

A close-up photograph of a train wheel and track. The wheel is dark and metallic, with some wear visible. The track is made of steel rails and gravel. The background is blurred, showing more of the track and some vegetation.

# SmartVision™ Track Condition Monitoring

*Solution Description*



SmartVision™  
by

**EKE**



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# The Data-Driven Future of Maintenance

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## Introduction

The SmartVision™ team provide leading technologies to operators, maintainers and infrastructure owners to provide solutions for the condition monitoring and predictive maintenance needs of rolling stock and infrastructure.

This document describes the generic functionalities of the SmartVision™ Track Condition Monitoring solution. The solution may be adapted for specific characteristics of rail networks or rail asset databases.

Do not hesitate to get in touch if you would like to discuss how the SmartVision™ Track Condition Monitoring can meet your track condition monitoring requirements.

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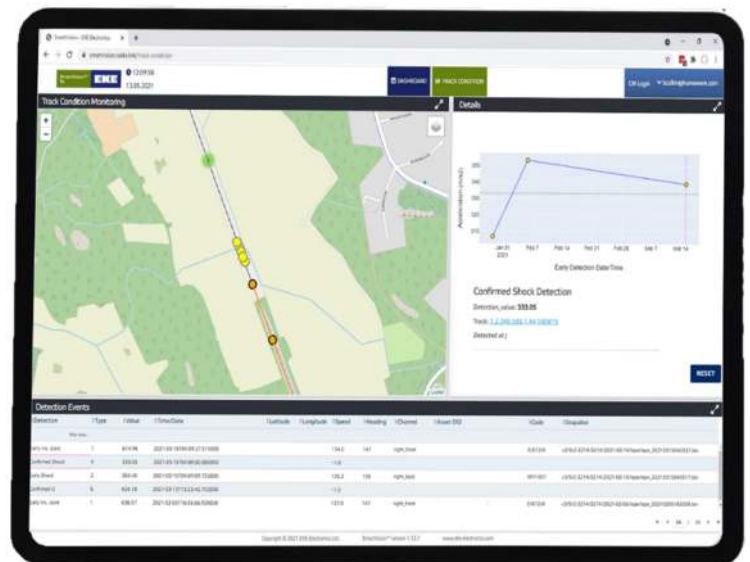


# SmartVision™ Track Condition Monitoring



SmartVision™ by EKE-Electronics, offers a powerful suite of solutions for condition monitoring and predictive analytics of both rolling stock and the track. SmartVision™ Predictive Analytics takes condition monitoring one step further by using advanced algorithms and analytics to predict the remaining useful life of assets.

In collaboration with VR FleetCare, we have developed an industry-leading solution to monitor the condition of tracks and track assets from in-service trains, detecting problem areas to provide a timely view to the condition of the track infrastructure and thus enabling well-timed condition-based service interactions.

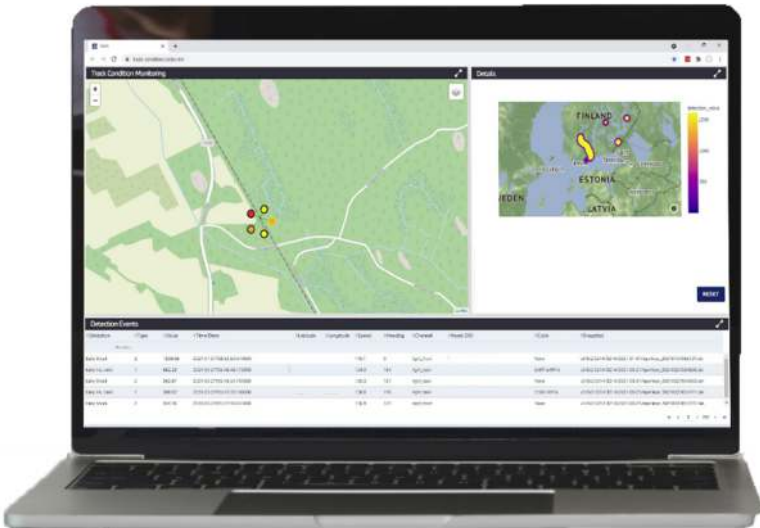




# SmartVision™ Track Condition Monitoring

Sensor data from in-service rolling stock captures both the response of the vehicle from the direct wheel/track interaction and movements of the bogie. Measurement data is collected from both the frame of the bogie and the axle bearings enabling a comprehensive understanding of how the track condition affects the moving vehicle.

