GNSS on ERTMS

Massimilinao Ciaffi - RFI

RIAMS
Rail Infrastructure
Asset Modernisation Summit

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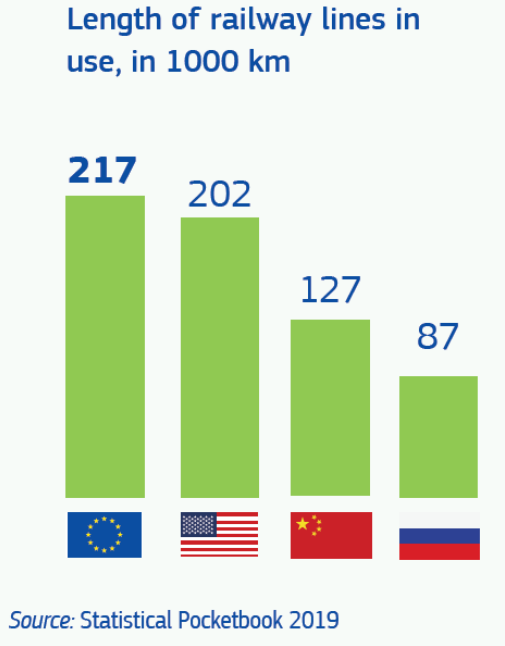
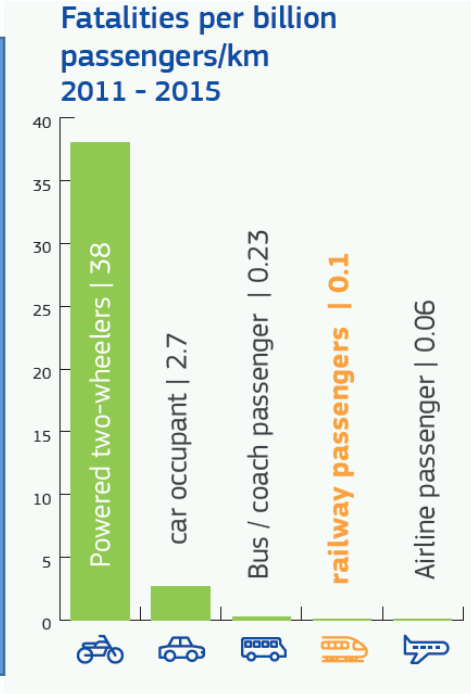
2021: THE EUROPEAN YEAR OF RAIL

New Green Deal Objectives



- Increase rail's share of passengers and goods
- Manage capacity demand
- Priority on Safety
- Sustainability: economical and environment

We want to make rail more attractive!



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MASTERING NEW TECHNOLOGIES

With + 20 years of roll out, ERTMS is *de-facto* a global standard providing the highest safety levels while eliminating way-side signals and open to innovations with

- **new train positioning** systems to reducing the dependency on physical balises to be manufactured, installed, maintained
- **flexible telecom platform**, using any technology w/o legacy to reduce dedicated track-side infrastructures

Step-change technologies w/o impacting on the ERTMS architecture

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EXPLOITING SATELLITE ASSETS FOR RAILWAY APPLICATIONS

Improve Competitiveness & economical sustainability

About 50% of ERTMS products are exported world-wide

Most of local &regional lines must be renewed

Satellite Navigation

Train positioning, ATO, supervision of shunting operations train integrity, track worker protection

maintenance, passenger services, asset management, tracking and tracing

Satellite Communication

Complementing terrestrial networks for train – RBC and RBC – Object controllers

IoT. Maintenance,

Passenger services

Capacity + 1 Gbit/sec

Earth Observation

infrastructure monitoring, early warning of landslides and railway subsidence to mitigate risks

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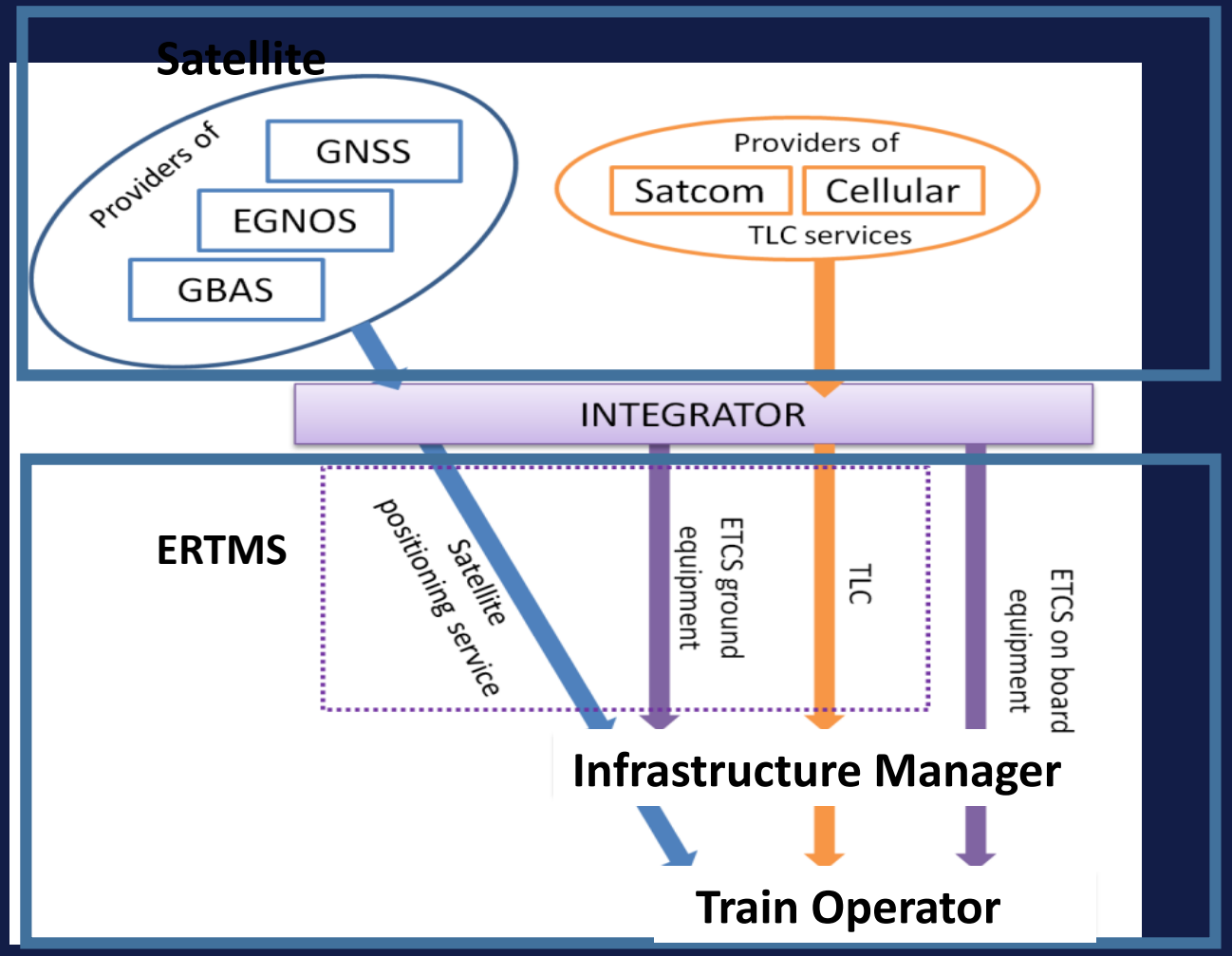
INTEGRATION OF SATELLITE ASSETS INTO THE ERTMS



