Ansaldo STS

A Hitachi Group Company

An ERTMS System Integrated with the Location Determination System based on Satellite Positioning and Public Mobile Radio Networks (Land and/or Satellite)

Roma 25 Gennaio 2018
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Acknowledgements

This presentation is based on the results of:

- the Ansaldo STS R&D projects
- the Roy Hill project
- the H2020 ERSAT-EAV Project
- the ESA 3InSat Project
- the ESA SBS RailS (Space Based Services for Railway Signalling) Project and
- the H2020 RHINOS Project

Market Needs

In Europe ERTMS allows trains to be competitive with other types of transportation means.

ERTMS signalling systems are economically convenient where the high cost of investment (for wayside and on-board signalling equipment and for GSM-R) can be amortized over the revenues coming from the services.

Such significant capital investment represents an obstacle for ERTMS deployment on those lines where there is not a strong business case behind.

Market Needs

DIRECTIVE (EU) 2016/797 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 states that for new lines (also regional) ERTMS is mandatory and that upgrade of an existing system must foresees ERTMS (some reason for not doing this must be provided).

Local/regional lines are generally old and need important investments to be upgraded. Most of these lines are not providing the highest safety standard.

Market Needs

GSM-R is reaching its obsolescence; the alternative solution that is under discussion in the European Railway Community (S2R initiative) is an IP-based adaptable communication.

Railways signalling solutions suitable for hostile environments (e.g. extreme climates, hard to reach equipment along the track, high mechanical stress, …).

New solution must: guarantee **short time to delivery**, be **interoperable** and not relax **safety** requirements (for train positioning) and be **scalable** (for TLC part).

Market Needs

Expected cost reduction on:

CAPEX:

purchase of equipment, installation and commissioning

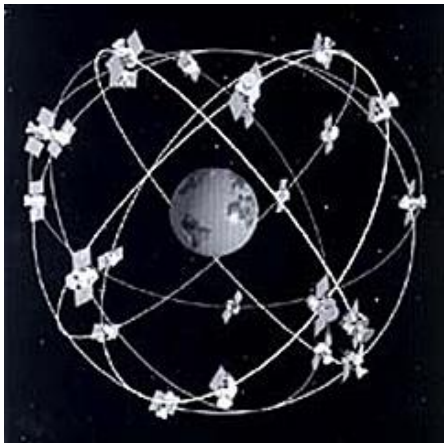
OPEX:

equipment maintenance, power consumption

- ✓ **Radio Telecommunication System**
- ✓ **Trackside Infrastructure**
- ✓ **On-Board**

ERTMS Enhancements

The proposed approach for introducing GNSS and innovative technologies for managing on-board/trackside communications (based also on SatCom) meets the following main requirements:



- ✓ Backward compatibility
- ✓ SIL 4 at system level
- ✓ Cost Effective solution
- ✓ Limiting the impacts on the existing ERTMS specifications, hazard analysis, operations and certification process

ERTMS Enhancements: Main concepts

Train Position based on the Satellite Technology

*The **Virtual Balise** Concept*

Public (Terrestrial and Satellite) Networks

***Wireless Multibearer** Solution*

ERTMS Enhancements: Train position

The identified solution preserves the existing ERTMS mechanisms to determine the Train Position, i.e. **Balises** and the related **Functions** associated with balises.

Physical balises can be replaced by **virtual** balises through the introduction of the **Virtual Balise Reader**

ETCS On-Board Functions / kernel

ETCS On-Board

ERTMS Enhancements: Train position

The Virtual Balise Reader shall:

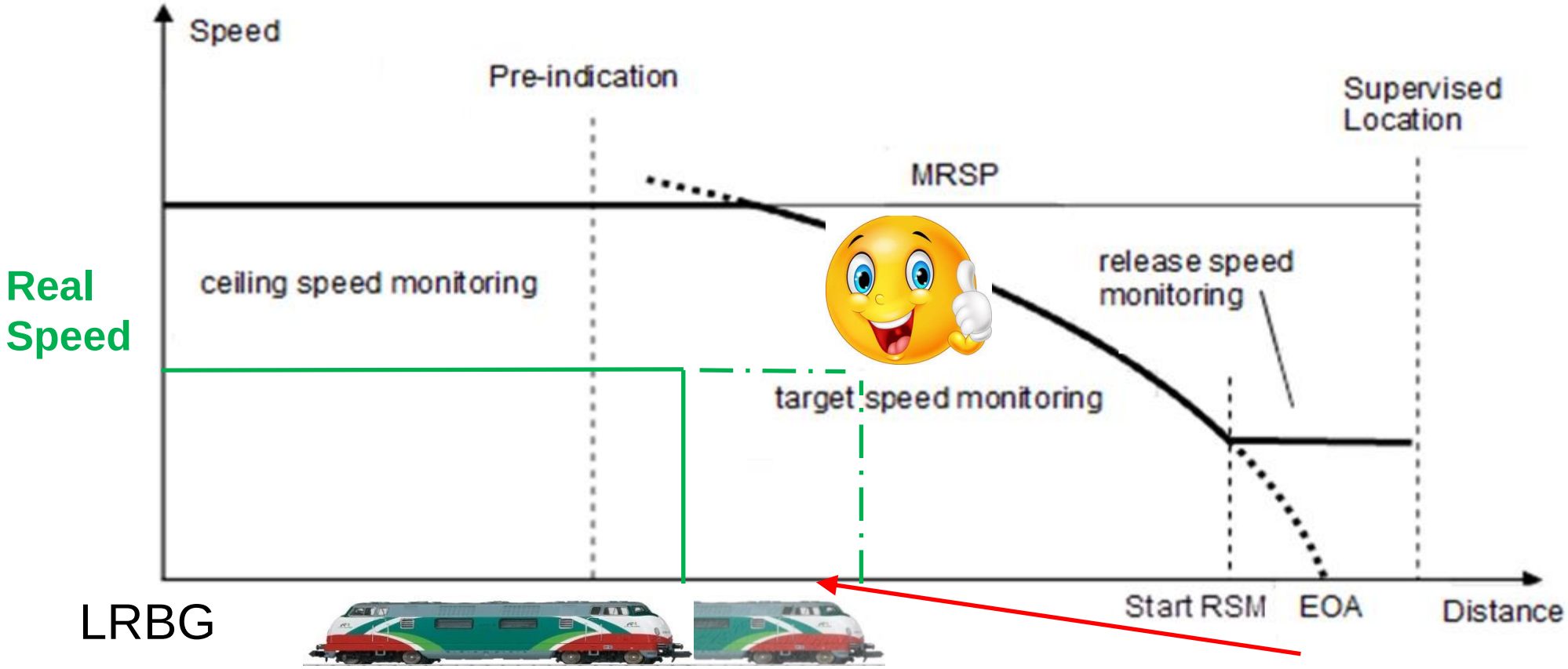
- detect the train position using GNSS to compare the position with pre-known virtual balises positions
- when detecting a match, generate balise information to the EVC position/linking function (balise telegram, estimated balise location and maximum estimated balise location error)
- guarantee delivery of balises in the sequence they are detected
- compute the train orientation and take it into account