The system contains a hierarchical track topology model of the rail network, which, when correlated with on-vehicle GPS information, enables the location of track related events to be pin-pointed and visualised on a map, identifying gradually developing problems for the rails, various track elements and supporting structures.



## SmartVision™ User Interface



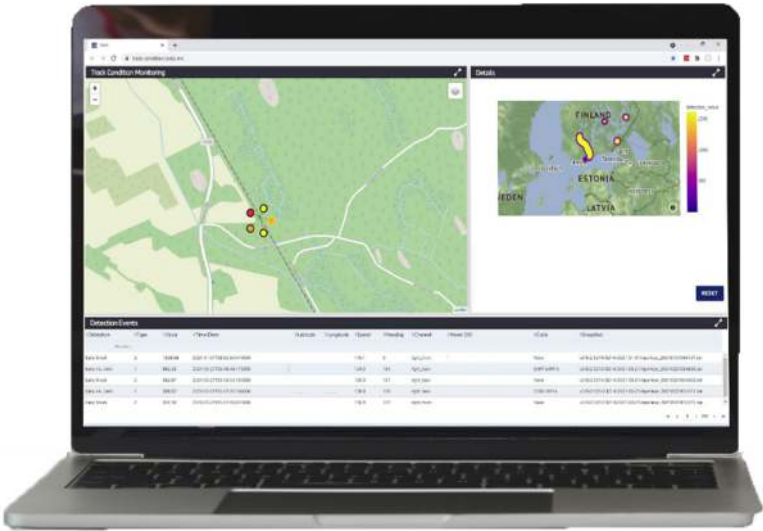
SmartVision's™ user interface is designed so that it is easy to use and understand. Initially, information is presented at a high level, giving an overview of the health status of the asset. Further screens are available to allow people to review the data in more detail.

SmartVision™ gives users full access to their data so it is possible to download the raw data that led to the alert to enable further analysis using your own tools.

SmartVision™ is accessible via a standard web browser. EKE recommends performing user authentication via integration into the operator's single sign-on environment.



# Overview Screen



SmartVision's™ map application accurately pinpoints the location of warnings and alerts. These are colour-coded to indicate the level of severity.

A table is provided giving further information about the alert such as date/time, asset ID, detection value, speed and location.



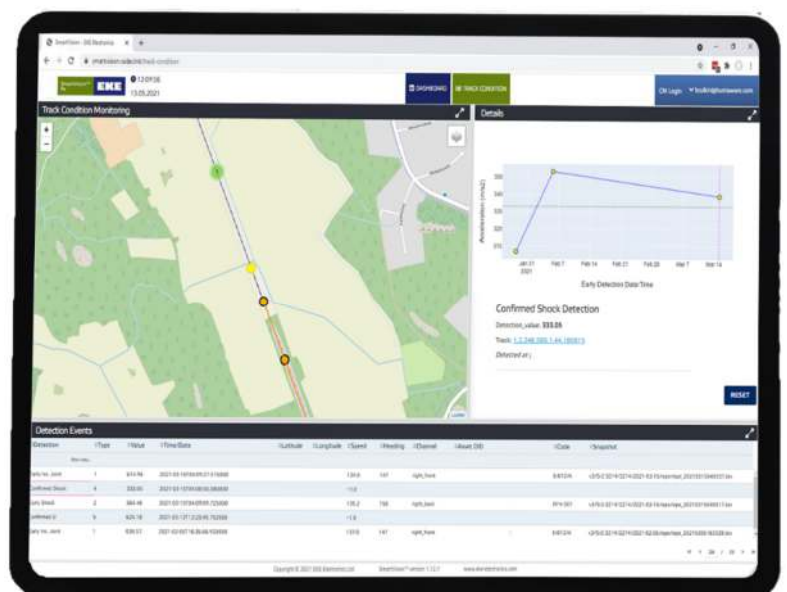
## Detailed View



Clicking on a map pin or a table row will zoom into the map view to show a detailed view of the asset, together with the alerts related to that asset.

The table can be further filtered and sorted on the overview and detailed view screens.

Finally, a view of the data that led to the alert is displayed. The user can zoom in to the data to examine its features and export it for their own analysis.





# Onboard Data Acquisition

**SmartVision™ Track Condition Monitoring** data collection is performed by a sensor gateway, equipped with signal processing software developed by EKE. This on-train element comprises of vibration sensors mounted at the axle bearings and the sensor gateway, equipped with integrated 3-axis gyroscope and accelerometer, is mounted on the bogie frame.

