25 CAREC
Central Asia Regional Economic Cooperation

10th Railway Working Group Meeting

3-5 June 2026 |Ulaanbaatar, Mongolia

10-е заседание Рабочей группы по железнодорожному транспорту

3-5 июня 2026 года | Улан-Батор, Монголия

Practical Examples of Railway Digitalization

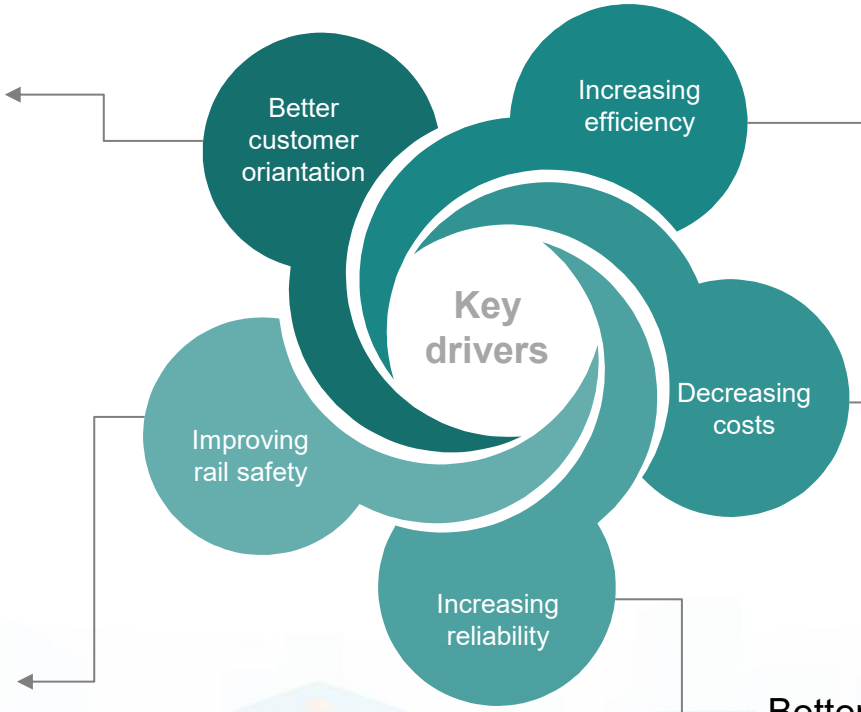
Udo Sauerbrey
Railway Sector Specialist (TA Core Team)
Managing Director, Railistics GmbH

Outline

- Key drivers for change
- Main pillars of digitalization
- Practical examples of railway digitalization

Strategic targets for digitalization

Higher reliability and transparency for the freight and passenger clients



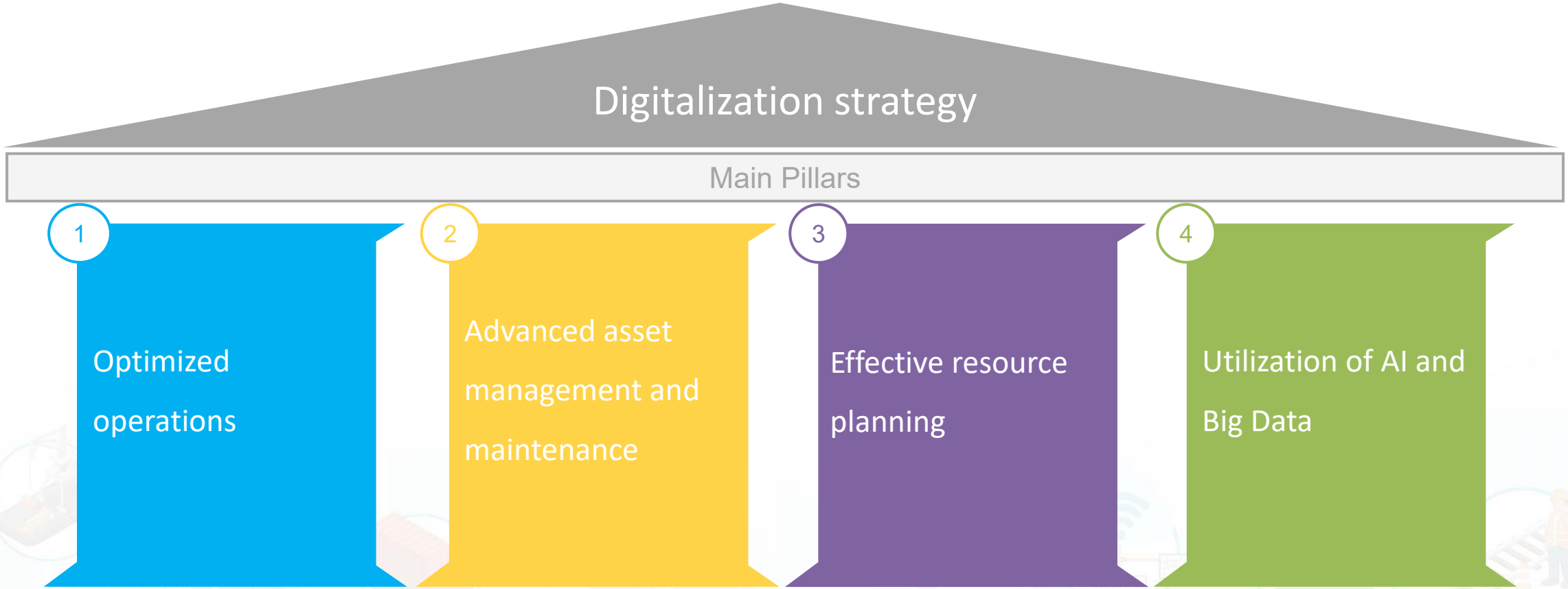
Optimization of asset management and railway operations.

