Author: FL
Date: 11 2023
Reference:

Uptime for rail systems

UPTIME ENGINEERING®

We make technology reliable

Content

The System-Reliability Partner

We offer Consulting and Software
to make products reliable,
to keep fleets running.

We optimize
product development,
and fleet maintenance.

We save warranty costs of products.
We raise the RoI from fleets.

Founded in 2010

by Franz Langmayr et al.

A team of 10

employees located at Graz, Austria

More than 100 projects

for technology leaders across Europe

Uptime Engineering - Rail Portfolio

Product Development programs

- Duty cycles, failure risks, test methodology
- Development program planning and supervision
- DoE for influence analysis

Product Validation

- Failure potential analysis and usage space
- Validation contribution from suppliers
- System validation

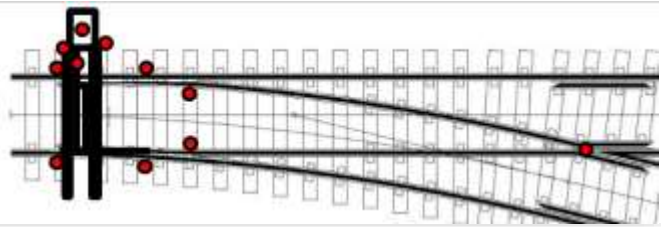
published in ZEVrail, 145 (2021)

CBM/PDM process

- Indicator modelling and calibration for critical sub-systems
- Implementation of the data process
- Implementation of the HARVEST solution for the CBM process

Reliability of infrastructure

- Status: Information flow, data, potential for analytics
- Requirements analysis and coverage of failure risks
- Action plan, instrumentation, automatization with HARVEST



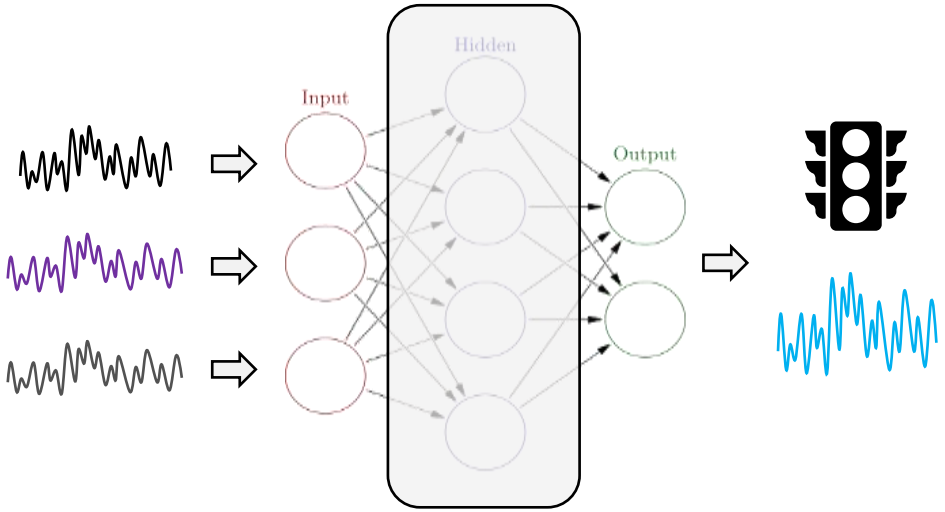
Analytics for Preventive Maintenance

Machine Learning / Neural Network

INPUT
- SCADA
- Events

Trained network

OUTPUT
- Detection

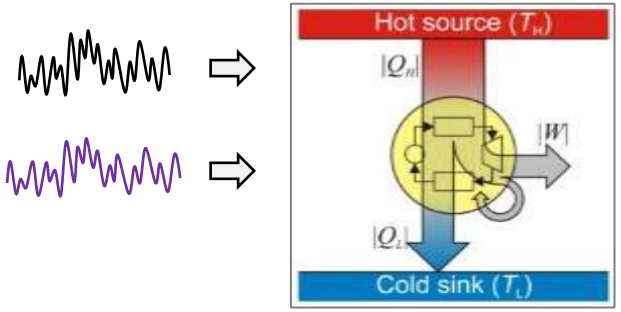


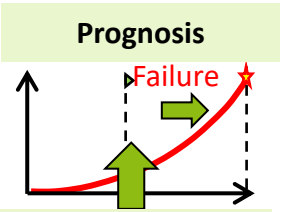
Knowledge- / Physics-based Models

INPUT
- SCADA
- Events
- Rules
- System Info

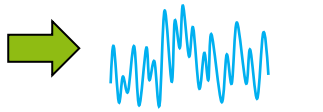
Physics-based Models

OUTPUT
- Detection
- Diagnosis
- Prognosis





Diagnosis



The Uptime Engineering Approach to CBM/PDM

DETECTION
Is there anything remarkable?

