



GNSS Initiatives in Shift2Rail: the challenges for EGNOS in the ERTMS evolution

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While some activities among competitors are both legal and beneficial to the industry, group activities of competitors are inherently suspect under the antitrust/ competition laws of the countries in which our companies do business. Agreements between or among competitors need not be formal to raise questions under antitrust laws. They may include any kind of understanding, formal or informal, secretive or public, under which each of the participants can reasonably expect that another will follow a particular course of action or conduct. Each of the participants in this initiative is responsible for seeing that topics which may give an appearance of an agreement that would violate the antitrust laws are not discussed. It is the responsibility of each participant in the first instance to avoid raising improper subjects for discussion, notably such as those identified below.

It is the sole purpose of any meeting of this initiative to provide a forum for expression of various points of view on topics (i) that are strictly related to the purpose or the execution of the initiative, (ii) that need to be discussed among the participants of the initiative, (iii) that are duly mentioned in the agenda of this meeting and (iv) that are extensively described in the minutes of the meeting. Participants are strongly encouraged to adhere to the agenda. Under no circumstances shall this meeting be used as a means for competing companies to reach any understanding, expressed or implied, which restricts or tends to restrict competition, or in any way impairs or tends to impair the ability of members to exercise independent business judgment regarding matters affecting competition.

As a general rule, participants may not exchange any information about any business secret of their respective companies. In particular, participants must avoid any agreement or exchange of information on topics on the following non-exhaustive list:

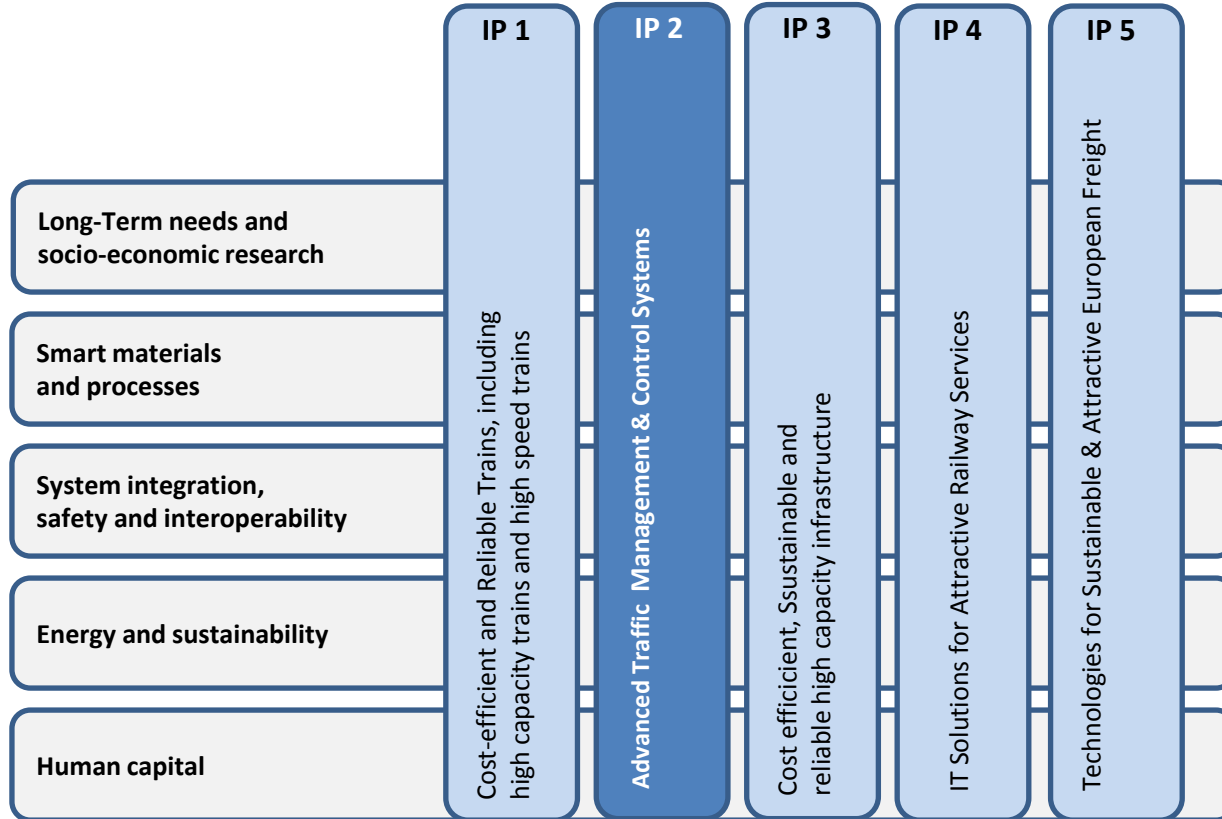
- Prices, including calculation methodologies, surcharges, fees, rebates, conditions, freight rates, marketing terms, and pricing policies in general;
- any kind of market allocation, such as the allocation of territories, routes, product markets, customers, suppliers, and tenders;
- production planning; marketing or investment plans; capacities; levels of production or sales; customer base; customer relationships; margins; costs in general; product development; specific R&D projects;
- standards setting (when its purpose is to limit the availability and selection of products, limit competition, restrict entry into an industry, inhibit innovation or inhibit the ability of competitors to compete);
- codes of ethics administered in a way that could inhibit or restrict competition;
- group boycotts; validity of patents; ongoing litigations.

