ERTMS & the Game Changers

ERTMS National Plan - Rete Ferroviaria Italiana (RFI)

RFI
RETE FERROVIARIA ITALIANA
GRUPPO FERROVIE DELLO STATO ITALIANE

Informazione ad uso interno

RFI: National Railway Infrastructure

Network :	**16.829 km**
Double track	*7.731 Km*
Single track	*9.098 Km*
Power supplied lines	*12.184 km (72.3%)*
Tunnels and bridges	1.980 km
Stations	2.200

Signalling technologies

SCMT (Class B)	*13.324 Km*
SSC (Class B)	*2.539 Km*
ERTMS HS (Class A)	*878 Km*
ERTMS Conv. (Class A+B)	*210 Km*
GSM-R	*11.700 km*
IXL	1.677 (~21% Electronic IXL)

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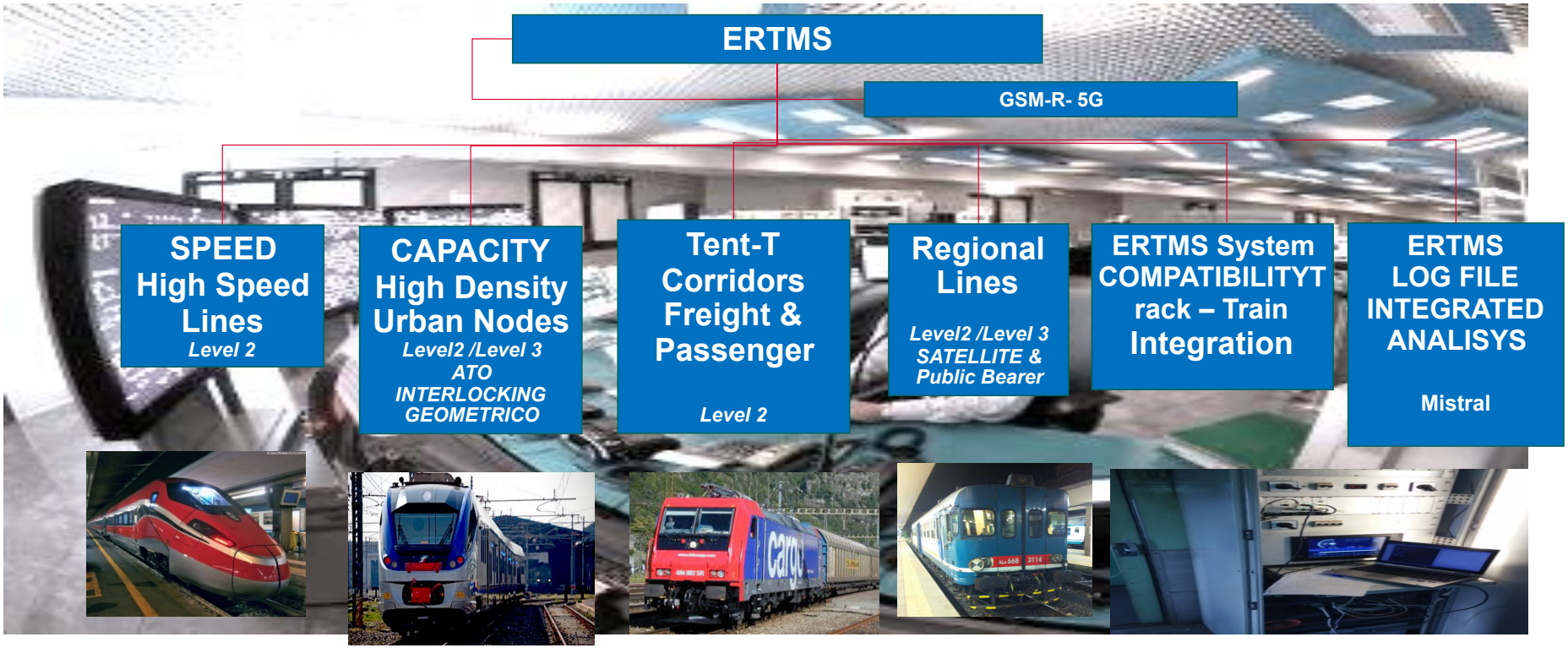
ERTMS Portfolio Application in RFI



ATO: AUTOMATIC TRAIN OPERATION (CAPACITY; DRIVELESS; ENERGY SAVING)

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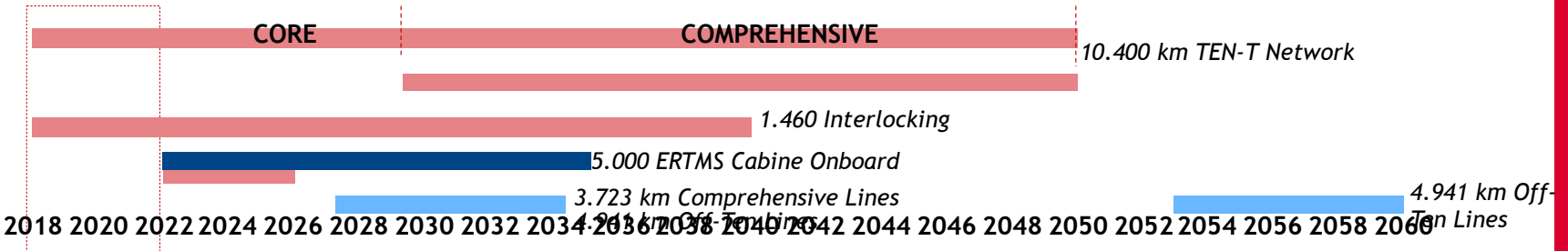
Technological Scenarios Analisys

