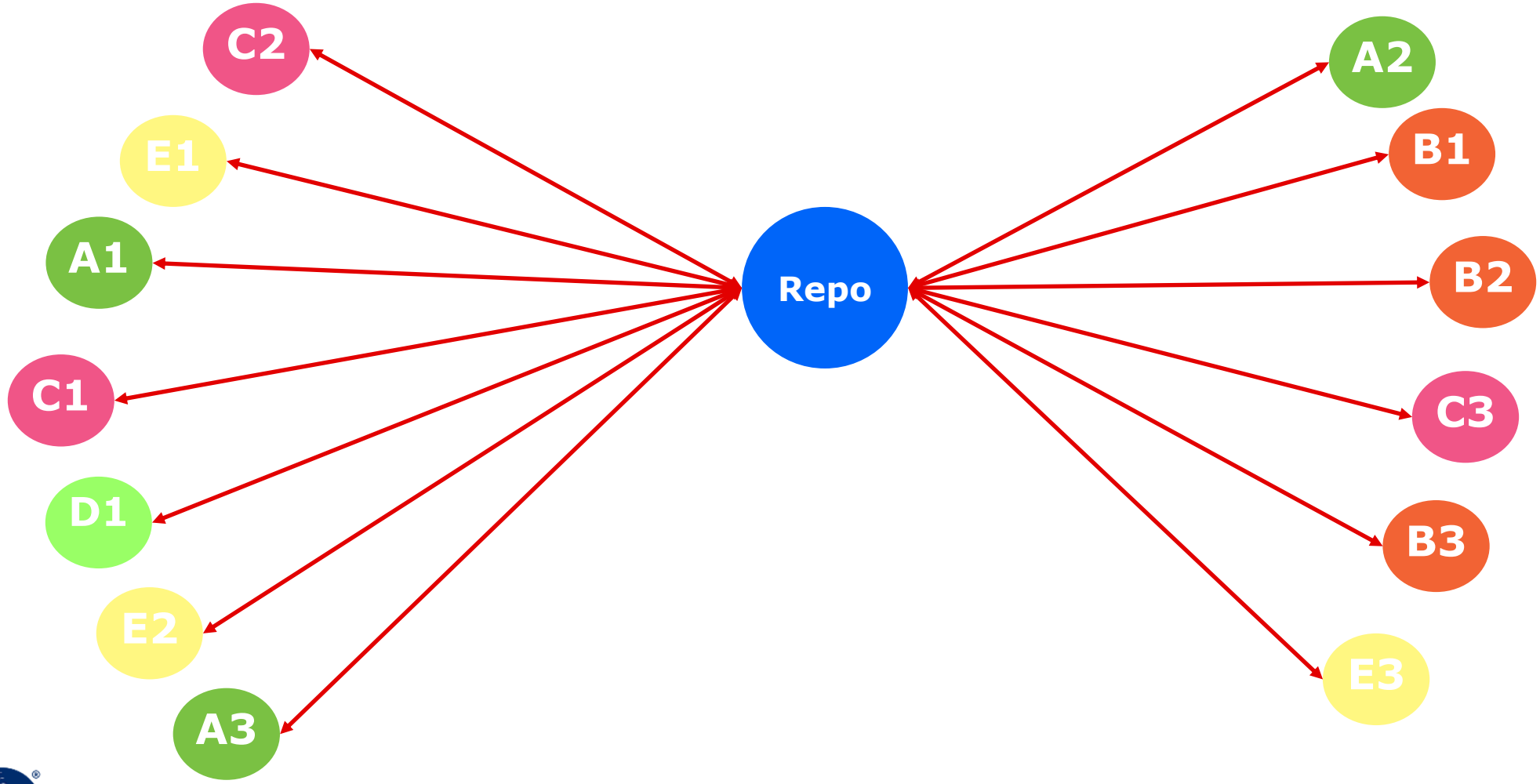
Exchange of visibility event data for lifecycle tracking of crucial and safety relevant MRO-objects across manufacturing, maintenance, repair and overhaul processes.

Release 1.0.1, Ratified, Feb 2018

EPCIS

EPCIS is the theoretical solution

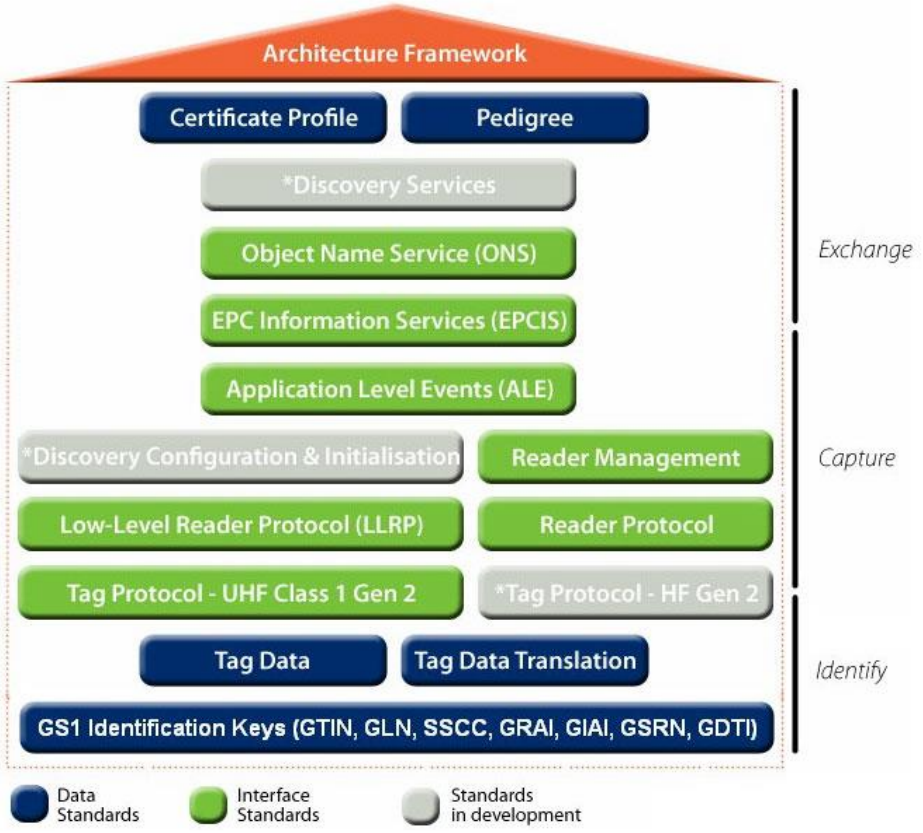
With the standards we now have theoretically everything in place



Where do we find the different repositories?

So far, the ONS (Object Name Service) has been missing

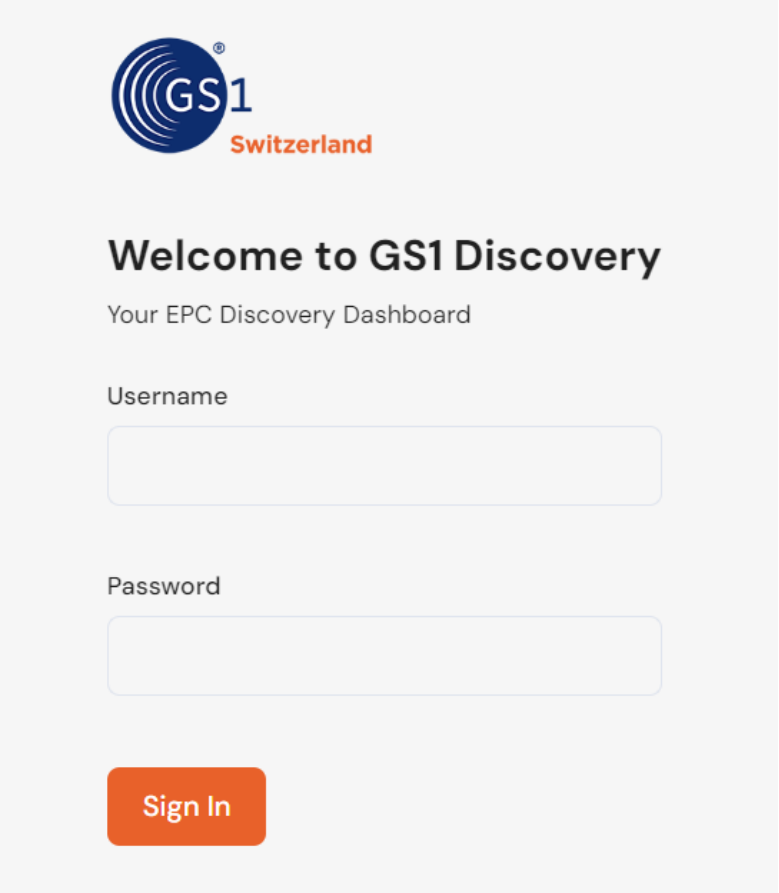
- The ONS keeps the information stored, where the information is
- The internet knows precisely the same architecture. It is called DNS (Domain Name Service). Different servers keep the info where the web pages we are looking for are located.
- The most well-known: IP 8.8.8.8 (Google DNS Server)



We have developed the first working PoC

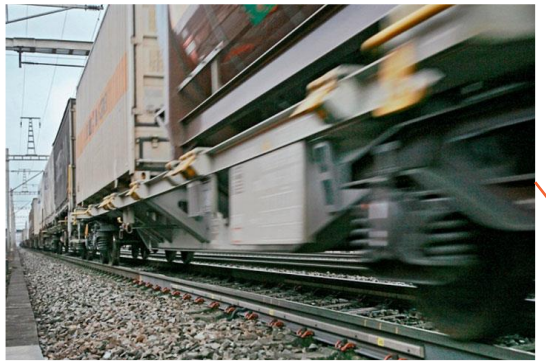
The GS1 Discovery Service is the first working ONS

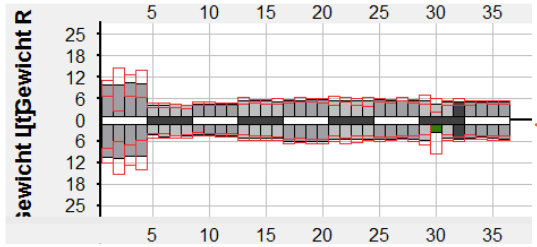
- We have built a Proof of Concept (PoC) ONS Discovery Service
- It is based on privacy require-ments by our rail membership community.
- Access to the ONS-service is restricted (password protected)
- Access to the data is again governed by the owner of the data (not by the ONS-service)

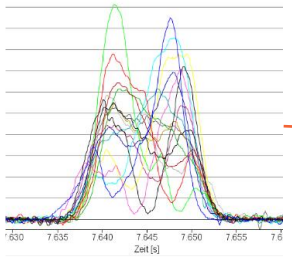


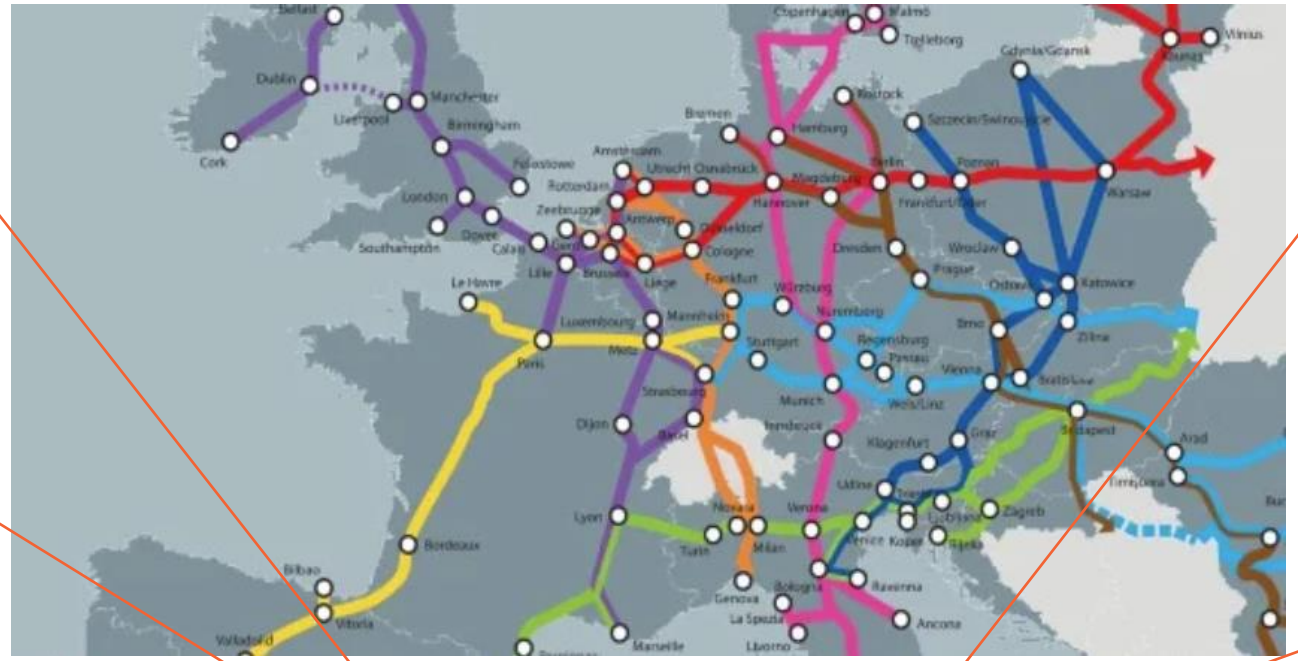
What’s the goal?

The goal is to gradually standardize and connect repositories.









