

RFI experience for the application of satellite technologies to ERTMS signalling system

Berlin, September 19th 2017

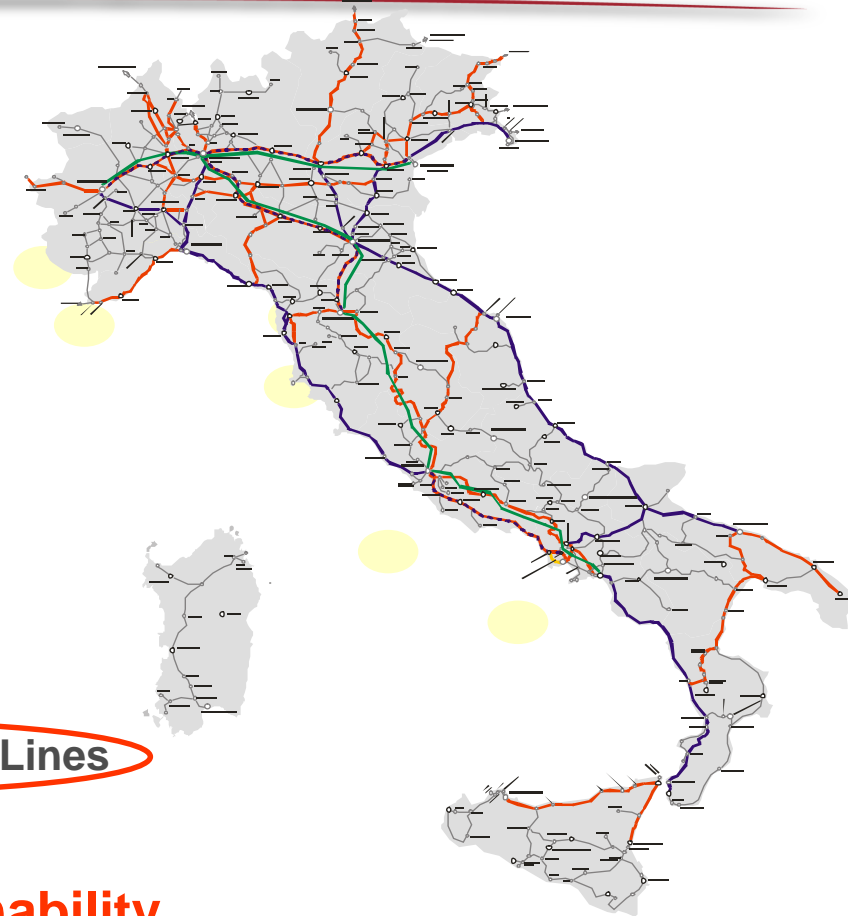
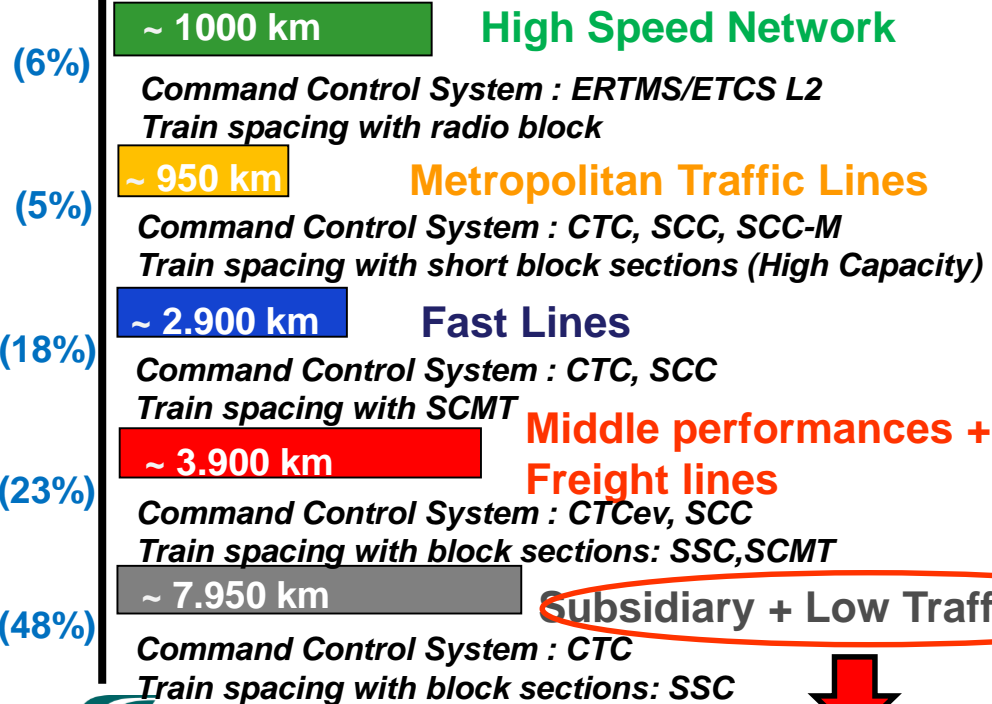
Massimiliano Ciaffi
Technical Department
Standard CCS