With a central configurable processing and storage unit, the sensor gateway performs continuous measurement of the track and movements of the bogie by measuring its movements in all dimensions.

Edge processing on the sensor gateway combines sensor data from the gyroscope, accelerometers, and vibration sensors to detect small changes at the rail surface as well as problems of supporting structures, which impact the movement of the bogie.

Measurement data including the detected problems is sent to SmartVision™ in the cloud for further analysis via a secure mobile data connection. This data, enhanced with time and location information, is always sent in real-time when the data connection is available.

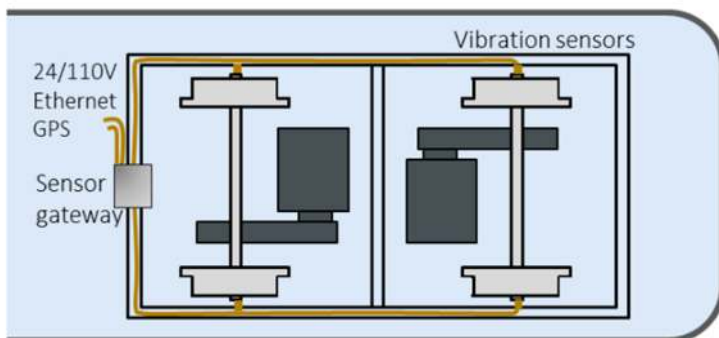
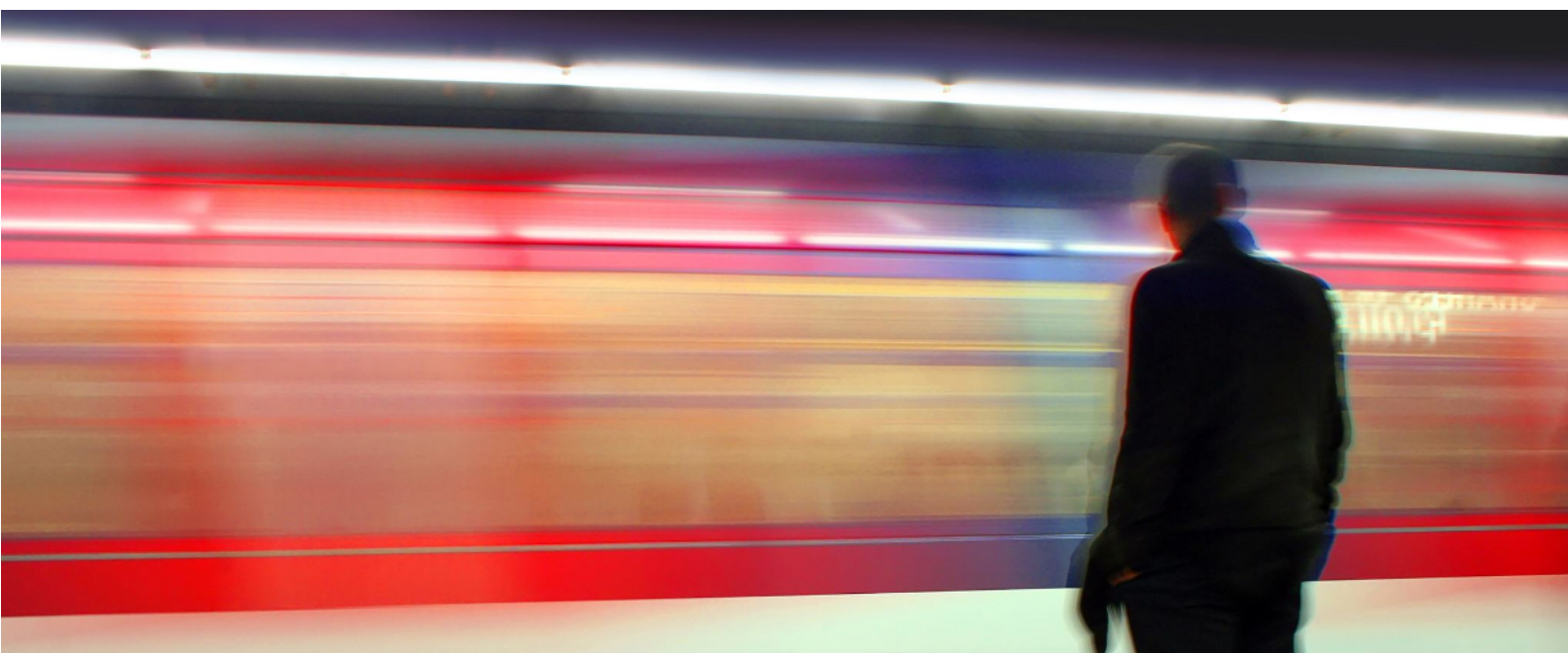


Figure 1. Schematic drawing of measurement equipment installed on a bogie





# Installation of Standard Components



**SmartVision™ Track Condition Monitoring** is installed on a number of trains travelling regularly on the lines to be monitored. The optimal number depends, among others, on train schedules and types of faults typically appearing on the lines.