Event declarations
Data remains private

ONS

Event declarations
Data remains private

Thank you very much

Ihr Kontakt

Dominik Halbeisen

Solutions Expert Technical Industries

+41 58 800 72 38

doh@gs1.ch

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virtual vehicle
RAIL SYSTEMS
Backbone for Green Digital Mobility
www.v2c2.at

AUTOMOTIVE

RAIL

Founded:	**2002**
Staff:	**~350**
Operating Income:	**~25 Mio. EUR**
Located in:	**Graz**

FUNDED BY:

Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

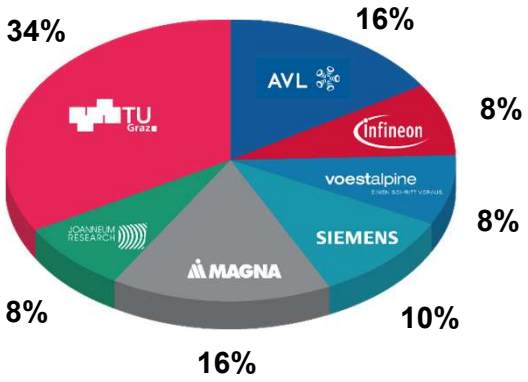
Federal Ministry
Republic of Austria
Digital and
Economic Affairs

FFG
Promoting Innovation.

Das Land Steiermark

SFG

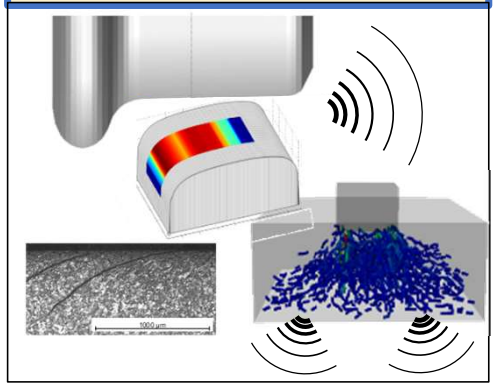
SHAREHOLDERS:



Dr. Jost Bernasch
Managing Director
Prof. Steffan, Hermann
Scientific Lead

Key research areas and expertise

Vehicle/Track Interaction



- Profound knowledge of physics
- Modelling of complex interactions and phenomena
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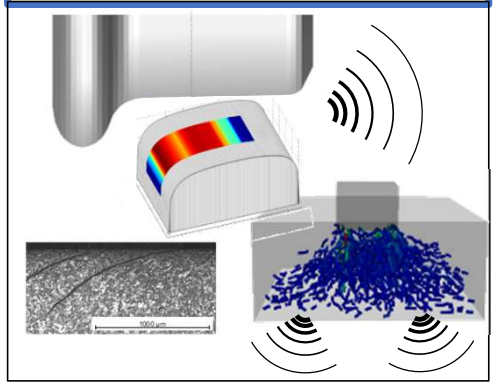

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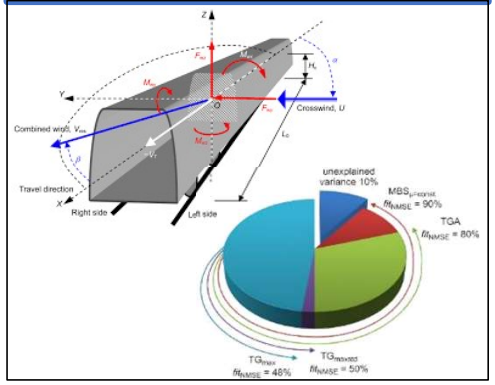
Vehicle Dynamics & Operation Analysis



- Profound knowledge of vehicle system dynamics
- Simulation and modelling of vehicle/track interaction
- Vehicle and track parameter identification
- Virtual homologation of running behaviour (EN 14363)
- Probabilistic vehicle and track design

Key research areas and expertise

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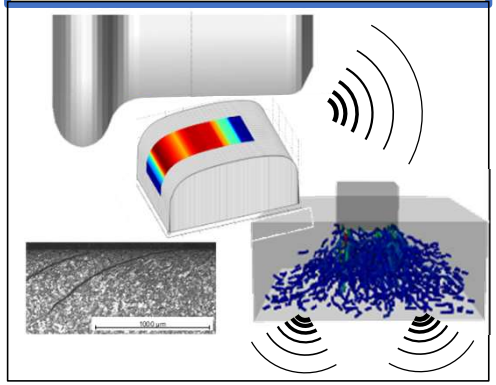

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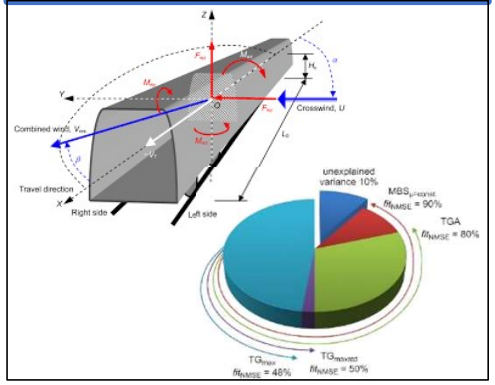

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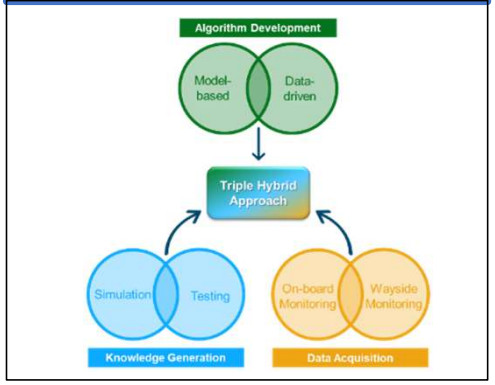
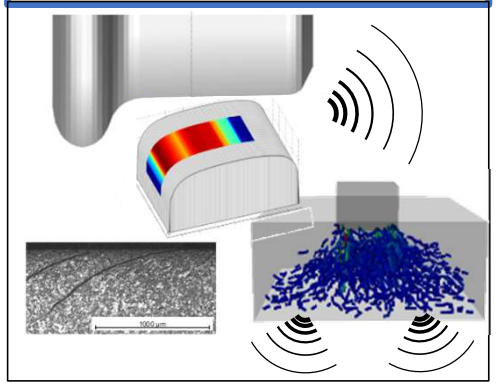
Monitoring & Diagnosis



- Profound context-based knowledge
- Algorithm development based on hybrid approaches
- Model-based and data-driven diagnosis and prognosis methods
- Monitoring, diagnosis and prognosis of vehicle components
- Track monitoring and assessment via on-board and wayside monitoring systems

Key research areas and expertise

Vehicle/Track Interaction



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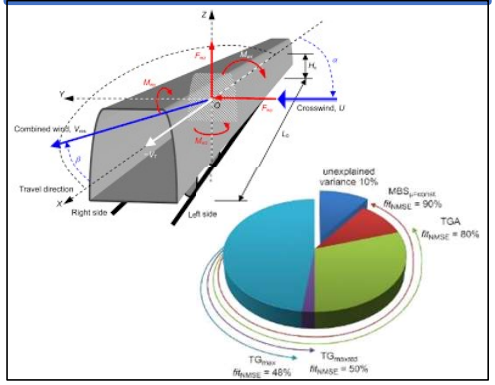

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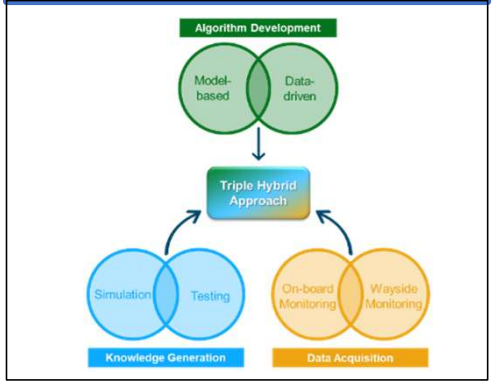
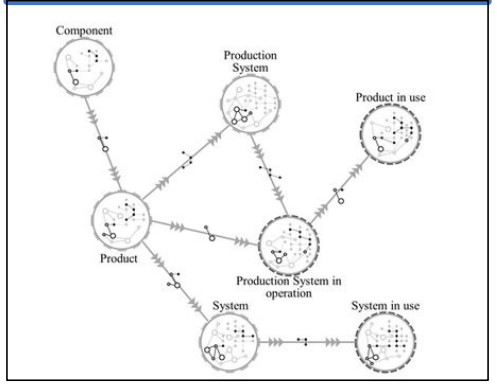
Monitoring & Diagnosis



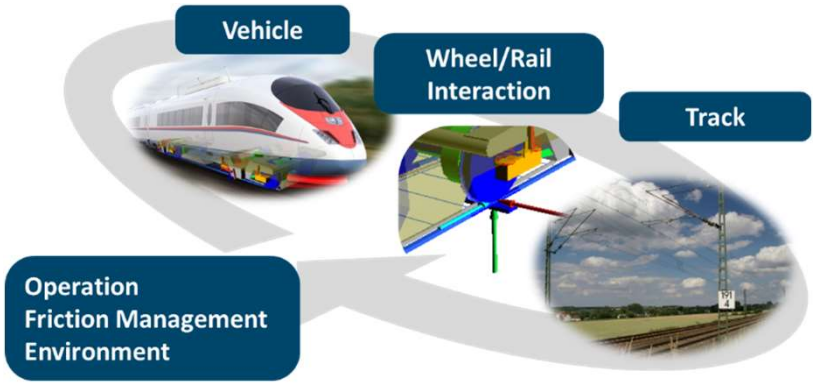
- Profound context-based knowledge
- Algorithm development based on hybrid approaches
- Model-based and data-driven diagnosis and prognosis methods
- Monitoring, diagnosis and prognosis of vehicle components
- Track monitoring and assessment via on-board and wayside monitoring systems

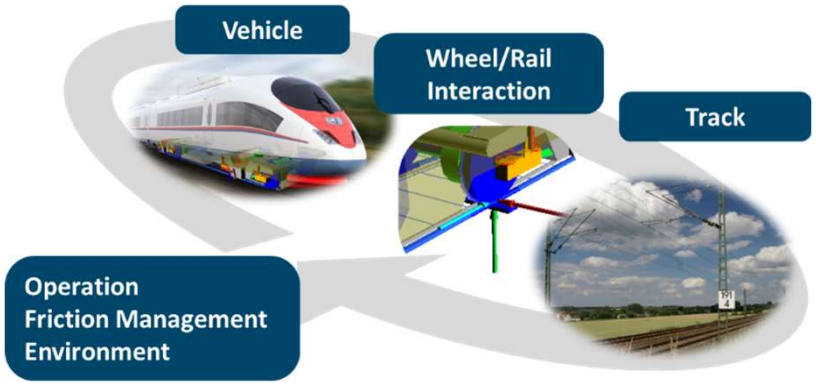
Digital Twins Network



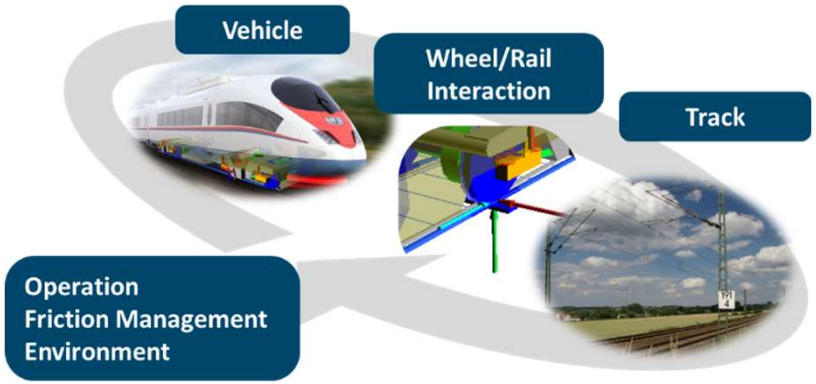
- Vertical integration:
  Analysis of interaction between digital twins
- Horizontal integration:
  System or component behaviour during all life cycle phases
- Single point of truth:
  Consistent and continuous system data and models

Wheel/Rail Interaction & Deterioration Phenomena





Damage & Deterioration
- RCF
- Wear
- Track settlement



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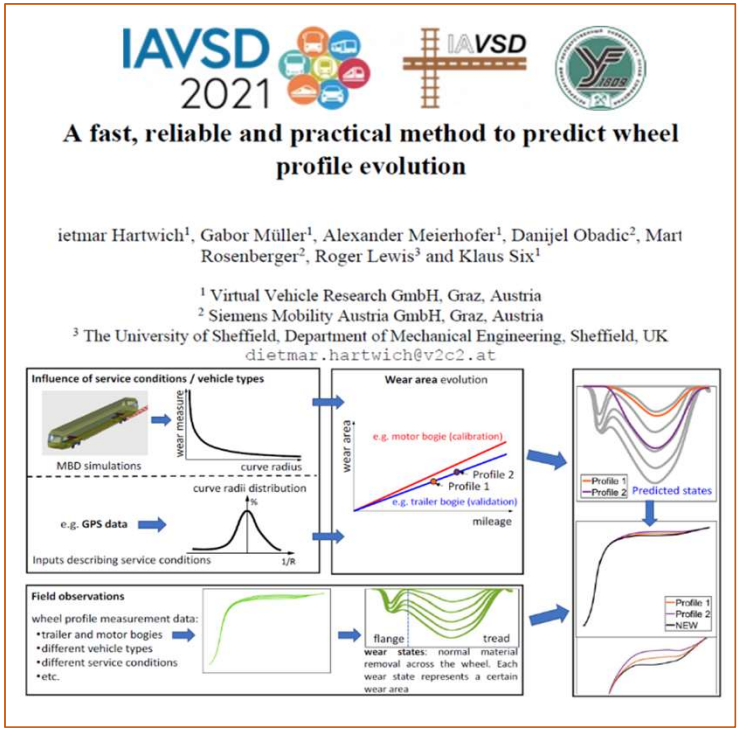
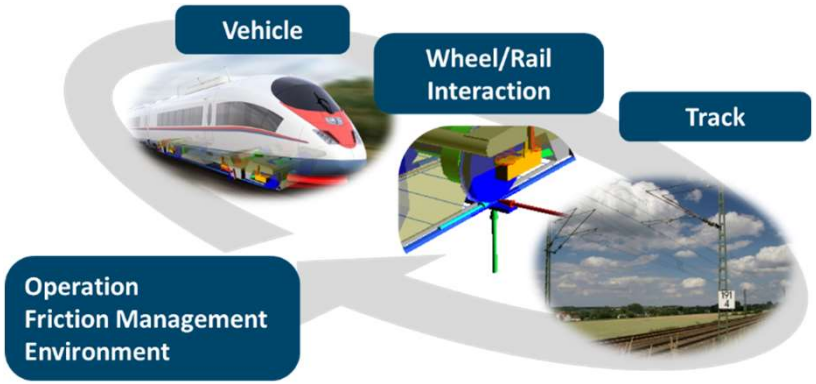