System Supervision
and
Pattern Recognition
and
System Response Models

→ **Indicators**
→ **Alarm & Warning**

DIAGNOSIS
How did it come?

Domain Failure Knowledge
and
Model based Reasoning
and
On-line and on-site Observation

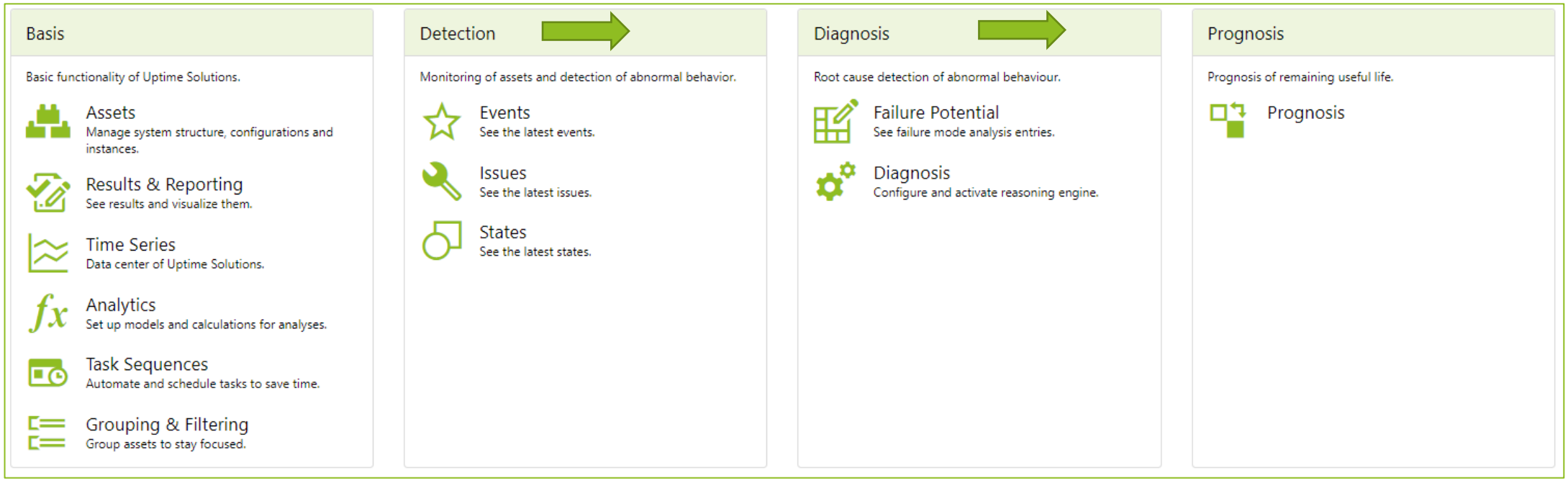
→ **Problem Solving Guidance**
→ **Failure Modes**

PROGNOSIS
Is it an urgent issue?

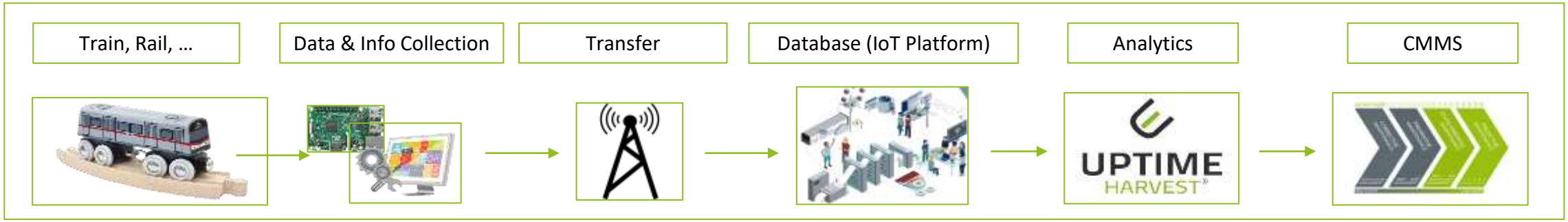
Physics of Failure Models
and
Lifetime References
and
Load History

