Digital System Solutions

Data Driven (Dynamic) Maintenance @ ÖVIA Congress

voestalpine Railway Systems
www.voestalpine.com

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AGENDA

01 DATA DRIVEN (DYNAMIC) MAINTENANCE

Introduction – WHY/HOW/WHAT

Why (customers pain)

Railway operators struggle with unpredictable rolling stock / infrastructure failures that disrupt service and increase maintenance costs.

Why (internal pain)

Traditional maintenance models limit innovation and scalability, preventing suppliers from offering value-added, performance-based services.

How

By leveraging real-time sensor data, historical trends, and predictive analytics, we shift from reactive to condition-based and proactive maintenance.

What

A dynamic maintenance model that adapts to actual asset conditions, optimizes intervention timing, and extends infrastructure lifespan.

Who

Infrastructure managers, maintenance service providers, and digital solution partners collaboratively enable a more resilient and efficient railway system.

02 DATA DRIVEN (DYNAMIC) MAINTENANCE

What? Understand Maintenance in Railway Infrastructure

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It is crucial to know and to have Knowledge about “how a physical product could fail”?

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Traditional vs. Data Driven Maintenance

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Traditional Maintenance		Data Driven Maintenance		
	← *Redundancy available* Run to failure OK	Important/critical to process *No reduncancy* →		
Reactive	**Preventive**	**Condition Based**	**Predictive**	**Prescriptive**
Unplanned maintenance after failure	Maintenance at regular predetermined intervals even when no defects are present	Inspection or continuous data based recognizing failure mechanism and defects in an early stage	Failure mechanism are detected at an early stage and remaining useful Lifetime allows for scheduling and minimal disruption to production	Providing recommendations for improving/optimizing forthcoming maintenance process
Repair	Prevent	Recognise	Forecast	Recommendation

In general, redundancy is referred to in technology when a system has the same or comparable *resources that are not needed under normal circumstances* (during trouble-free operation).

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Analytics Framework

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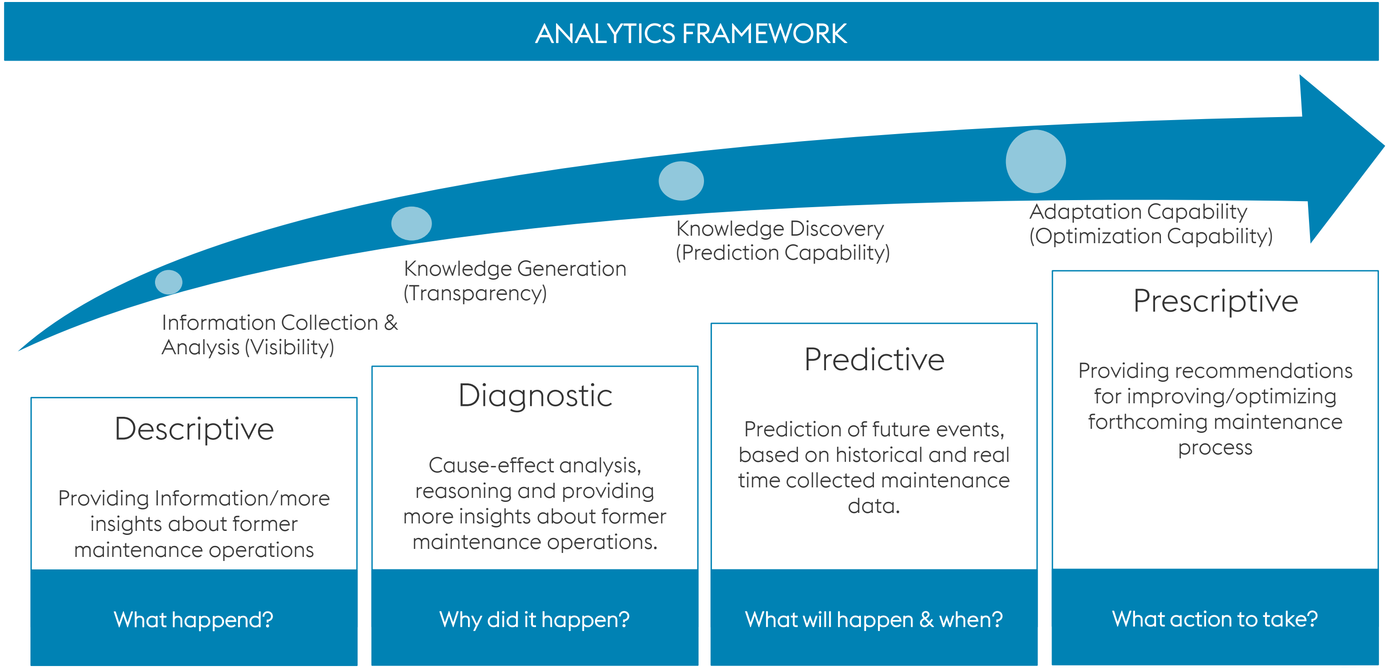