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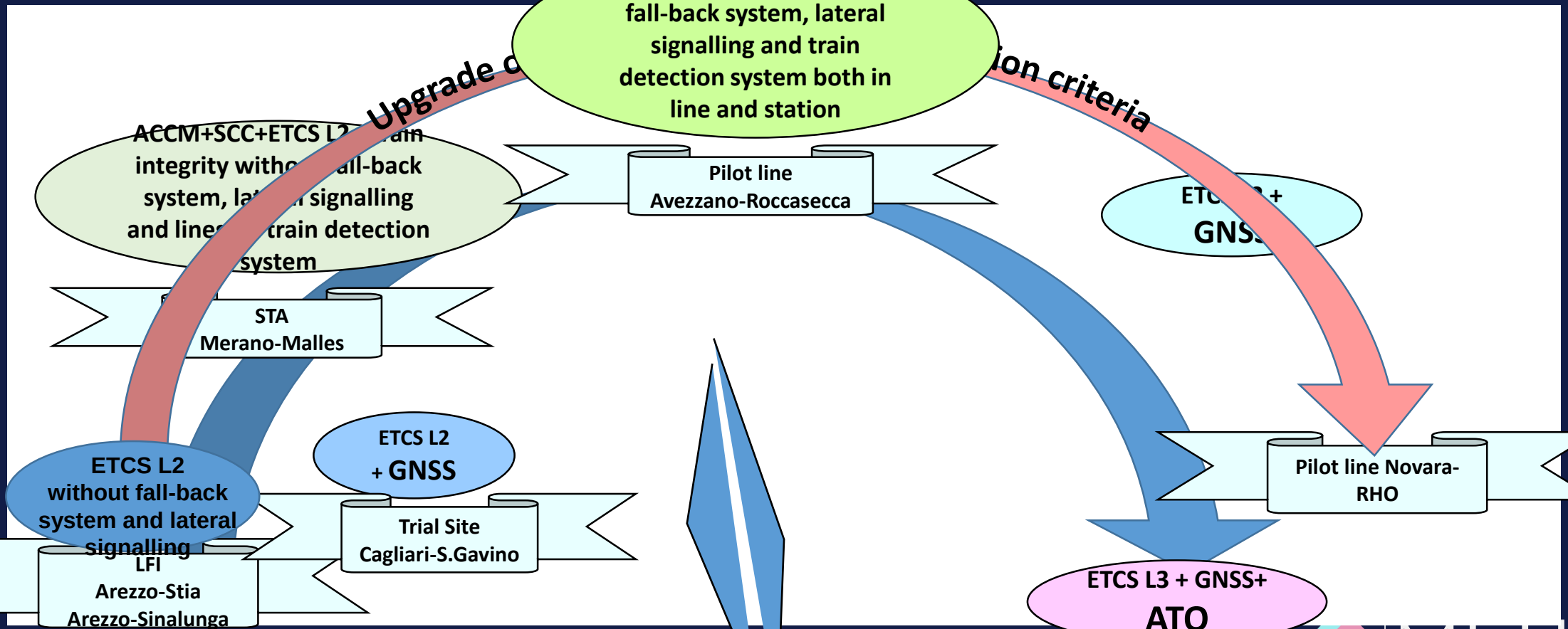
ERTMS ON REGIONAL LINES



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GAME CHANGER TECHNOLOGIES INCLUDED IN THE ERTMS LONG TERM PERSPECTIVE

- ❑ Next Generation Communicatioon system(s)
- ❑ Satellite positioning
- ❑ ETCS Level 3
- ❑ Automatic Train Operation

Innovations with a significant impact on the ERTMS business case

Contribution of Satellite technology

Higher accuracy of train localization, reduction of trackside equipments, capacity increase, regularity of operation

RFI is leader of Satellite positining *Game Changer* over ERTMS

Reduction of cost + increase of capacity = improvement of ERTMS economical sustainability and thus faster adoption

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RAILWAYS CCS PERSPECTIVE ON GNSS

virtual balises

Physical balises will disappear

Cost reduction

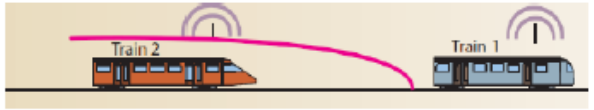
Interope-rability

Additional revenues

Applicability

the system is detected in the same way worldwide, certifiable for safety with an harmonised approach

higher accuracy to increase line capacity



broadening of use, including regional and local lines

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ERSAT PROGRAM: ERTMS + SATELLITE

- Conceived in 2012 to enhance the **ERTMS standard**
- Contribution to the **Game Changer** innovation
  - Satellite positioning
  - Bearer-independent telecoms

2 of the 4 Game Changers included in the ERSAT program

- Comprehensive plan to validate, certify, standardize and upgrade the new technologies in a stepped manner with milestones to activate the operational service
- Involvement of the **rail & satellite community**
- Expectations that EGNOS be an ***external service to ERTMS*** with support from EC, GSA and ESA