Scenario 0

Only TEN-T Netwok

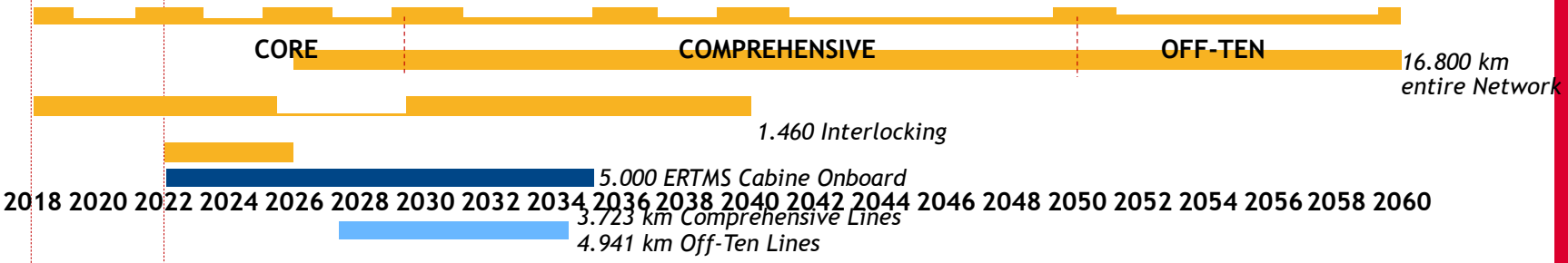
ERTMS not accelerated Plan



Scenario A

All Netwok

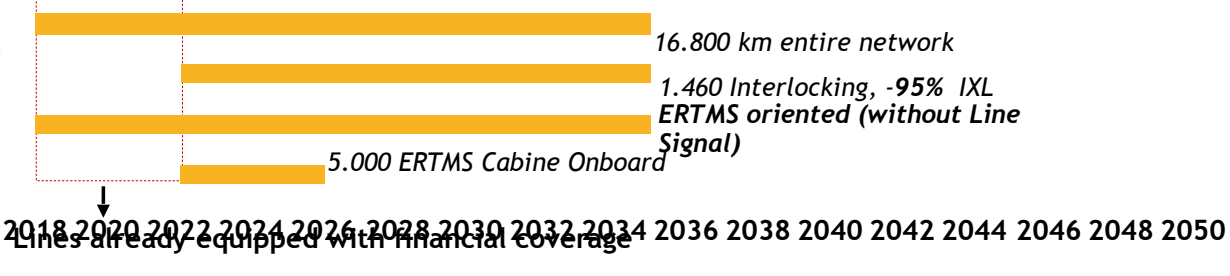
ERTMS not accelerated Plan

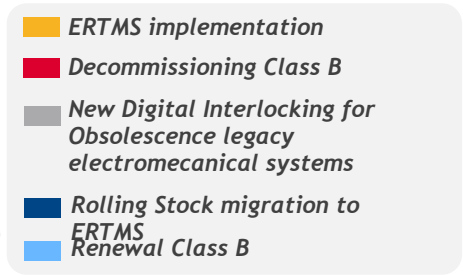


Scenario B

One System for All Netwok

ERTMS accelerated Plan





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The change of national strategy to embrace the migration to ERTMS

The switch underway to attain a more effective strategy:

from Dual Trackside → *to* → *Dual Onboard*

The experience of dual trackside: ERTMS + Class B system is showing considerable shortcomings:
higher costs for double maintenance and limited performances

The new *Dual On Board* strategy proposed by RFI/FSI means to process in parallel:

- ✓ the ERTMS trackside deployment,
- ✓ the decommissioning of Class B
- ✓ the upgrade/retrofit of the whole operating fleets

	ERTMS	HS LINES (ERTMS L2)	CONVENTIONAL LINES (ERTMS L2/L1 + CLASS B SYSTEM)
IN OPERATION	900 KM	270 KM	
IN COSTRUCTION	100 KM	900 KM	

The Cost-Benefit Analysis that accompanied the proposed initiative, shows that the most effective way to implement ERTMS is accelerating the deployment over the whole network.

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The ERTMS Accelerated Plan trackside: technical - financial dimension

A great challenge for the whole country and a new governance of investments

The ERTMS National accelerated Plan consists of:

Accelerated and extended ERTMS over the *whole* railway infrastructure (IT: 16.800 km) *by 2036* (TEN and Off-TEN)

Synchronized and harmonized ERTMS (trackside/on-board) deployment

Simultaneous decommissioning of the national Class B system, with incentives for the RUs, as of 2023

Technological renewal of Control Command and Signaling (CCS) (Digital Interlocking, Traffic Management System (TMS), TLC (GSM-R/FRMCS based), and ERTMS/ETCS), coordinated and driven by ERTMS system

INTEGRATED MULTI-TECHNOLOGICAL PLAN AND REALIZATION OF INVESTMENTS DRIVEN BY ERTMS

ERTMS L2	Interlockings	TLC	TMS	TRACK CIRCUITS AUDIO FREQUENCY

THE WHOLE ERTMS TRACKSIDE PLAN requires a total budget of 13B€ and 2022 - 2026 deployed with resources granted BY EC RECOVERY PLAN (3B€)

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Source: ERTMS Rev.P Plan

RFI Tender Strategy for Trackside

Multitechnological approach (Digital IXL, ERTMS L2, GSMR) + Geographical Uniformity
≈1.400 km up to 2024
≈2.000 km up to 2026 (3.400 km)
1.200 km up to 2027

1° Multitechnological Framework Agreement EU Tender
- 1 Geographical Section -
August 2021 - Assigned April 2022

- Roccasecca - Avezzano ≈ 80 km
- Sicilia ≈ 583 km
- FCU* ≈ 150 km

* FCU present even if it is not included in the ERTMS Accelerated Plan

2° Multitechnological Framework Agreement EU Tender
- 4 Geographical Section -
December 2021 - Assigned June 2022

- 2023 ≈ 350 km
- 2024 ≈ 430 km
- 2025 ≈ 860 km
- 2026 ≈ 1.160 km
- 2027 ≈ 1.200 km

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Framework Agreement Phase 1 and Phase 2

2 EU Tender (2021-2022) with 4 Multitechnological (ETCS, IXL, TLC) Supplier Winner : Hitachi, Alstom Progressrail MerMec

500 Mio€	2,7 Mrd€

Multitechnological Framework Agreement Phase 1 ERTMS Plan lines: Sicilia and Roccasecca - Avezzano

Roccasecca-Avezzano (pilot line)
≈ 80 km

Sicilia (first implementation)
≈ 583 km
Canicattì-Siracusa + lines of 2024

≈ 663 km up to 2024 (RF - PNRR- ERTMS)

Additional 152 km for two lines not included in the ERTMS Plan (Ferrovie Centrali Umbre)

ERTMS Plan Multitechnological Framework Agreement Phase 2

LOT 1 CENTRAL-NORTH Italy ≈ 1.887 km
DOIT: Firenze, Milano, Torino, Venezia, Verona, Bologna, Genova, Trieste

1,3 Mrd

LOT 2 CENTRAL-SOUTH Italy
≈ 1.396 km
DOIT: Roma, Napoli, Bari, Cagliari

900 Mio€

LOT 3 CENTRAL of Italy
≈ 534 km
DOIT: Ancona

323 Mio€

LOT 4 SOUTH of Italy
≈ 407 km
DOIT: Reggio Calabria

251 Mio€

≈ 777 km up to 2024 and ≈ 1840 km up to 2026 (RF -PNRR- ERTMS)
≈ 175 km for ERTMS Plan lines at 2025 and 2026 (not financed by RF -PNRR ERTMS)
971 km for lines at 2027 + additional 460 km as backup at 2027

Additional 250 km of lines to be contracted under the ERTMS Rev.P Plan in DOIT Palermo by 2026

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Maximize ETCS Geografical uniformity and distribute Interlocking effo

The Accelerated ERTMS Plan conditions

1. Authorization for the infrastructure manager to decommission the legacy system before 2026
2. Making the programs already in progress for the Digital IXLs realization (250/1511 already realized) and for the GSM-R extension (13.000/16.800 already covered) harmonized with the ERTMS Implementation Plan (reinforcing GSM-R and realizing Digital IXL ERTMS-Oriented)
3. Definition of an ERTMS deployment plan on the rolling stock coherent with the ERTMS lines equipment programs managed by Infrastructure Manager
4. Appropriate production capacity of the infrastructure manager, railway undertakings and suppliers (1.150 km/year of ERTMS and 100 IXL ERTMS-oriented/year)
5. Definition of a scheme of financing for the whole system (trackside and on-board system)

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The Accelerated ERTMS Plan

Deployment ERTMS on ≈ 16.800 km railway network

≈ of which 800 km HS already activated until 31.12.2022

2019 Lines Ranzo-Luino e Iselle-Domo

2020 Line Domo-Novara via Borgomanero

2022

Works in progress on all BT Program lines

Ago - Tender National Plan started for **500 mln on 700 km**

Dic - Tender National Plan started for **2.700 mln on 4.200 km**

2026

2030

Completion ≈ **5.800 km** Core Network

2036

Completion ≈ **16.800 km** on entire network

Breakthrough Program ≈ 1.350 km mainly core network

360 km already activated in 2022 and ~ **990 km rimanenti** will be activated on the plan