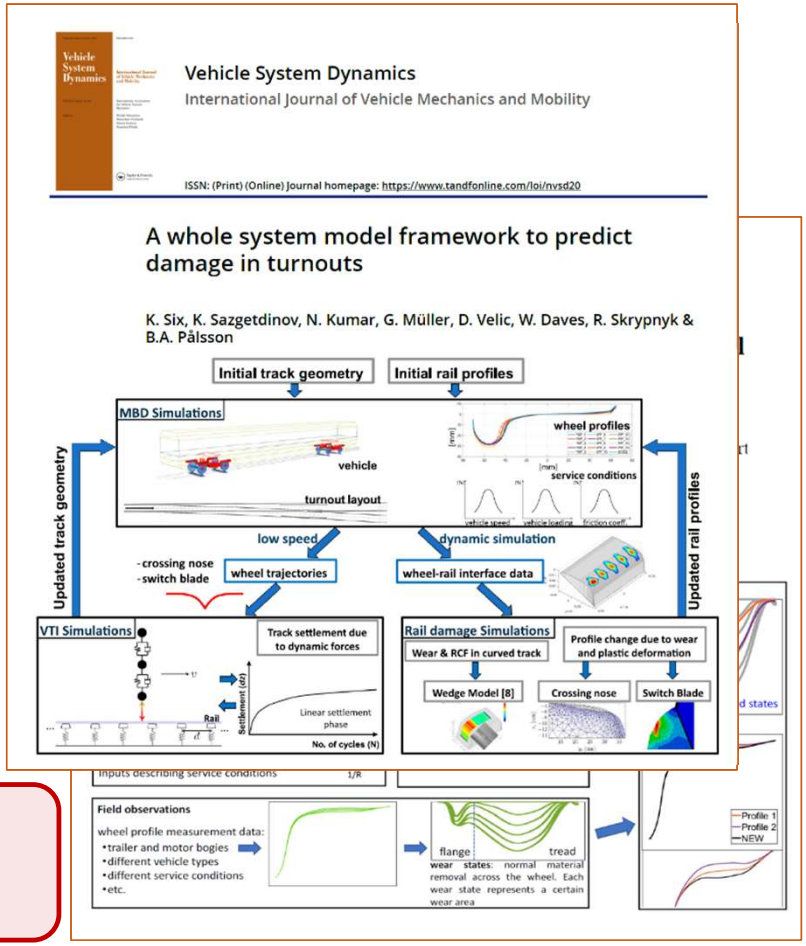
IAVSD 2021

A fast, reliable and practical method to predict wheel profile evolution

ietmar Hartwich[1], Gabor Müller[1], Alexander Meierhofer[1], Danijel Obadic[2], Mart Rosenberger[2], Roger Lewis[3] and Klaus Six[1]

[1] Virtual Vehicle Research GmbH, Graz, Austria
[2] Siemens Mobility Austria GmbH, Graz, Austria
[3] The University of Sheffield, Department of Mechanical Engineering, Sheffield, UK
dietmar.hartwich@v2c2.at





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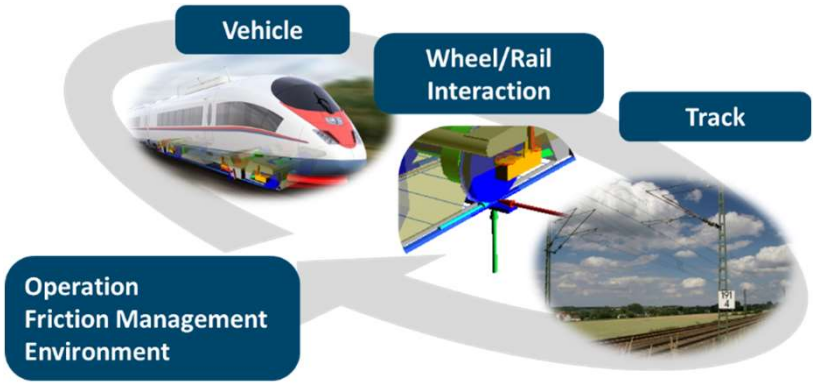

Material Modelling
- Severe plastic deformation
- Thermal phase change
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Damage & Deterioration
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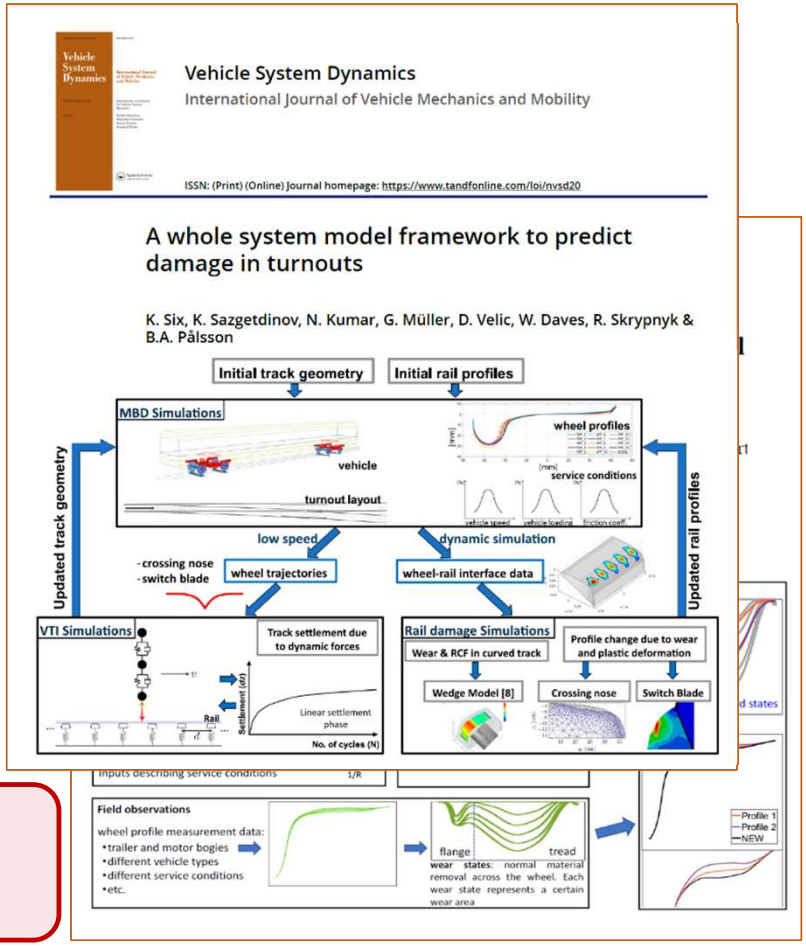

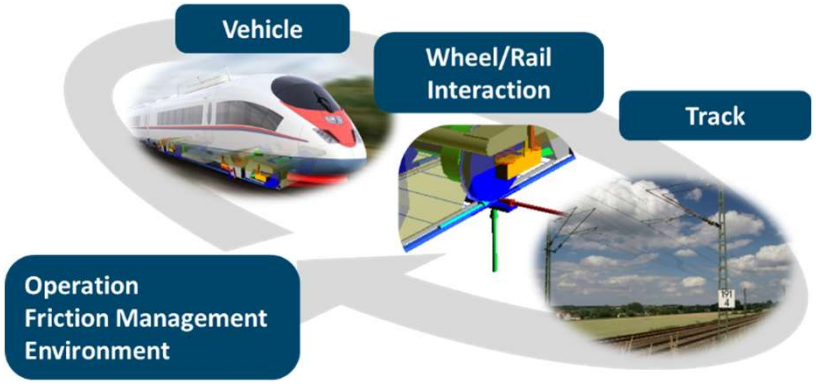

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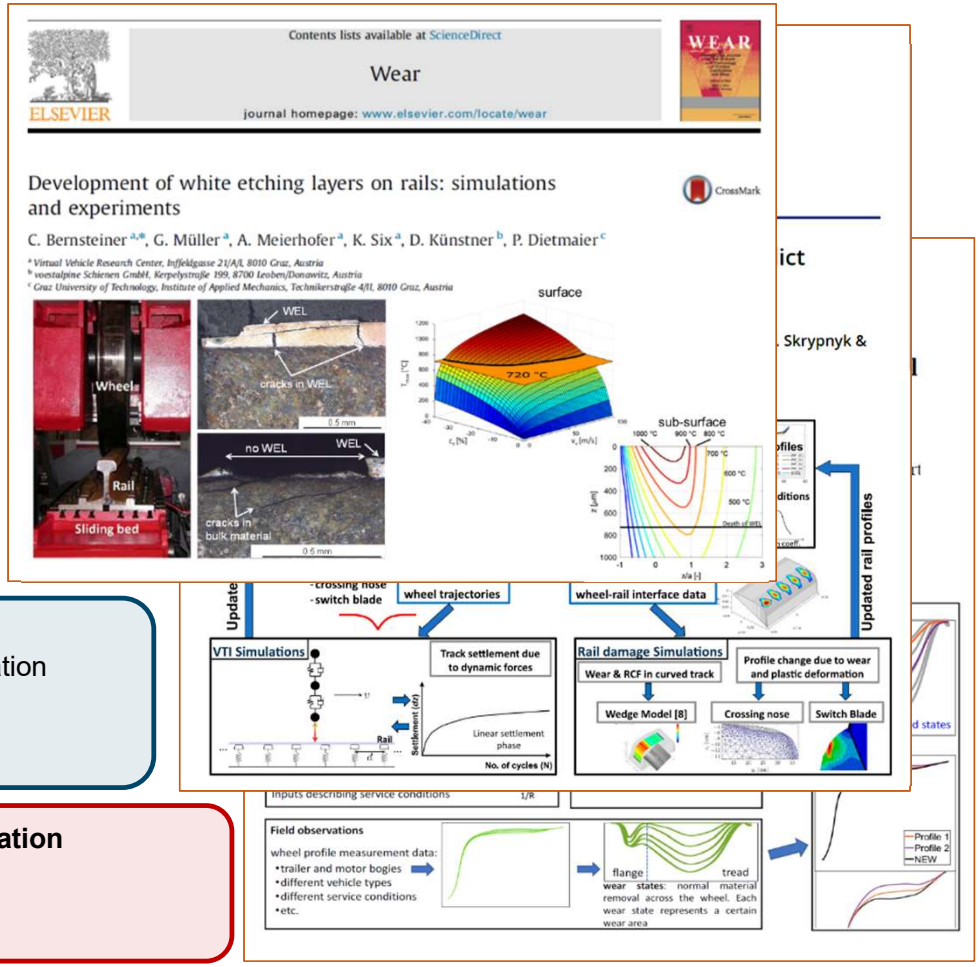

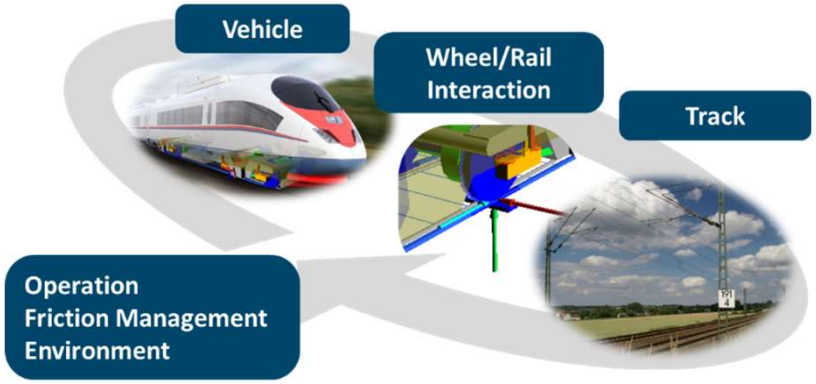

Wheel-Rail Contact
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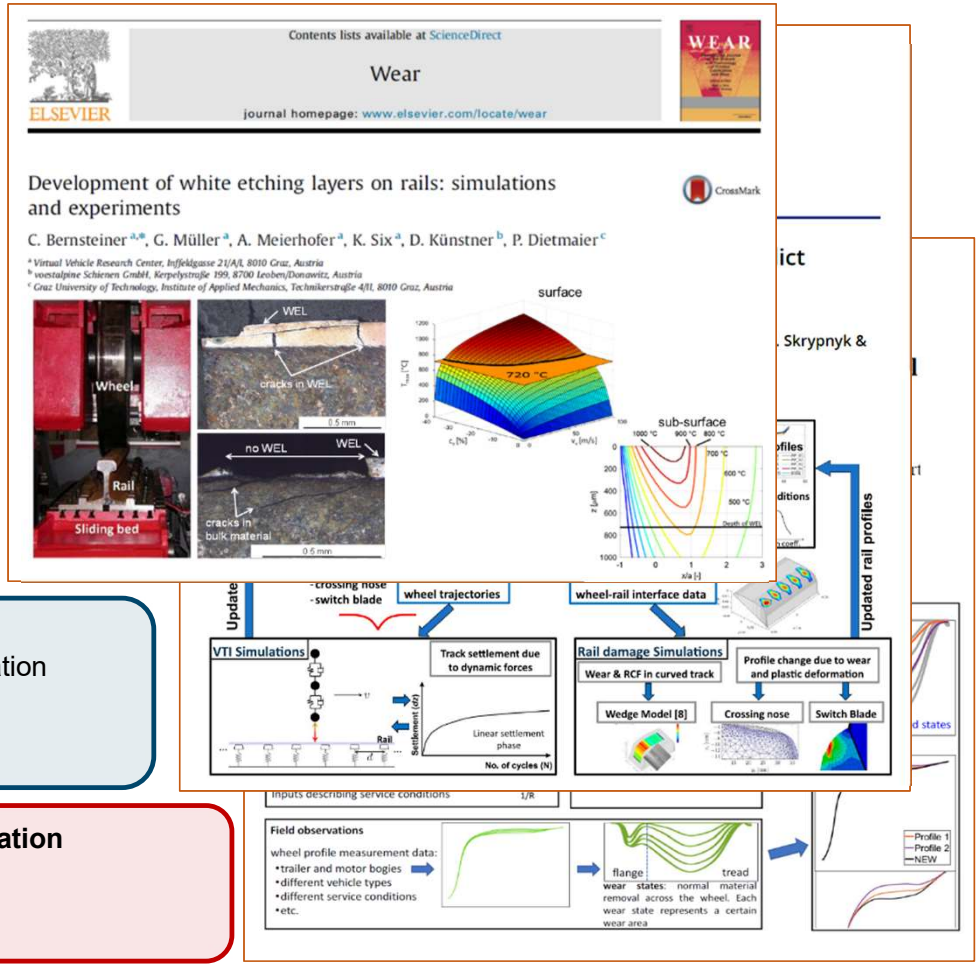