Reduced capital and operational costs in the long term

Utilising digital tools for early detection of failures, reducing risk of accidents

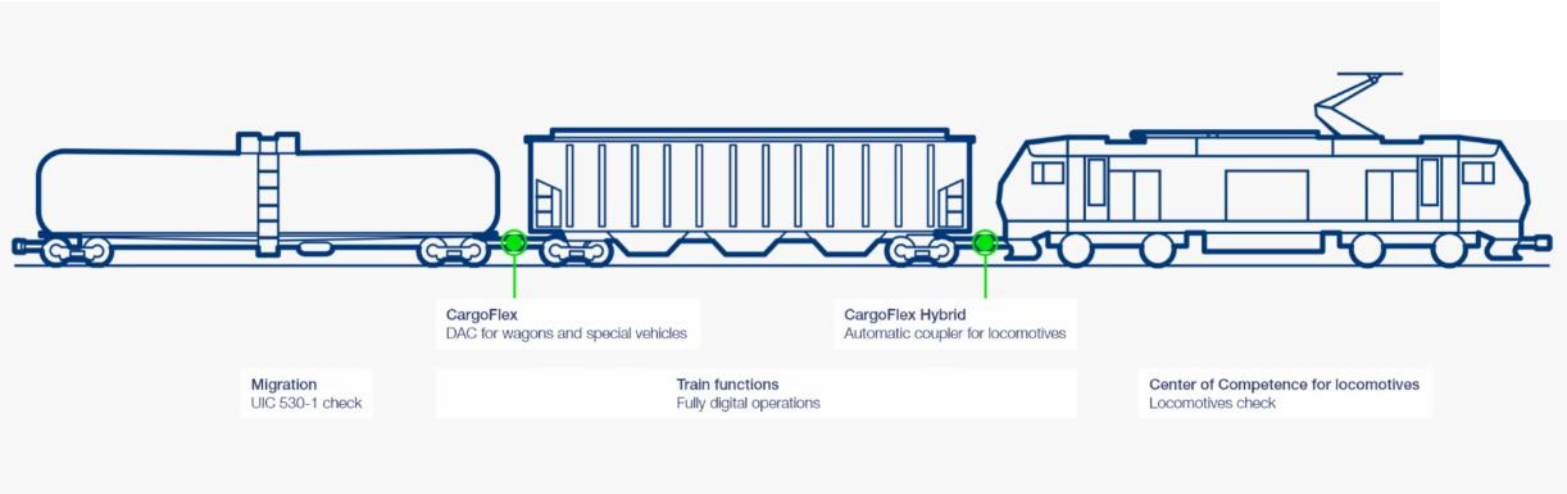
Better planning, real-time monitoring with the help of digital tools.

Main pillars of digitalization



1 – Digital Automatic Coupling

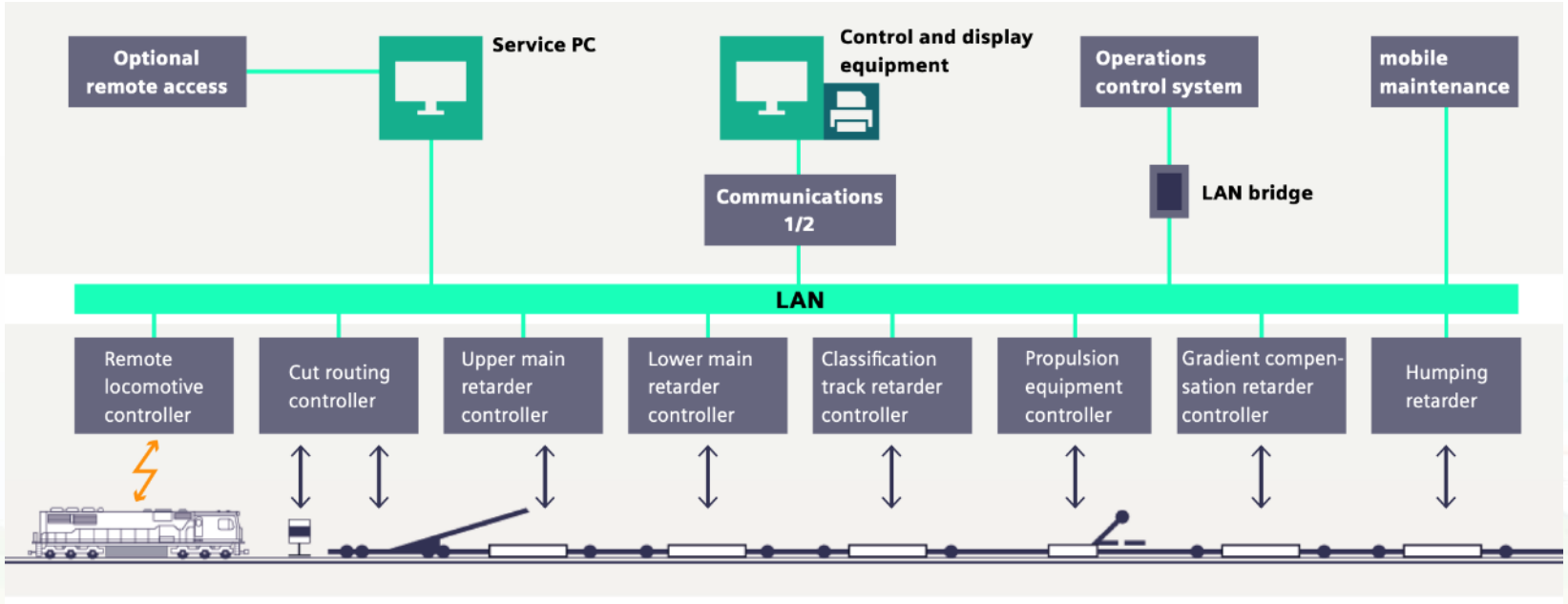
- **Voith's DAC** (Digital Automatic Coupler, DAC) offers a stable data link via the CargoFlex between wagons. Benefits of DAC includes higher safety (train integrity), and time savings during shunting processes.