Outline

- **Italian Rail Network**
- **Satellite Projects**
- **Results**
- **Preliminary Hazard Analysis (PHA)**
- **Conclusion**

The Italian Rail Network

Lines classification related to the traffic development



Subsidiary + Low Traffic Lines



Economic Sustainability

Renewal Technology Program of regional line

The ERTMS L2 Satellite / L3 Regional project is one of the steps of the renewal technology program of regional lines aimed at:

REDUCING the operating costs (OPEX) of the "Regional" lines with the aim of making them more economically sustainable

What is the context?

- Secondary medium / low traffic lines
- Normally simple track
- Normally not electrified or electrified 3 kV
- «Multistation» operating rules without attend PP
- Automatic Train Supervision

How to achieve the goal?

➤ **Eliminate:**

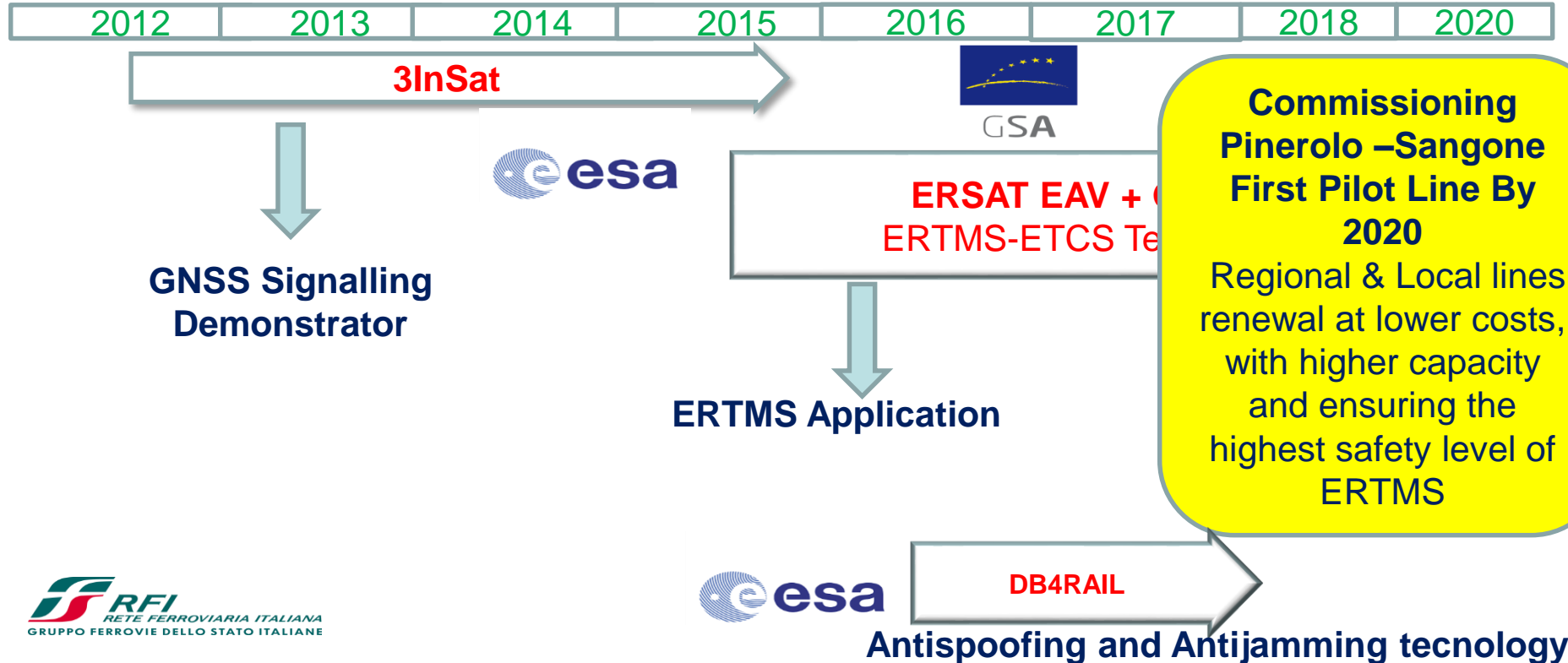
- Class B protection systems
- Light signals
- Train detection systems (track circuits, axel counter) both online and station

➤ **INTRODUCTION (in scalable configuration).**

- IXL functions according to ACCM logic with non-attend PPs
- SDT functions through ERTMS (L3)
- The adoption of a GSM-R or public radio system/ Satcom
- The Supervision and Automation function of the trains
- The function of "virtual balises" through the use of satellite technology

- OBU ETCS «Regional» with simplifications that can reduce costs with interoperability

Satellite Application Development Plan



RFI partner of ESA 3INSAT Project



Objective: to develop, test and validate in a real set up a new satellite-based platform suitable for a Train Control and Management System meeting the SIL4 safety requirements and compatible with the ERTMS standard.