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Step by Step Development of Asset Management

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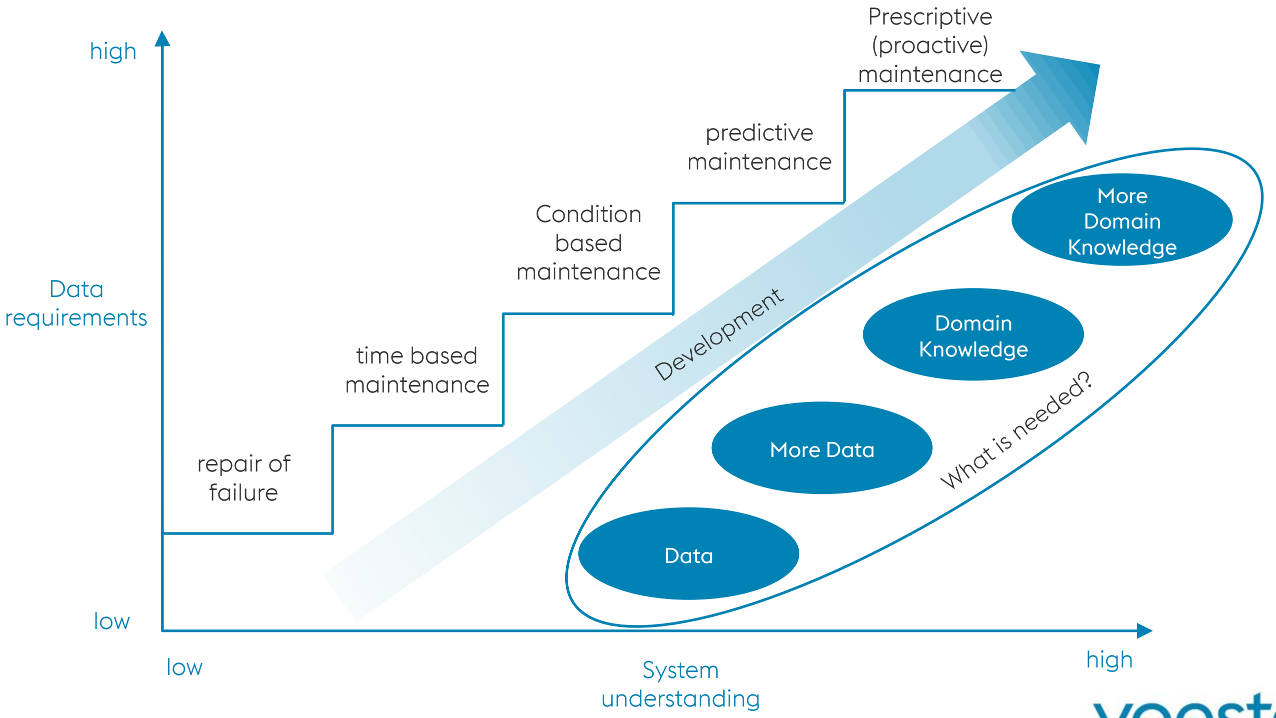

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03 DATA DRIVEN (DYNAMIC) MAINTENANCE