The SmartVision™ Track Condition Monitoring system is made up of a standard configuration of:

- Sensor gateway
- Sensors
- Wiring
- Router
- Antenna

Support can be provided for the planning and installation of these components. Access is required to a power supply (24/110V).





## Radio Router – Eltec Cybox LTE 2-W

An ELTEC router is used for sending measurement data to SmartVision™ in the cloud and for receiving positional data. This is mounted inside the train.

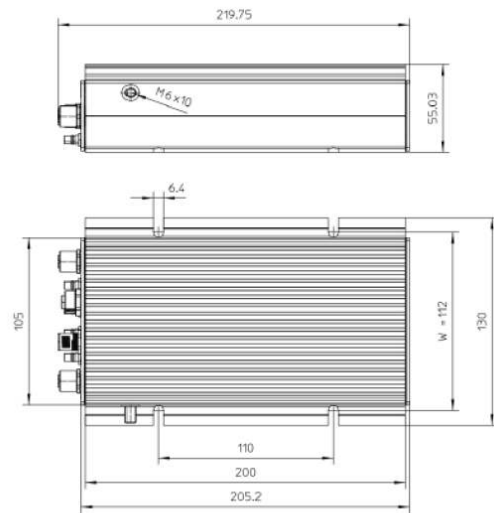


Figure 2 Dimensions of the CyBox AP 2 and CyBox LTE 2 housing





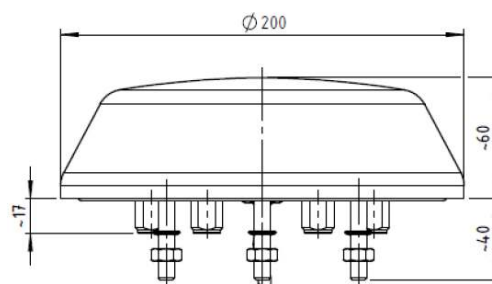
## Antenna – Antonics Omplecs



**Antonics OmPlecs 100-58-10-02.52**

**Train antenna for GSM-R, GSM 1800, UMTS, LTE, WLAN, GPS, GLONASS, Galileo, BeiDou**

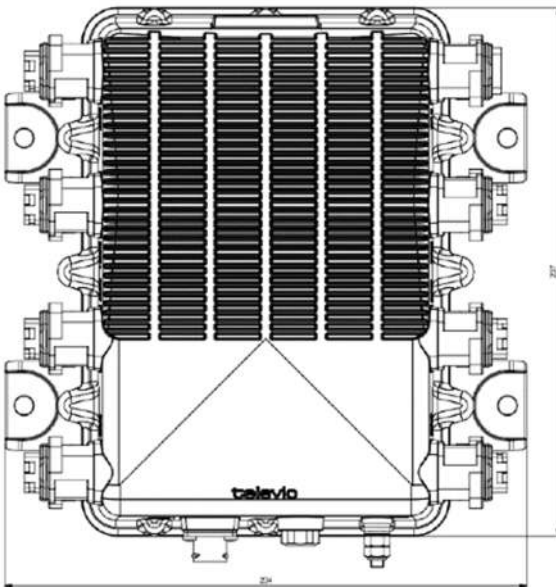
**This is mounted on the roof of the train.**



# Sensor Gateway – Televic Cosamira

Televic Cosamira sensor gateway is used for collecting and pre-analysing data from vibration sensors on the axle bearings and its integrated 3 axis accelerometer and 3 axis gyroscope.

The sensor gateway is railway certified IP67 protected and is mounted on the bogie or under the car body on firm structure.



