RAMS of train and infrastructure using the TELE-DIAGNOSTIC SYSTEM of the NEW ETR 1000

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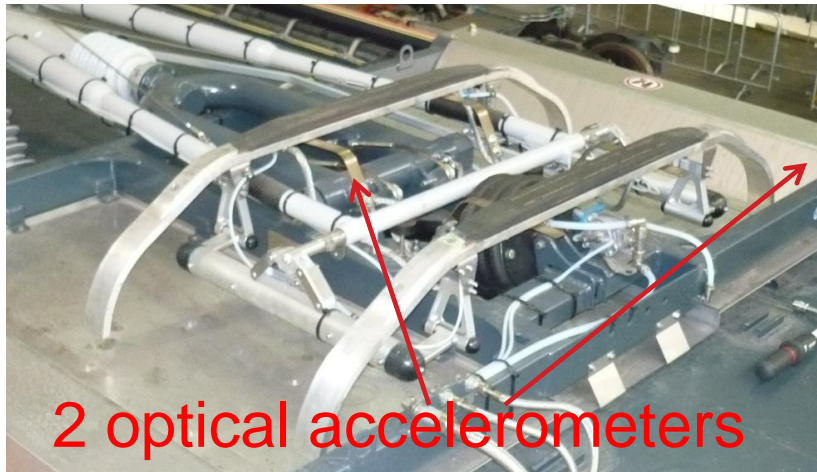8 July 2015, session 3,Technology B/ 3B: Safety & Security, 65

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Modern Railway: overview

- A good control of the vehicle speed and trajectory is the easiest way to avoid collisions an other accidents in all transport modes

- Railway is the transport mode more easily controlled, having only one degree of freedom, compared to the three or six degrees of the other modes.

- Application of TCMS and ERTMS allows for a safe drive of the train, avoiding collisions and over-speed

- **C**ondition **B**ased **M**aintenance and Diagnostics become the main issues to improve **R**eliability, **A**vailability, **M**aintainability and **S**afety in Railway Systems

- **THE PRESENTATION DEALS WITH A DIAGNOSTIC SYSTEM, EASILY IMPLEMENTED IN A COMMERCIAL FLEET, WHICH DRIVES THE MAINTENANCE OF THE TRAIN AND OF THE INFRASTRUCTURE**

Pantograph and Bogie CBM: Sensor layout on the ETR1000

2 optical accelerometers

ALS (lateral +vertical accelerometer) mounted on bolster

ALS (lateral +vertical accelerometer) mounted on bogie frame

IMS (lateral accelerometer) mounted on diagonal corners of bogie frame
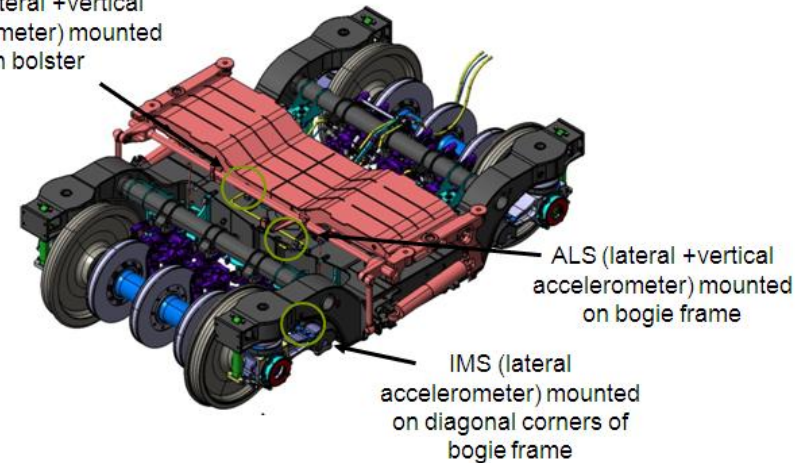
- One optical accelerometer placed on each collector - Measurement range 0.5 Hz to 250 Hz.

- Straightforward wiring from the high-voltage pantograph to the electronic board inside the car-body, thanks to the insulating properties of fibre-optics.