Monitoring Quadrantes Concept

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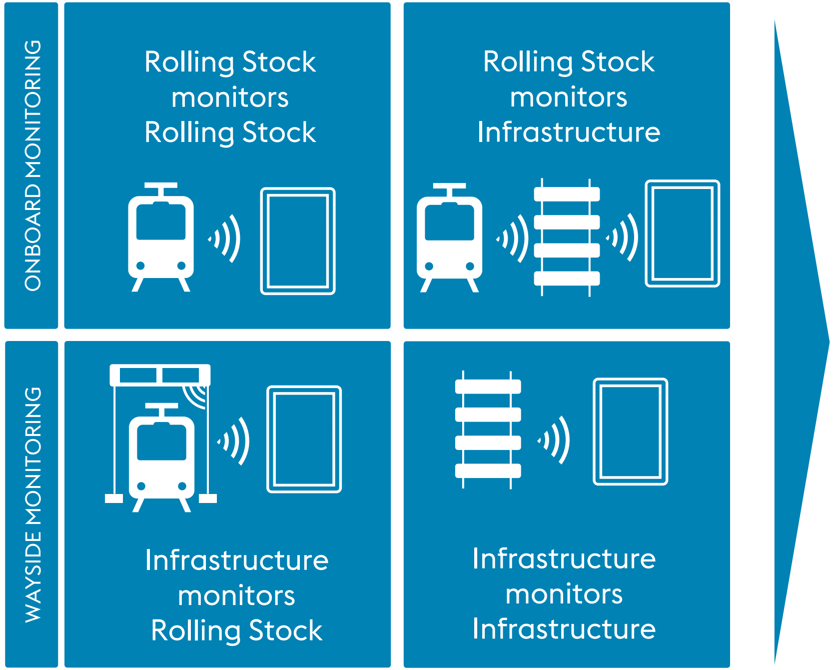
Monitoring 4-Quadrants Concept



In the railway industry, monitoring systems play a crucial role in ensuring the safety, reliability, and efficiency of operations. The difference between the various monitoring approaches—Infrastructure monitors Infrastructure, Rolling Stock monitors Infrastructure, Rolling Stock monitors Rolling Stock, and Infrastructure monitors Rolling Stock.

Each monitoring approach serves a unique role in ensuring the efficient and safe operation of railway systems. By integrating these methods, rail operators can maintain a comprehensive oversight of both infrastructure and rolling stock conditions, leading to improved safety, reduced costs, and optimized performance. The use of advanced sensor technology, data analytics, and real-time monitoring systems is crucial in achieving these goals.

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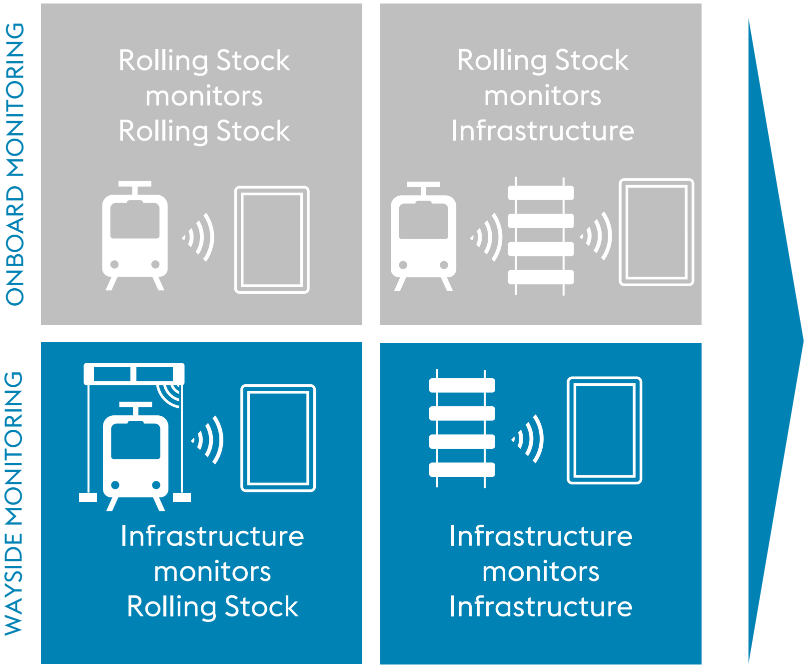
Monitoring 4-Quadrants Concept



voestalpine Railway Systems and the Profit Center Signaling focus on wayside T/O & Track and Rolling Stock monitoring solutions. The strengths here lies primarily in the quadrants “Infrastructure monitors rolling stock” and “Infrastructure monitors infrastructure”.

The acquired and collected data of all quadrants represent a certain interdependence in an overall data model.

For example, condition data of the rolling stock can have an impact on the future performance of the T/O & Track system. Conversely, the status of the T/O & Track system can have an impact on the condition of the rolling stock.