## Technical Data

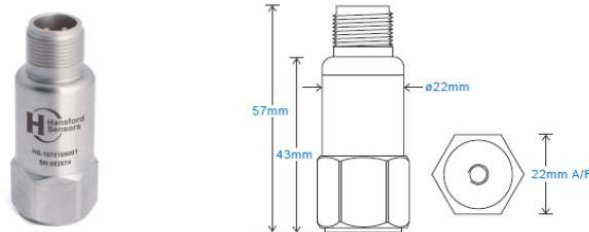
- EN50155 compliant
- Voltage: 24 V or 110 V
- Power consumption: maximum 30W
- Weight: 2900g
- Ingress protection: IP67
- Operating temperature: -40°C to 70°C (EN50155 Class OT4)
- Cold start temperature: -40°C
- Cooling method: Natural cooling (reserve free area of at least 10cm around for convection)
- Storage temperature: -40°C to 45°C
- Altitude class: Up to 1000m (EN50125-1:2014 class A2)





# Vibration Sensors

Hansford HS-107 Accelerometer



**A sensor is attached to each of axle heads to constantly monitor the vibration generated by the track.**

**These sensors capture the response of the vehicle from the direct wheel and the rail track interaction.**

# Cloud-based SmartVision™ Track Condition Monitoring Software

SmartVision™ offers a powerful suite of solutions for condition monitoring and predictive analytics of the track.