- S2R Overview
 - ✓ Innovation Programmes
 - ✓ Technology Demonstrators
- TD2.4: Fail-Safe Train Positioning (including Satellite Technologies)
 - ✓ Implementation Projects
 - ✓ Physical Balises vs. Virtual Balises
 - ✓ High Level New Railway Architecture suitable for the introduction of the GNSS Positioning
 - ✓ List of the deliverables (X2Rail-2 Project)
 - ✓ X2Rail-2 Participants

- **Shift2Rail** is the first **European rail initiative** to seek focused **research and innovation** (R&I) and **market-driven solutions** by accelerating the integration of new and advanced technologies into innovative rail product solutions.
- **Shift2Rail** promotes the **competitiveness** of the European rail industry and will meet **changing EU transport needs**. R&I carried out under this **Horizon 2020 initiative** will develop the **necessary technology** to complete the **Single European Railway Area (SERA)**.
- The **European Commission** has promoted a **modal shift from road to rail** to achieve a more competitive and resource-efficient European transport system. EU research and innovation (R&I) must help rail play a new, broader role in global transport markets, both by addressing pressing short-term problems that drain rail business operations, and by helping the sector to gain a stronger market position.
- The S2R Initiatives relates to the use of GNSS technologies have also been supported by **GSA**.

S2R Overview

- The **Shift2Rail** framework is structured around **five** asset-specific **Innovation Programmes (IPs)**:
 - IP1: Cost-efficient and Reliable Trains, including high capacity trains and high speed trains;
 - **IP2: Advanced Traffic Management & Control Systems;**
 - IP3: Cost-efficient, Sustainable and Reliable High Capacity Infrastructure;
 - IP4: IT Solutions for Attractive Railway Services;
 - IP5: Technologies for Sustainable & Attractive European Freight.
- These IPs are not just **independent programmes**. They form a whole assembly of the railway system, with a number of common cross-cutting themes. Therefore, in addition to the five Innovation Programmes, the work of Shift2Rail is also structured around five **Cross-Cutting Activities (CCA)**.