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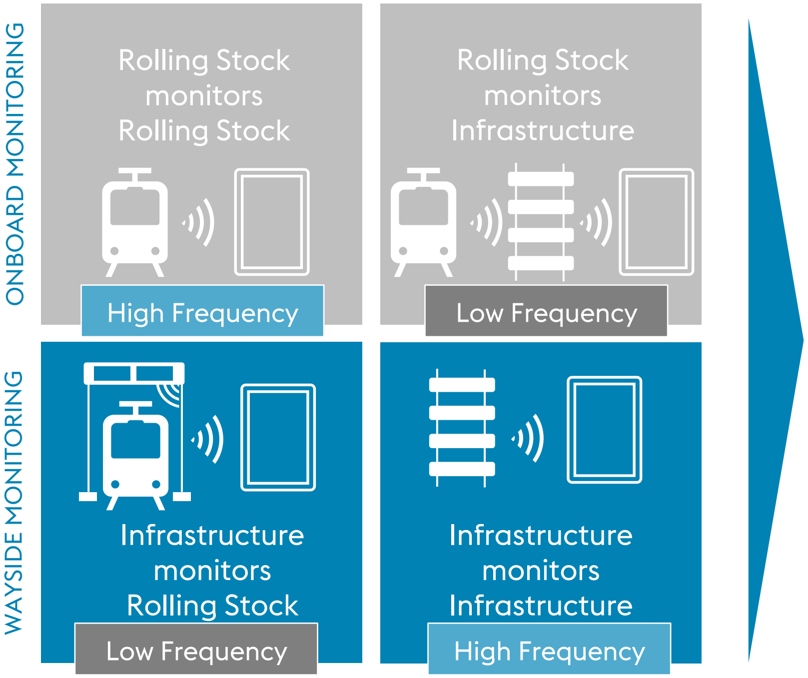
Monitoring 4-Quadrants Concept



Due the difference in nature of each quadrant, they generate data in different frequencies. This leads to a distinction between High Frequency and Low Frequency data sources.

High Frequency – Time series data that is gathered at high frequency, representing "real-time" data in a sense, typically being sensor data of components do not move relative to the sensor, respectively sensors are build into or onto what they monitor.

Low Frequency – Data generated periodically but in lower frequency due to the sensor or the object that is monitored being separate by time and distance. (e. g. turnout and trains). Frequency is often dictated by traffic or scheduled (e.g. inspections)

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Monitoring 4-Quadrants Concept

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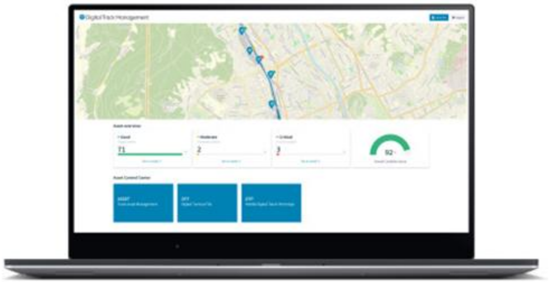

zentrak

Asset Management (AM)

- Header Data (Asset ID)
- Asset Structure (Asset BOM)
- Digital Touch Point (DTP & UID)
- Customer Portal (Content & Interface)

Maintenance Management (MM)

- Work Order Management (Asset ID)
- Asset & Equipment Management
- Preventive/Predictive Maintenance Management
- Preventive/Predictive Spare Parts Management

Infrastructure Monitoring (IM)

- Harvest Data
- Provide Information
- Recommend Action
- Basis for Decision

ISO 13374

- Data Acquisition (DA)
- Data Manipulation (DM)
- State Detection (SD)
- Health Assessment (HA)
- Prognostic Assessment (PA)
- Advisory Generation (AG)

Technical displays and Information presentation UI/UX

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04 DATA DRIVEN (DYNAMIC) MAINTENANCE