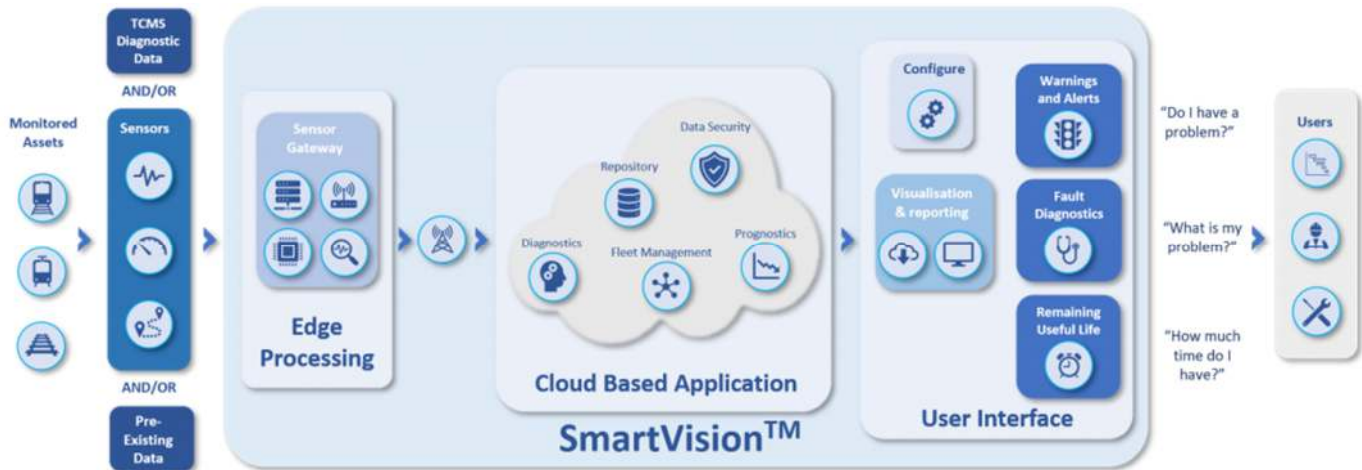


Figure 2. Overview of the SmartVision™ remote condition monitoring system

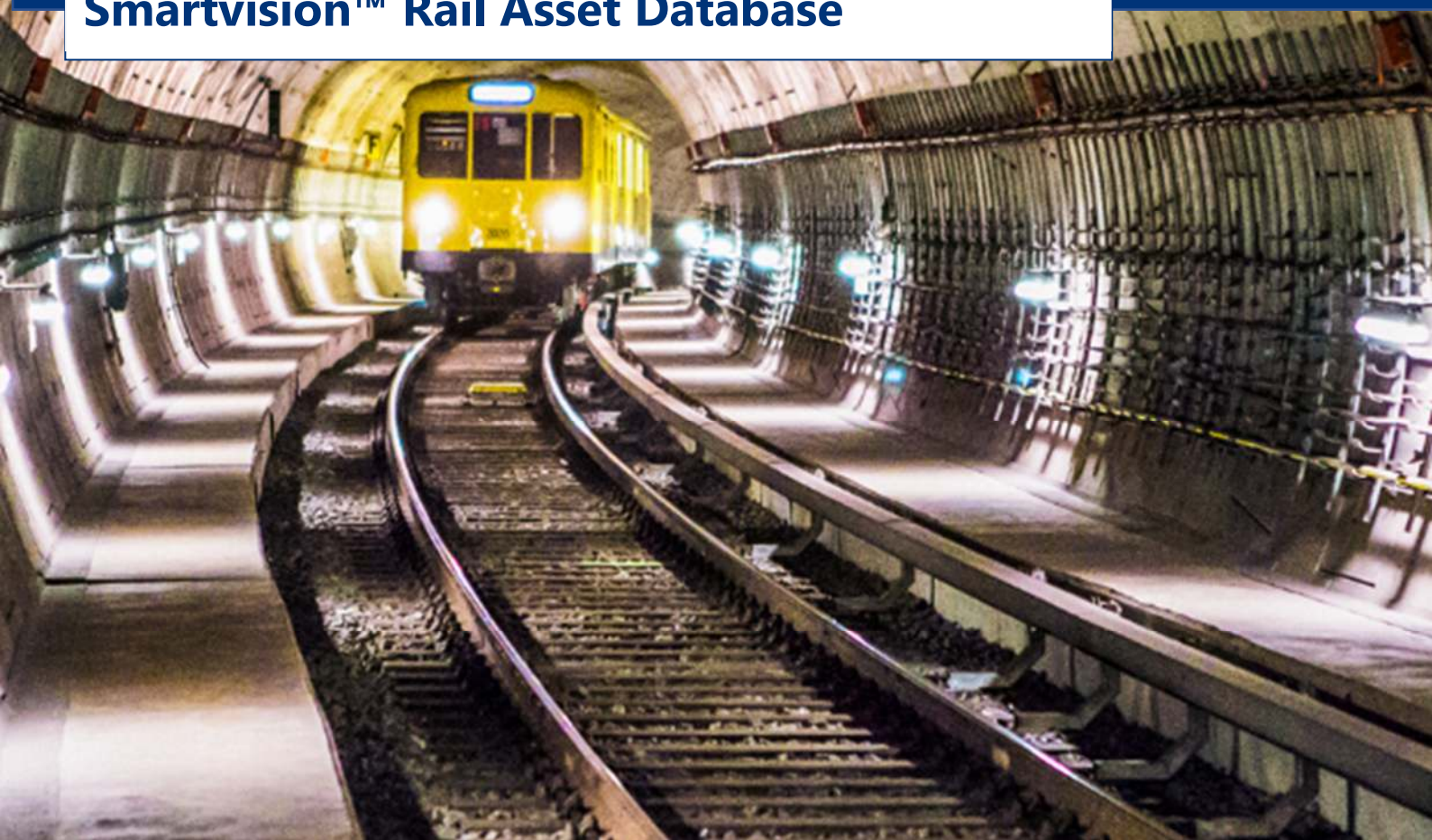
SmartVision™ is implemented in a secure cloud environment and provides a high level of protection for the exchange of information between the trains and the centralized software. Cybersecurity measures are taken to guarantee the privacy of customer data and avoid intrusion. Firewalls are used for restricting access to the SmartVision™ gateways and servers.

The SmartVision™ software is available as a Software as a Service (SaaS) providing a turnkey solution for track condition monitoring. SmartVision™ utilises server virtualisation and is based on microservice architecture. This allows true scalability providing optimal computing power to process the varying data flow from fleets as well as to execute the analysis procedures initiated by the users. This allows flexibility when adding new fleets or applications to the system.