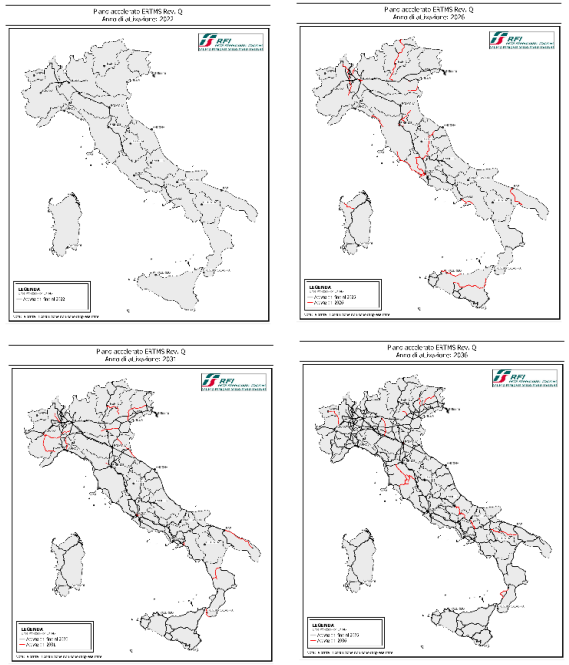
Accelerated Plan - 1^ phase (PNRR) ≈ 3.400 km conventional network

Accelerated Plan - network completion

About 5.800 km core network to activate in the Plan (total accelerated plan until 2032 10.505 km)

rate deployment ≈ 1.150km/year and adjustment ≈ 100 ACC/year

Acceleration of **ERTMS deployment at 2036** on the entire network and contextual adjustment Interlocking, upgrading/ extention GSM-R, traffic supervision and regulation systems (SCCM) and decommissioning of the existing SCMT system.



Vantaggi

- Improved Safety Standards
- More Interoperability
- Increased Efficency
- Augmented Capacity Performances
- **Future integration** for European standard like 5G, Satellite, ATO and FRMCS

The **infrastructure investments**, included preparatory technology are estimated in about **13 billions.**
The interventions will affect the entire **network in operation** and must be **coordinated** with the **on-boards equipping.**

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Accelerated Plan- scenario 2024(*)
ERTMS L2 Stand Alone

CANICATTI' - SIRACUSA (tratta SIRACUSA-MODICA)
ROCCASECCA - AVEZZANO
CALTANISSETTA XIRBI - ARAGONA-CALDARE
LERCARA DIRAMAZIONE - AGRIGENTO CENTRALE
LAMEZIA TERME CENTRALE - CATANZARO LIDO

(*) Compatibly with the availability of fleets equipped with ERTMS.

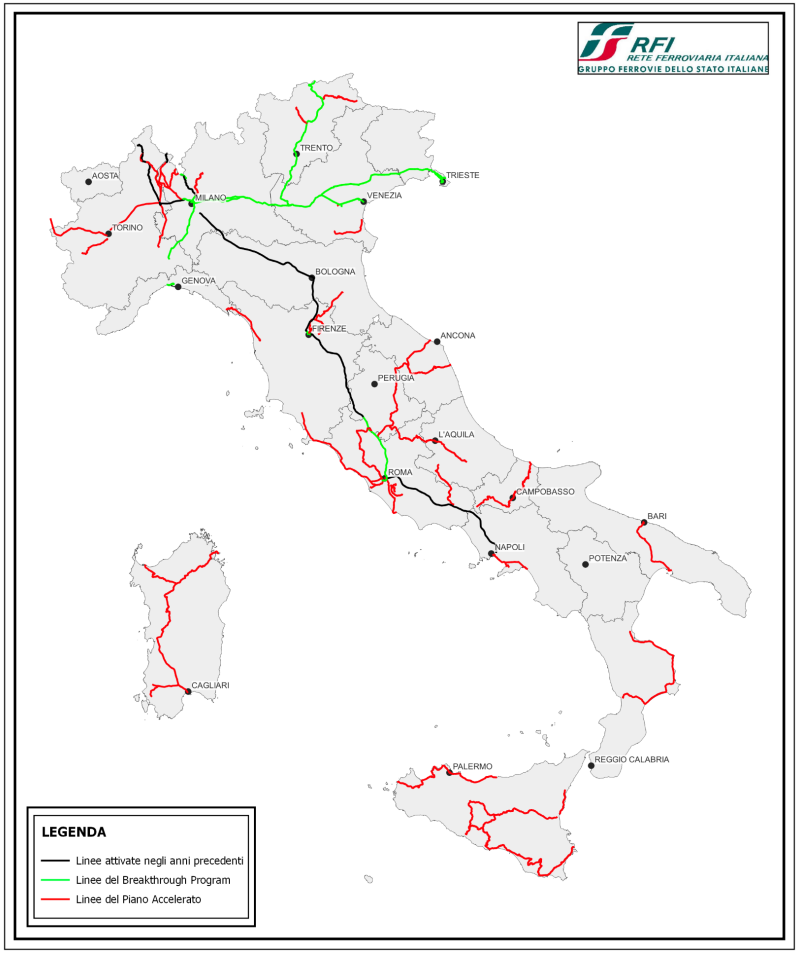
Breakthrough Program – scenario 2024
ERTMS L1/L2 + SCMT

Chiasso smistamento- Bivio Pc Rosales (MO1)	Pioltello - Brescia -Vicenza - Padova
Vicenza - Treviso - Portogruaro	Completamento DD.ma FI-RM (ERTMS L2 Stand Alone)
Brennero - Verona (Tratta Trento - Bolzano))	

Breakthrough Program – scenario 2026
ERTMS L1/L2 + SCMT

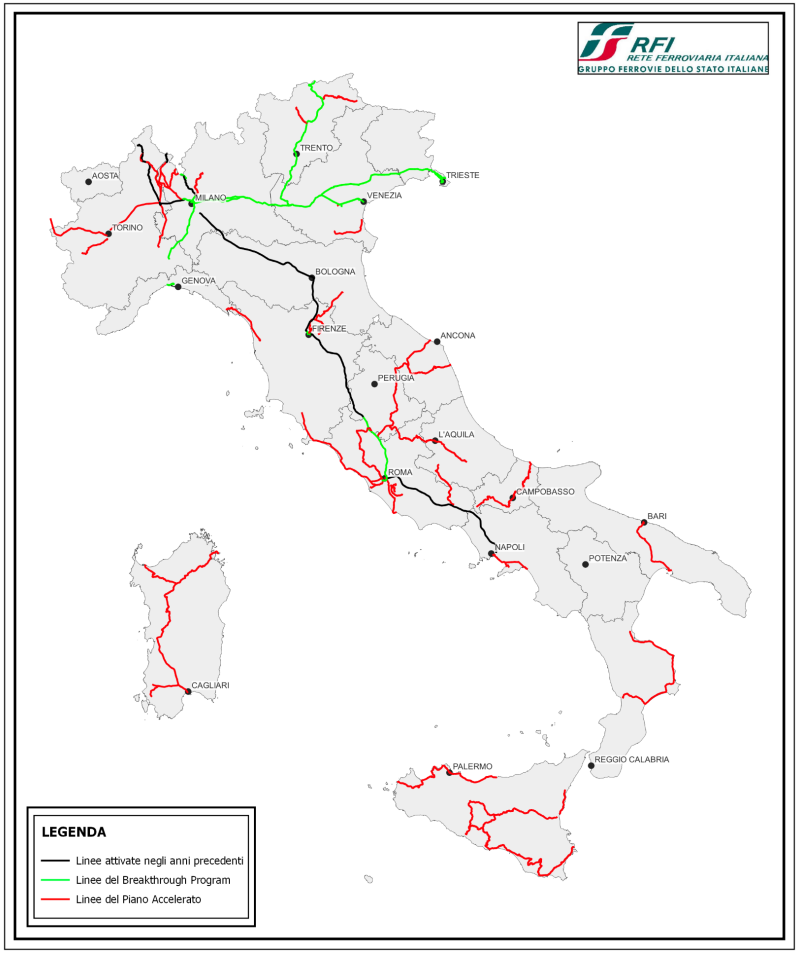
Monza - Milano C.le e Milano Sm.to	Portogruaro-Villa Opicina-Trieste
Milano - Genova (via Tortona)	Brennero - Verona (completamento)
Padova - Venezia	