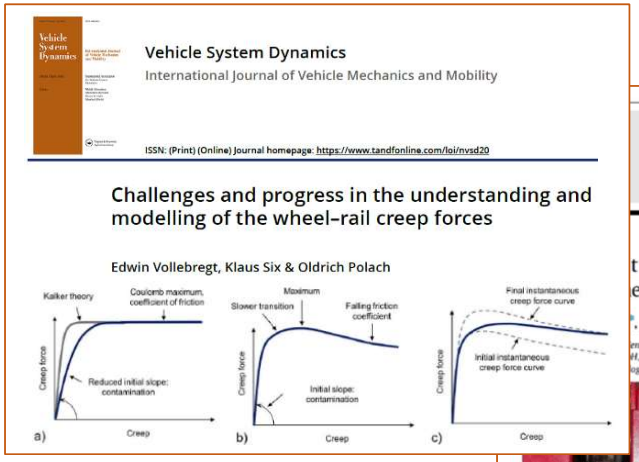

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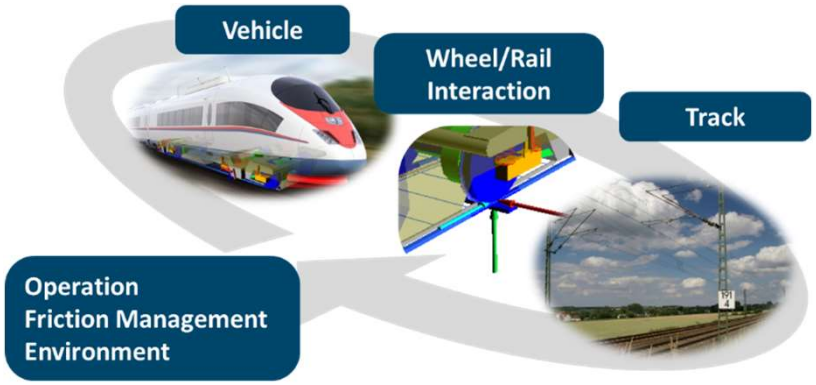

Noise & Vibrations
- Modular approach
- Combination of sub-modules to describe complex situations

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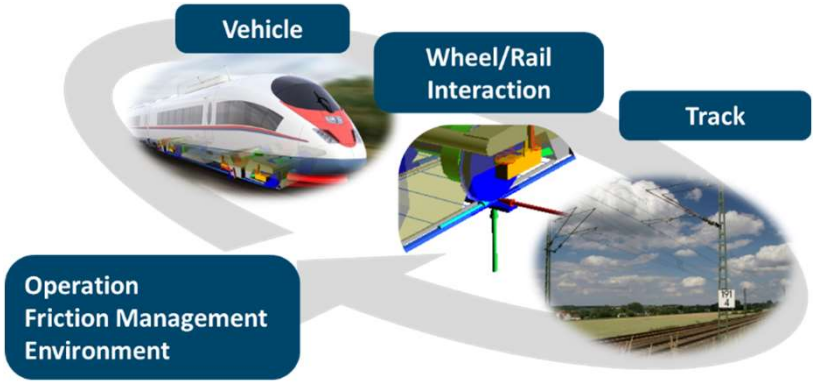

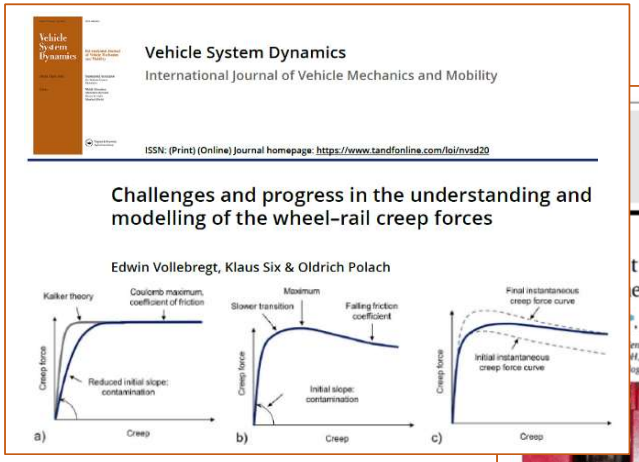

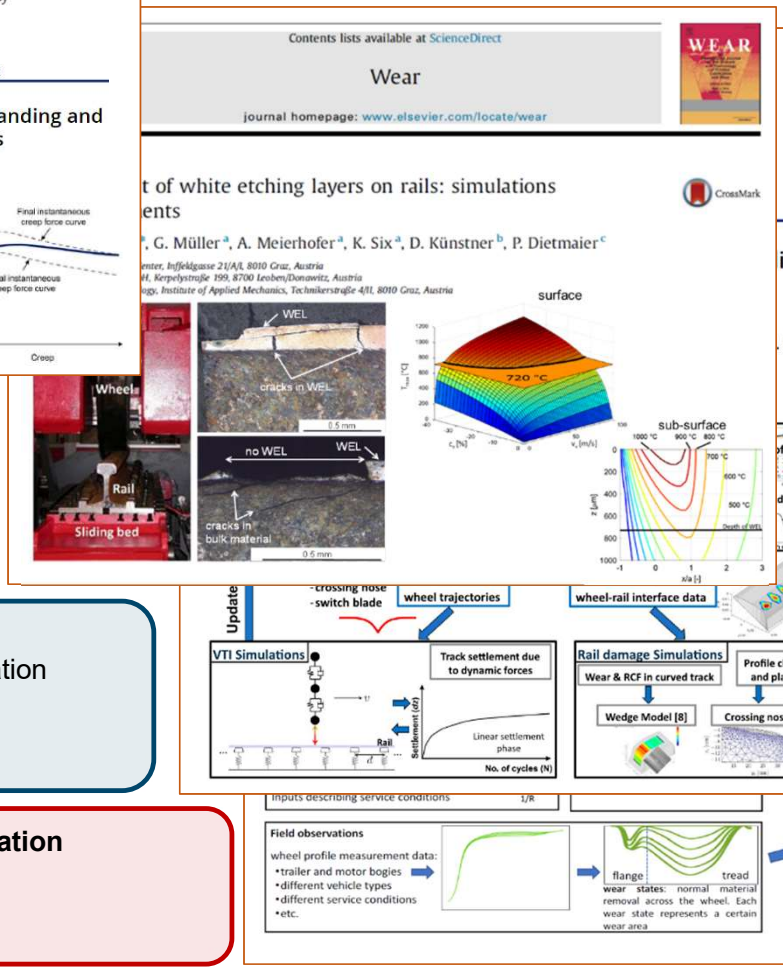

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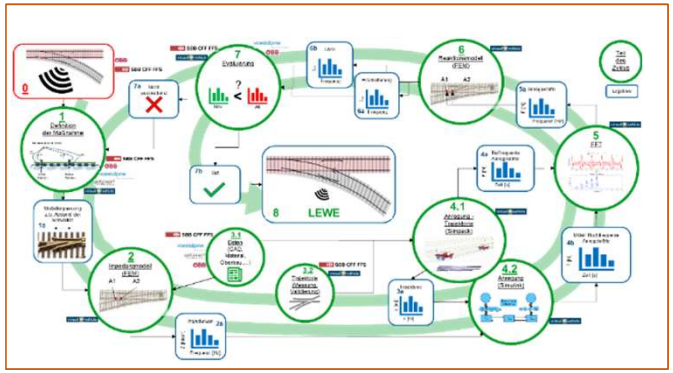

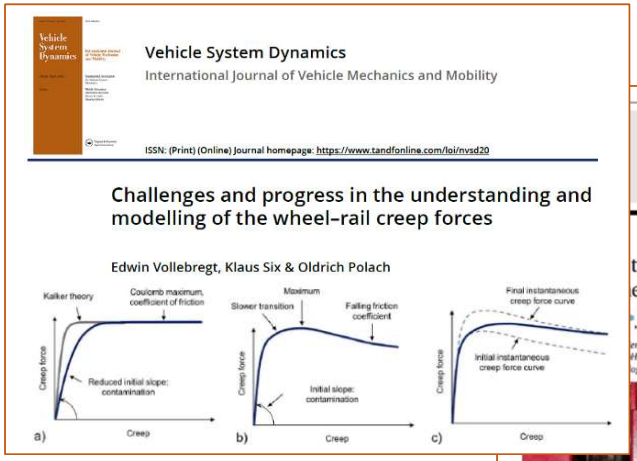

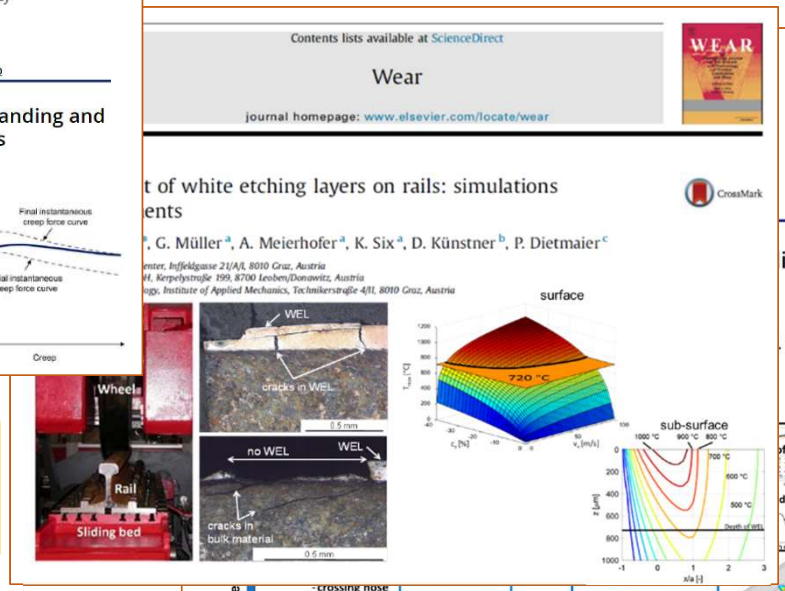

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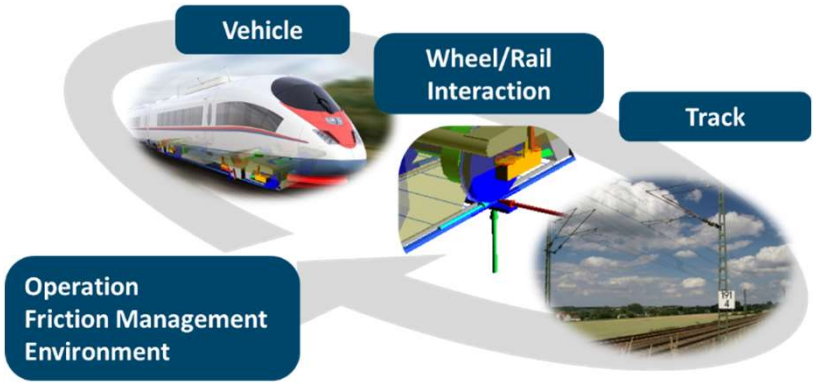

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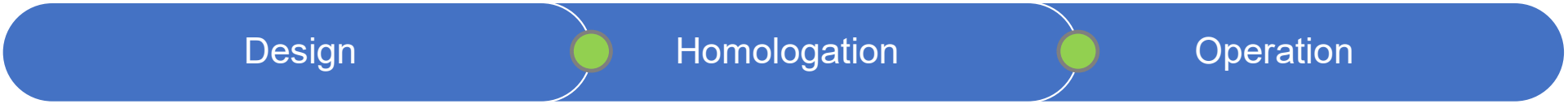
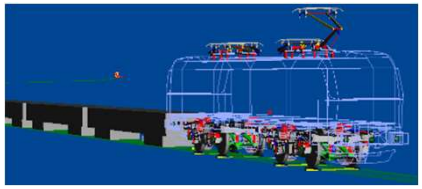

Design
Homologation
Operation

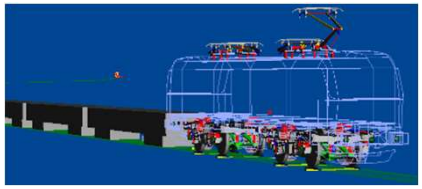
Design | Homologation | Operation



Probabilistic Design

» Dimensioning of design parameters based on varying operating conditions

Design | Homologation | Operation



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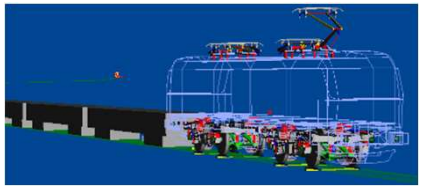
» Methods for quantifying uncertainties in the model validation process
» Automation of calculation methods for vehicle homologation
» Methods for the parameterization of simulation models