- **Location Determination System (LDS)** including Au-Network
- **Integrated TLC solution** based on SatCom, 3G/4G, TETRA to realize a link between the on board train control system interfaces (e.g European Vital Computer EVC) and the ground based infrastructure (e.g the Radio Block Centre RBC)



Double track line



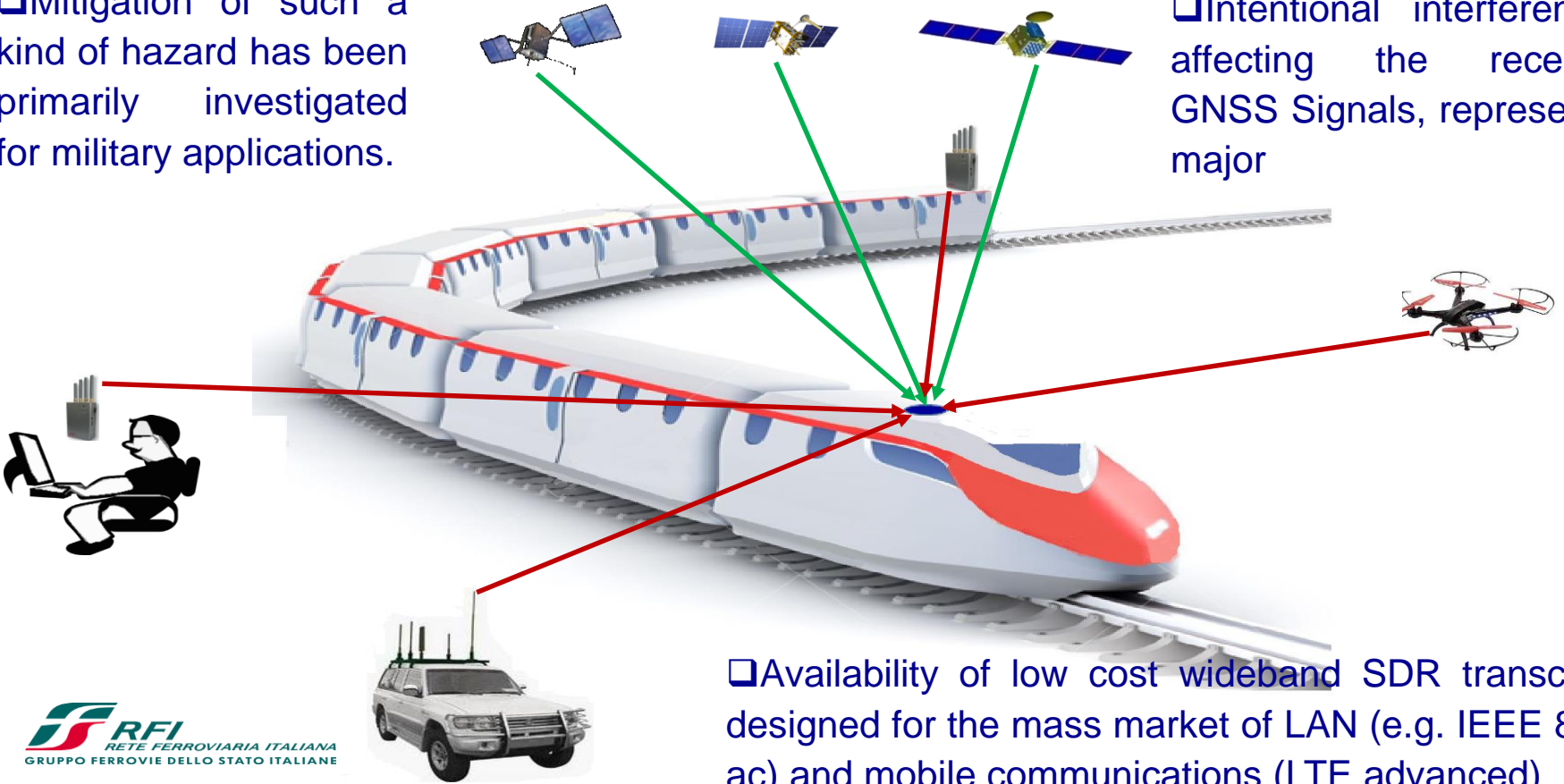
Selex ES
A Finmeccanica Company



DB4Rail – ESA Project

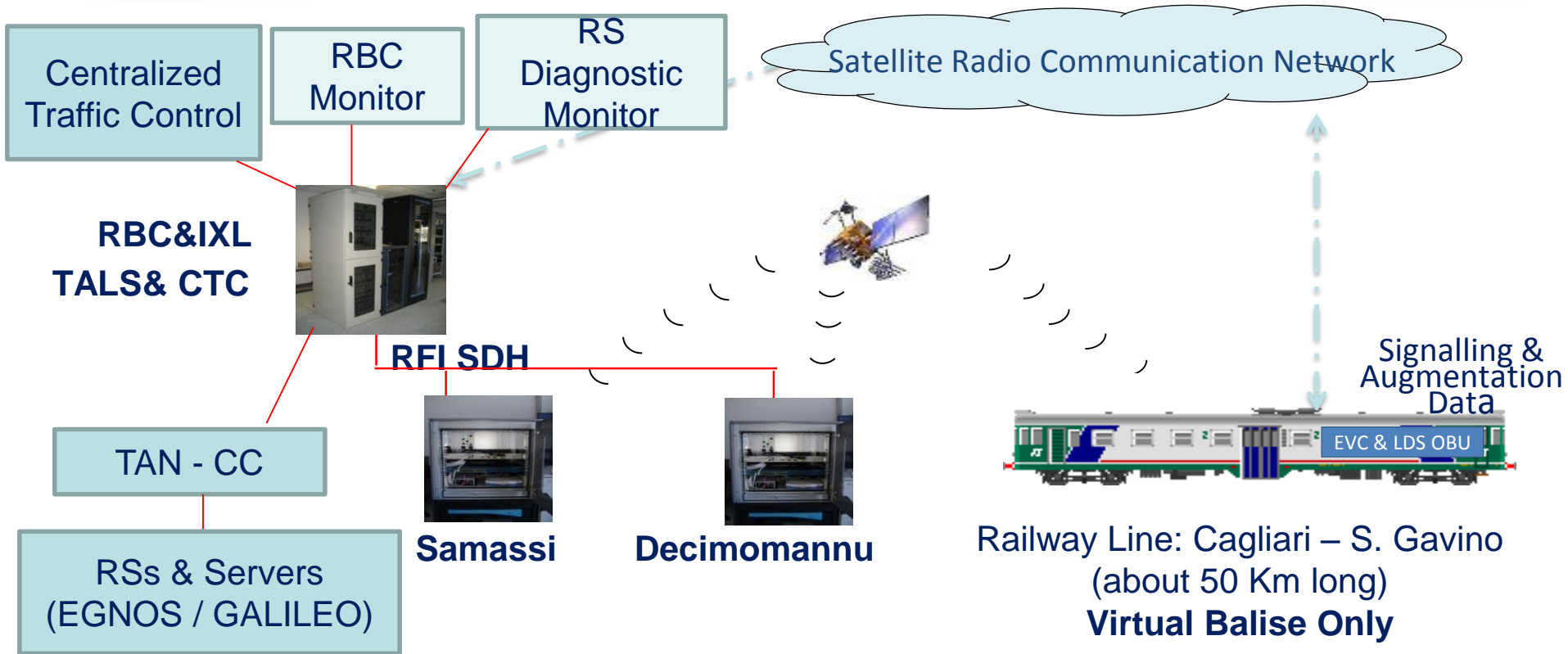
□ Mitigation of such a kind of hazard has been primarily investigated for military applications.

□ 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)