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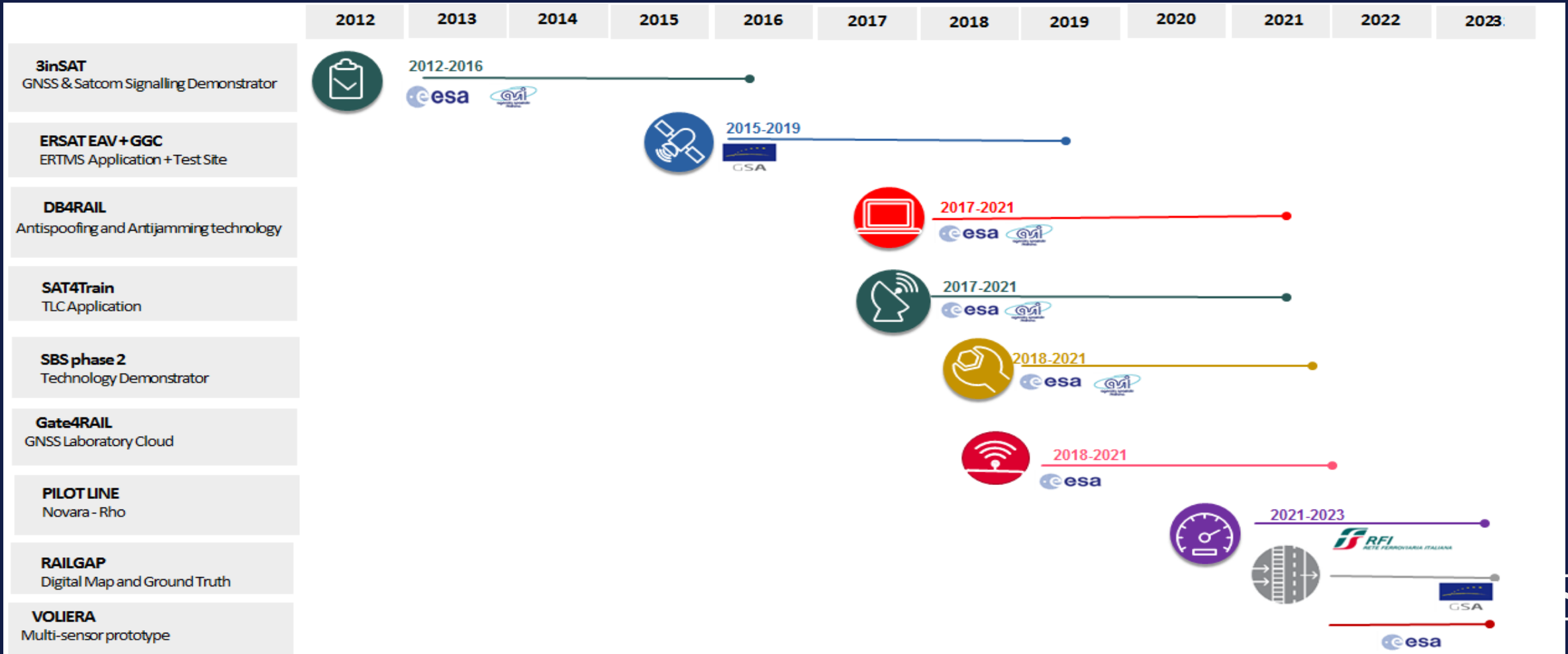
TECHNOLOGY DEVELOPMENTS



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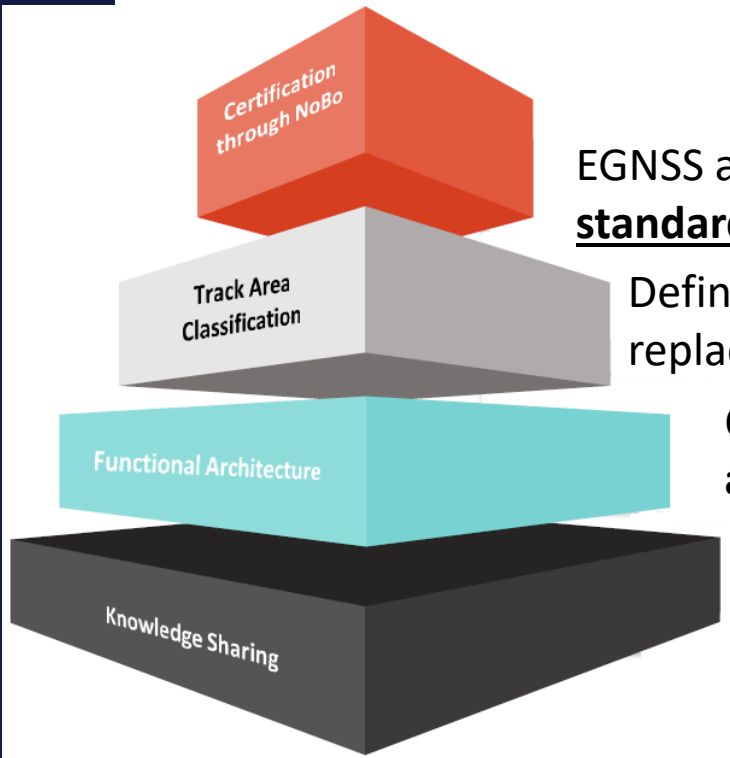
ERSAT GGC PROJECT PRIORITIES



EGNSS assets validation and relevant certification process **compatible with ERTMS standards**

Definition and Certification of **standard process**, methodology and toolset for replacing physical Balises with **Virtual balises**

Consolidation and certification of the enhancement of the functional ERTMS **architecture integrated with satellite based location determination system**

Contribute to the **standardization process** & dissemination of results with the satellite and rail stakeholders

☞ **Integration of EGNSS w/o impacting on the ERTMS system**

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SARDINIA TRIAL SITE

Double-Track

Onboard Subsystem:

- Rolling Stock Aln668 3114, equipped with an ERTMS platform
- LDS OnBoard Unit (LDS OBU)
- GPS RTK receiver
- Mobile Terminals, via the GSM / 3G public radio network or the satellite network
- Data Logger

Trackside Subsystem:

- 2 Reference Stations
  - Samassi
  - Decimomannu
- 1 Radio Block Centre (RBC)
- 1 TALS (Track Augmentation LDS Server)

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ERSAT TRIAL SITE ARCHITECTURE

TALS & RBC Cagliari

RFI SDH Network

Radio communication network

Pk Augment

Pk Augment

si Reference Station

Decimomannu Reference Station

Position Report

GNSS Constellation (GPS+Galileo)