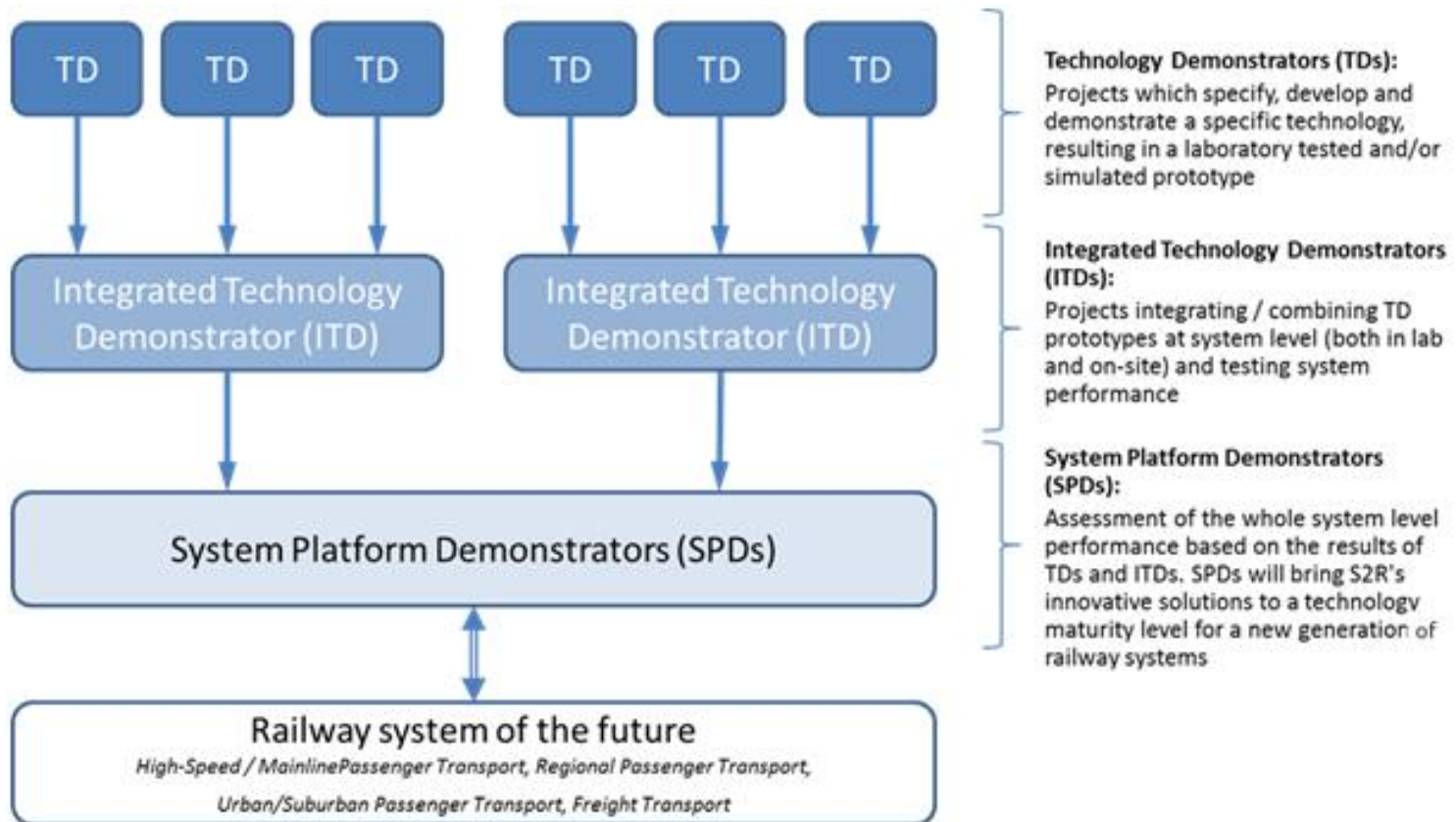


TD means Technology Demonstrator

Shift2Rail – Innovation Programme 2

TD2.1	TD2.2	TD2.3	TD2.4	TD2.5	TD2.6	TD2.7	TD2.8	TD2.9	TD2.10	TD2.11
Adaptable Communication System	Automatic Train Operation	Moving Block	Fail-Safe Train Positioning (Incl. Satellite)	Train Integrity	Zero On-site Testing	Formal Methods	Virtual Coupling	Traffic Management Evolution	Smart Radio Connected All-in-all Wayside Objects	Cyber Security

Demonstration activities, up to TRL 7, are a priority within Shift2Rail, as they enable the entire rail sector to **visualise** and **concretely test** the **transformations** that they are able to bring about. Demonstrations also enable a more appropriate **quantification of the impact** of each new technology and provide a **first estimate** of the **anticipated potential** for sector improvement (at regional, national and EU transport network levels) as a result of the developed innovations.