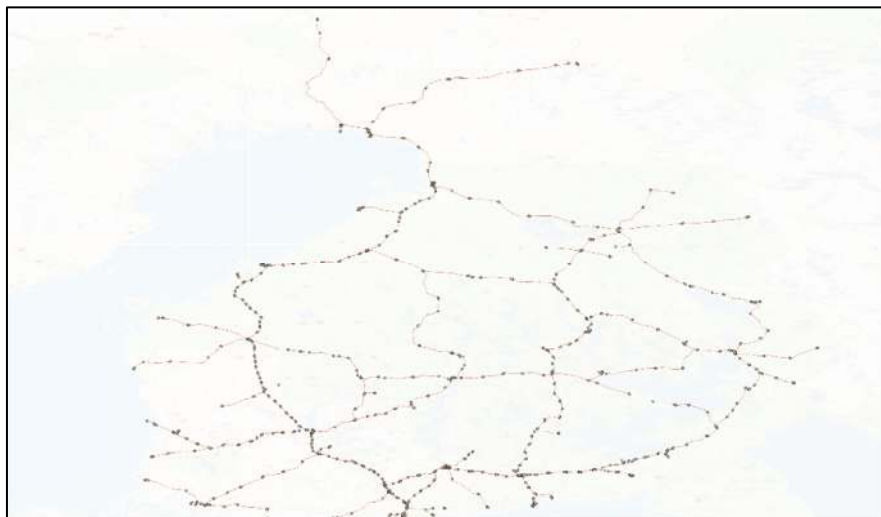




## Smartvision™ Rail Asset Database



SmartVision™ includes a rail asset database, which is a hierarchical location-based topology model of the rail network. It is typically populated with asset data imported from a national railway asset register and stores information about the configuration and maintenance history of each asset. The track topology, when correlated with SmartVision™ on-vehicle GPS information, enables the location of track related events to be pinpointed.



*Figure 3. Example track topology.*

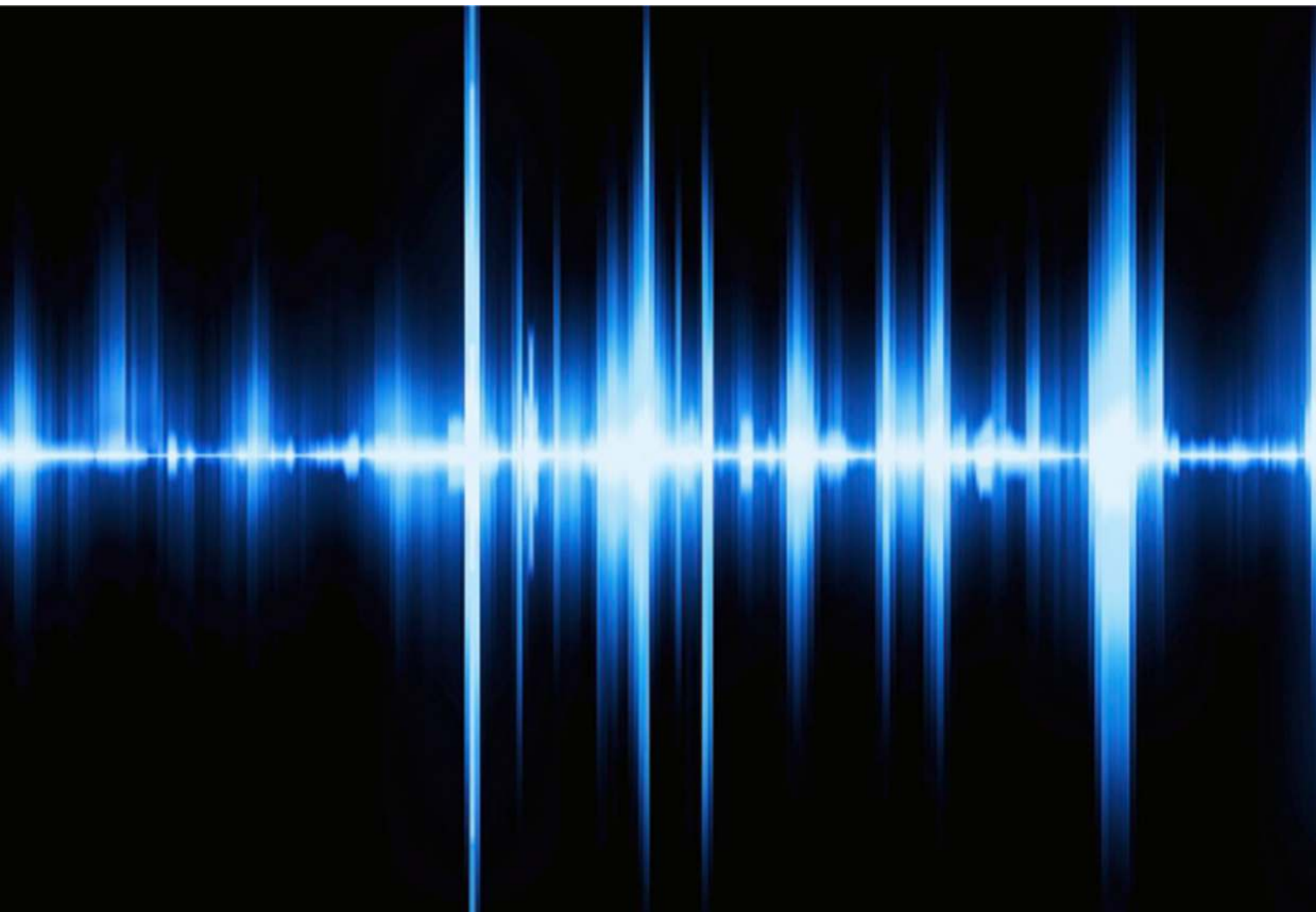
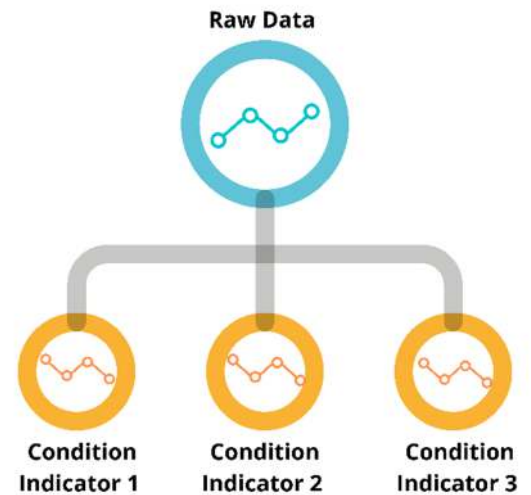
Sensor data received from the trains include GPS co-ordinates. These co-ordinates are checked against the database to determine whether the alert is from a rail asset, such as insulated joints and switches, or whether it is track related. Data of each detection is stored for each asset or track to form a trend curve describing the changes in condition of the asset. This enables the condition monitoring and predictive analytics process to be performed individually for each segment of track or track asset.