GSM

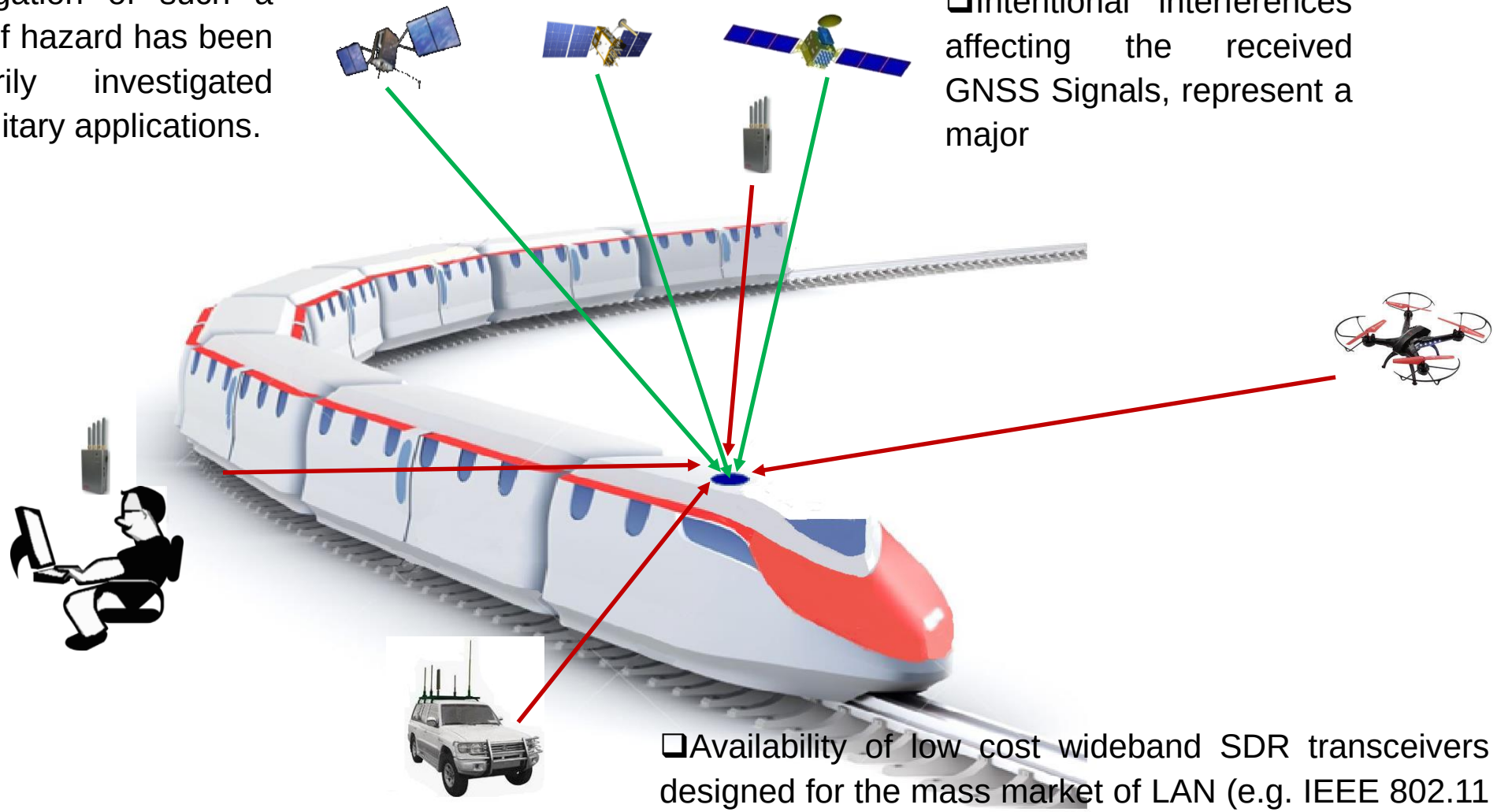
GPS

ERTMS/ETCS
(EVC, Odometry, Radio)

Virtual Balise

DB4RAIL

❑Mitigation of such a kind of hazard has been primarily investigated for military applications.



❑Intentional interferences affecting the received GNSS Signals, represent a major

❑Availability of low cost wideband SDR transceivers designed for the mass market of LAN (e.g. IEEE 802.11 ac) and mobile communications (LTE advanced)

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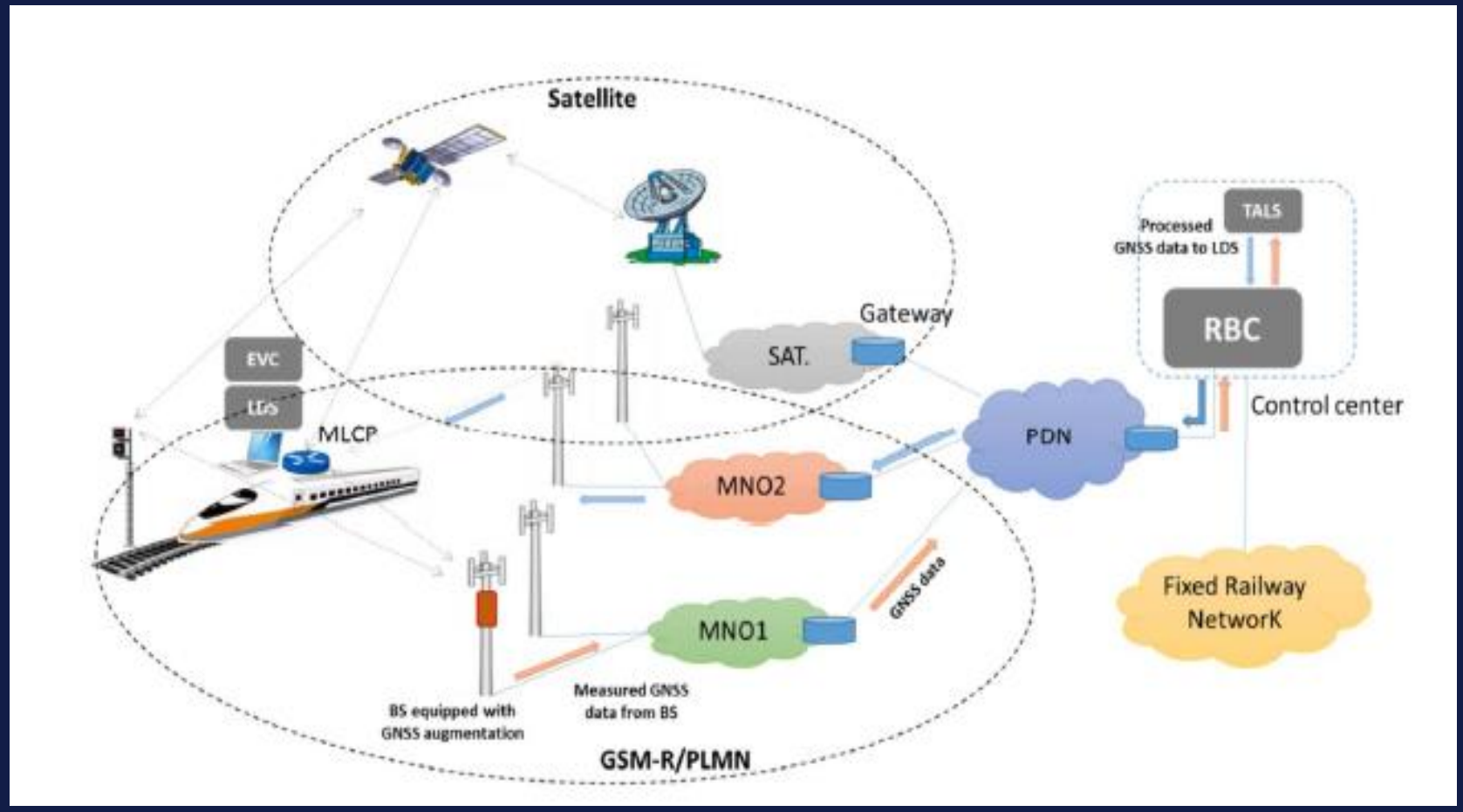
SAT4TRAIN