Source: [Digital Automatic Coupler | Voith]

1 – Optimized shunting in yards

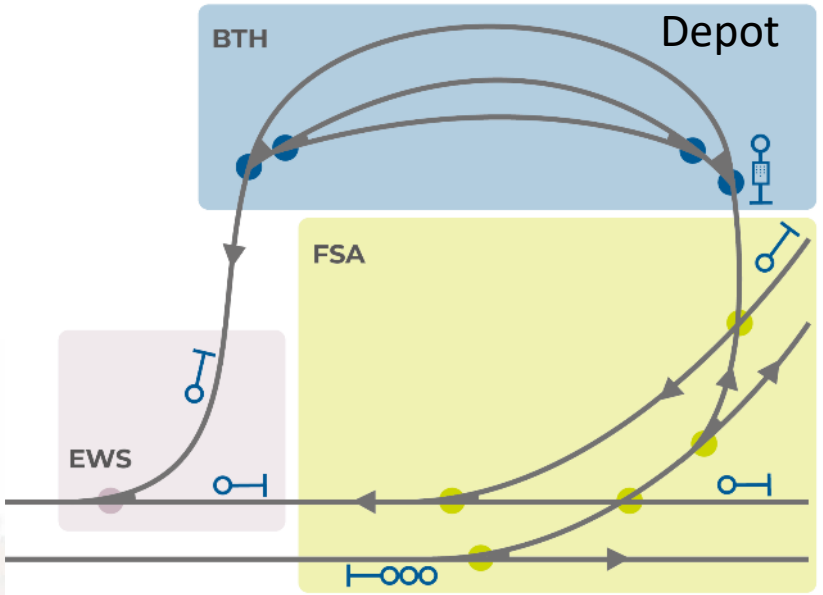
- **Trackguard Cargo MSR32** by Siemens automation system for marshaling yards.



Source:1. Stadler Nova Depot | Stadler , 2. trackguard-msr32-en.pdf

1 – Automatic shunting – in Depots

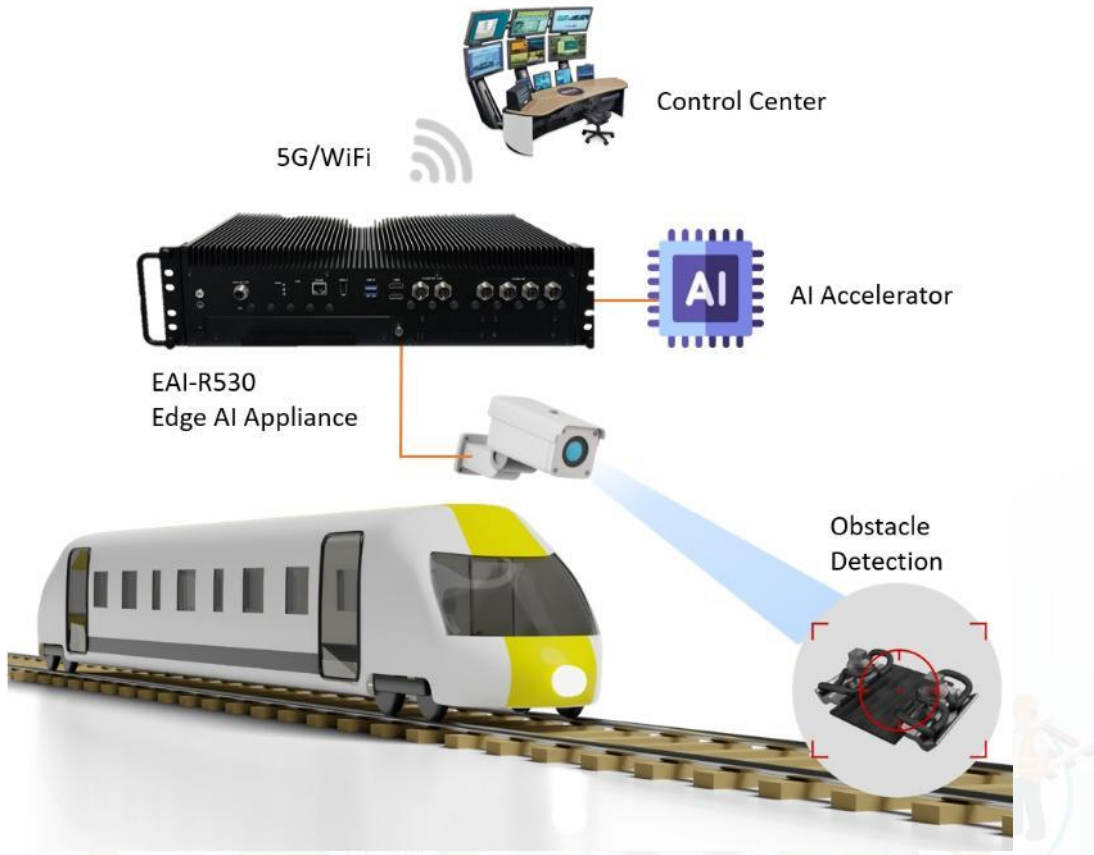
- **Automated Depot** : Stadler NOVA Depot monitors automatically moved trains and locomotives within a depot. Accurate positioning, switch changes and the traction device are remotely controlled.