How? Customer Pain & Opportunity

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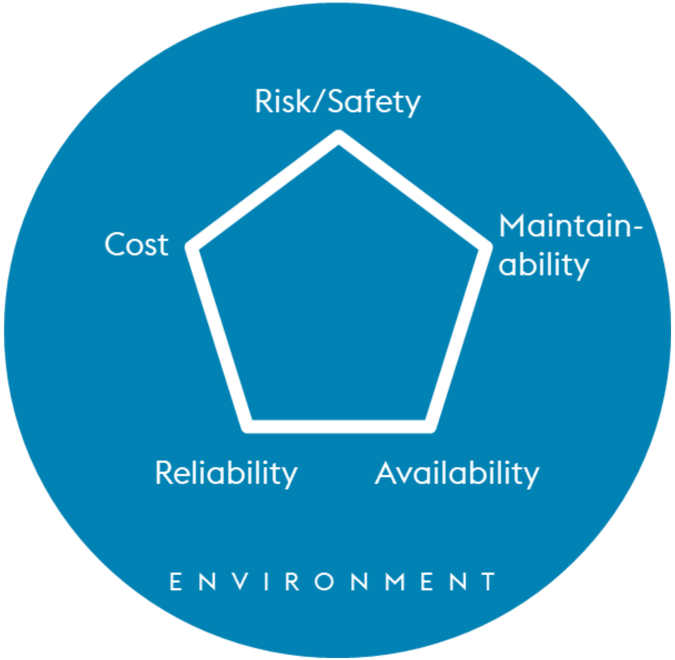
Customer Pain & Opportunity



Customers struggle with the reliability and availability of T/O assets throughout the entire "as used" life cycle phase as the main failure potential and therefore as a critical part of linear asset management.

Followed by maintainability (maintenance and inspection), embedded in a risk/safety and corresponding environmental influences.

The failure and fault potential of an asset generates non availability and corresponding additional costs over its life cycle due to the maintenance and inspection required. Therefore, the goal is to reduce, optimize and/or automize maintenance and inspection as much as possible using robust mechatronic T/O and track systems while still ensuring compliance with safety requirements.

Digital services, such as data driven maintenance are the key to support the request for higher reliability, availability and optimized maintainability in the lifecycle phase "as used".

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05 DATA DRIVEN (DYNAMIC) MAINTENANCE

Visual Train Analysis – Initial State

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Use Case – Visual Train Analysis

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The need for automated support of decision-making processes through accompanying recommendations for action for railway operations is constantly growing.

The reason lies in the increasing complexity on the one hand and the growing shortage of qualified specialists on the other.

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Use Case – Visual Train Analysis

06

DATA DRIVEN (DYNAMIC) MAINTENANCE

Visual Train Analysis – Future State

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Use Case – Visual Train Analysis

Visual Train Analysis (VTA) analyzes passing trains based on captured camera images and provides users with information on vehicle maintenance. This includes the recognition of letters and numbers, such as the car number, as well as the condition of individual components and assemblies.

The system was developed to continuously detect and evaluate trains. Therefore, cameras and infrared flashes are used, providing consistently high-resolution black and white images both day and night. This ensures consistently high quality, with the near-infrared flashes invisible to humans and therefore not affecting train operations.

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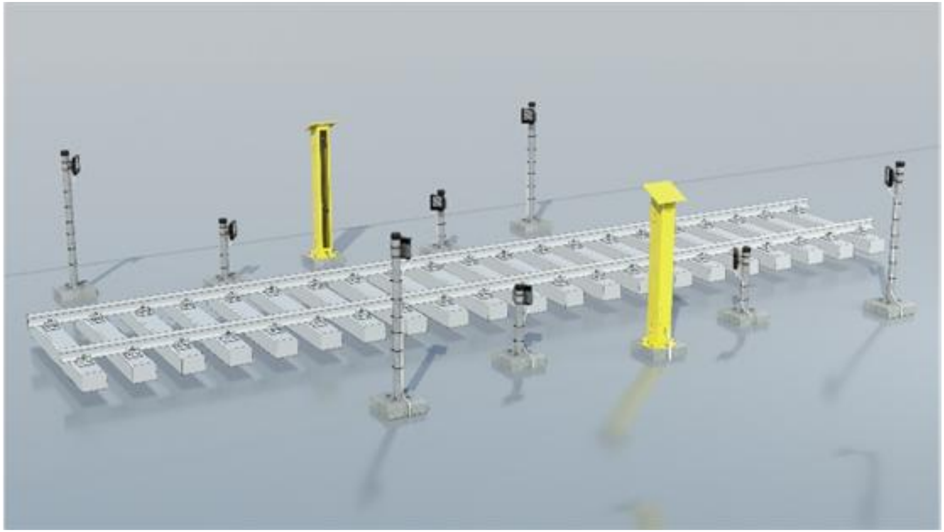
Use Case – Visual Train Analysis



The core elements of this measurement function are one or more cameras for detecting and evaluating the bogie and the side of the vehicle.