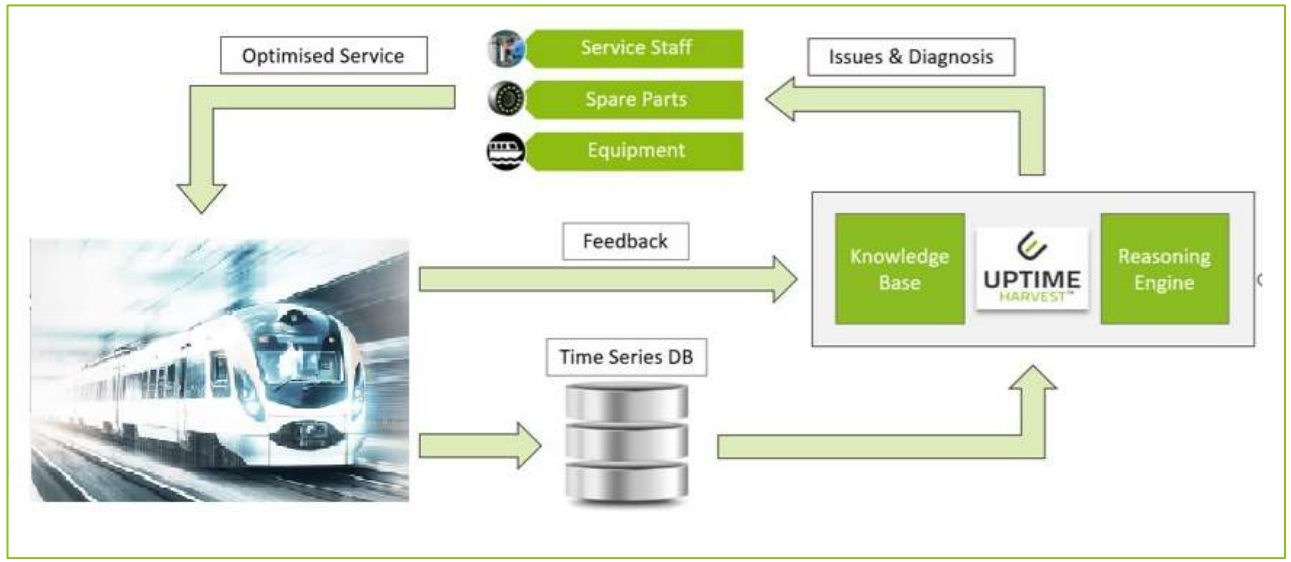
→ **Risk Propagation**
→ **Recommendation**

The Software for Preventive Maintenance



The Data Process & Software Implementation





Use Case: CBM retro-fit for a Metro System

metro trains, ~ 30 years in operation

Status

- overall high reliability with some exceptions
- operation data available but just a few sensors on train
- no permanent data transfer to landside, no analytics

Project

- identify and solve reliability issues
- pilot for data process, methodology & software
- CBM process implementation with the service staff

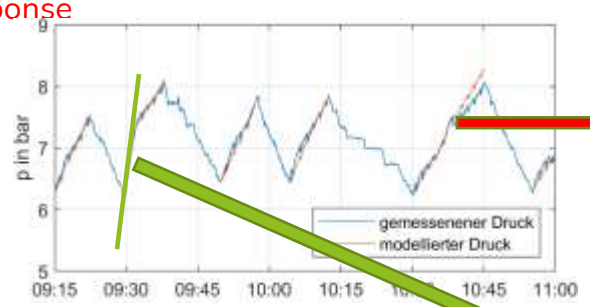
from corrective ...