Introduzione TPL Lungo percorso Merci Piani nazionali



Accelerated Plan - scenario 2027
ERTMS L2 Stand Alone

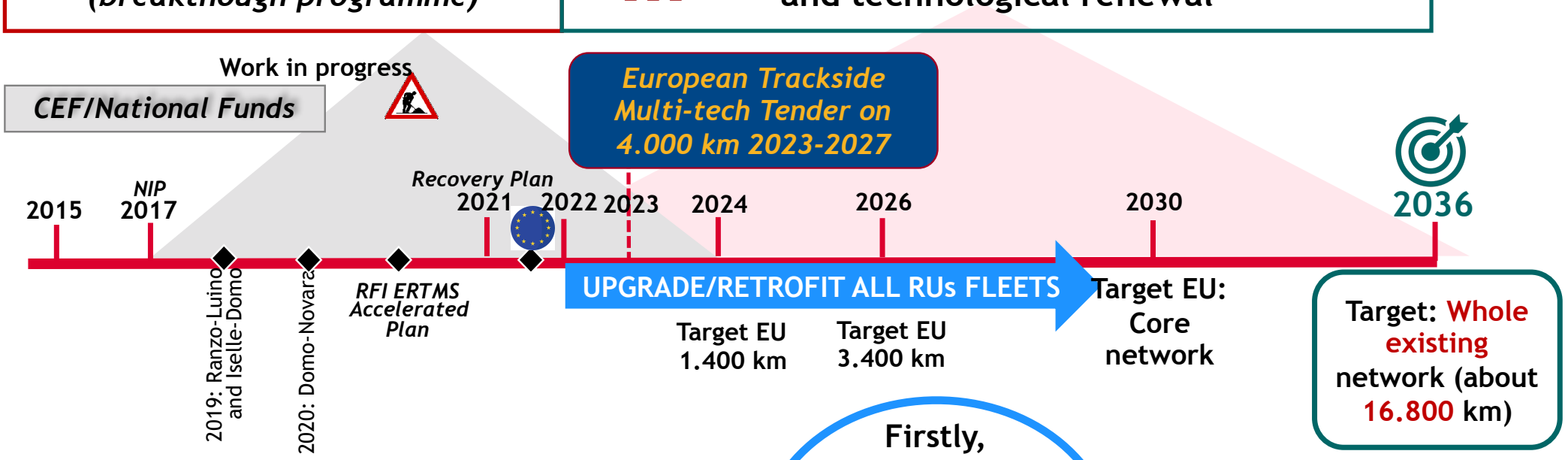
CANICATTI' - SIRACUSA (tratta Gela-Canicatti-Modica)	P.M. BEVERA - STABIO	ARONA - VIGNALE
DECIMOMANNU - CARBONIA STATO	PALERMO CENTRALE - TRAPANI (Tratta da Piraineto a Trapani (via Milo))	GALLARATE - VARESE - PORTO CERESIO
VILLAMASSARGIA-DOMUSNOVAS - IGLESIAS	BIVIO SANGONE - TORRE PELLICE	MACCARESE-FREGENE - PONTE GALERIA
CAGLIARI - ORISTANO	ORTE - FALCONARA MARITTIMA	NOVARA - PONTE TANARO ALESSANDRIA
ALCAMO DIRAMAZIONE - TRAPANI	BORGO S.LORENZO - FIRENZE CAMPO DI MARTE	MODANE FOURNEAUX - AVIGNANA
CAMPOLEONE - NETTUNO	SIBARI - CATANZARO LIDO	NAPOLI CENTRALE - S.Giovanni Barra - Nocera Inferiore
CIAMPINO - VELLETRI	ROMA TERMINI - POMEZIA - CAMPOLEONE	CASTELBUONO - PALERMO CENTRALE
CIAMPINO - ALBANO LAZIALE	LAVENO-MOMBELLO - GALLARATE	BARI PARCO NORD - TARANTO
CIAMPINO - FRASCATI	LUINO - OLEGGIO	FIUMEFREDDO - CATANIA
MERANO - DEV. ESTREMO BOLZANO	SALERNO - ARECHI	Nocera Inferiore - Salerno
CIVITANOVA MARCHE - ALBACINA	GROSSETO - CIVITAVECCHIA - ROMA S.PIETRO	TERMOLI - VENAFRO (Via Campobasso)
TERNI - SULMONA	TORINO (e) - SETTIMO - NOVARA (Chivasso - Novara)	PIRAINETO - PUNTA RAISI
ORISTANO - CHILIVANI	PADOVA - GS MONTA'	PALERMO CENTRALE - TRAPANI (Tratta da Palermo Centrale a Piraineto)
MONZA - MOLTENO	DOMODOSSOLA - ARONA - RHO	LERCARA - BICOCCA
LECCO - MOLTENO	PONTASSIEVE - FAENZA	TORRE ANNUNZIATA C.LE - GRAGNANO (1 impianto; 4,75 Km)
S.CANDIDO -FORTEZZA	ROVIGO - CHIOGGIA	LA SPEZIA CENTRALE - PISA CENTRALE
CHILIVANI - OLBIA - GOLFO ARANCI	ATTIGLIANO - VITERBO PORTA FIORENTINA - ROMA OSTIENSE- FIUMICINO AEROPORTO	OZIERI-CHILIVANI - PORTO TORRES MARITTIMA
DEV.CHIL.LATO MACOM.(BRETELLA) - DEV.CHIL.LATO P.T.(BRETELLA)		



Milestones of the ERTMS Accelerated Plan trackside/onboard

Previous strategy: Dual on Track
(breakthough programme)

New Accelerated Plan: Dual OnBoard and technological renewal



	Until 2026	2027-2030	2031-2036
Core network	40%	60%	
No Core network	26%	22%	52%
Off TEN	30%	8%	62%

Firstly, investments on regional off-ten network (smaller fleets) as requested by RUs

