

25/02/2020

ETALON Project technical presentation

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Open call challenges

S2R-OC-IP2-02-2017

**“Energy harvesting methodology for trackside and on-board signalling and communication devices.
Adaptation of already existing technologies for developing a purely on-board Train Integrity”**

**On Board
Train
Integrity
OTI**

- The identification of solutions and the development of devices focusing on radio communications, energy harvesting technologies, antennas suitable to be installed in the queue of a very long train also in non-line-of-sight (NLOS) conditions. This is particularly targeted at cases where trains (especially **freight trains**) do not have any power supply available on the wagons
- The most suitable solution for energy powering and energy storing the OTI device

**Trackside
Energy
Harvester
TEH**

- The analysis of the economic models of the energy harvesting systems focusing notably on regional and freight lines
- The identification of the most suitable energy harvesting solution

ETALON APPROACH

The ETALON project aims to develop competitive solutions for enhancing train integrity functionalities, including the provision of suitable energy supply and energy harvesting for enhanced trackside object controller deployment, with the vision to **minimizing trackside infrastructure**, especially **cabling**.

ONBOARD TRAIN INTEGRITY

Using the Train Positioning based on GNSS and other sensors, it is possible to cut/reduce all the current trackside infrastructure as balises, axle counters, track circuits ... Moreover Moving block, and Virtual Coupling, is best exploited in conjunction with the elimination of track-side train detection systems

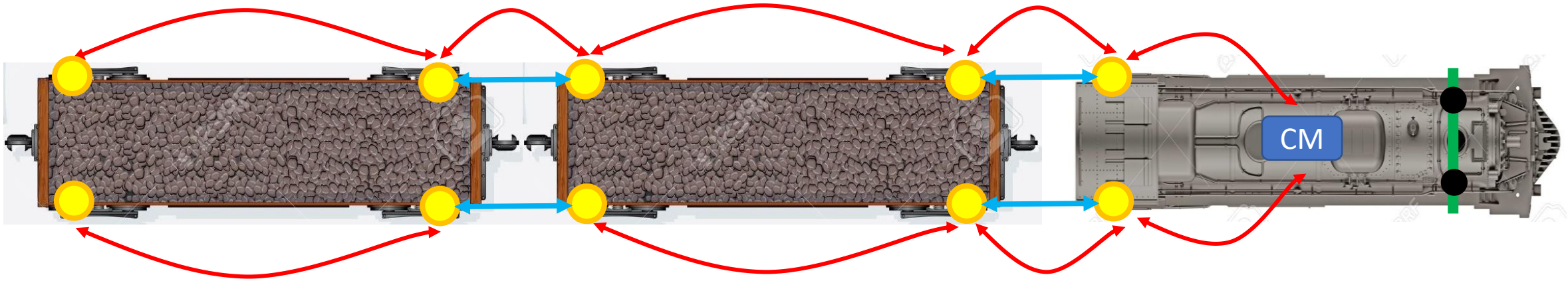
But is mandatory to have an on-board train integrity solution, capable of detection of train interruption.

NEW WAYSIDE OBJECT CONTROLLERS

The solution of the new object controllers realizing a decentralized approach to rail automation.

The target is a significantly reducing the life cycle cost of future railway project through elimination of cabling, which is expensive, subject to theft and difficult to maintain, especially in case of changes in the trackside layout.

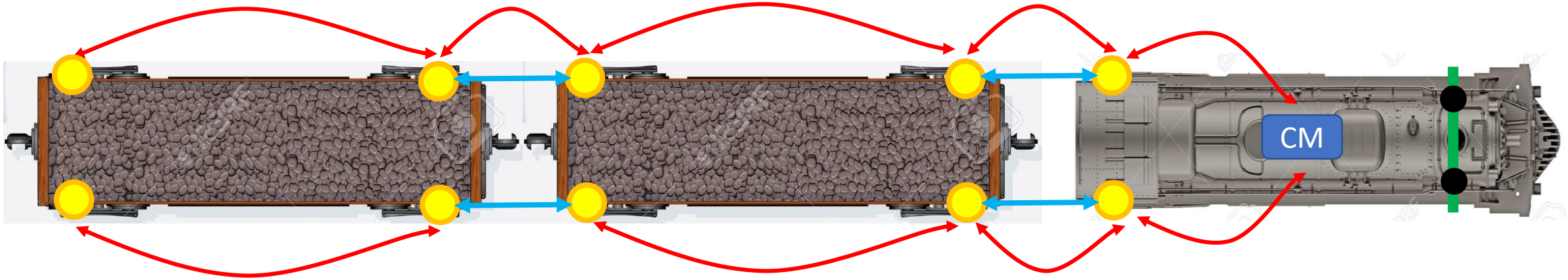
ETALON: ONBOARD TRAIN INTEGRITY



The ETALON project designed and developed an OTI system, with an architecture SIL4 capable, that is formed by nodes, energy harvesters and a control module.

The nodes form two independent chains that carry information on the integrity of the train to the control module located in the locomotive.