Trial Site Architecture and Configuration for Demonstration



Field Test Results - Position

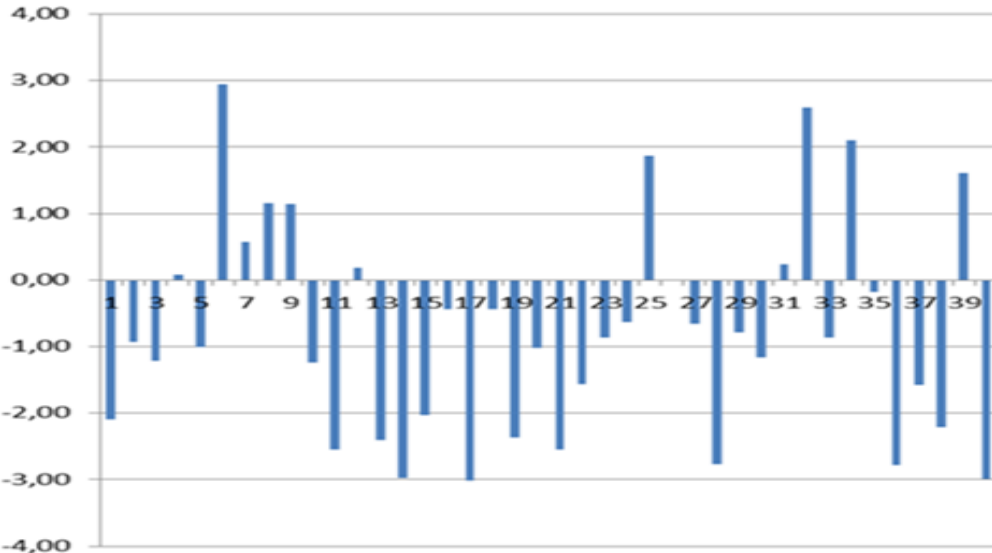
The expected value of GNSS **Position** Average Accuracy per train run is less than +/- 3 meters

10.000 km of field test

■ GNSS Position Average Accuracy per train run (*)

(*) Ground Truth based on RTK

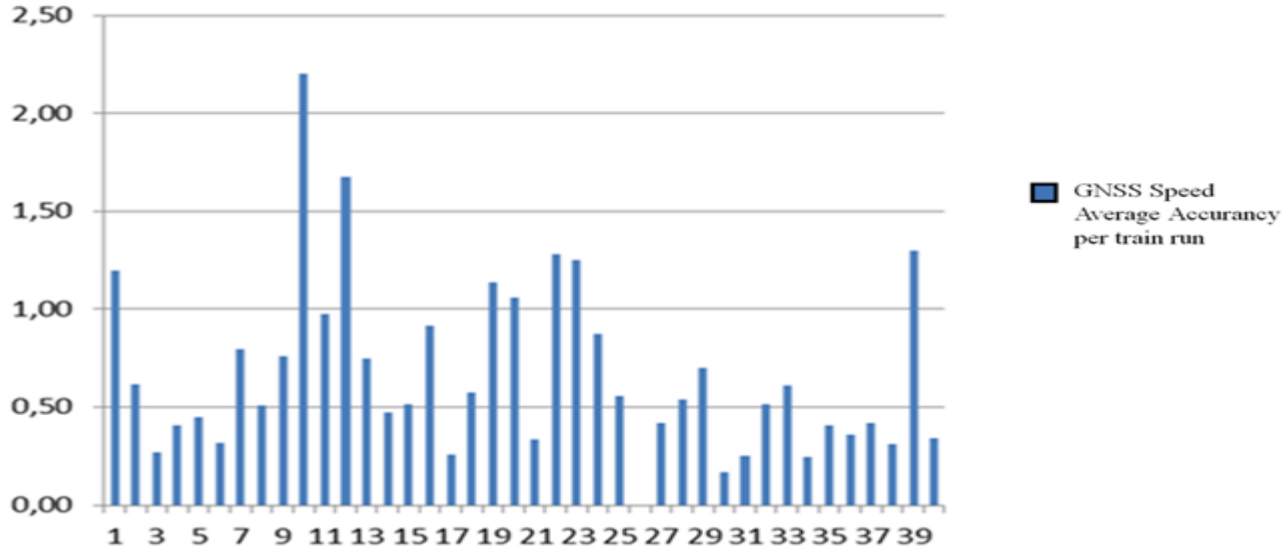
About 2 m with Galileo



Std Dev is less than 4 meters (GPS)

Field Test Results - Speed

The expected value of GNSS **Speed** Average Accuracy per train run is less than +/-5 km/h



10.000 km of field test

Std Dev is less than 2 km/h

Field Test Results – Control Command System

ERTMS Signalling KPIs

Expected Delivered vs. Planned Virtual Balises per train run (expected greater than 95%)	✓ PASSED except two cases (one for two different train runs)
Correct Sequence of Provided Virtual Balises per train run (expected no error)	✓ PASSED (at 100%)
Virtual Balise Groups detected inside the Expectation Window per train run (expected greater than 95%)	✓ PASSED
Train Position Confidence Interval (the actual safe front end, based on the Ground Truth, must be never outside the train confidence interval for every measured distance from the applicable LRBGs)	✓ PASSED