Core TEN-T: ≈5.800km
No Core TEN-T: ≈4.600km
Off-TEN: ≈6.400km
Globale TEN-T

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ERTMS TREE

Off-TEN Network

TEN-T Network

Breakthrough Program

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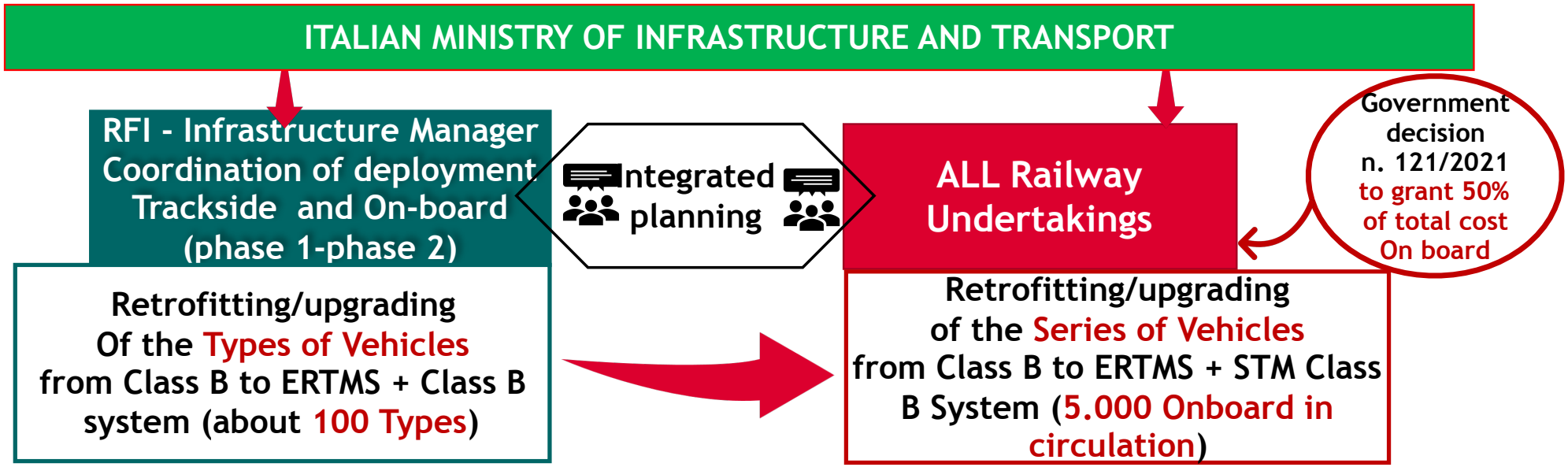
ERTMS ON BOARD: IT retrofit/upgrade strategy for the Circulating Fleet



This model *will be successful in EU* if:
Incentives on Series and Vehicles are granted up to 100% of the cost for ALL Rus
(Denmark, Great Britain, Netherlands, Belgium)

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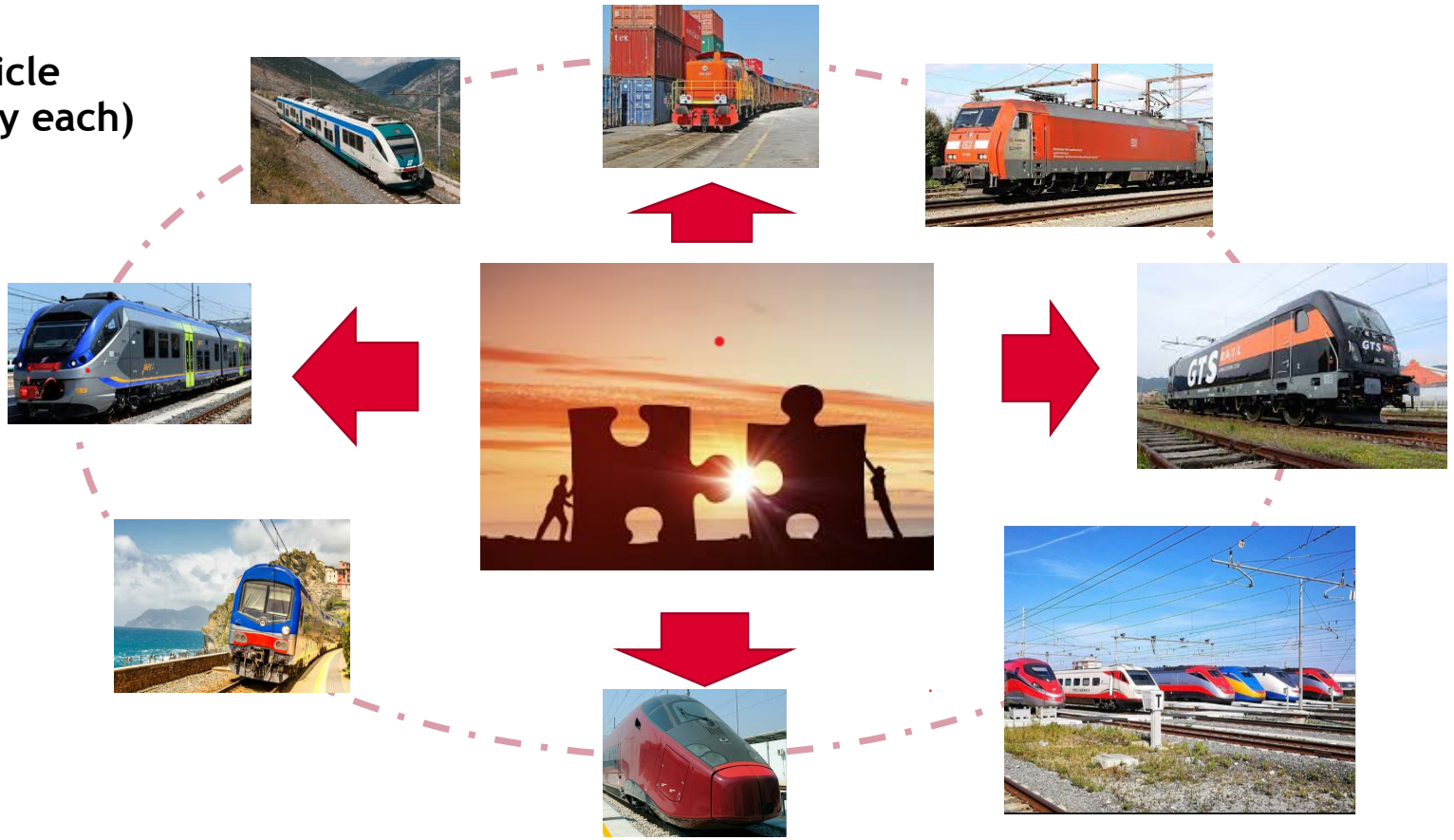
Permanent Coordination of Stakeholder

Since 2019 MIT- RFI - NSA- RUs- ASSIFER (industrial association) Consultation Table Planning of the introduction of ERTMS for each Class B decomissionig line and Type of vehicle

101 Type : upgrading from existing Class B SCMT (80% ERTMS prefitted components) to ERTMS B3 R2 + STM SCM

3800. Fleet Vehicle (upgrading : 7day each)

4 CCS Generic Application



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ERTMS plan: Retrofitting/upgrade strategy for onboard ERTMS (2022)

Phase 1: Negotiation activity by RFI for the assignment of the necessary services limited to the development of only the 4 Generic On-board ERTMS Applications from SCMT to ERTMS and a further 2 optional for upgrading Basline 2 to 3 ERTMS, with relative Authorization for Use and AISM of the early vehicle types. The invitation letters were sent on July 4th - offer deadline July 22nd;

Phase 2: Award procedure by RFI for the renewal/refurbishment of all other Vehicle Types and AISMs circulating in Italy (102) by December 2022 .