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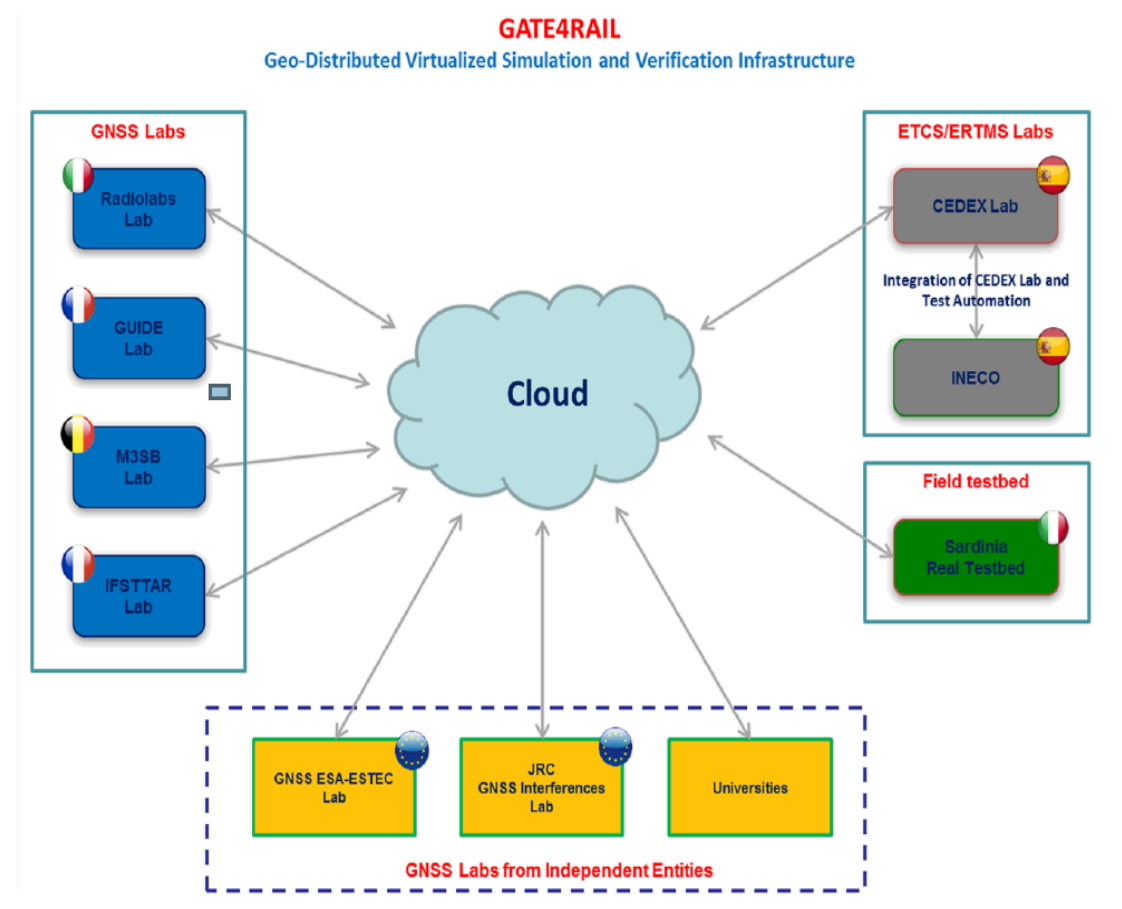
GATE4RAIL



GATE4Rail will provide a **LABORATORY TEST ARCHITECTURE** capable of simulating railway scenarios for GNSS-based ERTMS applications by integrating different simulation blocks and by defining their interfaces in order to cover a global simulation chain

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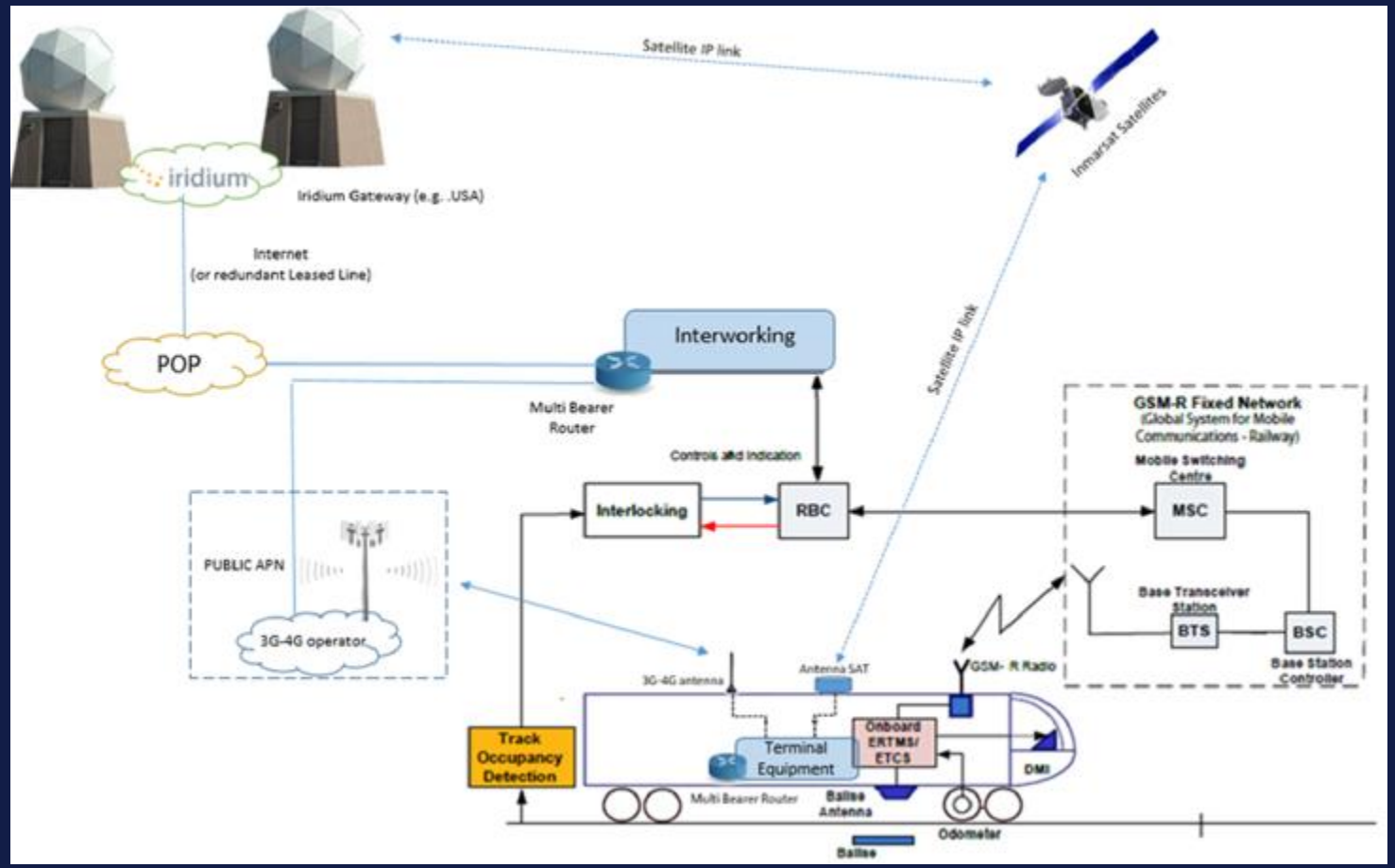
SBS PHASE 2