AXLE BOXES: 1 sensor - Vertical Direction - High Frequency
BOGIE SENSORS: 2 sensors - Vertical/Lateral Direction
BOGIE IMS (Stability): 2 sensors Lateral Direction
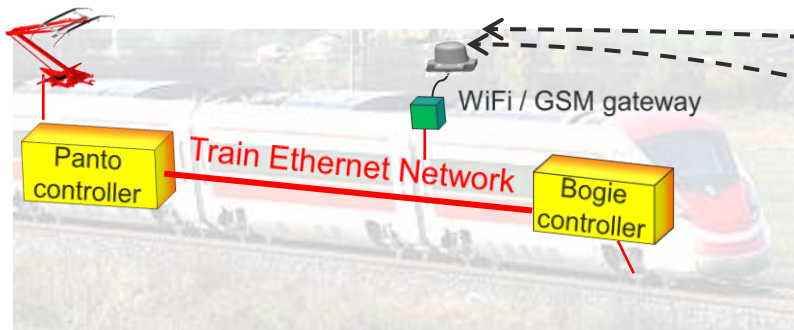**CARBODY:** 2 sensors Vertical/Lateral Direction

On board signal processing

- **On-board software to analyze the acceleration data and to calculate suitable indices, to be transferred and stored in a data base, as a function of the train position and speed.**

- **Examples of indices:**

  - RMS values for given frequency bands.

  - Instability index of the bogie.

  - Maximum lateral acceleration on the bogie.

  - First order and higher harmonics of wheel revolution.
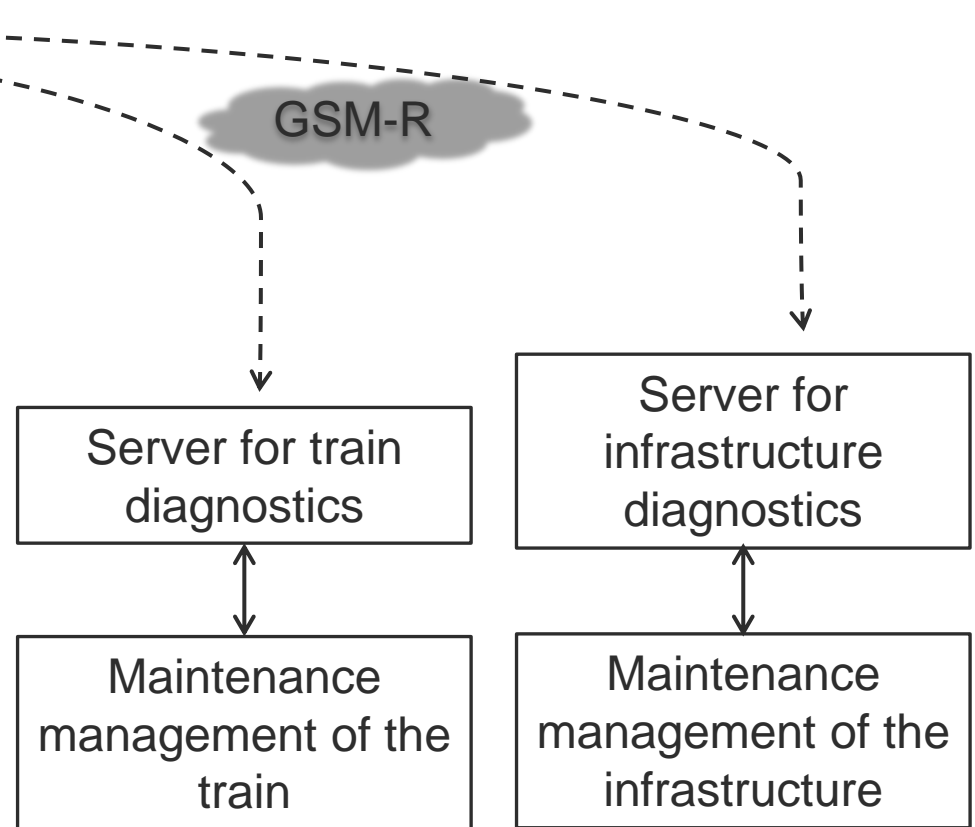
Data storage and transmission