Source:1. Stadler Nova Depot | Stadler , 2. trackguard-msr32-en.pdf

1 – Object detection

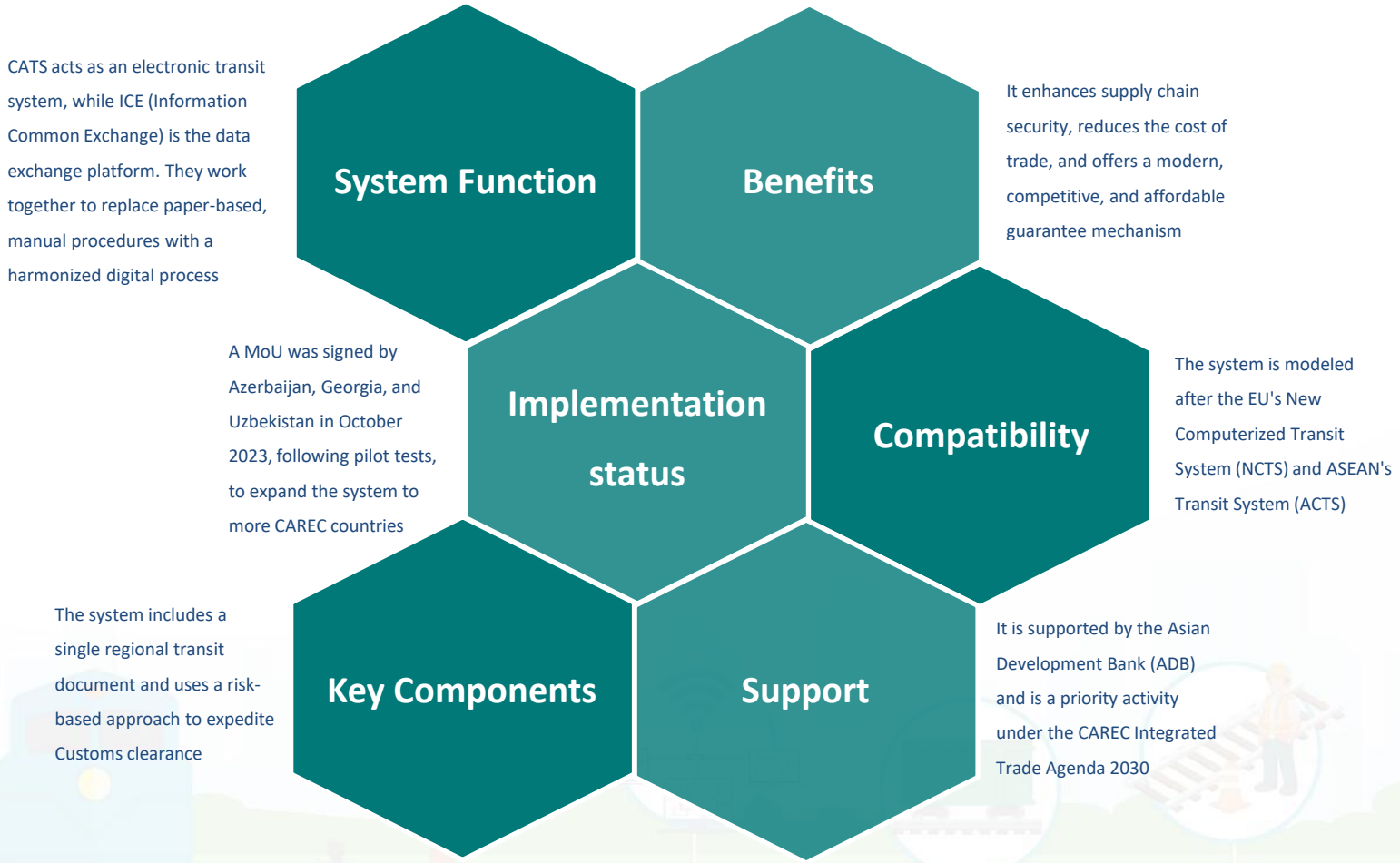
- **Object detection:**
- To tackle the challenge of enabling real-time obstacle detection over rail track, **Lanner provides EAI-R530**, an EN50155 certified edge AI appliance designed for processing data for real-time video analytics in the railway trains.
- By analyzing information from sensors, cameras, and other sources locally, the EAI-R530 edge AI appliances can enable continuous monitoring of the railway tracks ahead.



Source: [Real-Time Obstacle Detection Over Railway Track with In-Train Edge AI Appliance]

1 – CAREC CATS-ICE

- The CAREC Advanced Transit System (CATS) and Information Common Exchange (ICE) is a 2017 developed harmonized, digital, and risk-based customs system designed to streamline the movement of goods across Central Asia Regional Economic Cooperation (CAREC) member states.
- It uses a single electronic transit document and a regional guarantee mechanism to reduce time, costs, and border bottlenecks for compliant operators, aimed at increasing trade efficiency and connecting to European markets.



Source: 16th CAREC Customs Cooperation Committee Meeting | CAREC Program Event
CAREC Advanced Transit System/Information Common Exchange: Technical Working Group Meetings | CAREC Program Event

1 – Robot technology in terminals

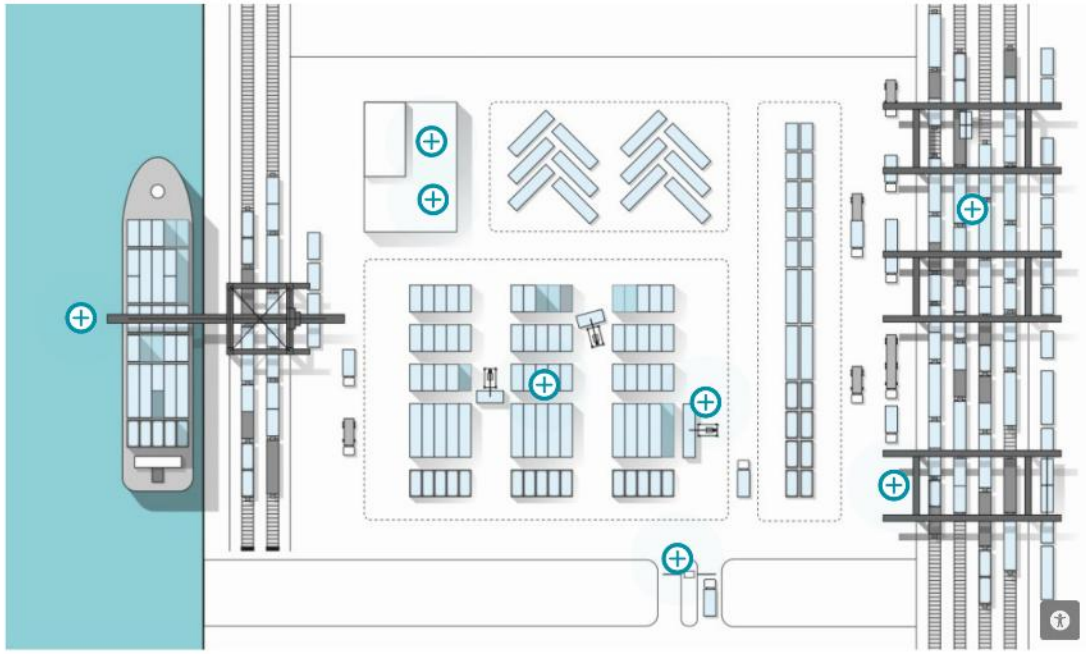
- The Port of Hamburg tested a smart PORT system of robots with sensors and cloud data to manage the pins on container wagons within the terminal
- The robots autonomously closed and opened the wagon pins according to the container size. Finally, robots were too slow and unreliable, and the tests were not continued.
- Self-driving tractors now handle rail container loading and terminal connections.