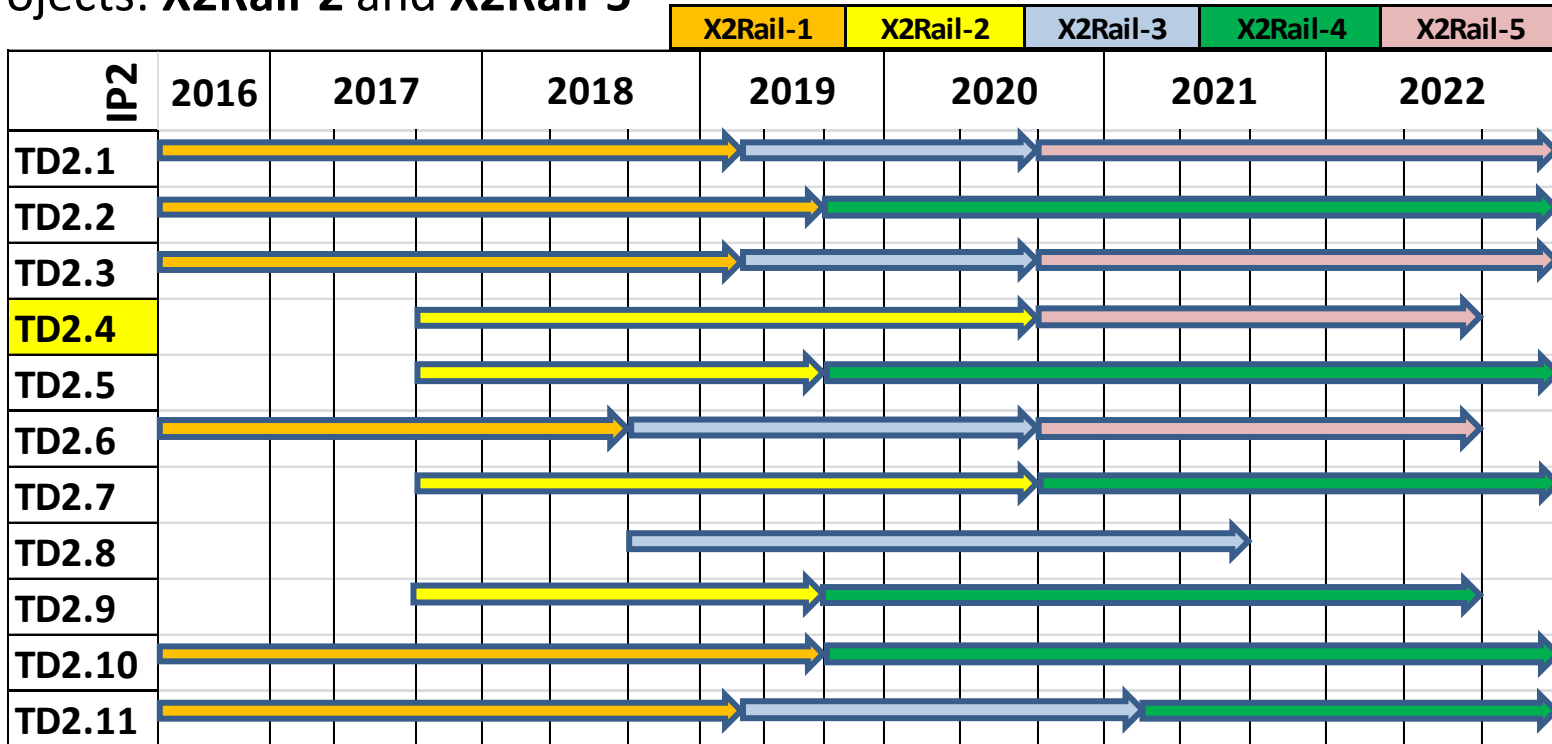


AREA	SCOPE
<p>TD2.4: Fail-Safe Train Positioning (including satellite technologies)</p>	<ul style="list-style-type: none"> • Acquire information and analyse the state-of-the-art of GNSS, radio localization and kinematic sensor technologies. • Define the SRS and the System Architecture in the context of the ERTMS evolutions (*). • Identify different possible technological solutions, develop proof of concepts based also on modeling and simulators. • Identify enhancements to the Railway V&V Processes to also include the new technologies and their impacts at the level of interoperable constituents and Command & Control Subsystems • Develop Technology Demonstrators to be verified both in Laboratory and on the Field • Provide a Business Model for GNSS application in Railway which takes into account the outcomes and the results of others relevant projects and specific requirements of different Railway Market Segments.

(*) http://www.era.europa.eu/Document-Register/Documents/ERA-REP-150_ERTMS_Longer_Term_Perspective-Final_Report.pdf

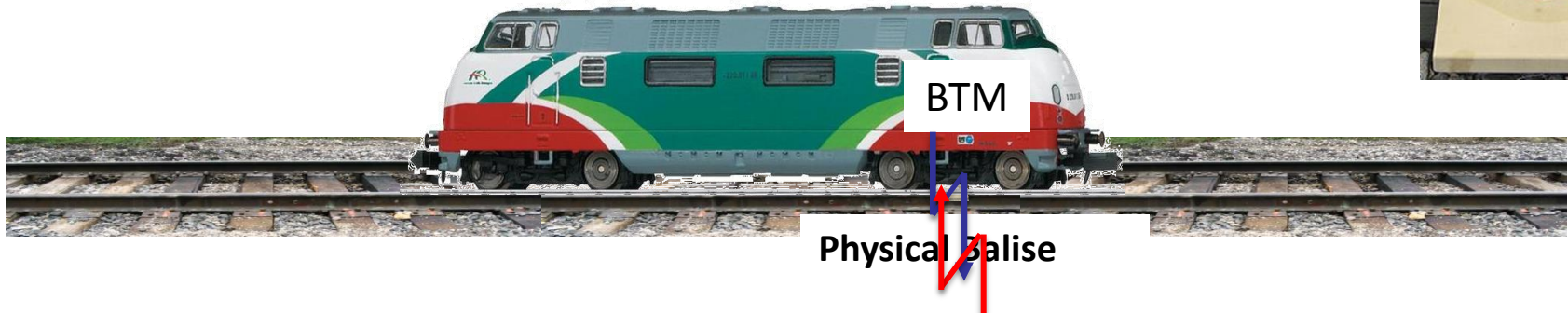
The new ERTMS, based on this **SIL 4 Fail-Safe Train Positioning**, must guarantee the **backward compatibility** and the **interoperability requirements**. In the context of this TD, collaborations with the **European GNSS Agency (GSA)**, the **European Space Agency (ESA)** and the **European Union Agency for Railways (ERA)** have been foreseen.