22.000
virtual balises
generated

Economic Sustainability

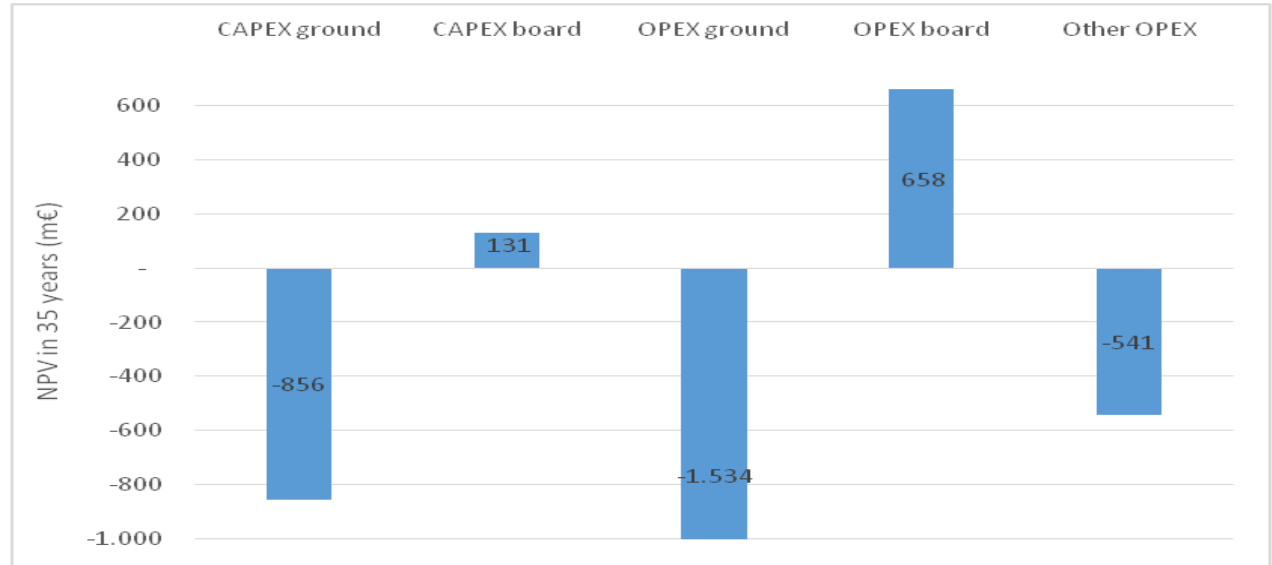
The main benefits of the new solution are two:

→ the **reduced need of physical balises**, which generates savings in the associated capex and opex

→ **avoided investments in additional GSM-R infrastructure**, which also generates savings in capex and related maintenance opex

*An application of a
Cost-Benefit Analysis
to compare the
convenience of GNSS-
based ERTMS vs
traditional ERTMS at
the European level*

*(source: Bocconi
University)*



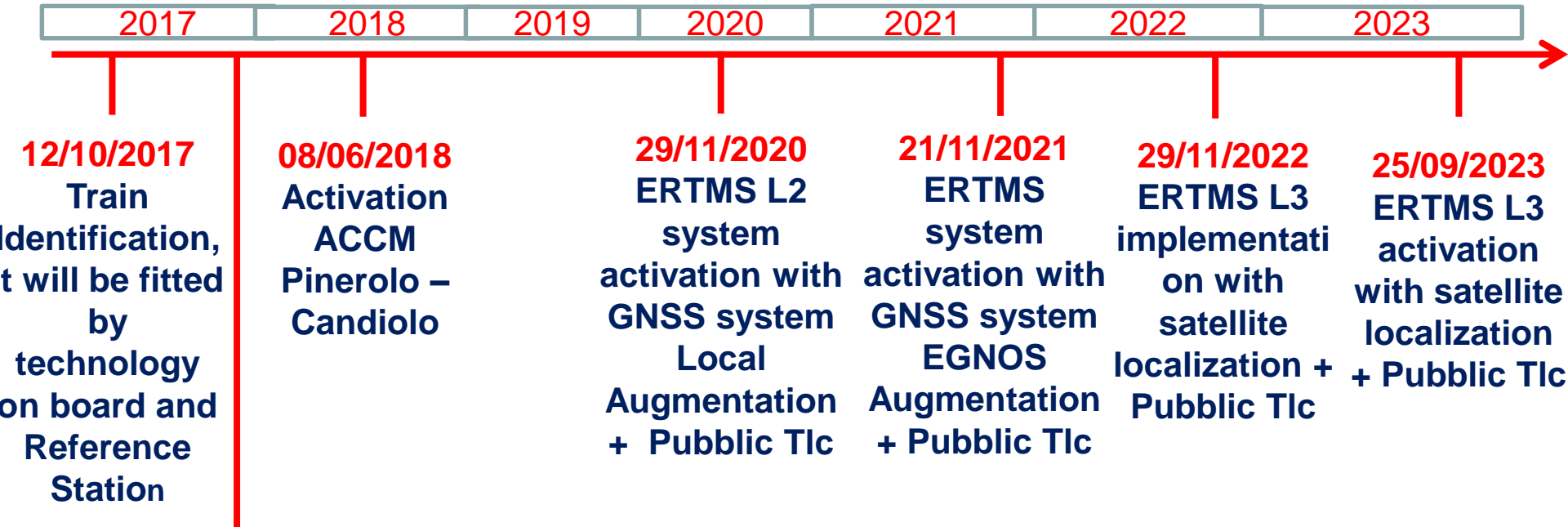
PILOT LINE MONCALIERI SANGONE - PINEROLO