Design | Homologation | Operation



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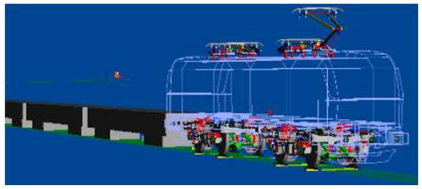
- Generation of load assumptions
- Scenarios for virtual vehicle design

Design | Homologation | Operation



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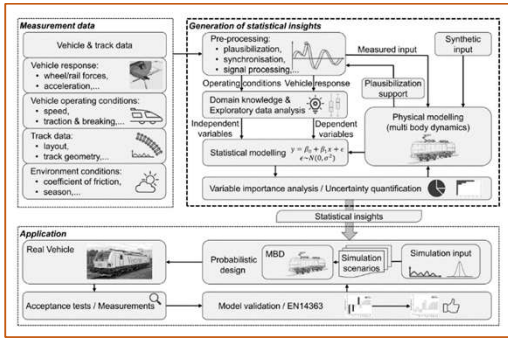
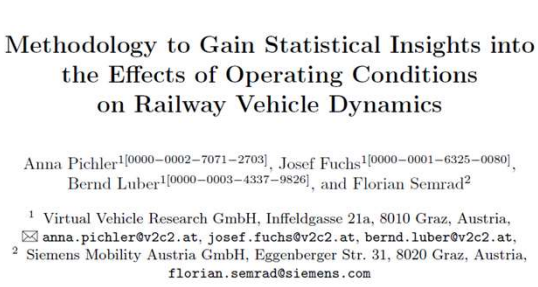
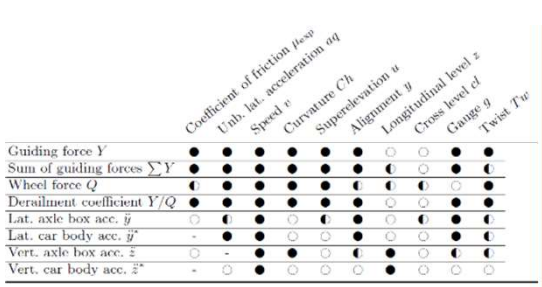




Methodology to Gain Statistical Insights into the Effects of Operating Conditions on Railway Vehicle Dynamics

Anna Pichler[1][0000−0002−7071−2703], Josef Fuchs[1][0000−0001−6325−0080], Bernd Luber[1][0000−0003−4337−9826], and Florian Semrad[2]

[1] Virtual Vehicle Research GmbH, Inffeldgasse 21a, 8010 Graz, Austria,
✉ anna.pichler@v2c2.at, josef.fuchs@v2c2.at, bernd.luber@v2c2.at,
[2] Siemens Mobility Austria GmbH, Eggenberger Str. 31, 8020 Graz, Austria,
florian.semrad@siemens.com

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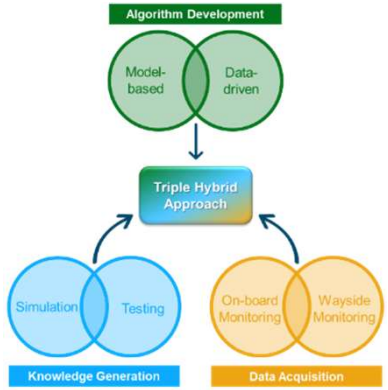
Algorithm Development

» **Model-based methods** for monitoring of component states

» **Data-driven methods** for high complex systems



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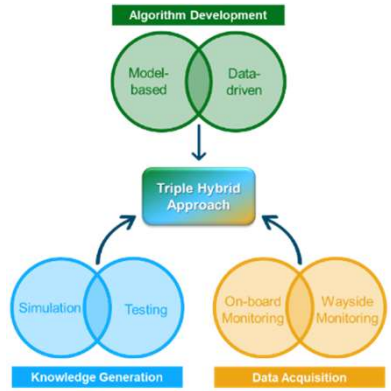

Context-based Knowledge

» Description and understanding of **physical effects** based on simulations and testing

Data Acquisition

» **Measurement equipment** for ‚Proof-of Concept' analysis
» Evaluation of innovative **sensor concepts**

virtual vehicle

Vehicle Monitoring

- Monitoring of **bogie components**
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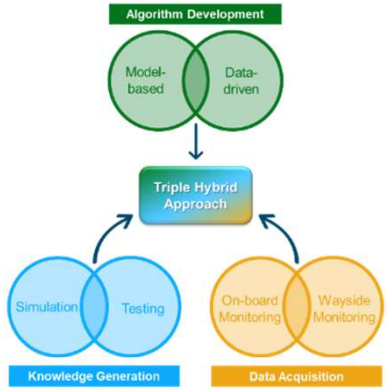

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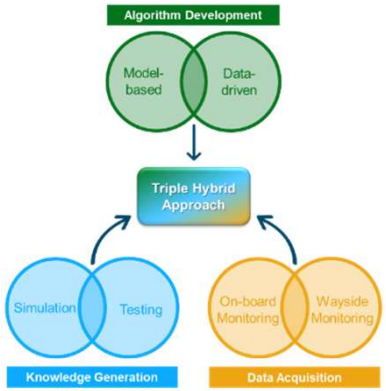

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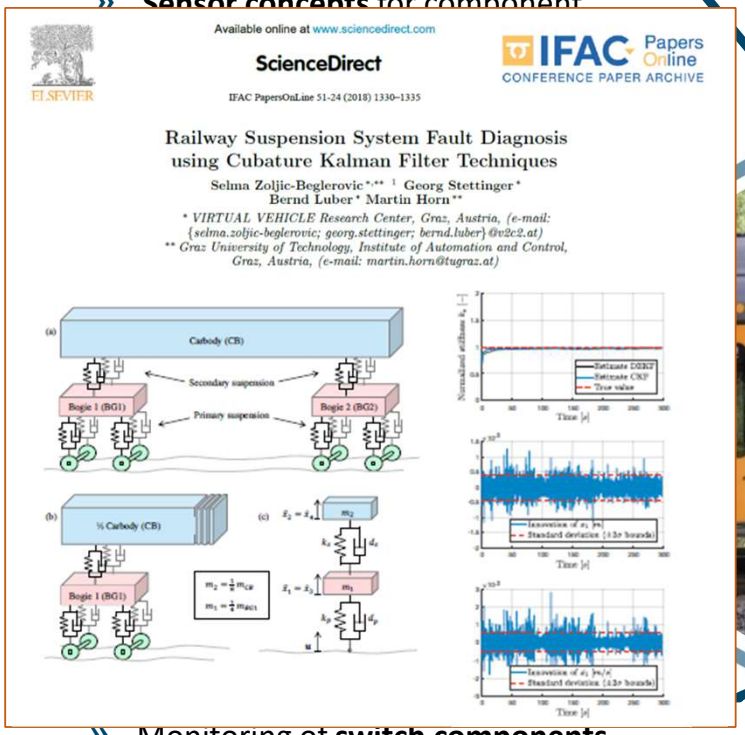
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Railway Suspension System Fault Diagnosis using Cubature Kalman Filter Techniques

Selma Zoljic-Beglerovic *,** [1] Georg Stettinger * Bernd Luber * Martin Horn **

* VIRTUAL VEHICLE Research Center, Graz, Austria, (e-mail: {selma.zoljic-beglerovic; georg.stettinger; bernd.luber}@v2c2.at)

** Graz University of Technology, Institute of Automation and Control, Graz, Austria, (e-mail: martin.horn@tugraz.at)

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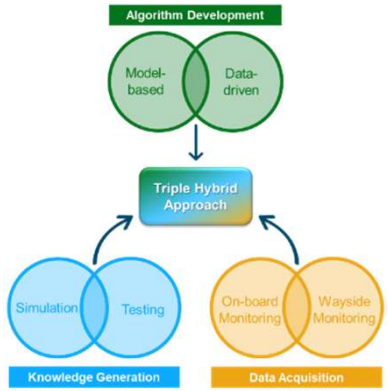

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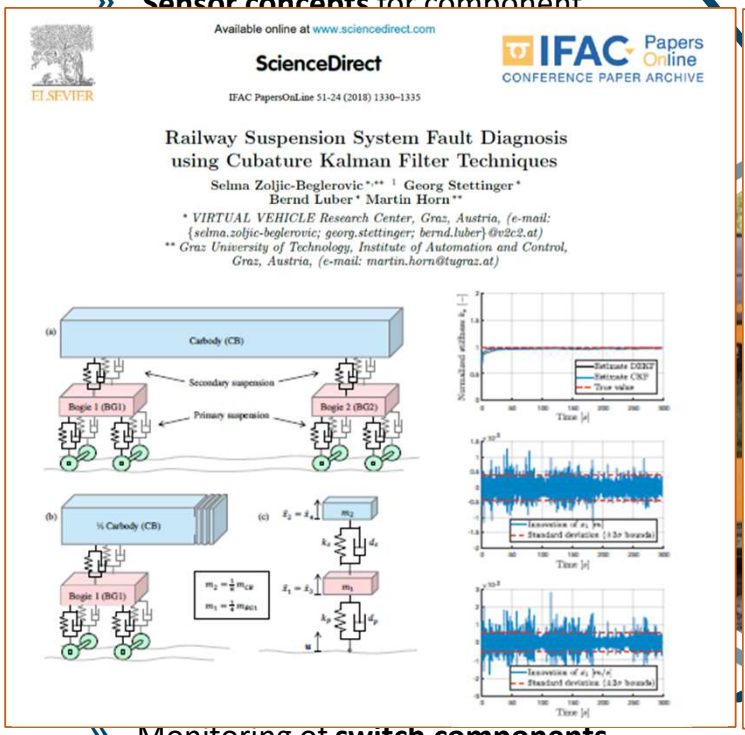
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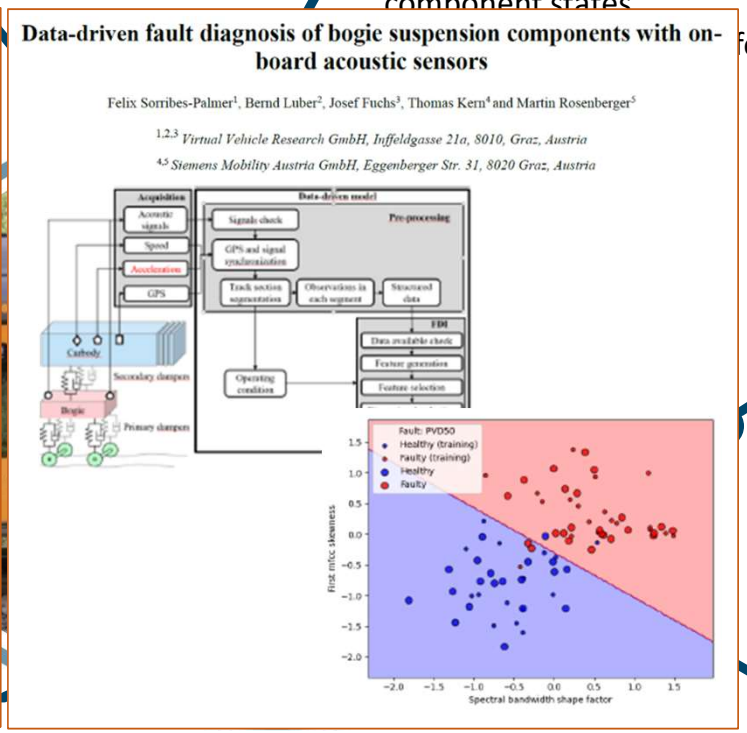
Data-driven fault diagnosis of bogie suspension components with on-board acoustic sensors

Felix Sorribes-Palmer[1], Bernd Luber[2], Josef Fuchs[3], Thomas Kern[4] and Martin Rosenberger[5]

[1,2,3] Virtual Vehicle Research GmbH, Inffeldgasse 21a, 8010, Graz, Austria

[4,5] Siemens Mobility Austria GmbH, Eggenberger Str. 31, 8020 Graz, Austria

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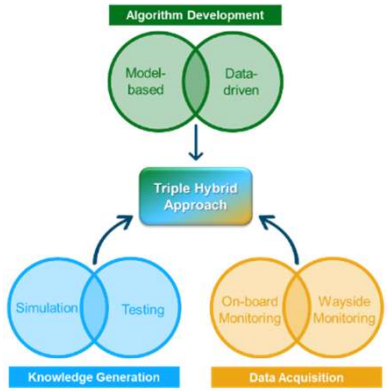

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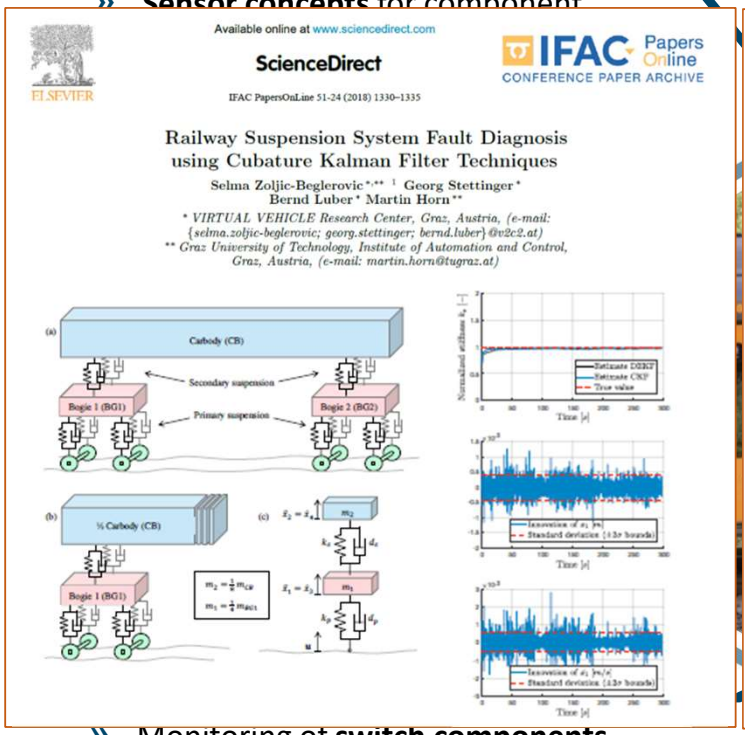