Pin-handling in the Container Terminal Tollerort

Source: https://hamburg-business.com/en/news/hhla-and-fraunhofer-cml-driving-automation-in-port

1 – Terminal operations software

- Terminal operating systems can improve:
  - Vehicle operations
  - Crane operations
  - Storage effiency
  - Booking
  - Maintenance and repair
  - KPI



Source: various websites for terminal operating systems

2 – Wagon diagnostic and inspection

- **Vossloh RailWatch:**
- Wayside monitoring system for rail infrastructure and rolling stock.
- Uses sensors and AI for condition monitoring.
- Detects wheel defects, overloads, and track issues.
- Provides predictive maintenance insights.
- Real-time data analytics platform.

Source: https://www.vossloh-railwatch.com/de/

2 – Wagon diagnostic and inspection

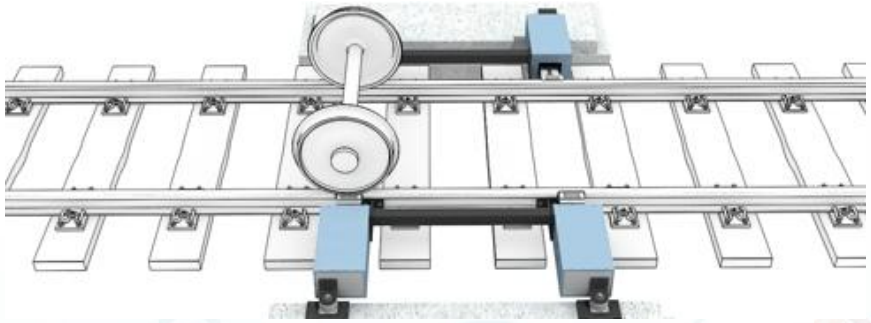
- **Camera Gantries & AI Diagnostics :** Camera gantry technology for freight wagon diagnostics was tested and implemented at DB Cargo in a Germany-wide rollout at the end of 2022.

- **Digital Inspection Portal Uses AI (USA)**: Collaboration between Norfolk Southern Corporation and the Georgia Tech Research Institute (GTRI) has led to the development of digital train inspection portals that use advanced machine vision and artificial intelligence to examine trains moving at speeds of up to 60 miles per hour to identify mechanical defects that may exist. Two train portals are currently in operation on adjacent tracks in Leetonia, Ohio.

Source: Pilot implementation of artificial intelligence | DB Cargo
Digital Inspection Portal Uses AI and Machine Vision to Examine Moving Trains | Research

2 – Rolling stock inspection

- **MERMEC – Wheel Surface Defects Detection System:**
- Automated wheel defect inspection system for moving trains.
- Uses machine vision and ultrasound technologies to detect wheel tread defects.
- Detects shelling, spalling, and flat spots before failures occur.
- High-definition cameras and AI-based image analysis inspect wheels in motion.
- Full wheel tread coverage during train passage.
- Enables predictive maintenance and automated condition monitoring.



Source: https://www.mermecgroup.com/inspect/train-monitoring/85/wheel-surface-defects.php

2 – Rolling stock inspection

- **L.B. Foster – WILD IV Wheel Impact Load Detector:**
- Trackside Wheel Impact Load Detector (WILD) system.
- Monitors wheel impact forces and wheel-rail interaction.
- Detects wheel defects that could damage tracks or cause derailments.
- Rail-mounted strain gauges and sensors capture wheel impact loads in real time.
- Continuous automated monitoring of rolling stock health.
- Digital analytics platform provides alerts and maintenance recommendations.

Source: https://lbfoster.com/rail/total-track-monitoring/wheel-impact-load-detector

2 – Rolling stock inspection

- **voestalpine – zentrak Wheel Defect Detection & Weighing in Motion:**
- Integrated wheel defect detection and weighing-in-motion system.
- Monitors wheel condition, train weight, axle load, and load distribution.
- Supports continuous wheel-rail interaction monitoring.
- Sensors continuously monitor wheels during normal train operations.
- Dynamic weighing system detects overloads and imbalances.
- Self-diagnostic and self-calibration digital monitoring platform.

Source: https://www.voestalpine.com/railway-systems/en/products/zentrak-weighing-in-motion-wheel-defect-detection/

2 – Rolling stock inspection

- **Norfolk Southern – Digital Train Inspection Portals:**
- AI-powered Digital Train Inspection (DTI) portals.
- Automated inspection of moving freight trains using high-speed cameras and sensors.
- Thousands of high-resolution images captured for every passing train.
- AI algorithms detect defects in railcars and locomotives.
- Real-time alerts improve maintenance response and operational safety.