ETALON: ONBOARD TRAIN INTEGRITY FEATURES



- There is a network detection procedure, during the convoy set-up, able to discovery the location of any nodes in the wagon and therefore all the nodes in the warehouse are identical
- The node has two antennas, one for measuring the distance from the adjacent car and the other for transmitting infos
- The typology of the on board Energy Harvester is vibration

ETALON: NEW TRACKSIDE OBJECT CONTROLLERS

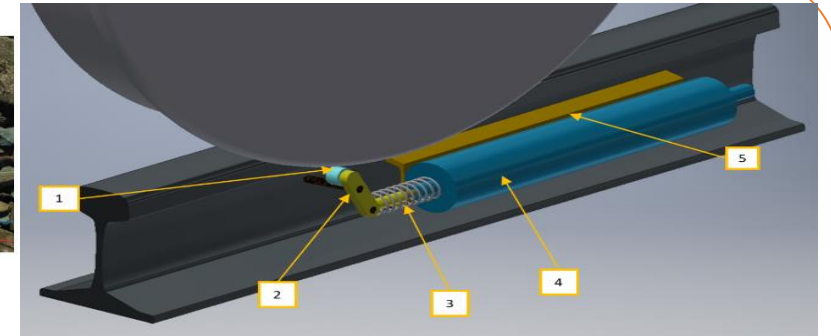
ETALON specified and developed **energy harvesting solutions** to support the new trackside object controllers which are **economically** viable and **suitable** for application, particularly considering modern radio communication requirements.



Passive – harvests waste energy through vibration



Magnetic interaction



Mechanical contact

Active – convert train movement into energy

ETALON: NEW TRACKSIDE OBJECT CONTROLLERS

ETALON made an economic analysis considering the usage of energy harvesters, for the new trackside object controllers, in several scenarios for benchmarking and prioritization of the studied suitable technological solutions.

- Collectioning the data, primary and secondary;
- Make a Capital Budgeting analysis;
- SWOT, Market and GAP analysis for the transition towards powering with TEH;
- Building a Model useful for the decision makers (i.e. IMs).



ETALON delivered a comparative analysis considering various solutions for energy harvesting, taking into account factors such as efficiency and costs;

The prototypes were tested in laboratory conditions to validate:

- the energy harvesting system is collecting power;
- correctly managing the energy inputs and
- properly storing the produced energy.



Thank you for your attention!

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Project Conclusions and Results

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ETALON Project:

- Made an **economic** analysis, regarding the usage of trackside Energy Harvester for the New Wayside Object Controller in several scenarios;
- Investigated, implemented and tested technologies (sensors, communications and energy harvester) for the On Board Train Integrity System, specific for the **freight trains**;
- Investigated implemented and tested technologies relative to usage of Energy Harvester for the **New Wayside Object Controller**



ETALON RESULTS: ONBOARD TRAIN INTEGRITY SOLUTION

- A vibration energy harvester mounted on the axlebox is capable of powering communication for on-board train integrity.
- The defined **OTI architecture** is based on Wireless Sensor Network (WSN) and **Distance Sensors** that use the UWB radio technology
- The defined **Network Discovery** and **Train Integrity (TI)** procedures are robust and were ready for the tests in the “relevant environments”



ETALON RESULTS: TRACKSIDE ENERGY HARVESTING SOLUTION

- A methodological approach for building a robust techno-economic analysis has been developed by using real data from the market
- A Decision Support System (DSS) tool useful for the IM has been realized
- Mechanical contact and vibration energy harvesting are both capable of powering low power communication trackside.
- Multiple redundancy of harvesting and communication devices must be coupled with enough energy storage capacity to provide reliable operation.
- Additional devices using solar PV harvesting can provide background energy supply when no train motion is available.



ETALON AFTER THE END OF THE PROJECT

Regarding new developments of our OTI after the end of the project, is possible:

- To make a real **SIL4 product** useful for the **freight trains** :
 - redesign the HW to reduce energy consumption;
 - To connect the control module to the vital network of the loco;
 - Validate and certificate SIL4 the SW and all the system.
- Enhancing communication features of the actual OTI system would enable its use in conjunction with other systems such as:
 - Condition monitoring of components of rail vehicles (e.g., wheels, axes, ...);
 - Tracking and tracing of the wagons.

Regarding the economic analysis:

- To use the same methodological approach for the **On Board System** (OTI) and provide a Cost Benefit Analyses (CBA) for **Railway Undertaking** (RU)



ETALON AFTER THE END OF THE PROJECT: EH

Regarding new developments of Energy Harvester after the end of the project, is possible:

- For the On Board Energy Harvesting:
 - To produce higher energy in order to supply other sensors.
- For the Trackside Energy Harvester:
 - To enhance the efficiency of the analyzed technologies (forces needed, ...);
 - Redesign, starting from the prototypes developed, a more cost efficient systems for innovative applications;
 - To investigate the behavior of new technologies in view of future acceptance and certification



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