Total length 30 km:

- Single track , 1 train each 30 minutes
- Line is electrified 3KVcc
- Vmax 135 Km/h
- Operators Trenitalia\ Mercitalia
- Mixed passengers/freight trafic
- 17 automated Level crossings
- No tunnels, only bridges for autoroutes
- Passengers trains:
 - TAF
 - JAZZ
- Freight trains:
 - E633 MERCITALIA
 - E652 MERCITALIA

Stazioni e fermate			
	0+000	Torino Porta Nuova	239 m s.l.m.
		linee per Milano e per Modane	
	4+318	Torino Lingotto	234 m s.l.m.
		torrente Sangone	
	0+000 6+866	Bivio Sangone linea per Genova e per Savona	
		Tramvia Torino-Saluzzo (* 1881 † 1950)	
	0+739	Moncalieri Sangone	222 m s.l.m.
	3+035	Nichelino	230 m s.l.m.
		Autostrada A55 - Strada europea E70	
	7+822	Candiolo	237 m s.l.m.
		torrente Chisola	
	13+199	None	246 m s.l.m.
		Airasca (vecchia)	
	17+828	Airasca	259 m s.l.m.
		linea per Saluzzo † 1986	
		Autostrada A55 dir. Pinerolo	
	22+460	Piscina di Pinerolo	286 m s.l.m.
	Riva di Pinerolo † 2003 ^[5]	325 m s.l.m.	
29+533	Pinerolo Olimpica * 2006 ^[6]		
	* 1882 † 2012		
30+479 0+300	Pinerolo FS / Pinerolo TPP	368 m s.l.m.	
	Tramvia Pinerolo-Perosa Argentina (* 1882 † 1968)		

Pinerolo – Sangone Plan



03/12/2017

ACC Activation
Pinerolo-Piscina



Activities to support the certification process

GNSS and public TLC networks are external components to the ERTMS standard

GNSS Adoption and Public Communications are required the definition of interfaces / Service levels between service providers and the «core» ERTMS

- **Evaluate the impacts on the safety and availability of the ERTMS with 'External' services to the ERTMS ecosystem**
 - **Augmentation System**
 - **Virtual Balise reader**
 - **RBC Interface - Augmentation Network**
 - **Multi-bearer telecom**

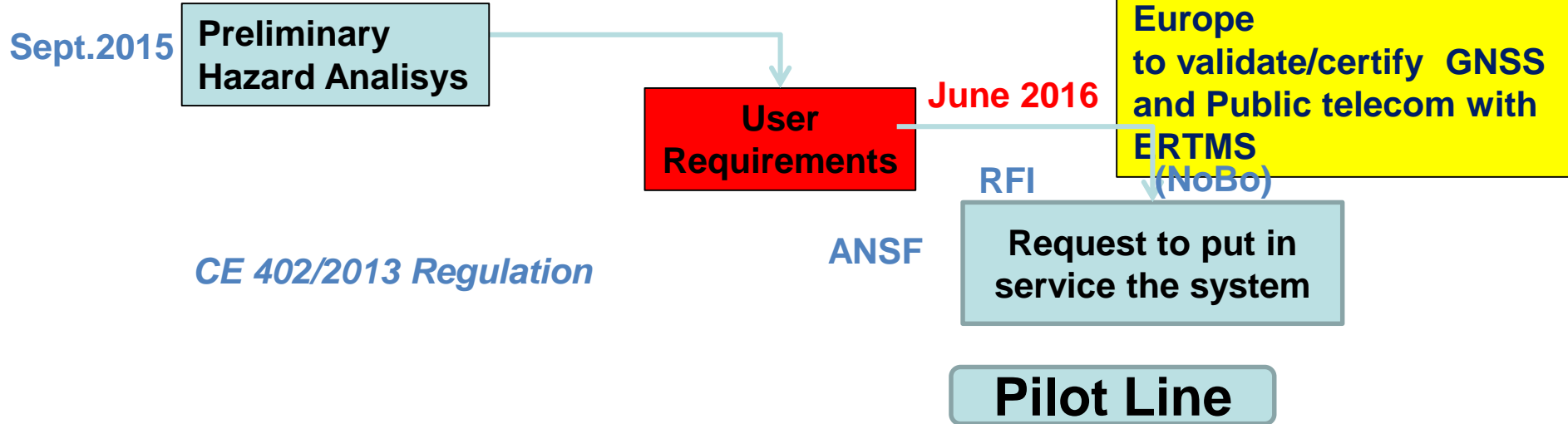
- **The Safety Case must be set up with the service levels required by the operators of the service**