Source: https://www.norfolksouthern.com/en/newsroom/story-yard/norfolk-southern-deploys-second-digital-train-inspection-portal-

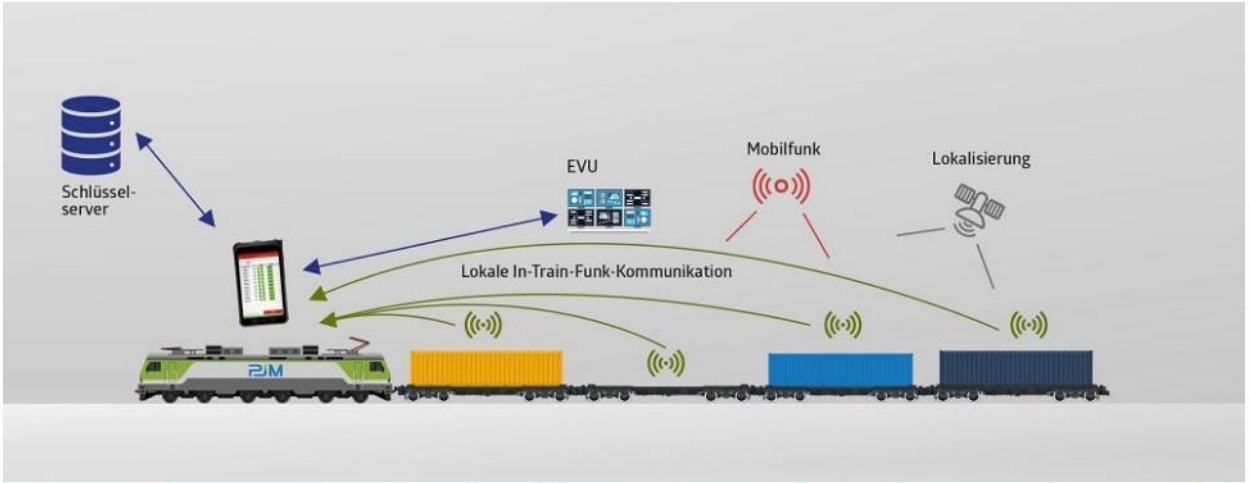
2 – Wagon monitoring device – railway undertaking

- **Sensor equipped wagons - DB Cargo Smart Wagons :** The GPS-based status messages integrate into DB Cargo's systems and feed different software solutions around the freight wagon fleet such as link2rail eServices, Track&Trace, Geofence Control and Roundtrip Control.
- DB has equipped almost 63,000 freight wagons with telematics and sensors. By that, they generate some two million datasets daily, which are transferred to and processed in the DB IoT cloud with position- and movement data.

Source: Wagon Intelligence

2 – Wagon monitoring and tracking – wagon owner

- **Sensor equipped wagons - WaggonTracker:**
- Real-time monitoring of the train run,
- Running characteristics,
- Loading state,
- Temperature of the axle bearing,
- Optical and acoustic indication directly on the train,
- Derailment,
- Brake status last wagon,
- Continuous brake diagnosis,
- end of train



Source: [In-Train-Communication – PJ Monitoring]

2 – Utilization of passenger trains

- Facing a shortage of delivery drivers, Japan has converted under-used space on Shinkansen (bullet train) passenger services into dedicated cargo zones.
- Small, time-sensitive packages travel at 300 km/h alongside passengers, coordinated by a digital platform.
- JR East projects annual revenue from this freight Shinkansen service at $66–70 million, and a crowd shipping system further optimizes spare train capacity.

Parcels of goods are loaded onto trucks that fit between the seats aboard a Shinkansen. (Provided by East Japan Railway Co.)

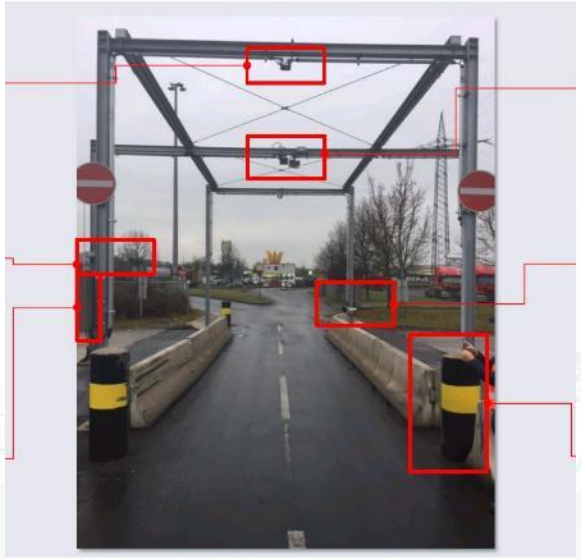
Source: https://www.railway.supply/jr-east-launches-freight-shinkansen-to-boost-logistics/
https://www.transportcorridors.com/12404

3 – Automatic monitoring gates

- A gate system located at intermodal terminals and equipped with high-frequency cameras to automatically identify wagons and intermodal loading units.

1. **Video gates at ÖBB terminal by CAMCO** : ÖBB Infrastructure will rely on state-of-the-art "video gate" systems at its three intermodal terminals – for higher overall performance and even more security.

2. **NUMBERCheck Video Gate used by DB**:The system identifies vehicle and truck number plates, container numbers, dangerous goods numbers etc. on vehicles and their loading units with intelligent image recognition using OCR system. Truck Gate works bidirectionally and detects incoming and outgoing vehicles in the speed range from 0 to 30 km/h.



Source: Transforming rail freight through digitalisation and automation - Europe's Rail
ÖBB: "Video gates" for even more – ÖBB , 3.NUMBERCheck Videogate Street | ASE Bruchsal

3 – Digital Twin

- **HMAX by Hitachi Rail:**
- A powerful new all-in-one digital asset management platform for:
  - Trains
  - Signalling and
  - Infrastructure

- HMAX is used to to predict issues and to simulate networks, performance and operations.
- HMAX provides a digital twin of the entire rail ecosystem, including software and data from your core systems, additional sensors, and third parties.