The application consists of putting into operation an ERTMS system by using GNSS satellites with proper localization device systems and IP-based public telecom (including SATCOM) services instead of the GSM-R. These functionalities are enabled by “services” that are external to the ERTMS, reducing the need to build dedicated infrastructures.

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PILOT LINE NOVARA RHO

First commitment at EU-level of a Railways company

- Line to be built in the European Mediterranean ERTMS corridor (most important at EU level)
- Train position determination based on GPS and subsequently on GALILEO
- Coordination with ERA and ANSF
- Established a basis **to exploit EGNOS and Galileo**
- **Roadmap supported by ESA projects and GSA**
- **Exploitation phase on selected Italian railways lines**

Part of the ERTMS Mediterranean corridor

Work Plan for the ERTMS, published by the European Commission in May this year, listed satellite positioning and FRMCS multi bearer as two of the game-changing technologies underpinning future evolutions of the system and a key element to be included in future Technological Specifications for Interoperability (TSI)

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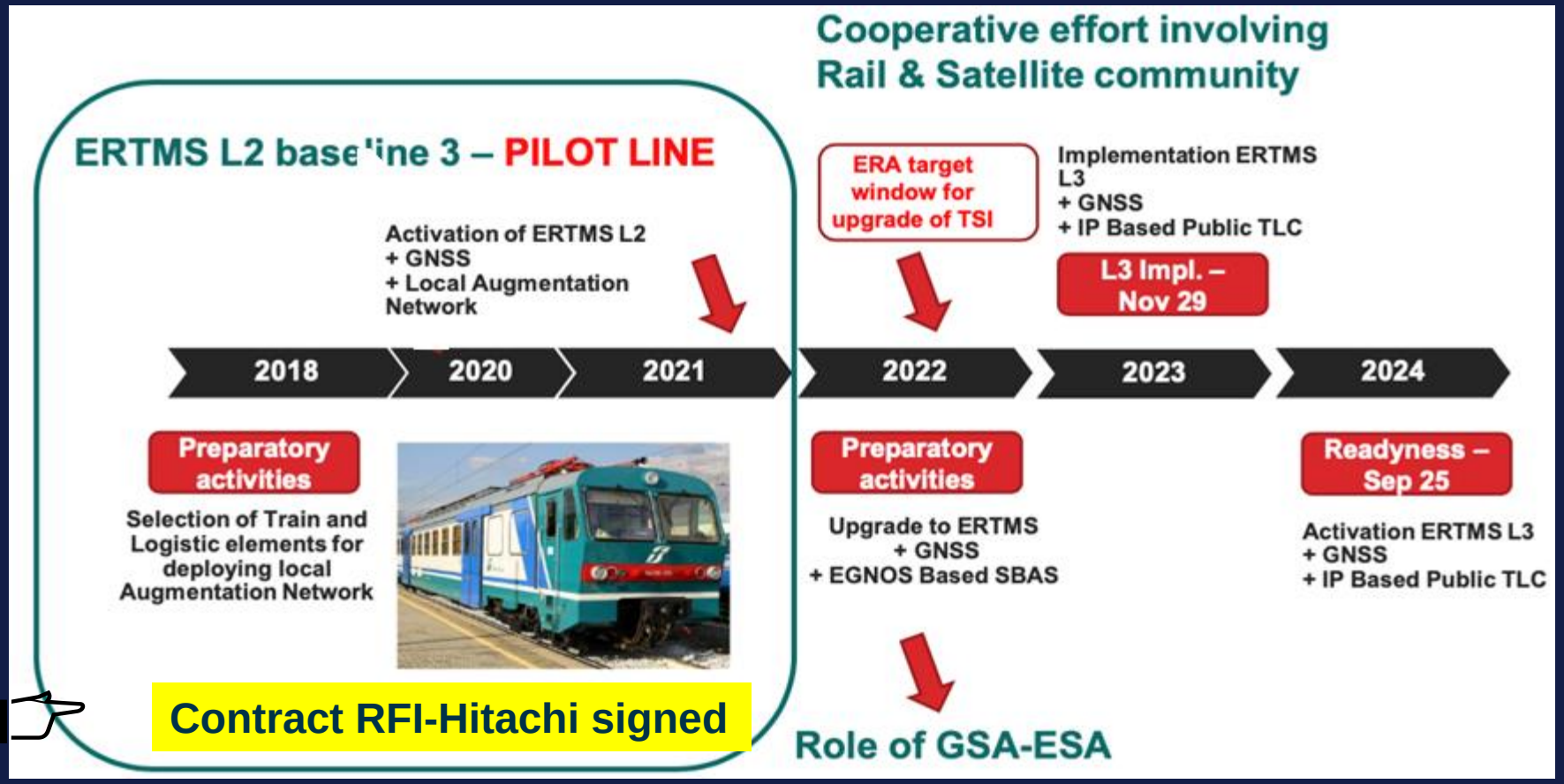
ROADMAP FOR CERTIFICATION AND EXPLOITATION OF SATELLITE TECHNOLOGIES INTO THE ERTMS



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PHASED APPROACH FOR DEPLOYING ERTMS L 2 WITH SATELLITE FUNCTIONALITY

1. **Upgrade of Novara – Rho pilot line to ERTMS Level 2 Baseline 3 Release 2**
   - Preparatory phase in preparation for upgrade with integrated GNSS functions

   On going

2. **Upgrade of Novara – Rho pilot line to support integration of virtual balise detection using GPS L1 (single frequency / single constellation), supported by a local augmentation system**
   - Upgrading on-board and trackside constituents with Virtual Balise Transmission System (VBTS) based on GPS L1 and installation of local augmentation

   On going

3. **Installation of RX4Rail receiver (EGNOS-ready receiver) on a train running on the Novara – Rho pilot line** to collect data and support offline post-processing for analysis of performances with EGNOS using an ad hoc VBR simulator, modified to enable the use of PVT provided by the RX4Rail receiver

   Planned

4. **Upgrade of Novara – Rho pilot line transitioning from the local augmentation to the use of EGNOS**
   - Bringing EGNOS-Enabled operations to a pre-operational demonstration fleet