Phase 3: Assignment procedure by RUs for the renewal/refurbishment of onboard units (5000) of series machines (3800 Rolling Stokes vehicles) compliant with the Vehicle Types circulating in Italy to be started from December 2022. Use of state incentives for state aid for RUs (DL 121/2021) the phase of EU approval to increase aid up to 100%

Industrial criticality found: In the event that the on-board signaling supplier does not coincide with the vehicle manufacturer, there is a lack of collaboration at an industrial level for the adaptation of the vehicle and for obtaining the AISM from ANSFISA (NSA).

This entails a rise in costs and an increase in the time required for carrying out the work itself and a risk for the entire ERTMS Programme.

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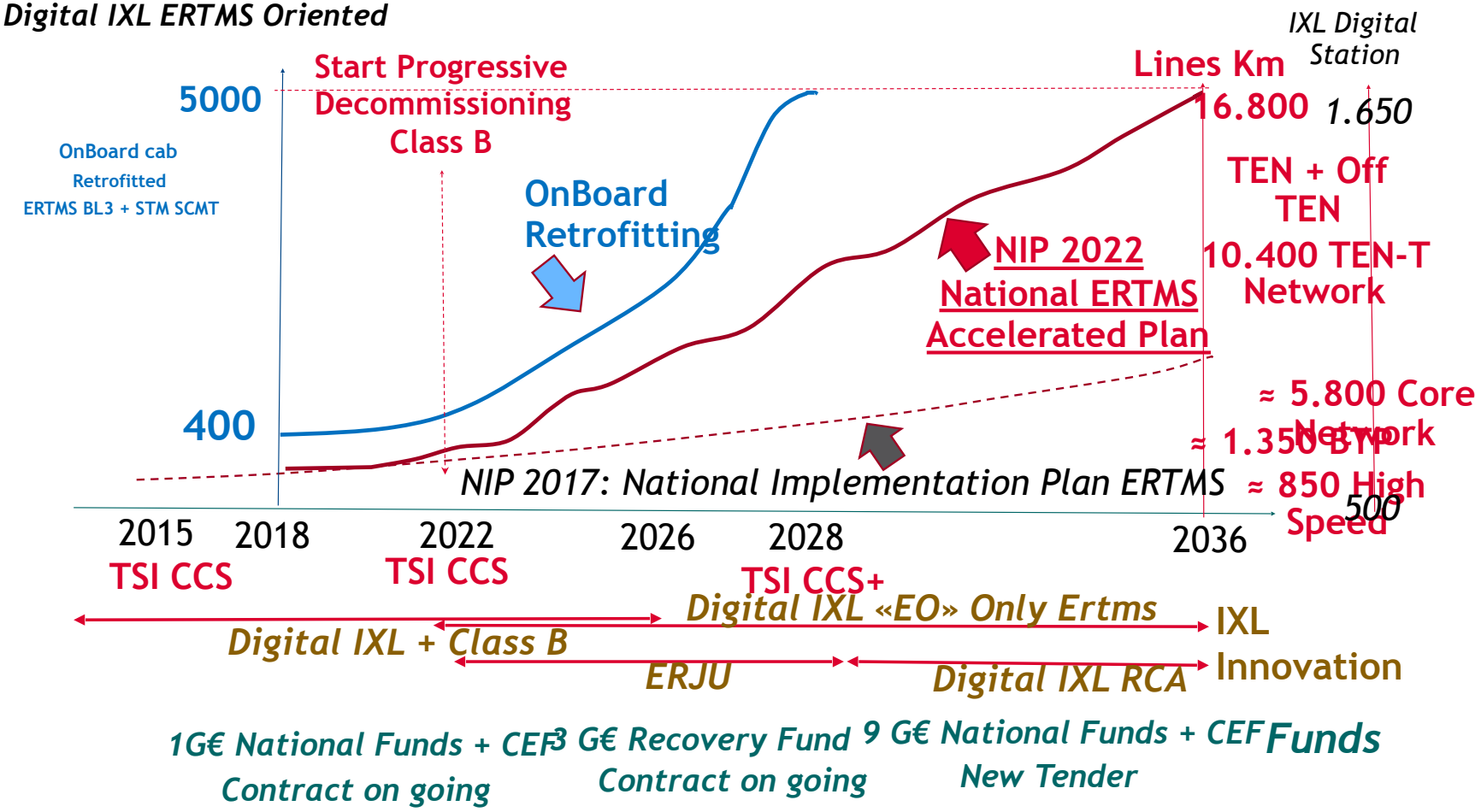
Forecast ERTMS Trackside and OnBoard migration

BTP Breakthrough Program
IXL «EO»: Digital IXL ERTMS Oriented



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ERTMS deployment: challenges and risks

Especially in the context of ambitious and large-scale implementation plan, it becomes essential the following challenges

Public funds for the ERTMS deployment track side/on board

Public funding has to be available also for updating on-board systems as represent an integral part of the trackside signaling system. Lack of public funds for the RUs risk to slow down the ERTMS implementation plans.

Deployment vs Innovation: Dynamic System Version Management (Multi TSI)

The introduction of innovation contained in new TSI version has to take place in a compatible way of the deployment of previous TSI (i.e. without interrupting the operation of vehicles that have not yet been updated) . This must be possible in a "dynamic" way in ETCS radio application (level 2 or 3) , in order to follow baseline migration and not to lose the investments already made.

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The upcoming challenges and Game Changers : High Density

High Density projects for increase punctuality in *Urban Nodes* traffic

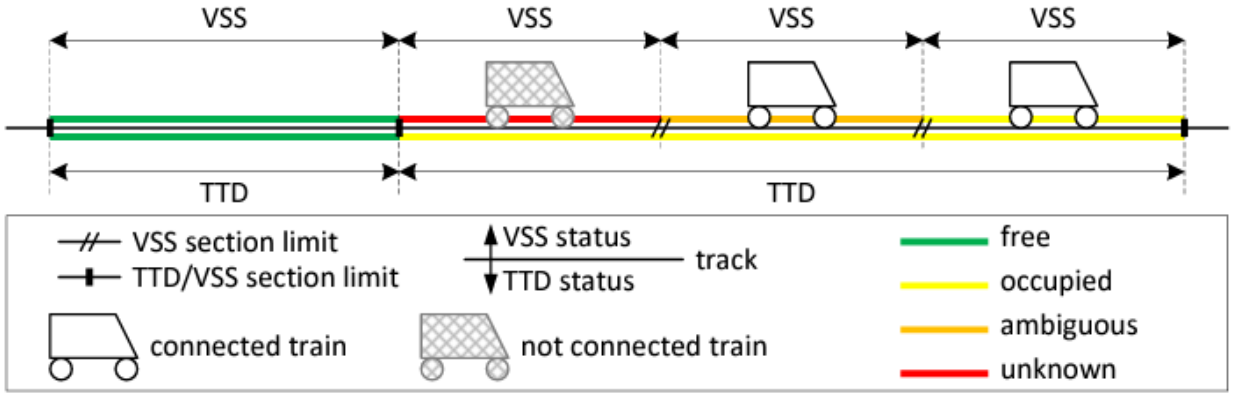

Figure 1: Section conventions

ERTMS High Density (IT)
ERTMS Hybrid

Initially Mixed traffic → Best case: ERTMS only

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The upcoming challenges and Game Changers : Geometric Interlocking