Source: Digital Asset Management | Hitachi Rail

3 – Digital Twin - Workshop

- KORAIL has implemented a 1:1 digital twin of its KTX maintenance depot using AI algorithms to predict signs of component anomalies. It is used for automating maintenance processes and work schedules to improve the efficiency of railway vehicle maintenance.

Source: https://www.seoulwire.com/news/articleView.html?idxno=719044

Source: https://www.railexpress.com.au/realising-the-potential-for-digital-twins-in-rail/

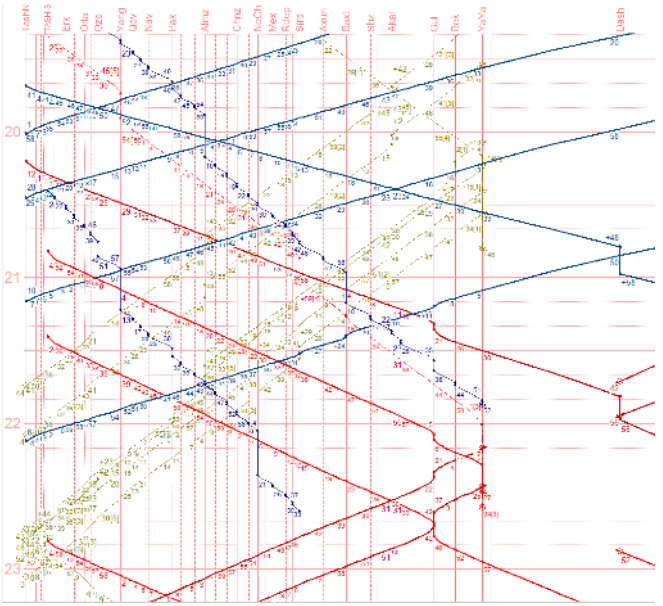
3 – Digital Twin – Energy savings

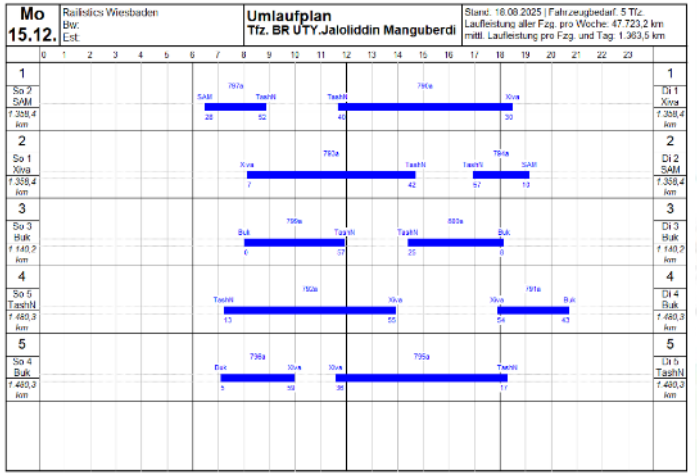
- Hyundai Rotem verified the energy-saving effects of Intelligent Energy-Saving Train Automatic Control System (IEOS) through repeated driving experiments and validation tests in a Digital Twin environment
- In a validation test on the Gangneung Line using the KTX-Eum train, IEOS demonstrated energy savings of 12.2% on the Seowonju-Gangneung section.

Source: https://www.chosun.com/english/industry-en/2026/04/17/J7TYZHOJMBBCBLAX3KLFZDKXMU/

3 - Capacity Management and Planning

- **Capacity planning with timetable software**
- Allows to simulate future situations with adjusted infrastructure or additional traffic volumes
- Shows conflicts and capacity constraints
- Provides train utilization information