ERTMS Enhancements: Train Position

Physical Balise

Virtual Balise Location

ERTMS Enhancements: Train position

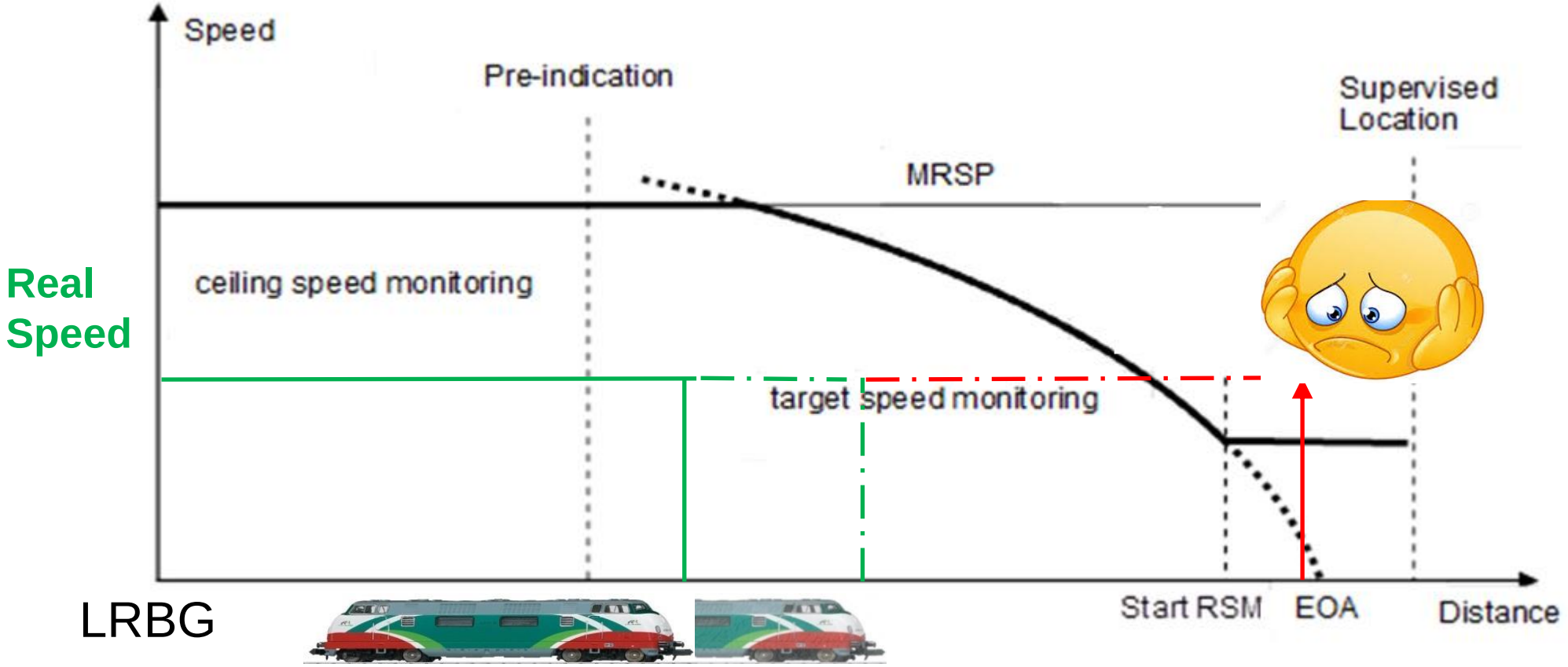


Estimated Safe Front End

Estimated Max Safe Front End

Actual Front End

ERTMS Enhancements: Train Position