   Planned

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ERTMS IMPLEMENTATION PLAN

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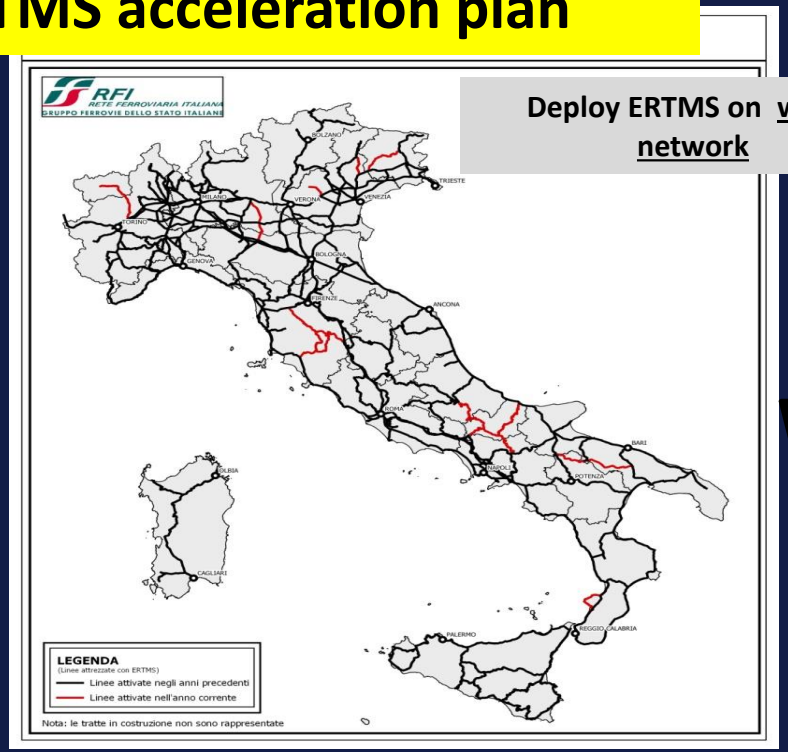
TOWARDS A FULLY ERTMS NETWORK IN LINE WITH EU DIRECTIVES

ERTMS acceleration plan



Deploy ERTMS on <u>whole network</u>

Virtual Balise can be introduced progressively on 16000km starting from low trafic lines (6000km) after standard is included in TSI, leveraging on the Novara – Rho pilot line

Satellite technologies are strategic to ERTMS evolution

ATO driverless	ETCS 3	Satellite positioning	Next Gen. Telecom

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OTHER RAILWAYS LINES BENEFITTING FROM SATELLITE TECHNOLOGY

Need to modernise local lines

- **1400** km of **interconnected** Lines requiring compatibility with technological standard and safety level as for the national network
- **1330** km of **isolated** single-track lines where safety standard have to be improved

Possible pilot line on selected railways in coordination with RFI to exploit satellite positioning and public telecom technologies

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RFI PLAN TO EXTENDING ERTMS LEVEL 2 ON OTHER LINES WITH A STANDARD INTEROPERABLE SATELLITE FUNCTIONALITY

Vehicle to equip with satellite technology and ERTMS for a pre-series deployment and operation

ROCK

ETR700

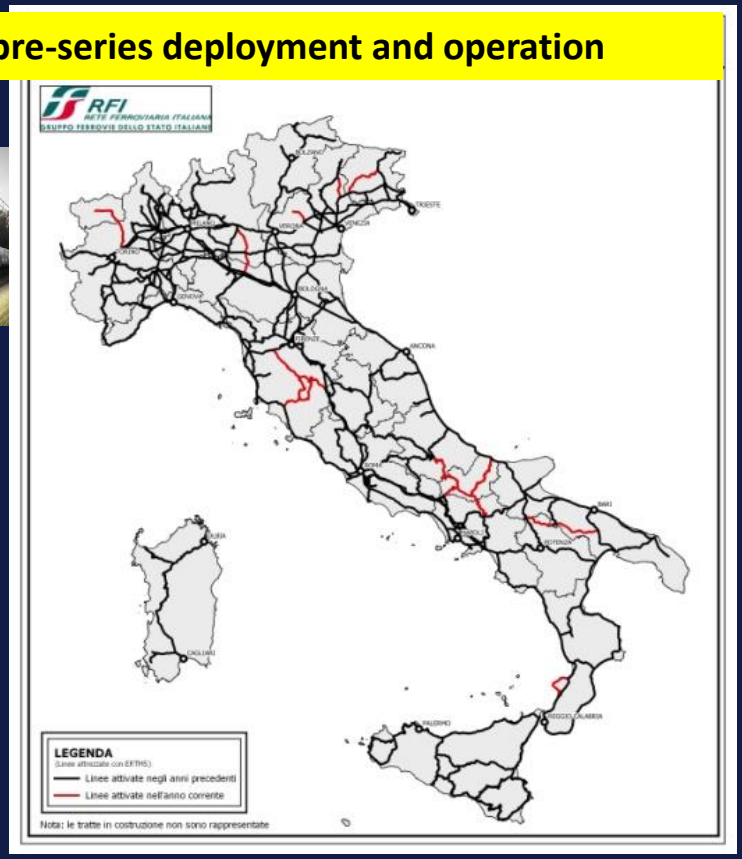
BLUES

E401

E403

E402B

CDPTR



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ERTMS IMPLEMENTATION MILESTONES

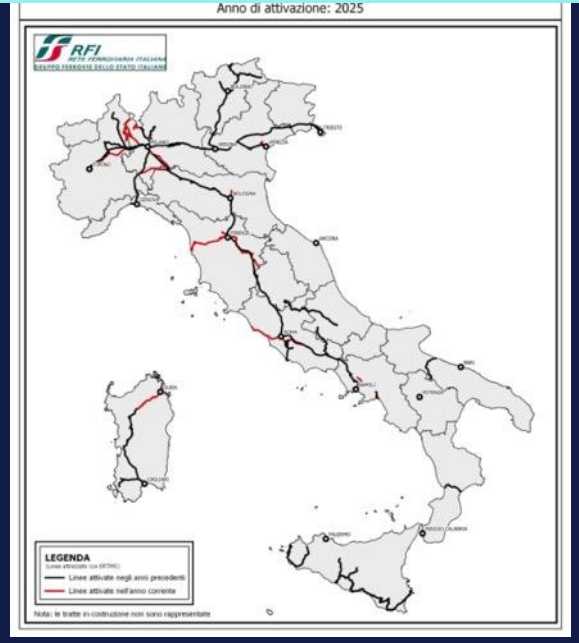
2022

- DD FI-RM
- Roma-Napoli AV/AC
- Novara-Rho
- Milano Smistamento e Milano Centrale – Chiasso