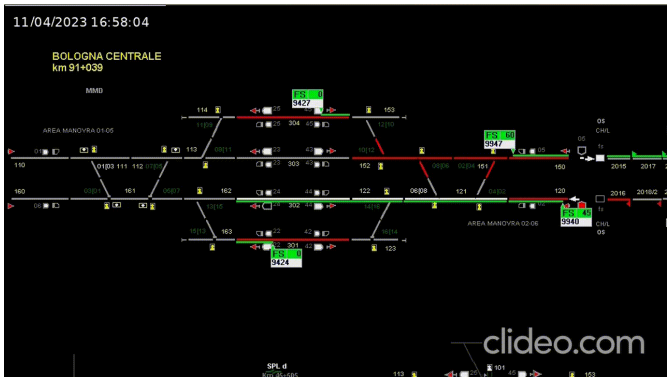
Optimization station logistics with *Geometric Interlockings*

Braking curve model optimisation, for improvements through the balance between safety and capacity requirements;

New CCS (eg IXL ERTMS oriented/geometrical interlocking)

The facilitation of the introduction of digital technologies in rail through modularisation. It includes work primarily on changes linked to CCS

Enhancements to ERTMS technical and operational harmonisation



Initially RBC+IXL

Best case: new CCS

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The upcoming challenges and Game Changers : L3

Introduction of ERTMS Regional *L3*

Provisions to allow for the deployment of ETCS Level 2 with moving block (formerly Level 3), which increases capacity and reduces trackside life cycle costs;

Onboard train integrity, complementing the provisions above and providing a significant opportunity for cost reduction in trackside equipment

Initially RBC+IXL

Best case: new CCS

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The upcoming challenges and Game Changers : ATO

Automatic Train Operation: *ATO over ERTMS*

[GoA] 2, 3, 4), reducing energy consumption and increasing capacity

Further enhancement of safety and efficiency of manoeuvres, through the (supervised) mode of supervised manoeuvres replacing the unsupervised shunting mode.

SHIFT2RAIL

SYSTEM PILLAR

INNOVATION PILLAR

FA1 TMS

FA2 ATO

From GoA2	To GoA3/4
Highly automated driving	Fully automated driving

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The upcoming challenges and Game Changers : Satellite

Localization of trains in ERTMS with *satellite* technology

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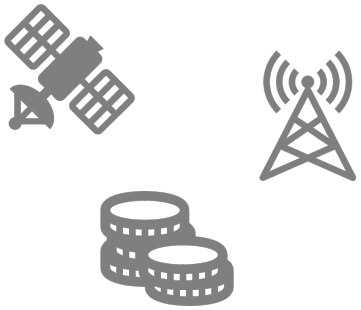
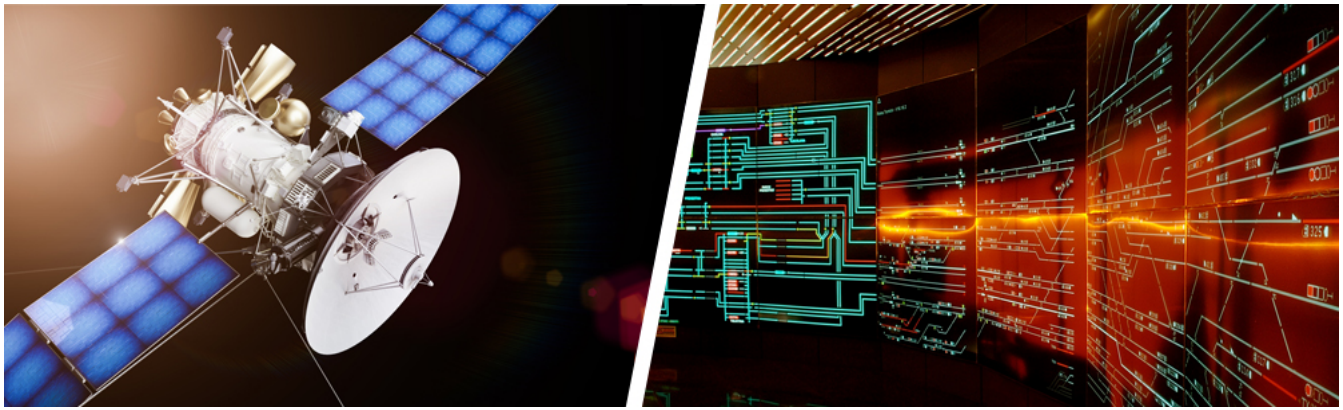
ERSAT: ERtms + SATellite

ERSAT began as an R&D project program aimed at integrating **satellite technologies** and **public TLC networks** into the **ERTMS evolution plan.**

Objectives:

- Improving the train positioning system
- Increasing line efficiency and capacity
- Reducing installation and management costs of ground equipment
- Facilitating the deployment of ERTMS on local and regional lines





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Challenges

- VIRTUAL BALISE DEPLOYMENT
- DFMC GNSS RECEIVER STANDARDIZATION
- GNSS AUGMENTATION SYSTEMS (LOCAL OR SPACE-BASED)
- ENHANCED ODOMETRY
- ON-BOARD TRAIN INTEGRITY
- DIGITAL MAPS & TRACK IDENTIFICATION
- CYBERSECURITY & SYNERGIES WITH OTHER SECTORS

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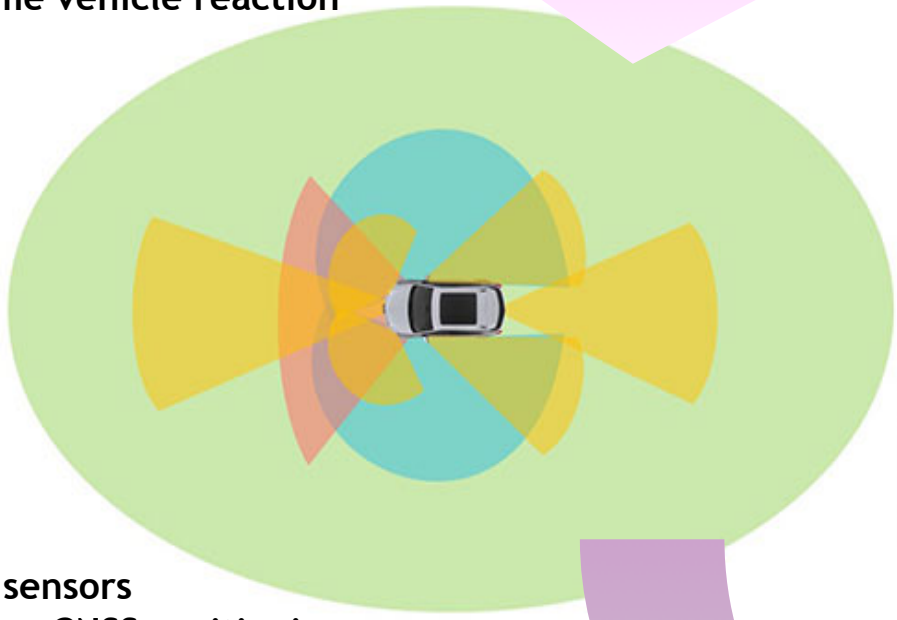
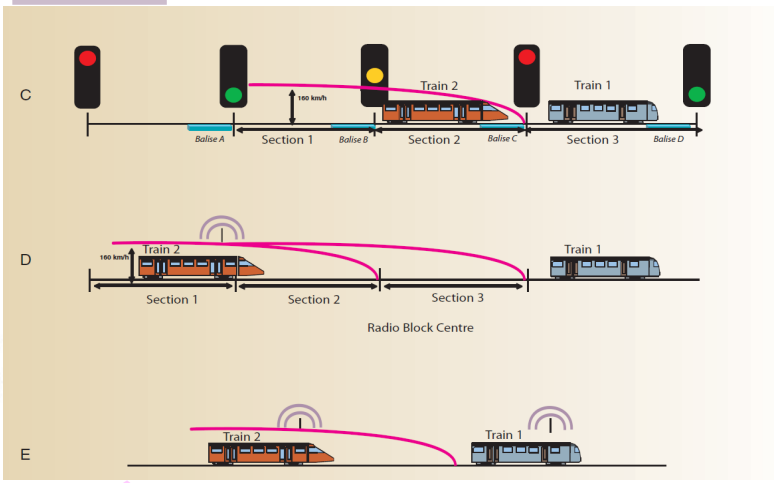
Rail and roads synergy