- **The calculated indices are transmitted through GSM-R to two different ground servers.**

ETR1000

Control room

GSM-R

| Server for train diagnostics	Server for infrastructure diagnostics
Maintenance management of the train	Maintenance management of the infrastructure

Train diagnostics

- **The values of the calculated quantities already mentioned (RMS, instability index, etc.) are stored in the ground database, as a function of the train position and speed for each train.**

- **The data coming from each train of the fleet are stored on the server and can be compared to reference values.**

- **A reference database is collected during the first runs of each train, when all the components are supposed to work properly.**

  - The reference database can also be elaborated by statistical analysis of the data coming from different trains.

 - Trend of main data are produced to drive C.B.M.

Infrastructure diagnostics

- Acceleration measurements on board the train are the best way to carry out Infrastructure Diagnostic

- The ETR1000 **Fleet** of trains leads to **a reliable approach**: comparison of different trains behaviour on the same track allows to identify the presence of defects, separating peculiar train dynamics
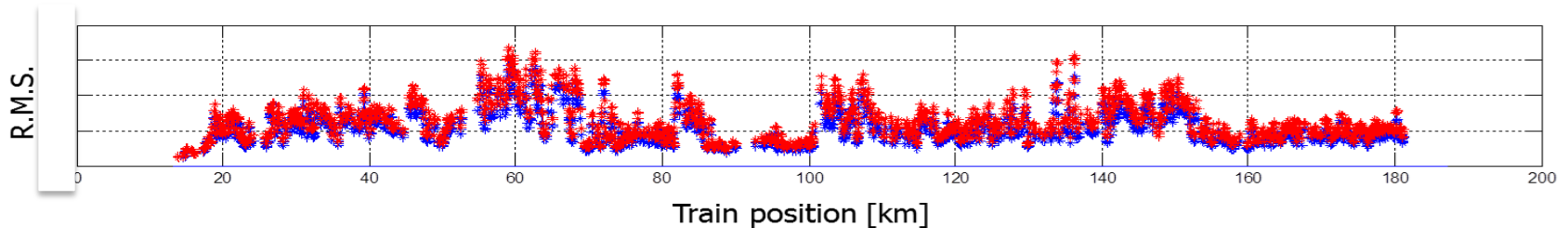
- Different **Frequency Bands** are considered to identify different defect types

- The reference condition (**Reference Profile**) is identified and a **data base** is defined, collecting measurements from different train runs

- Trend of main data are produced to drive C.B.M.

Infrastructure diagnostics

FLEET MEASUREMENTS

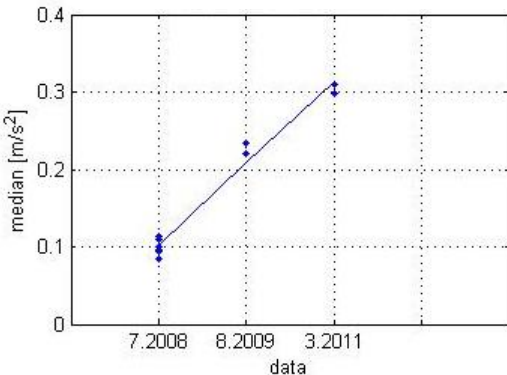Viaduct

Switches [km]

Slope changes
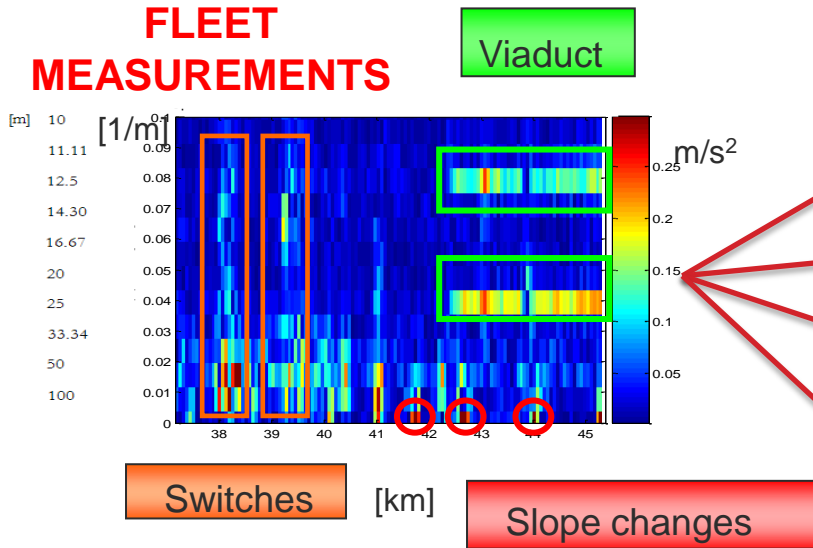
Wavelength content of defect on track