Rocca secca Avezzano
CANICATTI - GELA - MODICA - SIRACUSA

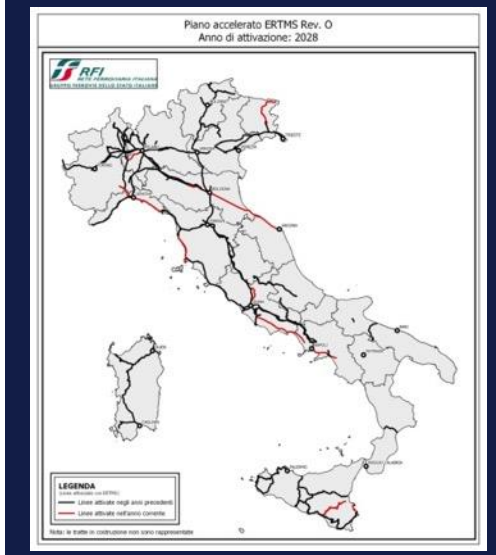
by 2024

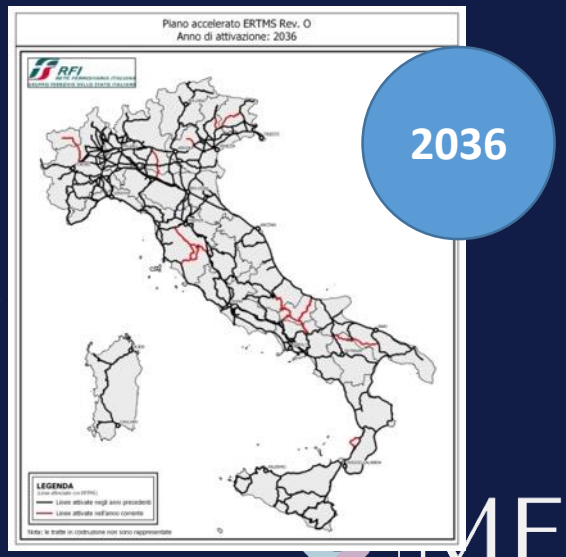
- CALTANISSETTA XIRBI - CANICATTI – ARAGONA
- MERCATO S.SEVERINO - SALERNO
- CIAMPINO - FRASCATI
- CIAMPINO – VELLETRI
- CIAMPINO - ALBANO LAZIALE
- TERNI - SULMONA
- BIELLA - NOVARA



2028

- P.M. BEVERA – STABIO
- PISA - MACCARESE
- VALENZA - ALESSANDRIA
- MACCARESE-FREGENE - PONTE GALERIA
- PALERMO C.LE - PALERMO MA.ma
- VENEZIA – VILLA OPICINA/TRIESTE
- SALSOMAGGIORE T. - FIDENZA
- SALSOMAGGIORE T. - MODENA





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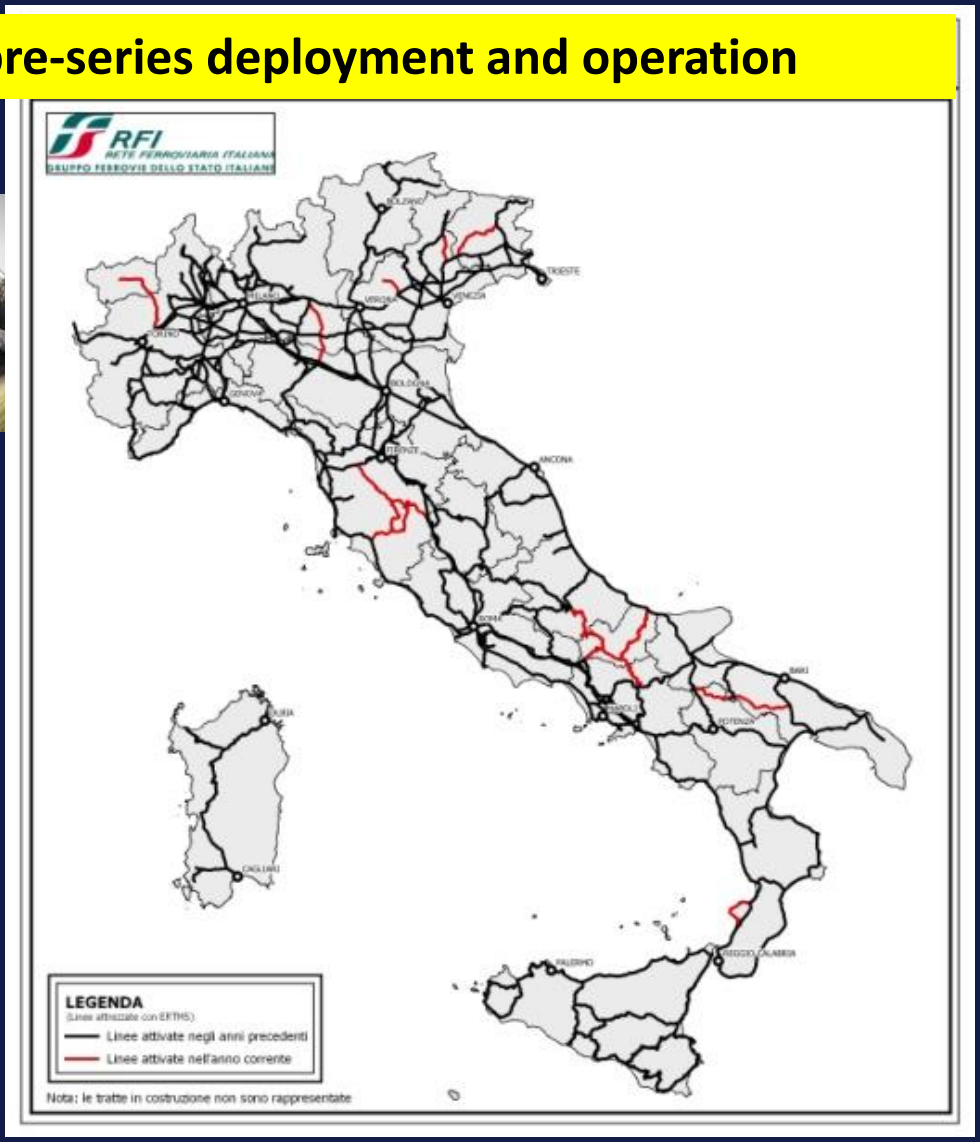

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SUMMARY

- RFI - **has gained 10 years of experience on satellite for ERTMS**
  - plan to migrate to a full ERTMS infrastructure (1st European Country)
  - support from Italian and European Space Agencies

- Certification process agreed with ERA (no derogations needed)
- Stepped Plan to first validate & certify a full ERTMS on the Novara – Rho
- Further innovations exploiting synergies with other applicatiions

ERSAT is now moving into the operational phase contributing to the standardization process

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THANKYOU

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