The cameras are placed next to the track outside the clearance gauge in a protected housing. Depending on the monitoring requirements, one-sided or two-sided recording of the passing train can be achieved, depending on the local conditions.

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Use Case – Visual Train Analysis

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Use Case – Visual Train Analysis

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Based on OCR (Optical Character Recognition) technology, alphanumeric information on the wagon side can be recognized and read. This includes, for example, the UIC number or the revision/inspection date.

The Analysis of the optical characters is AI-supported and presents user-defined warning and alarm thresholds so that a workshop visit can be optimally planned once deviation to the planned condition has been reached.

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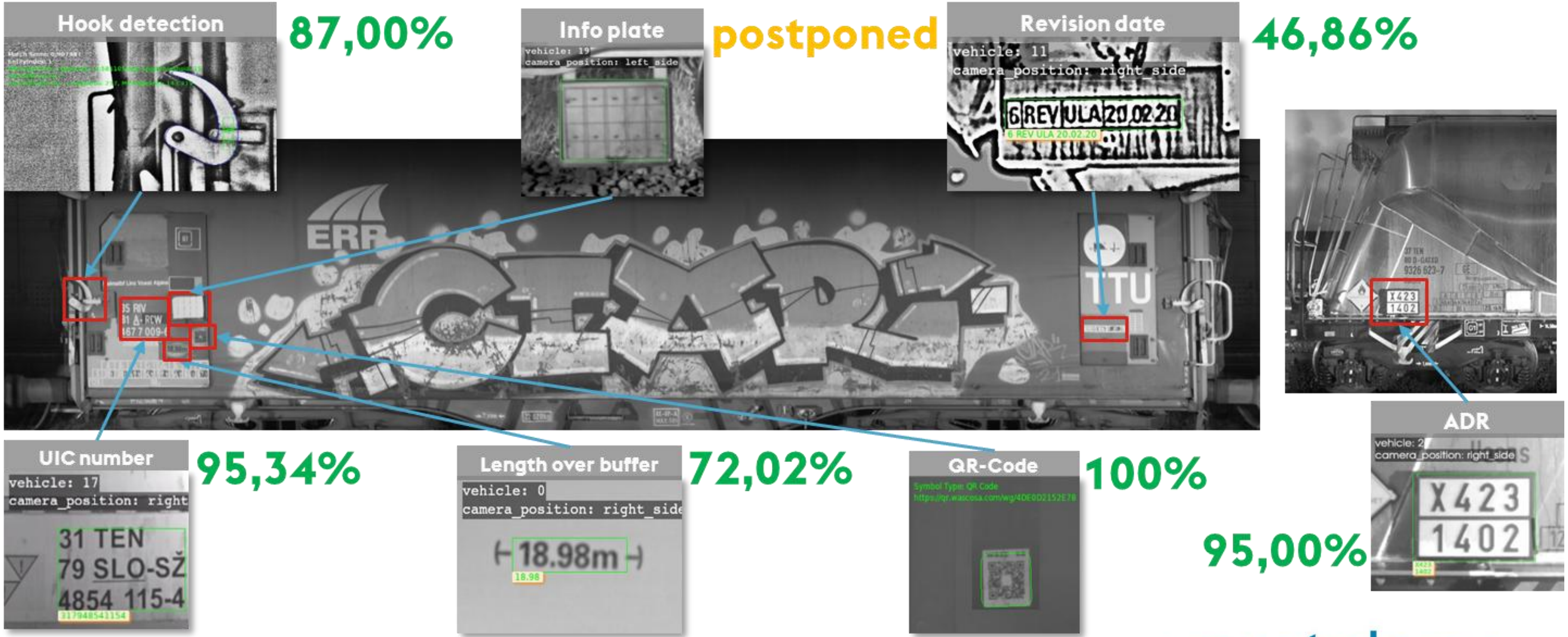
Use Case – Visual Train Analysis



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Use Case – Visual Train Analysis

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- Locate the writing
- OCR-method
- Extract the UIC's
- Check verification number
- Single-line, multi-line, dark on light, light on dark