The estimated **total budget** for TD2.4, including EU funding and Open Calls, is **24.29 M€**. TD2.4 will be implemented throughout two consecutive projects: **X2Rail-2** and **X2Rail-5**



GSA and ESA have also defined specific programs for GNSS in Rail, see respectively <https://www.gsa.europa.eu/sites/default/files/futureflowchartd.pdf> and www.space4rail.esa.int

The **ERTMS** train location principles are based on the concept of **Balises**



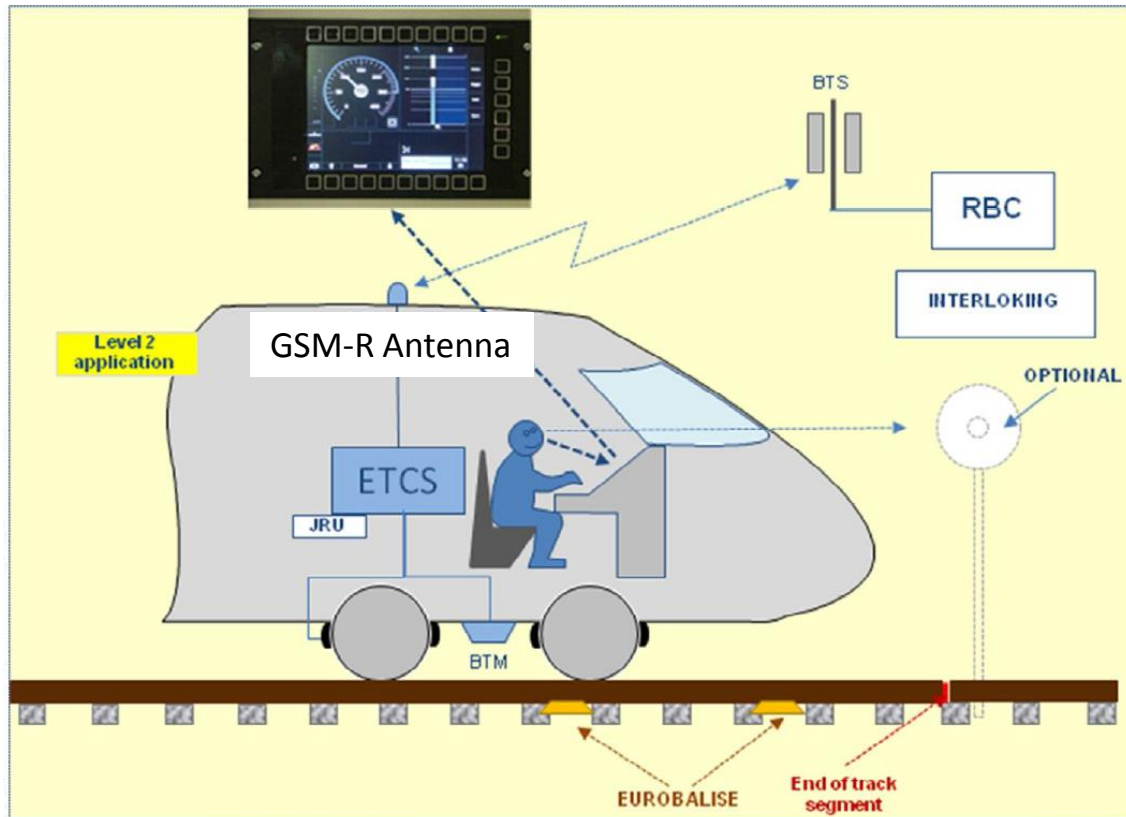
BTM provides:

- User Bits
- Nominal Balise Location
- Max/Min Balise Detection Error = +/- **1m**, THR = **$10^{-9}/h$**