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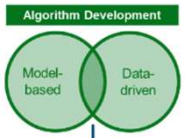
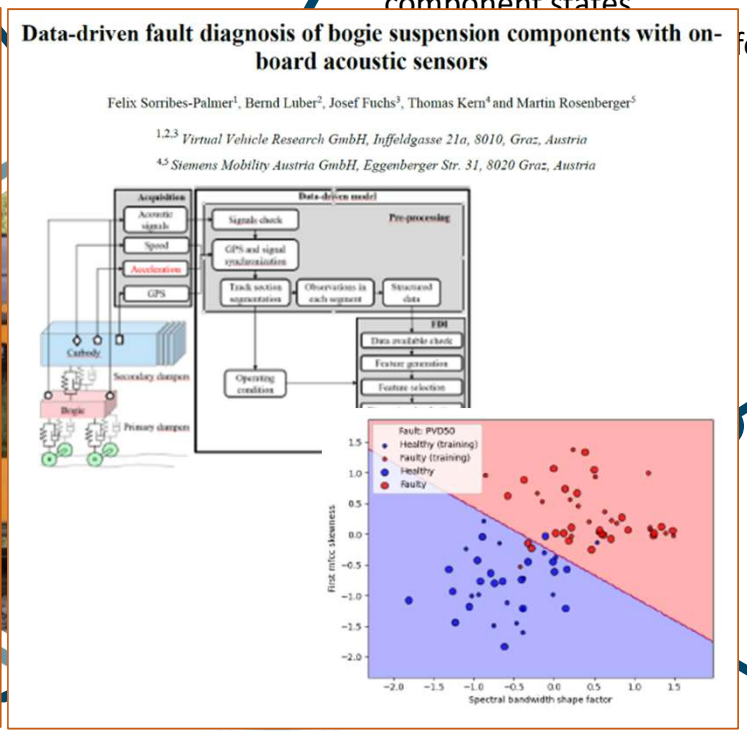
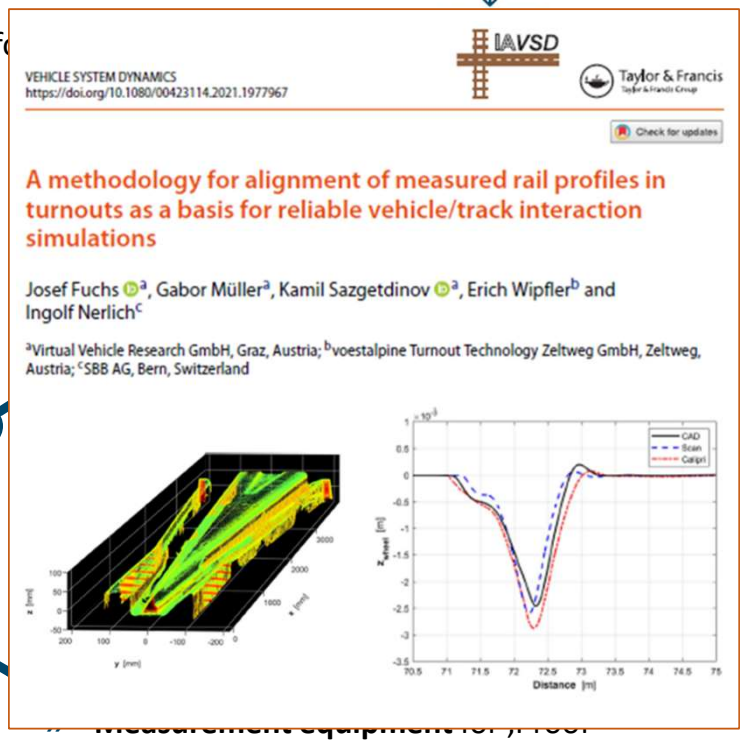
- **Model-based methods** for monitoring of component states

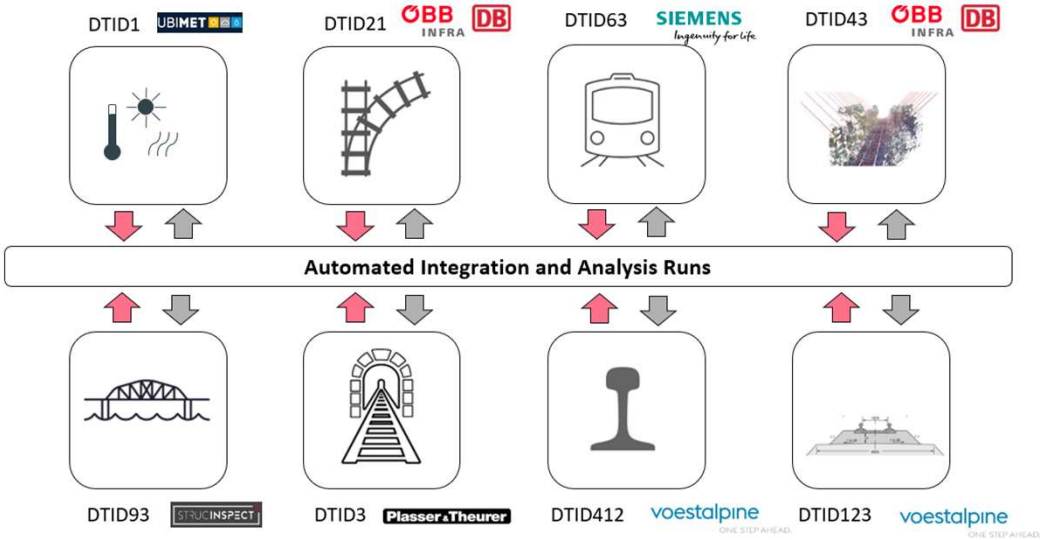


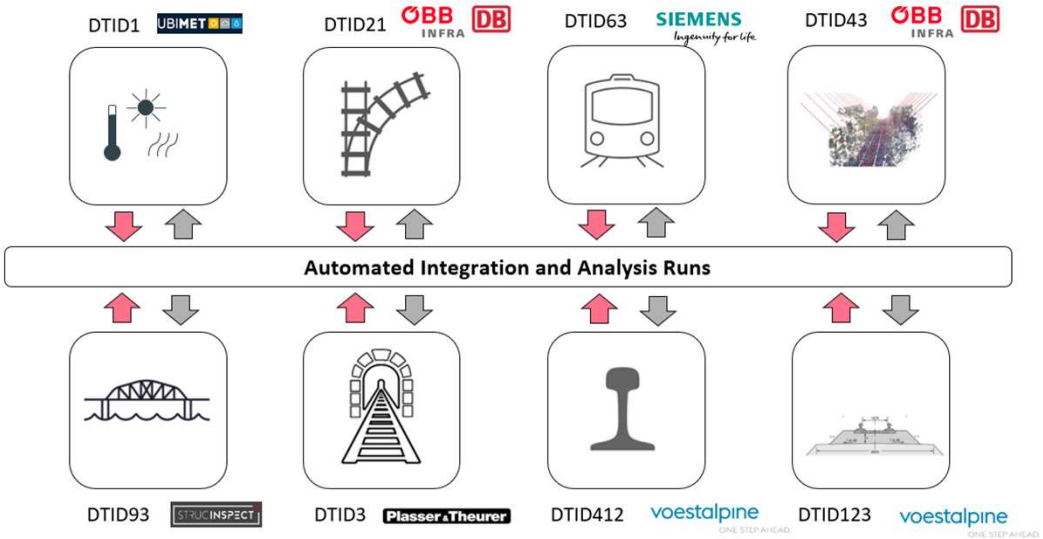




- of Concept' analysis
- Evaluation of innovative **sensor concepts**

Digital Twin Network





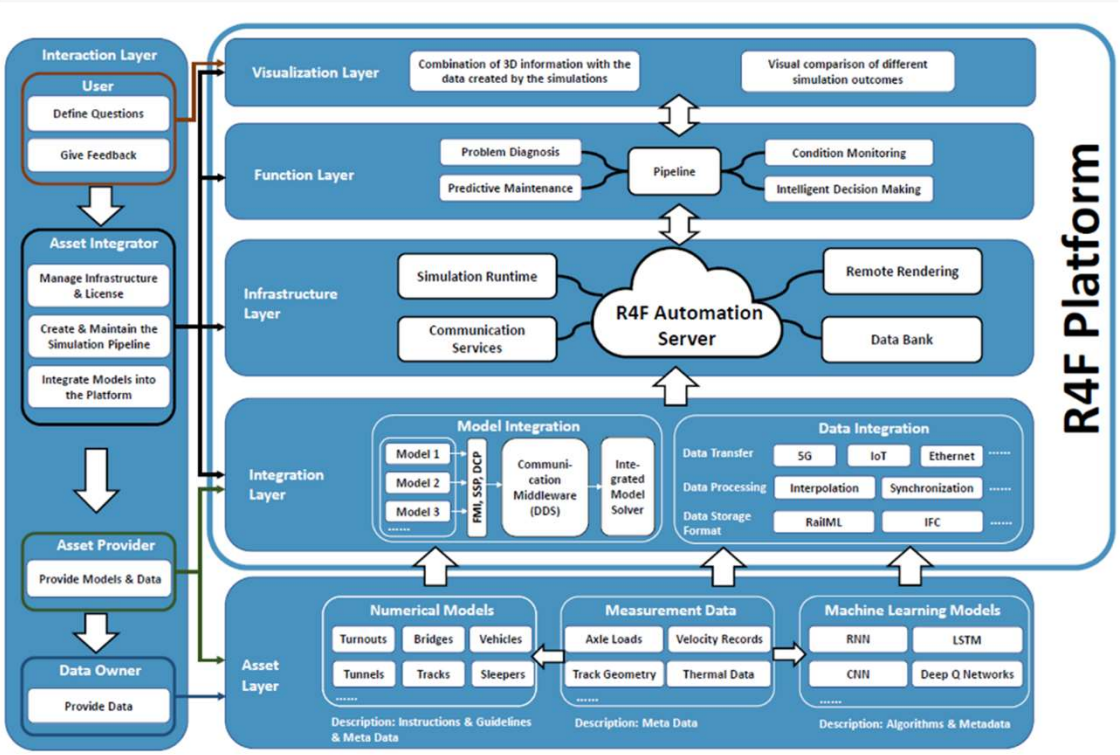
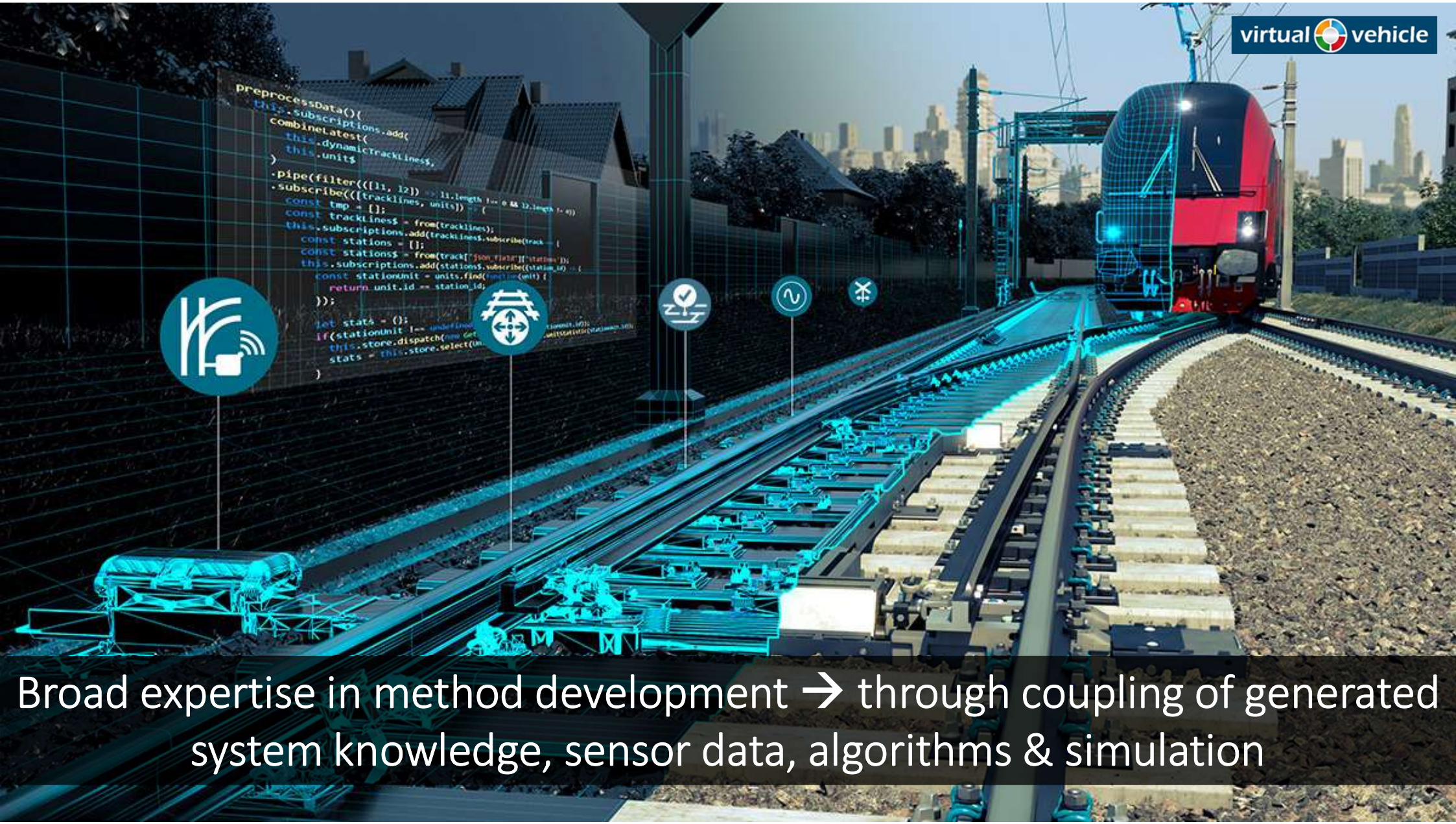


Fig. 2. The R4F Platform Landscape



Broad expertise in method development → through coupling of generated system knowledge, sensor data, algorithms & simulation

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Coordinator ERJU Projects
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Railway Metrics and Dynamics

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FLEET MANAGEMENT Technology

Expanding the scope of condition monitoring tools

Swedish company Railway Metrics & Dynamics has developed a low-power monitoring unit initially aimed at addressing rolling stock faults such as wheel flats. Now, as CEO **Jan Lindqvist** explains, the company is exploring how infrastructure can be monitored more effectively as well.