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Use Case – Visual Train Analysis

QR/Datamatrix-Code:
Decode the content
Weblink contains UIC and more
Barcodes and more possible features

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Use Case – Visual Train Analysis

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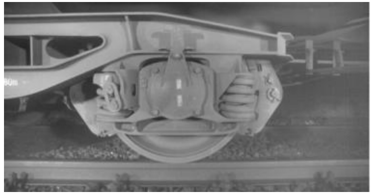
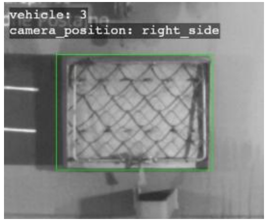
Panoramabilder

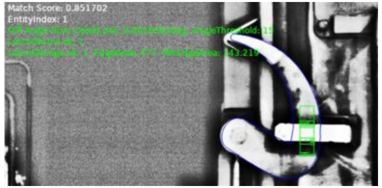
Detailbilder



Rad-/Reifendicke

Zettelkästen





Hakenerkennung

UIC- und Instandhaltungs-nummern

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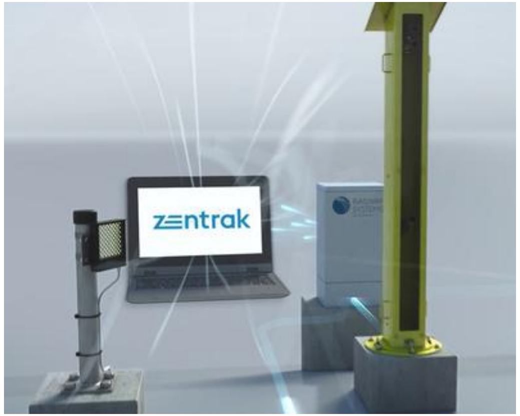
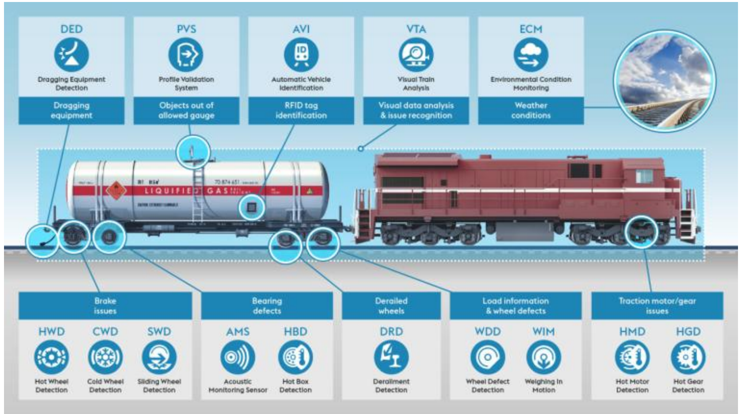
Use Case – Visual Train Analysis





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DATA DRIVEN (DYNAMIC) MAINTENANCE

The target and gain

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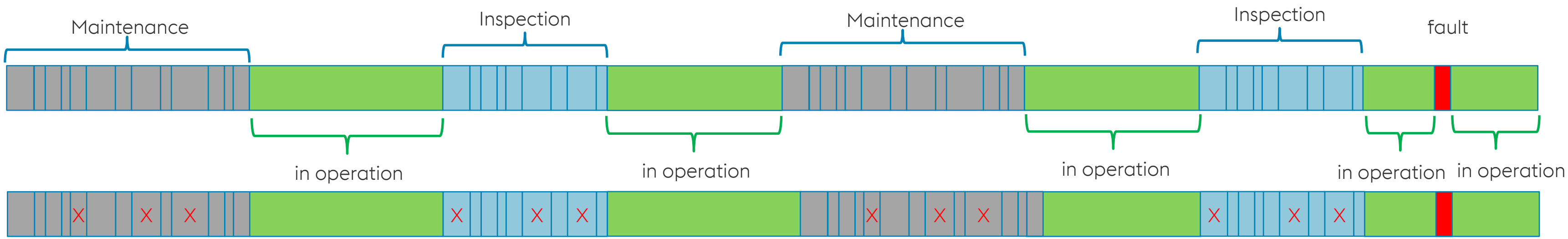
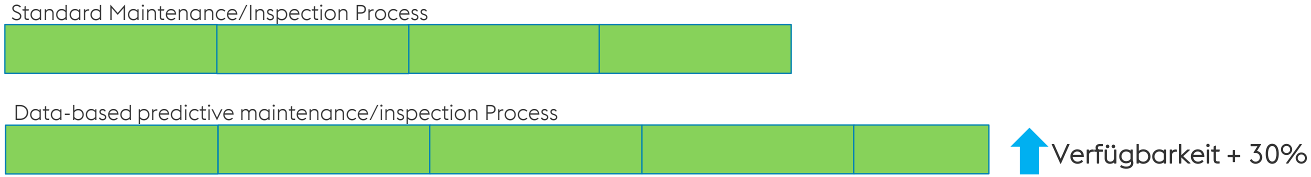
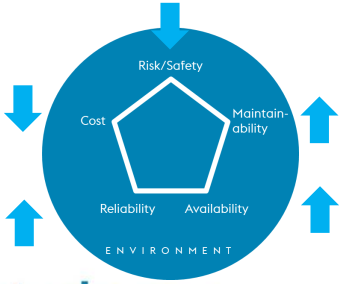
Dynamic Maintenance – Target and Gain