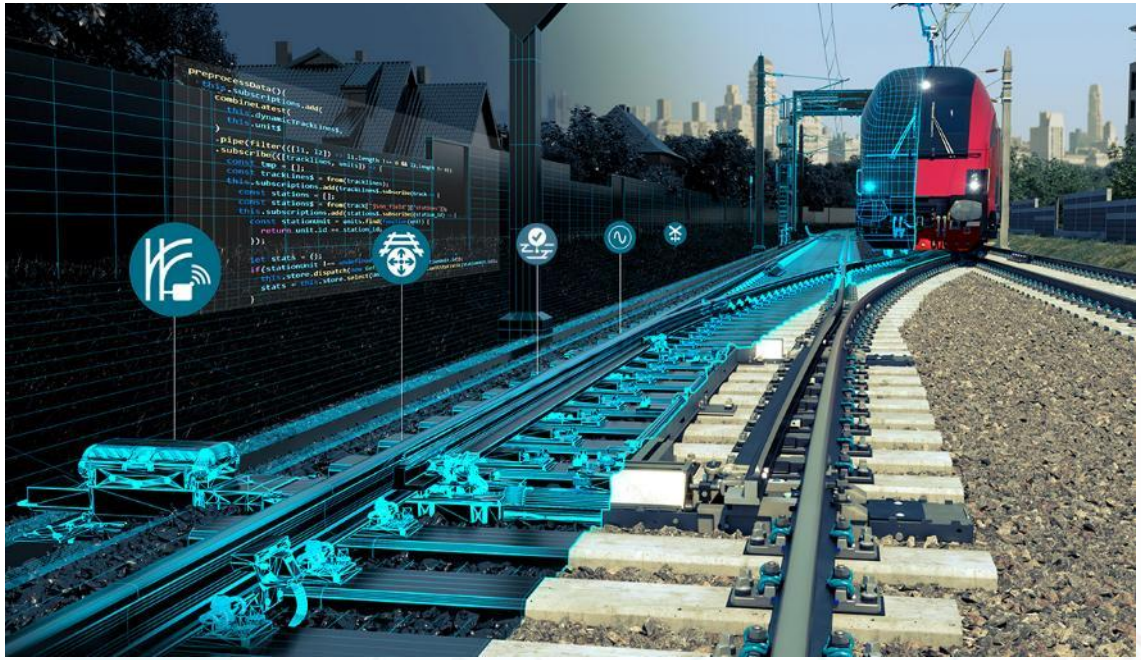




Source: https://carecprogram.org/?publication=track-capacity-timetable-software

4 – Infrastructure monitoring

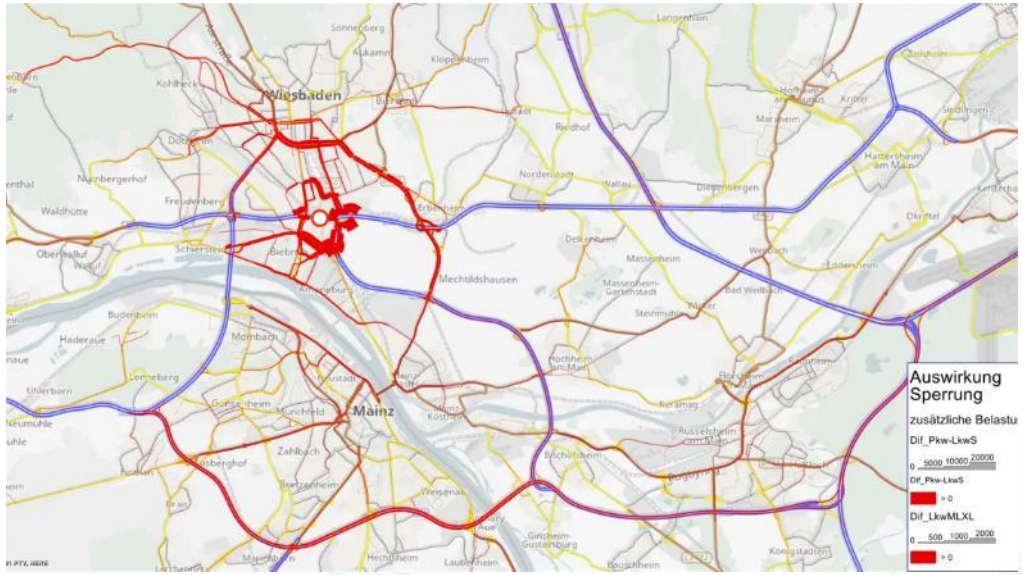
- **Railway Safety with AI-Powered TrackEi™ by L&T:** automatic high-speed inspections at over 60 Miles Per Hour, using high-resolution cameras and laser profiling to identify issues such as broken rails, cracks, track misalignments, and other structural defects.



Source: L&T Technology Services to Transform Railway Safety with AI-Powered TrackEi™ - Press Release

4 – Traffic simulation

- **PTV Visum:**
- Rail traffic simulation and transport planning software.
- Used to model train movements, infrastructure usage, and passenger/freight flows.
- Supports timetable planning, rail capacity allocation, and network optimization.
- Simulates rail operations before real-world implementation.
- Helps identify bottlenecks and optimize infrastructure usage.
- Supports strategic planning and operational decision-making.



Source: https://www.ptvgroup.com/en/products/ptv-visum

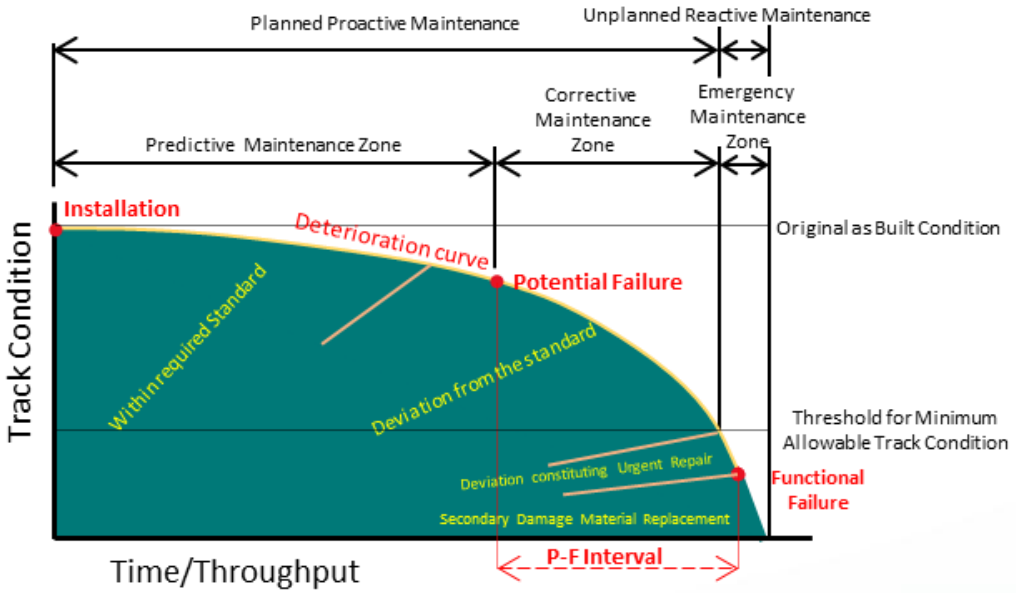
4 – Generative AI

- **SNCF – Generative AI:**
- Application of Generative AI across railway operations.
- Uses AI assistants and analytics to support employees and customers.
- AI tools for maintenance, operations, and customer service.
- Automates data analysis and document processing.
- Supports decision-making and predictive insights

Source: https://www.groupe-sncf.com/en/innovation/emerging-technologies/generative-ia

4 – Track Quality Index

- **A Track Quality Index (TQI)** provides information about infrastructure quality on line segments and compares them to create a preventive maintenance plan.
- High data volumes from different measuring devices need to analysed
- The “target quality” can be defined and a plan to achieve the target including the required maintenance, material and replacements can be established.



Thank you!