RMD

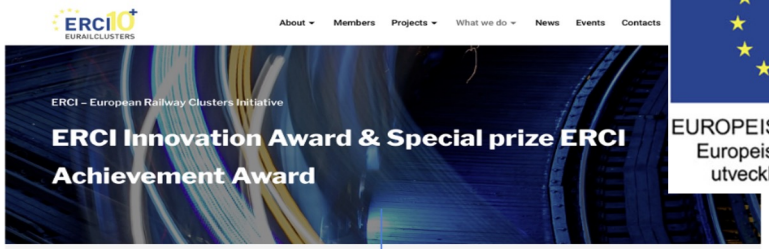
Automatiserad mätning av järnvägsanläggningen

RMD signs agreement with Trafikverket

Railway Metrics and Dynamics AB has today signed a contract with Trafikverket, the Swedish

RMD nominated for European railway innovation award

Railway Metrics and Dynamics AB (RMD) has been nominated for the prestigious ERCI Innovation Awards together with industry colleague Strainlabs.



EUROPEISKA UNIONEN
Europeiska regionala utvecklingsfonden

RMD in expert panel at major European rail conference

"Rail digitisation is more than vehicle positioning and maintenance windows. It is only when we fully share data that we will see the really big benefits". This was the message from Jan Lindqvist, CEO of RMD, speaking at Rail Transport Day in Stockholm on 30 May 2023.

A SYSTEM OF SYSTEMS

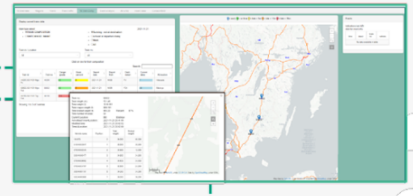
RMD

MAINTENANCE + ECM

INFRASTRUCTURE MANAGER (IM)

RAILWAY UNDERTAKING (RU)

DASHBOARD



Train Consist

Train Position

Common Interface (RNE)

Train delay, departure, arrival

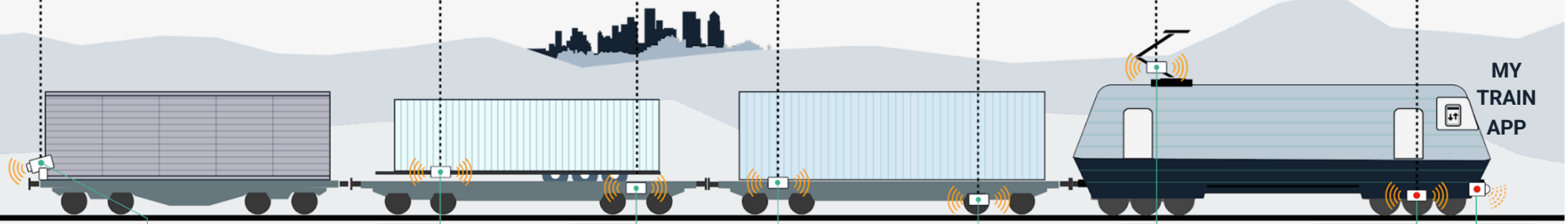
Train Consist

Dashboard

TMS
Infrastructure
Rolling stock,
Waggon location etc
Driver behaviour energy index
Ride Index

SERVER

COLLECT – ANALYZE – REPORT



MY TRAIN APP

RAILWAY CAMERA

KINGPIN LOCK SENSOR
VERIFY CARGO LOCKED

WEIGHT SENSOR
CARGO WEIGHT

PERFORMANCE MONITORING UNIT (PMU)
WHEEL FLAT DETECTION
TRUCK HUNTING
TRACK FAULTS, IMPACT
DERAILMENT, ROUGH LOADING

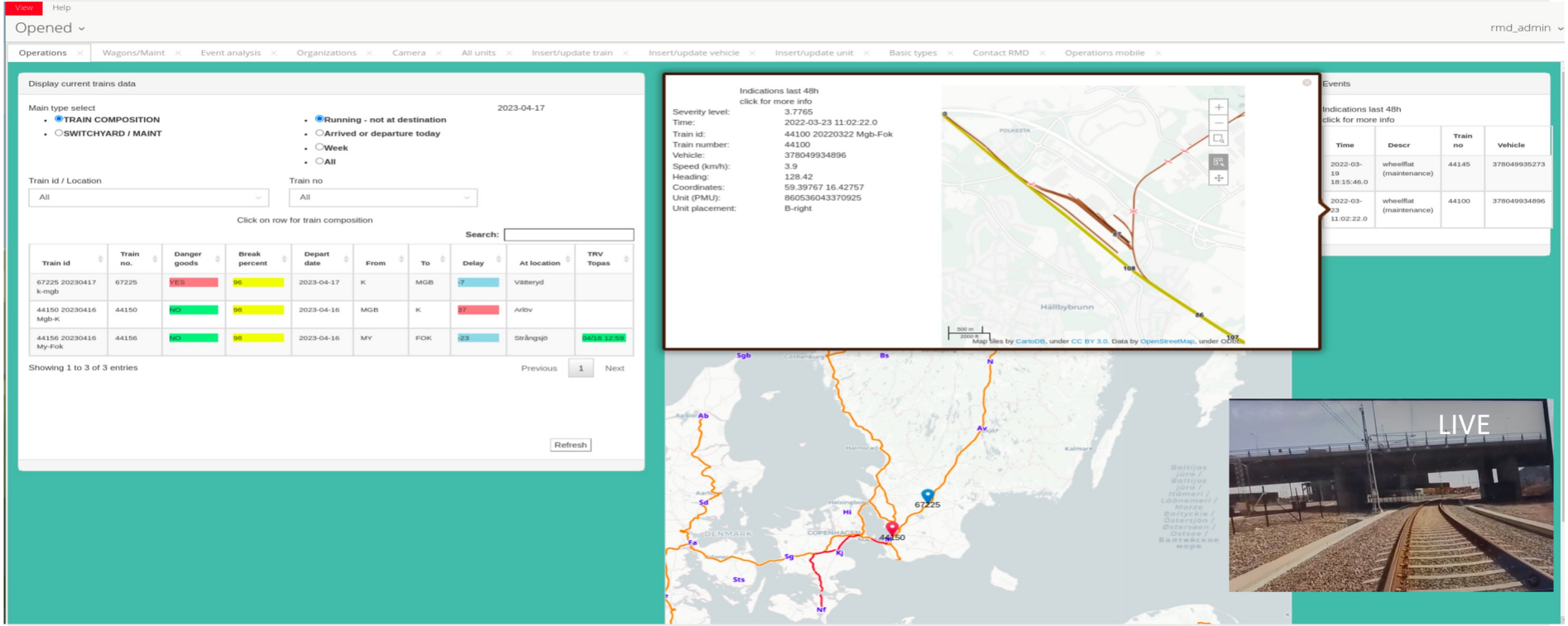
WHEEL SENSOR
WHEEL PROFILE

PANTOGRAPH SENSOR
VERIFY PANTOGRAPH AND CATENARY CONDITION

PERFORMANCE MONITORING UNIT (PMU)
WHEEL FLAT DETECTION
TRUCK HUNTING
TRACK FAULTS, IMPACT
DERAILMENT, ROUGH LOADING

FRONT SENSOR

Dashboard


View
Help
Opened
rmd_admin
Operations
Wagons/Maint
Event analysis
Organizations
Camera
All units
Insert/update train
Insert/update vehicle
Insert/update unit
Basic types
Contact RMD
Operations mobile
Display current trains data
Main type select
TRAIN COMPOSITION
SWITCHYARD / MAINT
Running - not at destination
Arrived or departure today
Week
All
2023-04-17
Train id / Location
Train no
Click on row for train composition
Search:
Train id
Train no.
Danger goods
Break percent
Depart date
From
To
Delay
At location
TRV Topas
67225 20230417 k-mgb
67225
YES
96
2023-04-17
K
MGB
-7
Vätteryd
44150 20230416 Mgb-K
44150
NO
98
2023-04-16
MGB
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37
Arlöv
44156 20230416 My-Fok
44156
NO
98
2023-04-16
MY
FOK
-23
Strångsjö
04/16 12:59
Showing 1 to 3 of 3 entries
Previous
1
Next
Refresh
Indications last 48h
click for more info
Severity level: 3.7765
Time: 2022-03-23 11:02:22.0
Train id: 44100 20220322 Mgb-Fok
Train number: 44100
Vehicle: 378049934896
Speed (km/h): 3.9
Heading: 128.42
Coordinates: 59.39767 16.42757
Unit (PMU): 860536043370925
Unit placement: B-right
Hällbybrunn
Map tiles by CartoDB, under CC BY 3.0. Data by OpenStreetMap, under ODbL
Events
Indications last 48h
click for more info
Time
Descr
Train no
Vehicle
2022-03-19 18:15:46.0
wheelflat (maintenance)
44145
378049935273
2022-03-23 11:02:22.0
wheelflat (maintenance)
44100
378049934896
67225
44150
DENMARK
COPENHAGEN
LIVE

OUR PLATFORM A SYSTEM OF SYSTEMS

Uniform cases and software for
- Vehicle monitoring
- Infrastructure monitoring

Industry quality. Fulfills applicable standards (CE, EN, ATEX…)

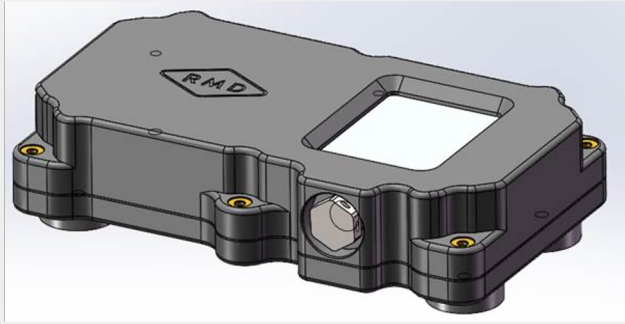
Load sensor

PMU

Railway Camera

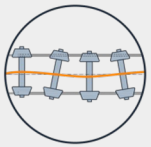
Our sensors in operation

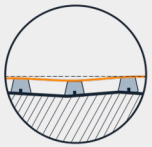
PMU today
A system for vehicles and infrastructure

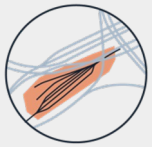



Derailments, “High alert Warning”


Wheel flats and Crush wounds


Instability (sinus)


Track setting


Geo Fencing


Trends (DTFI)


Train consisting/ rack


Late Train Mail


Ride index


Driver behaviour energy index

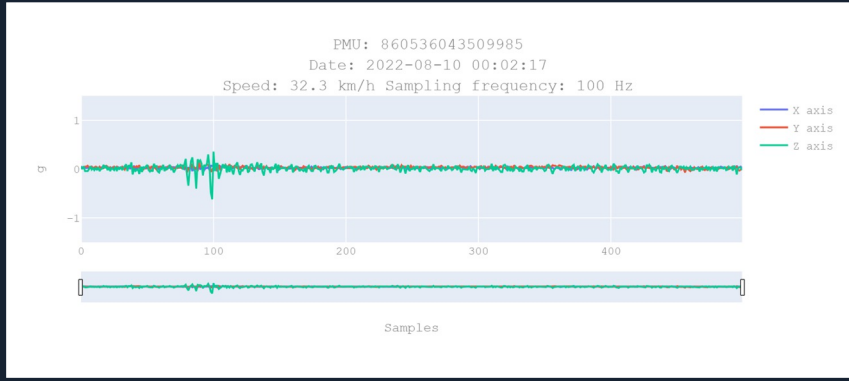
RMD

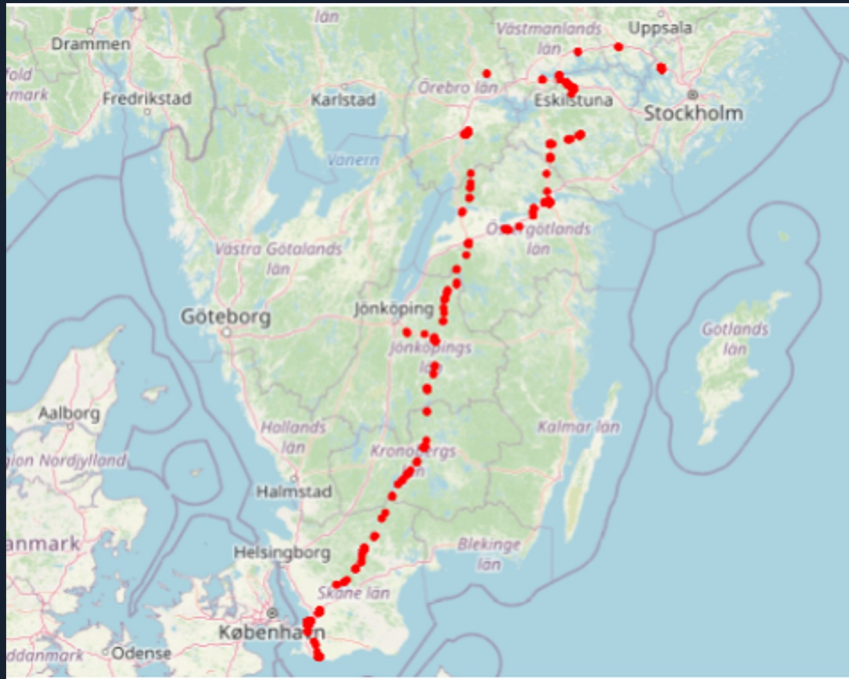
RMD Solutions: The Performance Monitoring Unit (PMU)

- Multiple ways of mounting the PMU on wagon frame or boogie
- Super-efficient energy management (up to 6 years non-stop battery use, solar power optional)
- PMU’s also communicate with the cloud (2G to 5G)
- Measures accelerations (vibrations) in three directions, GPS position and speed
- Continuous or event triggered measurements
- Can connect to external sensors as temp. moisture, etc

Vehicle monitoring

- Varje mätning innehåller
  - Fordonets respons (accelerationer)
  - Position
  - Hastighet
- Datan efterbehandlas för att framhäva felen
  - Filtrering
  - Statistik analys
- Behov av visualisering
- RMD utvecklat verktyg för att granska data





RMD

Railway Metrics and Dynamics

Infrastructure monitoring
(under development with Swedish track authority Trafikverket)

- Easy overview through heat maps
- Analysis of railway sections over time
- Trends over time
- Compare geographic stamps over time

RMD signs agreement with Trafikverket

Railway Metrics and Dynamics AB has today signed a contract with Trafikverket, the Swedish Transport Authority. The innovation procurement will be activated in phases, and if all requirements are met along the way, the contract value will be approximately SEK 25 million over a period of three years. The value of the current work in phases 1-3 is SEK 7,326,000.