Real Speed

Estimated Safe Front End

Estimated Max Safe Front End

Actual Front End

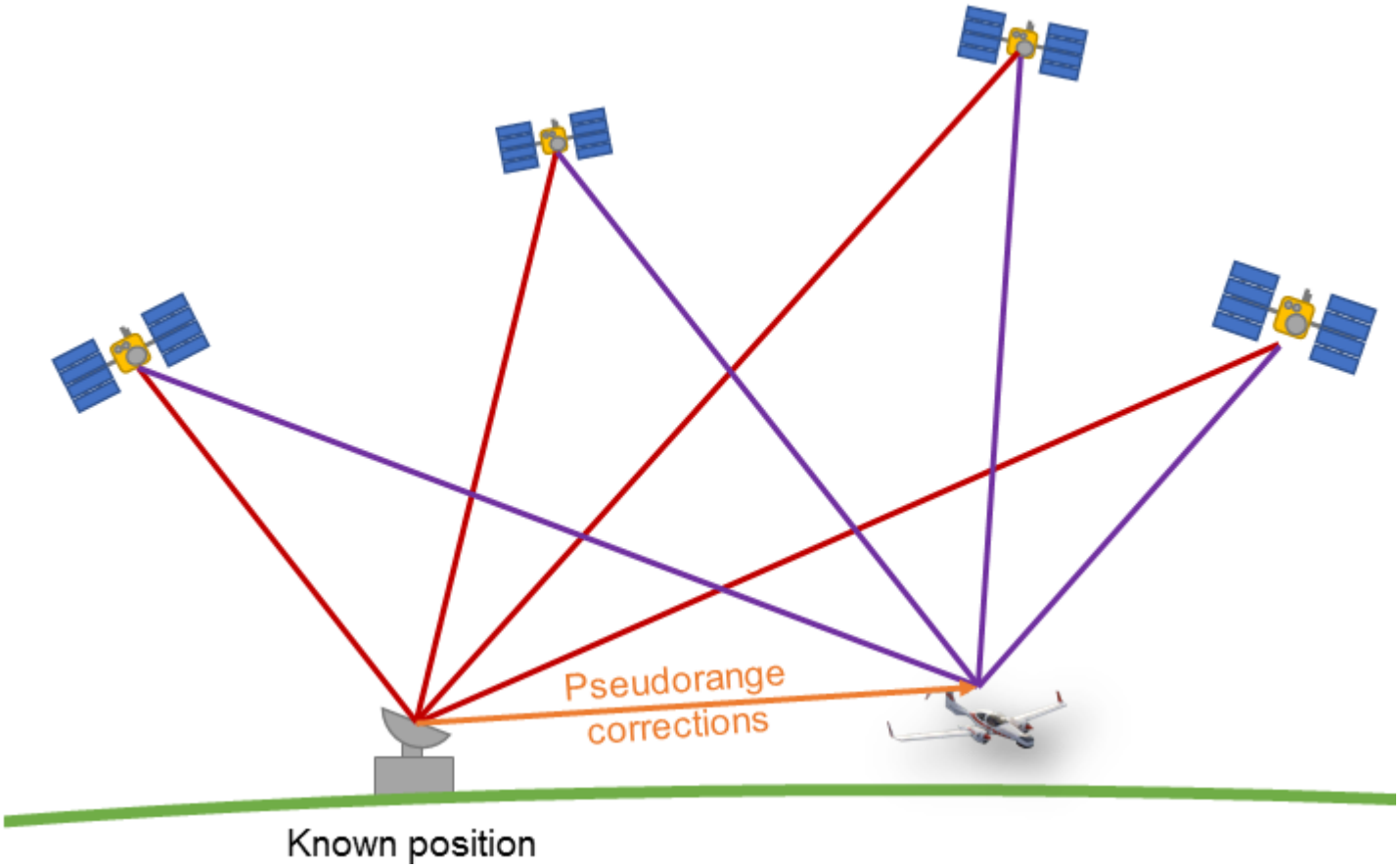
ERTMS Enhancements: Train position

To **trust** on the GNSS PVT, the use of **GNSS receiver stand alone is NOT enough**.