Support and involvement of experienced ASI, ESA and GSA are required

Space and ANSF / EUAR for Railway

User Requirements - PHA

RFI has activated the certification process for using GNSS & Public telecom as primary communication means in the ERTMS platform

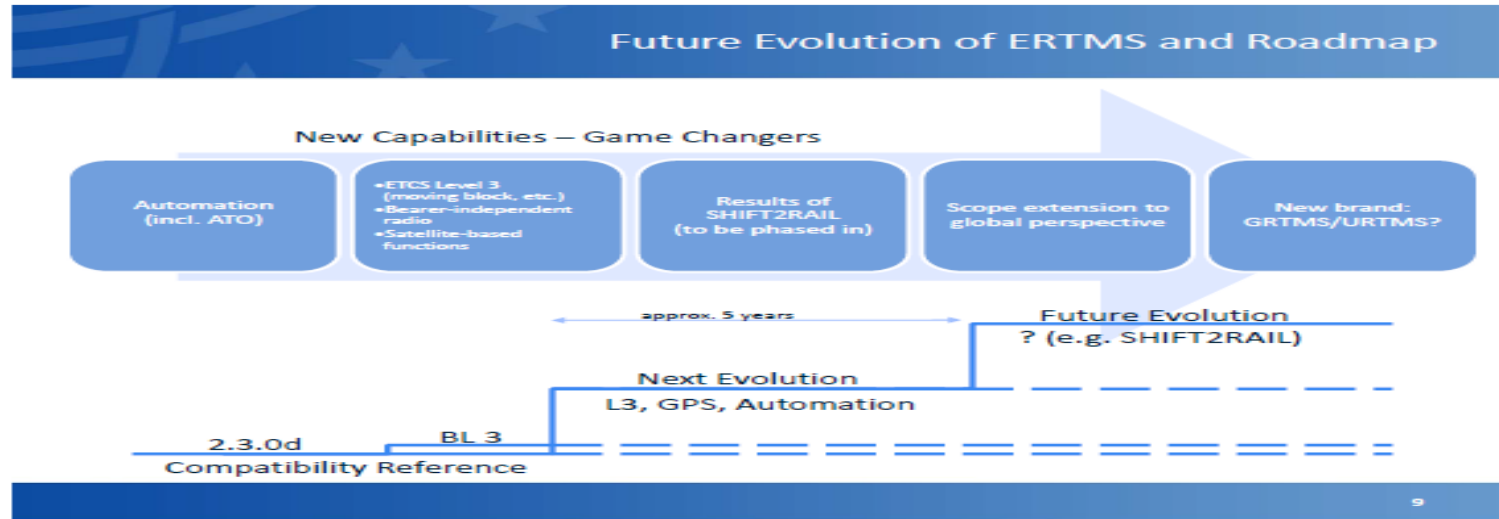


CE 402/2013 Regulation

Coordinator of technical committee & Responsible for Authorization Request to ANSF: RFI

Team of outside experts: Ansaldo STS, Radiolabs, Sogei, Telespazio

Game Changers



ERSAT exploits the potential benefits of **GALILEO & ERTMS** to innovate ERTMS with newest technologies impacting the «vehicle automation» landscape....and synergy with **driver-less cars innovation** as valuable resource → **ANAS-RFI**, first opportunity on cross-technology fertilization between two sectors with mutual benefits on **rail know how** and new technologies being *mass-developed* for intelligent vehicles & roads

Conclusions

- The **Virtual Balise Concept** is now a reality. The Sardinia Trial Site demonstrated that the proposed ERTMS based on the satellite LDS correctly works.

- The **Swit** region

- **Bar** frequency

- **Add** EGN

- **Star** gua

***SAT technology +
Euroradio over public bearer +
ERTMS L2/L3***

*appear as a feasible way for achieving
a safe and sustainable (for Total Cost of Ownership -
TCO) railway (at least in the regional low traffic
domain)*

*provided that benefit are equally shared among IM
and RUs*



m.ciaffi@rfi.it

Thanks for your attention