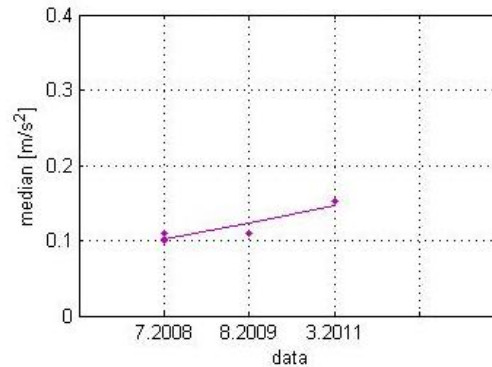Wavelength content of defect on catenary

Defect evolution with time: quantity levels

Limits for maintenance action programme: Reference Profiles and Data Base
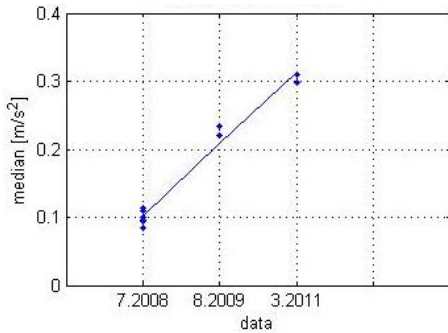
3-25 m

25-75 m

Infrastructure diagnostics

ETR1000 Fleet

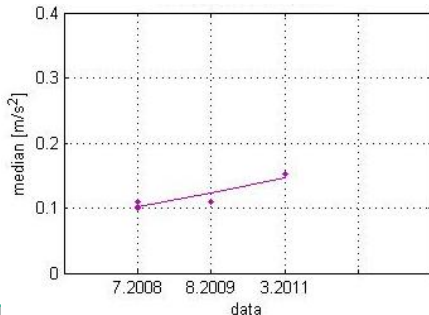**Track geometry measuring Train**

3-25 m

25-75 m

Infrastructure Manager Server

CBM Program and Maintenance Actions

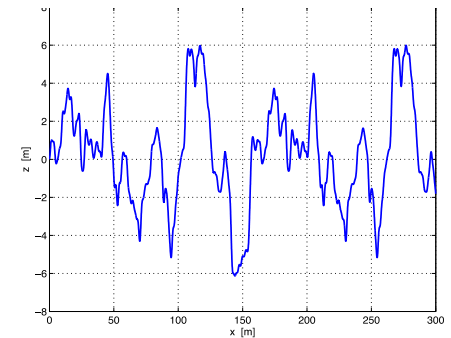**Track Irregularity Profile (longitudinal level, alignment)**

CBM and RAMS

- The diagnostic system designed for the ETR1000 new Italian Train allows for early detection of malfunctioning conditions both of the train and the track, in order to drive Maintenance on condition and not on time;

- Information from the fleet - and hence from different trains - allows to resolve different defects and problems: track faults, incipient bogie stability, wheel out of roundness, bearings malfunctioning, pantograph mechanical malfunctioning;

- A virtuous cycle is obtained through this enhanced **CBM** system, which allows to improve **R**eliability, **A**vailability, **M**aintainability and **S**afety both of the infrastructure and the train

- A considerable reduction of Life Cycle Costs is expected increasing the efficiency of the Railway transport.

CBM improves railway vehicle sustainability

...Thank you
for your kind attention