Innovation project with Swedish Transport Administration

- In short - to monitor railway infrastructure
  - Track and catenary system
- Instrumenting vehicles with PMUs to
  - Measure track and detect track irregularities
  - Measure overhead lines to detect anomalies
- Analyze the data to provide status over the railway infrastructure
  - Decision support – maintenance actions
  - Show changes over time to infrastructure

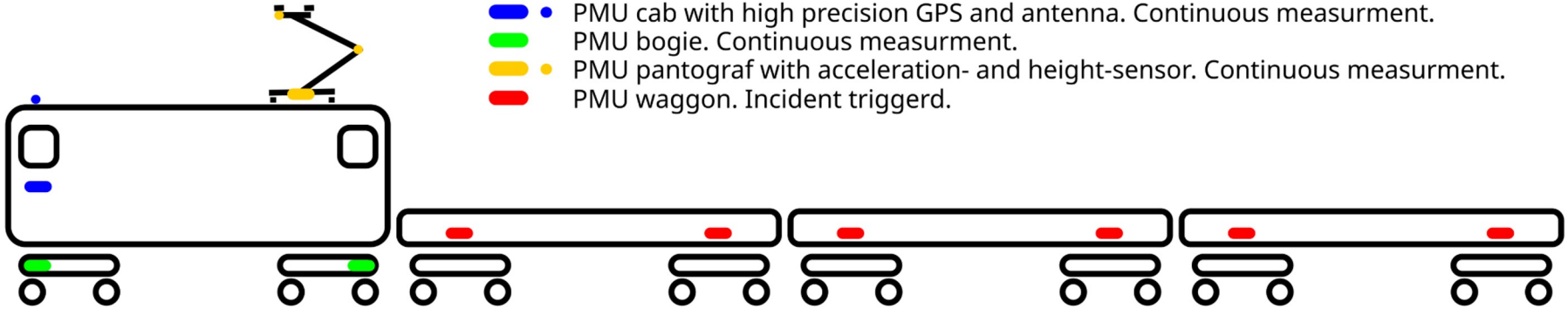
RMD

Railway Metrics and Dynamics

Part of system of systems

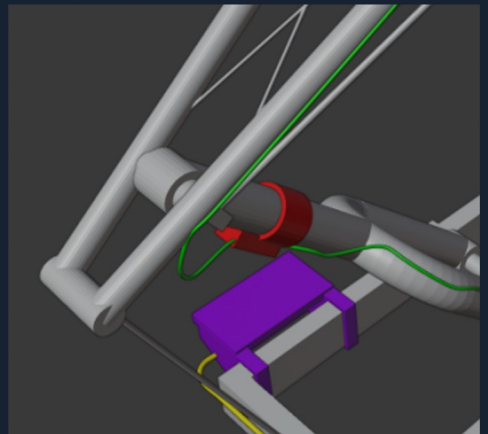
Infra structure monitoring

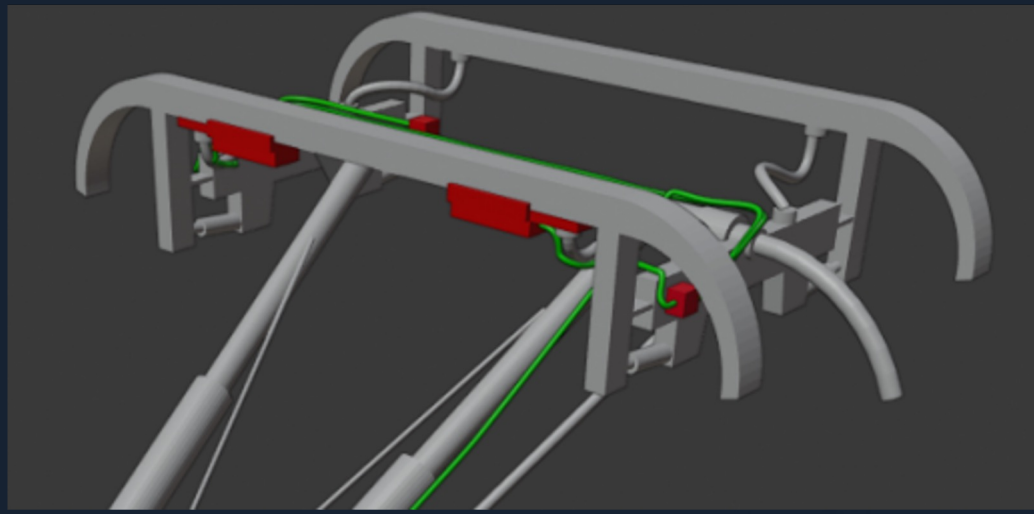
Trafikverket MAJ-project



Pantograph sensor system

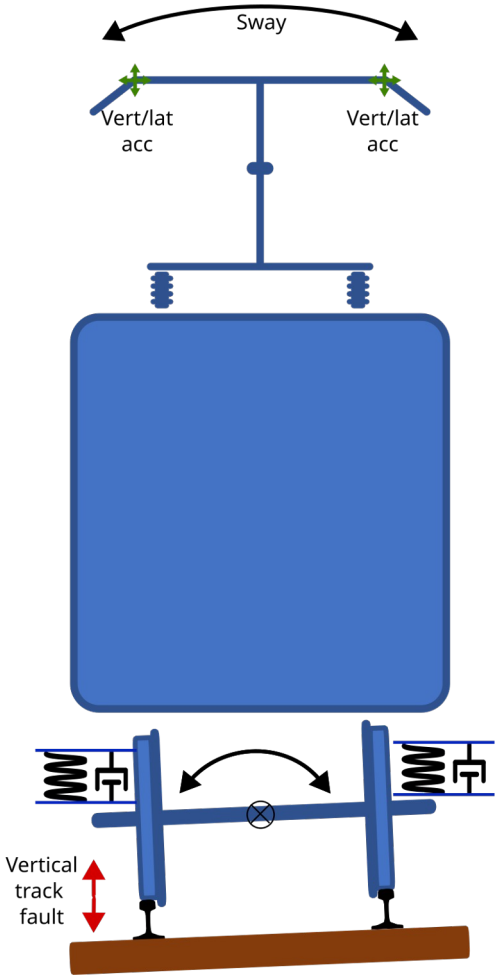
- Under development
- A PMU based system with external sensors
  - Connected to PMU with wiring
    - Communication via CAN-bus
  - Two accelerometers (per head)
  - Angle sensor





RMD

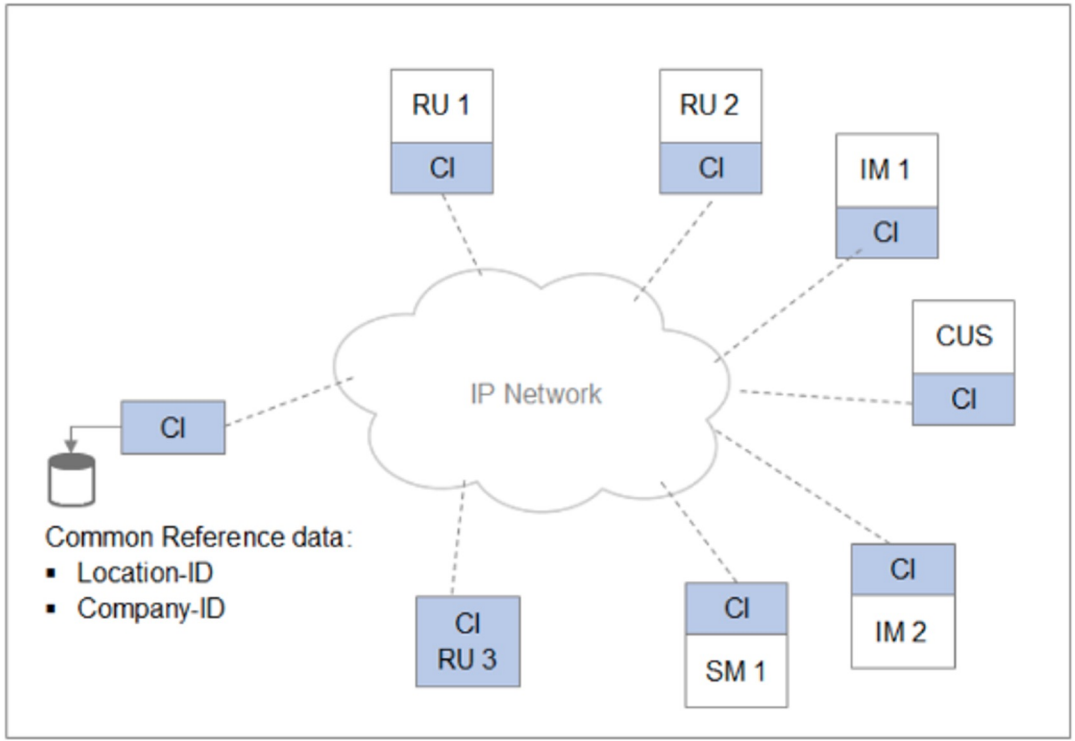
Railway Metrics and Dynamics



Pantograph sway:

- Track faults can lead to pantograph sway and damage to overhead wire
- By registering accelerations in both the pantograph top and the vehicle basket, track position errors can be linked to impaired current collection.

The Common Interface

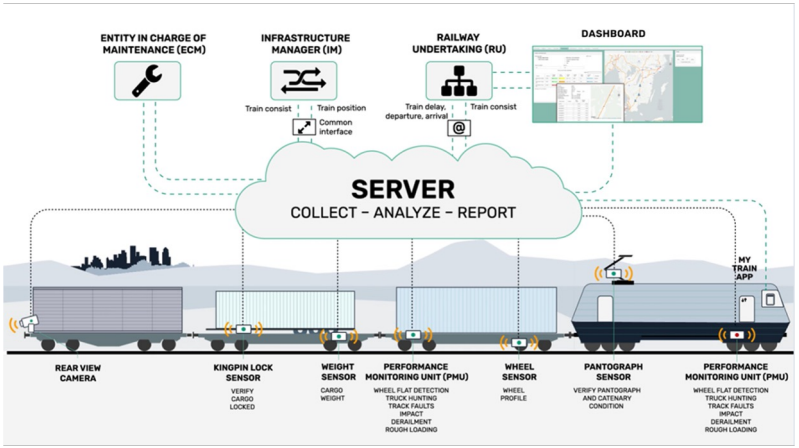


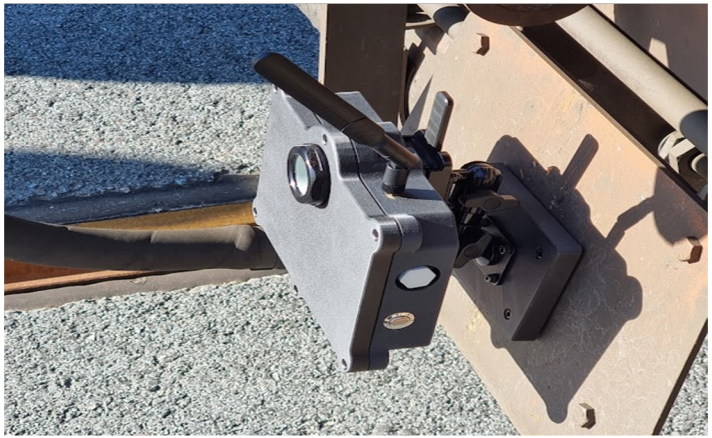
IM = Infrastructure Manager
RU = Railway Undertaking
SM= station Manager
CUS = Commonly Used System
CI = Common Interface functions

RMD Solutions: Railway Camera

A camera for reversing trains

- **Safety.** No need for a signalman at the end of the train in the shunting yard.
- **Money saver.** Less cost in personnel.
- **Problem solver.** Efficient reversing train in line traffic since driver can handle the situations himself.
- **Battery powered.** The camera can easily be recharged by the driver in locomotive when not in use.
- **Online streaming.** Traffic management or traffic control has the same view as the driver without any delay.





Macadam & bulk freight wagons

Monitoring of the laying of macadam in tracks

- Increases safety, less staff in tracks
- Amount of macadam laid out can be controlled & documented

RMD Solutions –Kingpin Sensor

- Report Locked or Not Locked trailers via dashboard/my train app/sms/mail.
- Easy mounting without any mechanical impact on the waggon (clamp attachment).
- Communicate with driver and any other function. (2G to 5G long Range or WiFi).
- Same PCB as the PMU.
- Super-efficient energy management.

OUR PLATFORM A SYSTEM OF SYSTEMS
Modular and expandable!

Example: IoT Bridge/KTH/Trafikverket PoC PMU.