# Condition Indicators

The SmartVision™ sensor gateway acquires raw data from various sensors which contain useful health data. Effective condition monitoring is achieved by pre-processing the raw data to create Condition Indicators which are influenced by developing faults in the asset being monitored.

The SmartVision™ Track Condition Monitoring system incorporates advanced signal processing and analytics functions to calculate a range of Condition Indicators for monitoring the condition of track assets and track segments.

The Condition Indicators can be further enriched by giving the data operational context and ensuring comparable results by applying regime recognition techniques.





# Condition Monitoring and Predictive Analytics Capabilities

**SmartVision™ Predictive Analytics** takes condition monitoring one step further by using advanced algorithms and analytics to predict the remaining useful life of assets.

The condition monitoring and predictive analytics functionalities of SmartVision™ build upon the Adaptive Anomaly Detector; a unique data-driven toolset that provides automatic, reliable and early alerts developed by Humaware (an EKE Company).

The processing behind the Adaptive Anomaly Detector automatically sets and maintains a unique threshold for each track asset being monitored and adapts to the “normal” behaviour of that asset. This means that no effort-intensive threshold management is required and deviations from normal are detected reliably and early. This is essential for the implementation of predictive maintenance and the generation of remaining useful life estimates.

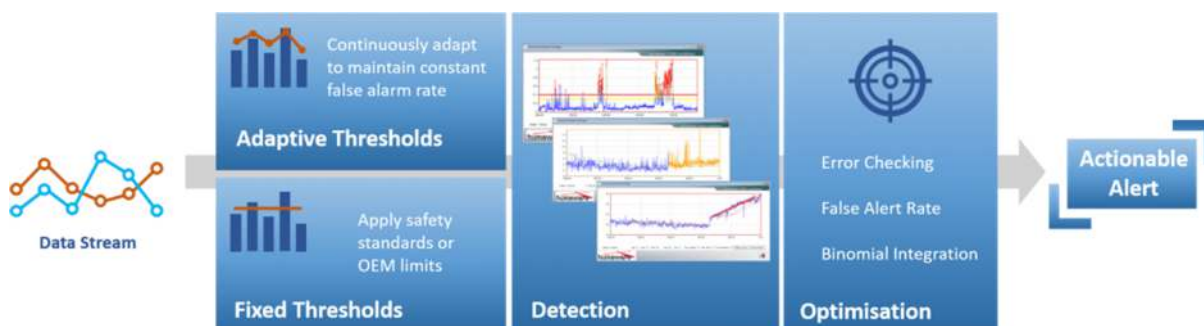


Figure 4. Overview of Adaptive Anomaly Detector, which is embedded into SmartVision™

## Detection Capabilities

The SmartVision™ Track Condition Monitoring system analyses the vibration generated by the track and generates a number of condition indicators that detect changes related to degradation within the track and for track assets.

Examples of defects detected include:



**Insulation  
joint fishplate  
damage**



**Switch crossing  
damage**



**Broken rails**



**Stones on  
the rail**



**Hunting**







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