The ERTMS train location principles are based on the concept of Balises



Physical Balise



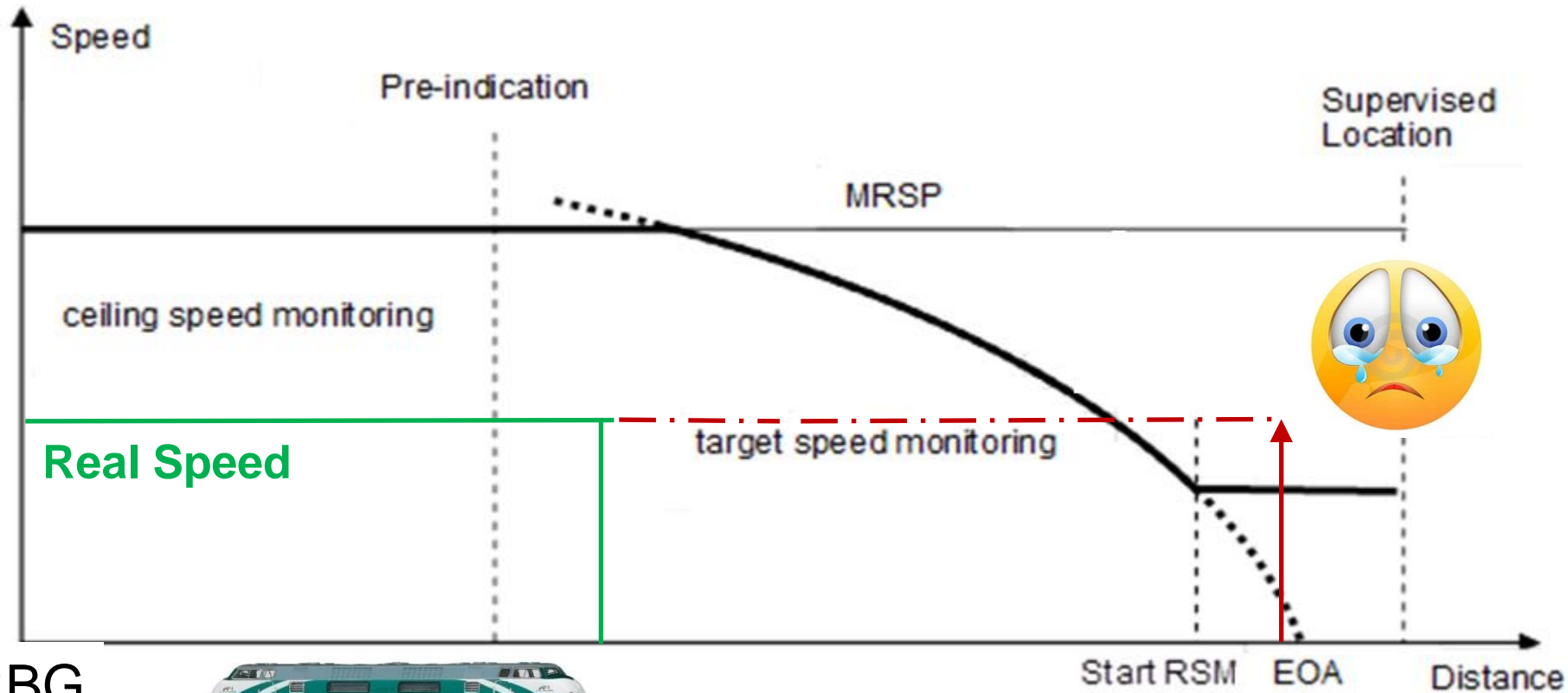
What is a Virtual Balise?



Virtual Balise Reader (VBR) provides:

- User Bits
- Nominal Balise Location
- Max/Min Balise Detection Error = $f(\text{Prot. Level}, \dots)$

How much is the virtual balise **location accuracy** important in ERTMS?