Increasing the "in operation" status by eliminating maintenance and inspection content due to a data-based predictive (vital and non vital) maintenance approach.







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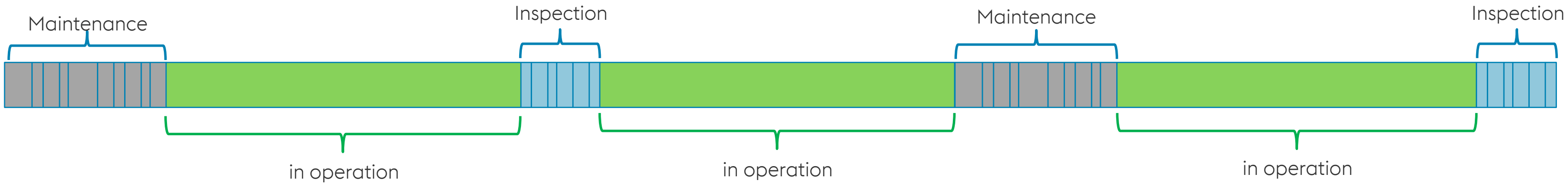
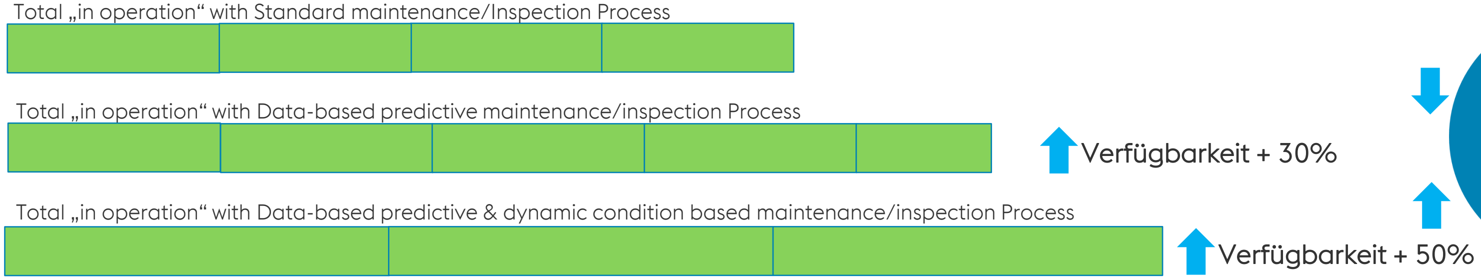
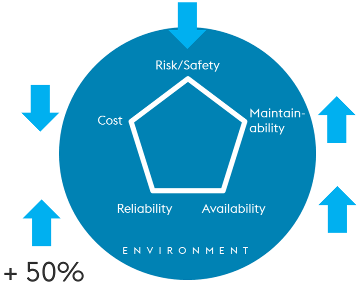
Dynamic Maintenance – Target and Gain

Increasing the "in operation" status by eliminating maintenance and inspection content due to a data-based predictive maintenance (vital and non vital) combined with dynamic (floating) condition-based maintenance approach (extend meantime between maintenance and inspection).







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DATA DRIVEN (DYNAMIC) MAINTENANCE

Q&A and Feedback

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Thank you!

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