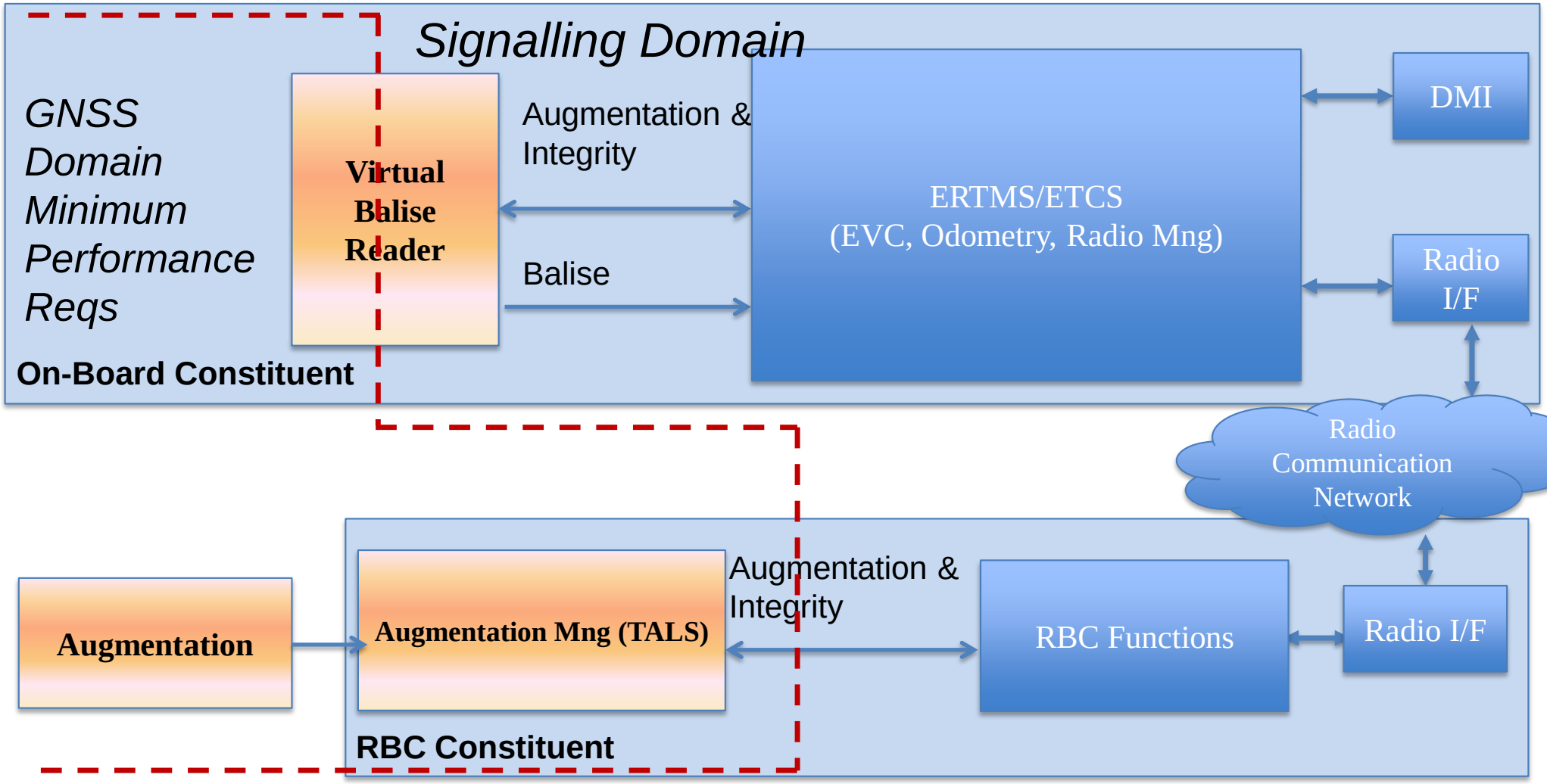
An Augmentation System is **required**

Improves the accuracy and reliability of GNSS Global Navigation Satellite System information by correcting signal measurement errors and by providing information about the accuracy, integrity, continuity and availability of its signals.

ERTMS Enhancements: Train Position



ERTMS Enhancements: Train Position



ERTMS Enhancements: Train position

- SIL 4 Odometry and linking functions to mitigate GNSS errors / improve integrity
- GNSS Minimum Operational Performance Requirements and Augmentation Subsystem
- RBC, IXL and CTC functions implemented in a unique SIL 4 platform
- This Enhanced ERTMS solution has been already assessed as a SIL 4 solution