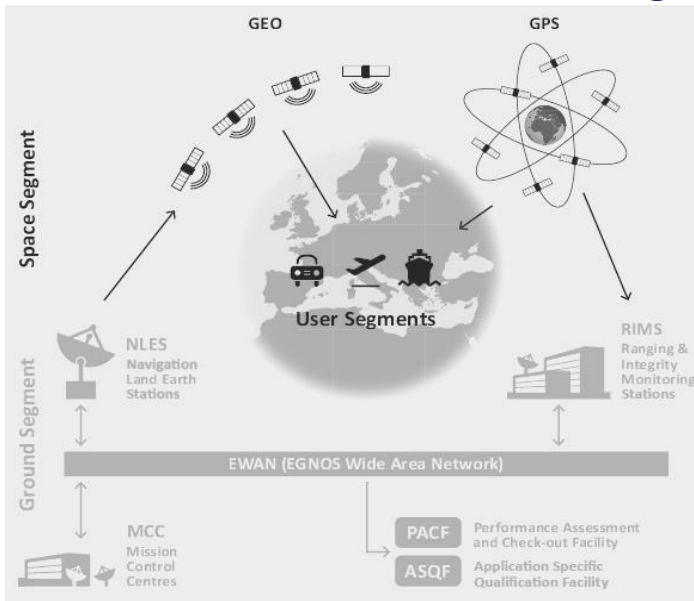


Estimated Max Safe Front End

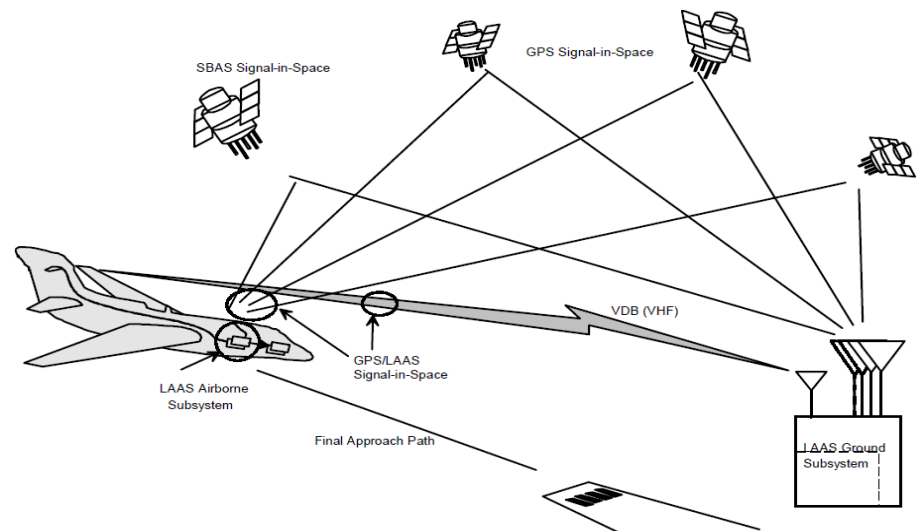
Actual Front End

Therefore, this new **Fail-Safe Train Position** must be developed to enable the on-board ERTMS/ETCS to **still guarantee the ERTMS SIL 4 Train Position function.**

TD2.4 will use the public available results of the state-of-the-art main related R&D Projects (e.g. **ERSAT-EAV, STARS, RHINOS, 3InSat, SBS**) as inputs. However, important and critical issues need still to be investigated and agreed. For example, **what will the communication channel for receiving augmentation data be?**