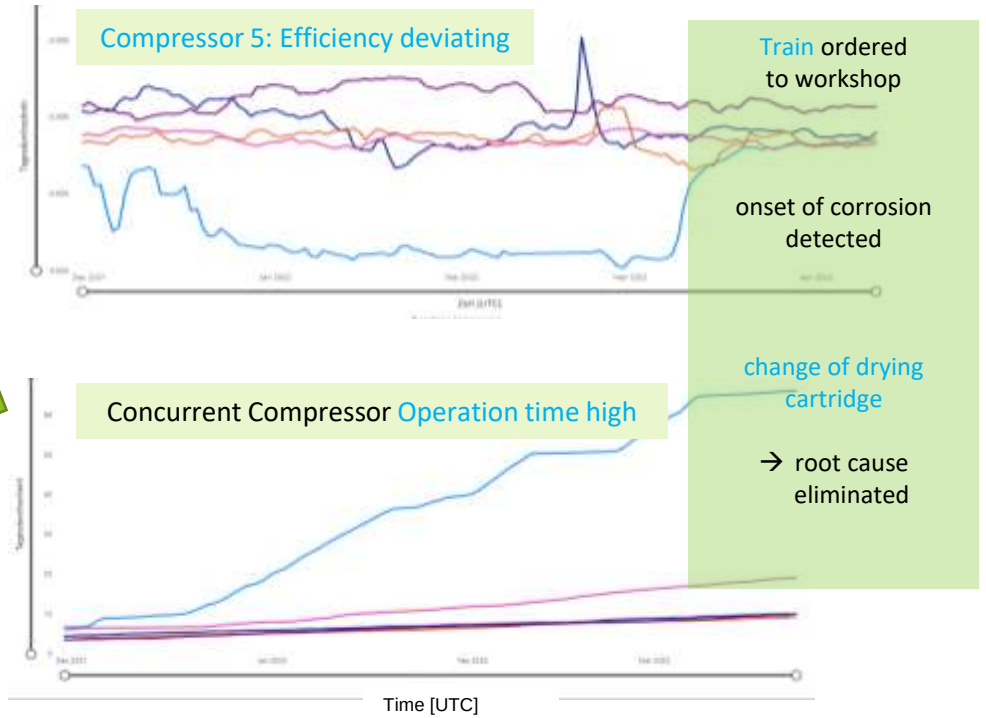
to predictive maintenance

Use case example: Compressor

Analytic modelling for automatic detection & recommendation

- Modelling and observation of compressor efficiency (dPr/dt)
  - used as indicator of system load response
- Observation of concurrent operation
  (both compressors on a train are active)
  - as indicator of the system control strategy

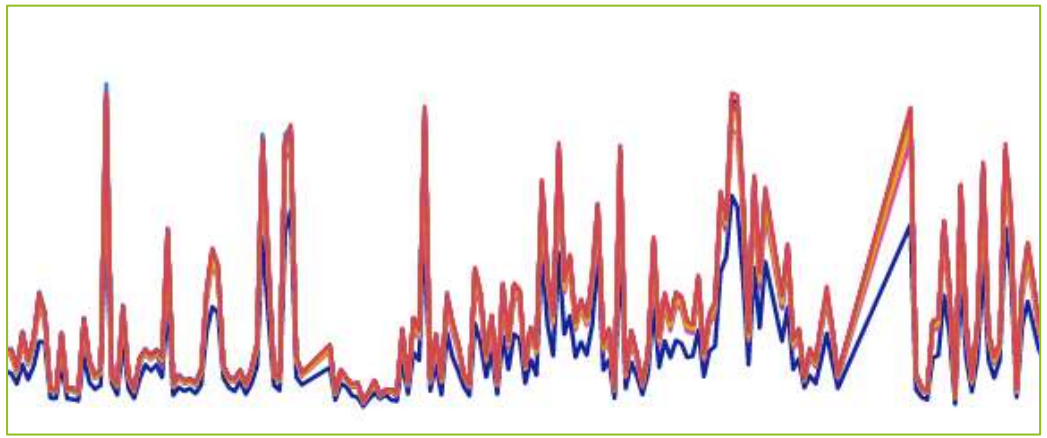




- Detection of deviation of both indicators for a train
  - not (yet) severe enough for a controller alarm
  - point to an incipient failure, resulting in leakage
- Train ordered to the workshop for inspection
  - corrosion due to assembly issue in drying cartridge identified
  - cartridge change avoids unplanned downtime
  - avoids consequential compressor damage
- Attractive business case
  - RoI = 1,33; Source: Vienna Lines, ZEV rail 146 (2022)

Use case example: Braking System

Cross-correlation of equivalent systems



Detection, solution and feedback

- Brake forces have to be equal (on each bogey).
- Deviations are safety relevant and the origin of large consecutive costs.
- Inspection confirmed the root-cause diagnosis, sustainable repair

Benefit

- Highly sensitive supervision of a dynamic system.
- No additional sensor required.
- Fault detection and root-cause diagnosis avoid severe failure cases and costs.

Uptime HARVEST Benefits

Quick Wins

- Value from available data
- Focus on elimination of weak-points
- Re-usable, understandable algorithms

Corporate Development

- Technical & process learning
- Dissemination of expert knowledge
- Service staff involvement

Life Cycle Solution: Software & Consulting

- Leverage on product development knowledge
- Model calibration, no cumbersome training
- Information merging

Analytics & Process

- Focus on efficiency and improvement
- Analytics triggers the maintenance process and vice versa
- Corporate learning process

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