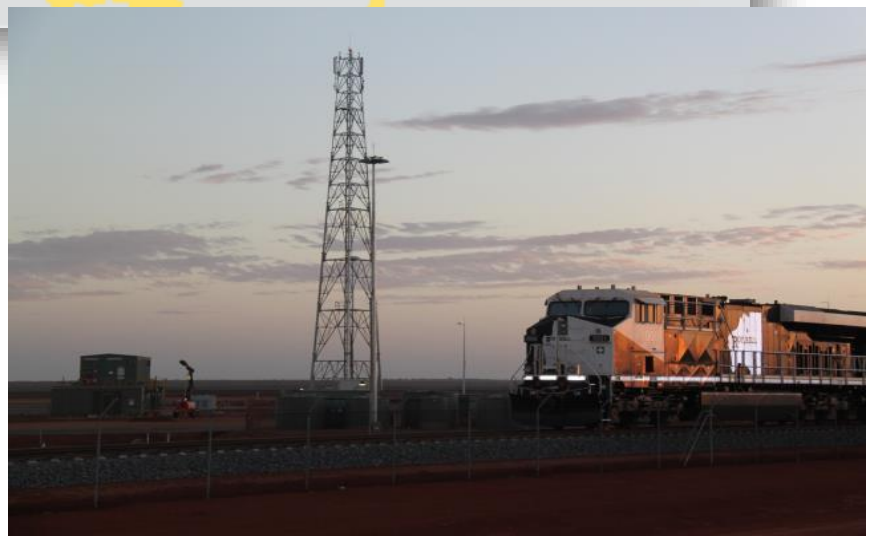
ERTMS Enhancements: Train Position

Sardinia Trial Site

- Total Length: ~ 50 km (Cagliari-San Gavino) Double Track , train powered by Diesel
- The equipped train covered a distance of more than **10.000 km**
- The maximum speed of the line is 150 km/h, but actually is limited to 130 km/h
- Network Augmentation (GNSS Track Area Augmentation System) with two Reference Stations in Decimomannu and Samassi
- Cagliari Control Room with RBC & TALS (Track Area LDS Server)
- Validation procedure RFI Test
- Independent evaluation of NoBo

ERTMS Enhancements: Train Position

Vital Satellite Positioning for Train Control Systems in Heavy Haul Application: Roy Hill Iron Ore Railway Line (Western Australia, Pilbara Region)

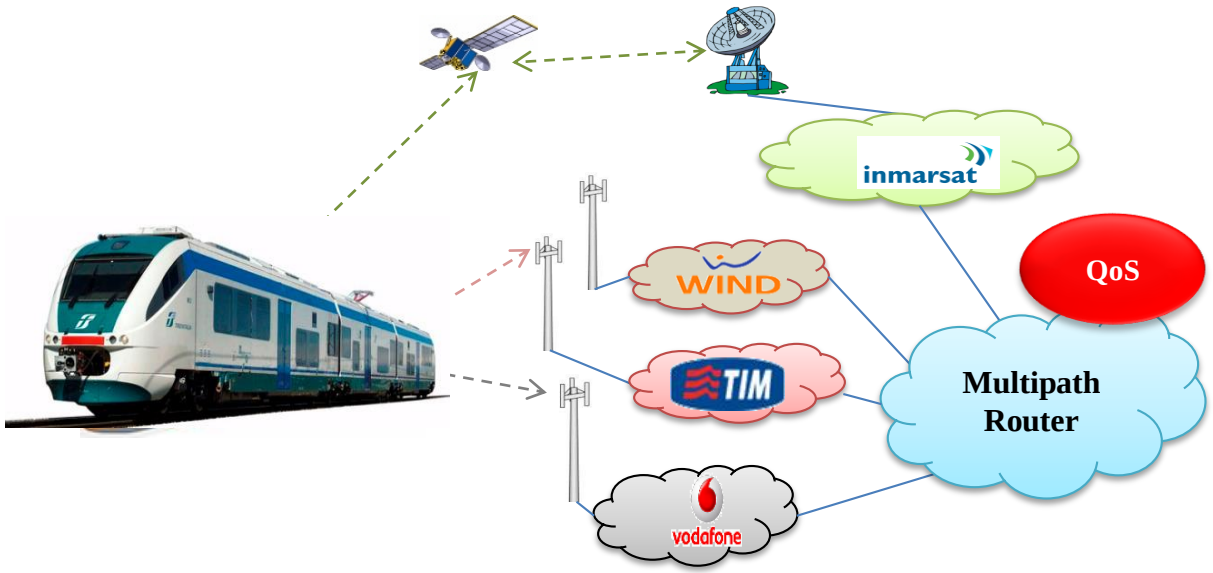


Ansaldo STS has developed the advanced signalling and telecommunications system for the Roy Hill Iron Ore project.

- 350 km Signalling and Telecommunication Radio-based Signalling with Satellite Localization
- Vital satellite positioning, CENELEC SIL4/SIL2 respectively for CBS/IETO configurations (commissioning performed in 2016 and 2017)

ERTMS Enhancements: Public Networks

The new TLC paradigm introduces a multi-bearer approach based on the use of existing public mobile networks (2G/3G/4G/….) combined with satellite communication technologies, as an alternative solution to the dedicated network (i.e. GSM-R).



ERTMS Enhancements: Public Networks

In Sardinia trial site Ansaldo STS in 2013->2016 experimented this radio telecommunication solution, based on the available public terrestrial and satellite network integrated with ERTMS, obtaining performance fulfilling railway requirements.

An Australian freight line is operative with a multi-bearer solution.

THANK YOU FOR YOUR ATTENTION