From EGNOS SDD for Safety of Life Service

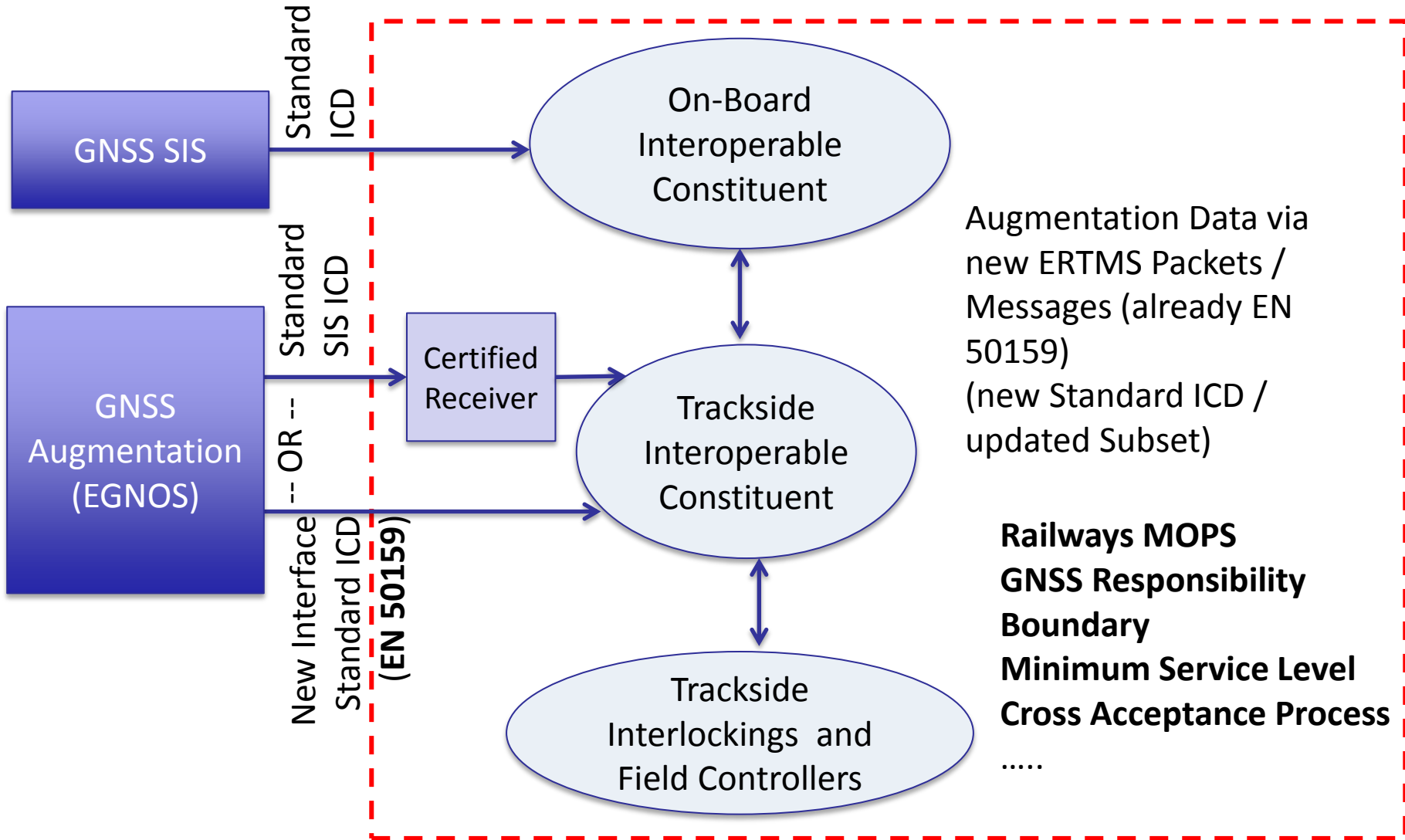


From RTCA DO-245A - LAAS

Rail scenarios are **complex** from the radio electric perspective and the GSA STARS project is characterizing the GNSS/EGNOS signal characteristics (e.g. multipath, canyons, stations, ..). Based on the results of other projects and the preliminary STARS results, it is initially proposed that each **on-board user receiver** would receive **augmentation data** from the **railway trackside interoperable constituent** (RBC) via the available ERTMS safe (radio) communication session.

Multipath and Non-Line of Sight Conditions: critical issues for the **on-board PNT component**





X2R2 (First Project of TD2.4) will deliver:

	Deliverable name	Short name of Lead Participant	Dissemination level	Delivery date (in months)
D3.1	System Requirement Specification of the Fail-Safe Train Positioning Functional Block	ASTS	PU	M15
D3.2	System Architecture Specification and System Functional Hazard Analysis of the Fail-Safe Train Positioning subsystem	ASTS	PU	M15
D3.3	Cost Benefits and Impact Analysis associated with the introduction of the Fail-Safe Train Positioning subsystem	ASTS	CO	M15
D3.4	Test campaigns analysis, Performance Analysis Toolset and Description of Main Toolset Specification	AZD	CO	M15
D3.5	Technical solutions for Fail Safe train positioning, advantages and disadvantages	ASTS	CO	M30
D3.6	Minimum Operational Performance Requirements of the multi-sensor devices required for the Fail-Safe Train Positioning subsystem	ASTS	PU	M30
D3.7	V&V Process Definition and Functional and Non Functional Test Specifications to be applied to the Fail-Safe Train Positioning subsystem	CAF	CO	M30

X2Rail-2 Participants (in red, the TD2.4 participants)

• Founding members

- ✓ **Ansaldo STS (Coordinator)**
- ✓ Alstom Transport S.A.
- ✓ Bombardier Transportation Sweden AB
- ✓ CAF Signalling S.L.
- ✓ Network Rail Infrastructure Limited
- ✓ Siemens Aktiengesellschaft
- ✓ Thales Transportation Systems GmbH
- ✓ Trafikverket

• Associate members

- ✓ AZD Praha s.r.o
- ✓ Asociación Centro Tecnológico Ceit-
IK4
- ✓ Deutsche Bahn AG
- ✓ Deutsches Zentrum fuer Luft- und
Raumfahrt e.V.
- ✓ Hacon Ingenieurgesellschaft mbH
- ✓ Indra Sistemas S.A.
- ✓ Mer Mec SPA
- ✓ Nottingham Scientific LTD
- ✓ Railenium
- ✓ SNCF RESEAU
- ✓ SCHWEIZERISCHE BUNDESBAHNEN
SBB AG

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