High accuracy and safe localization
Real-time vehicle reaction



New sensors
Video – GNSS positioning
Computerized road infrastructures

Automated train control
centralized intervention in the event of exceeding the speed limits or not complying with the stop signal



"Centralized" control
and autonomous vehicle

Technology exchange between Railway and Road sectors to exploit satellite innovations on a larger scale and develop sustainable transport infrastructures

ER²TMS (?)

→ *RAILWAYs*
→ *ROADs*

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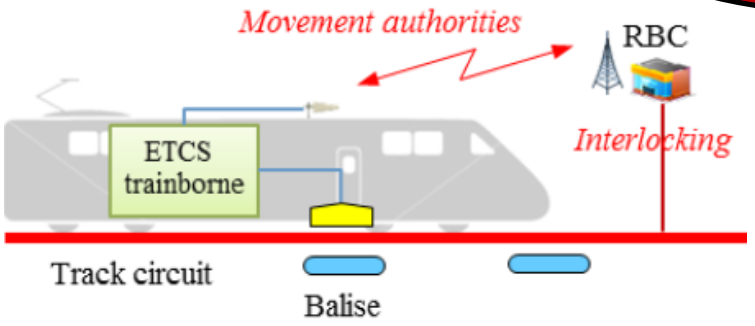
RAIL & ROAD SYNERGY: SMART MOBILITY

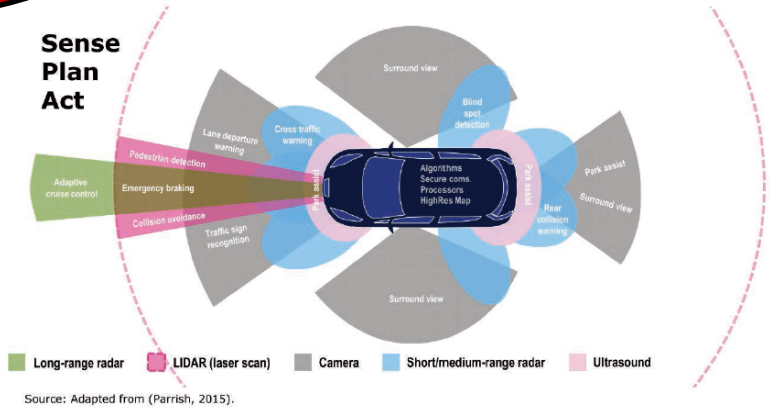
16.700 km of railway lines

26.400 km of

RAIL AND ROADS CAN SHARE ENABLING TECHNOLOGIES FOR SMART MOBILITY



Train control system
ATO e Driveless GoA4
Grade of Automation



Source: Adapted from (Parrish, 2015).

Autonomous driving

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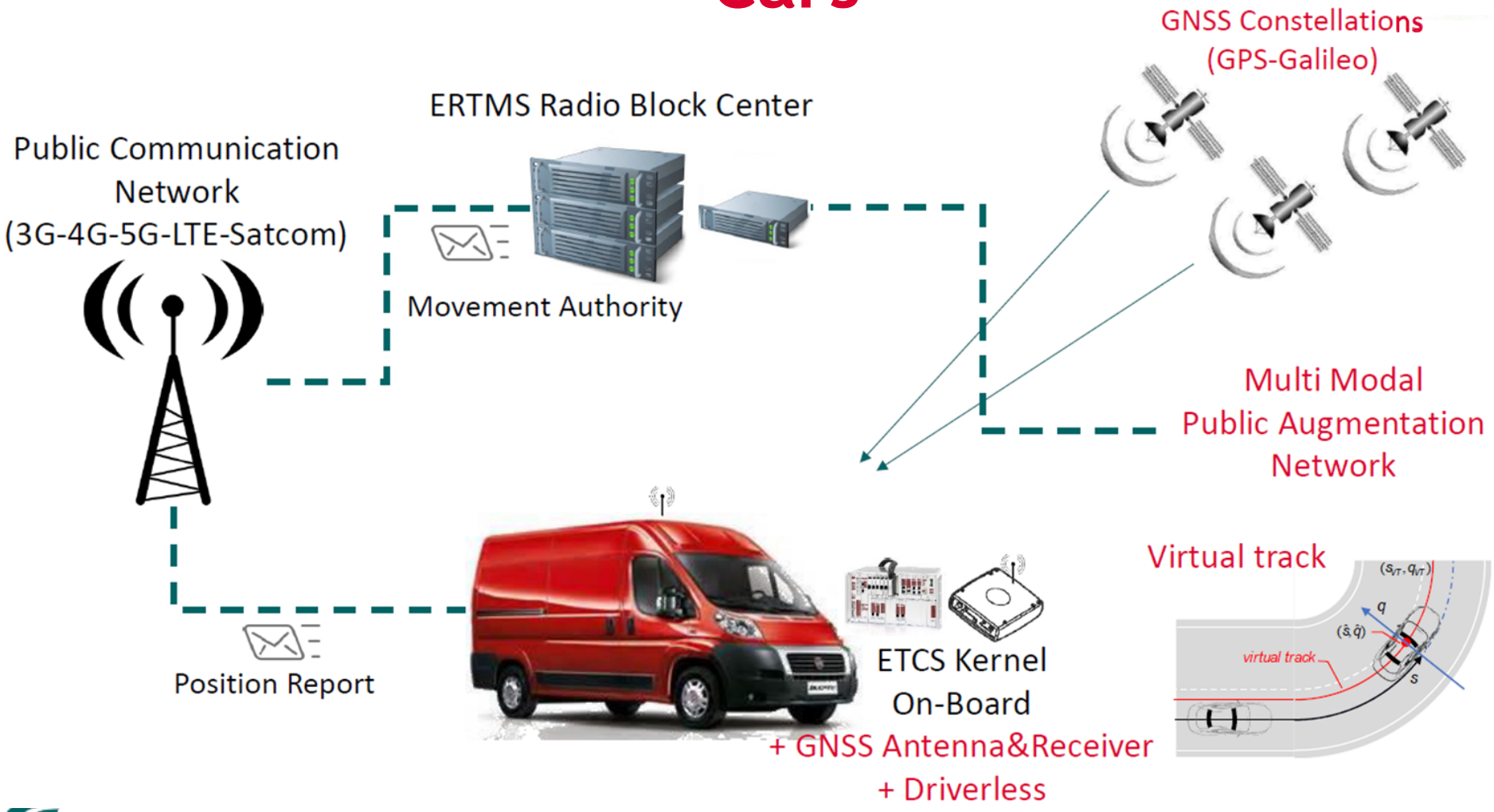
Applying the ERTMS principles to the Connected Cars



The upcoming challenges and Game Changers : FRMCS

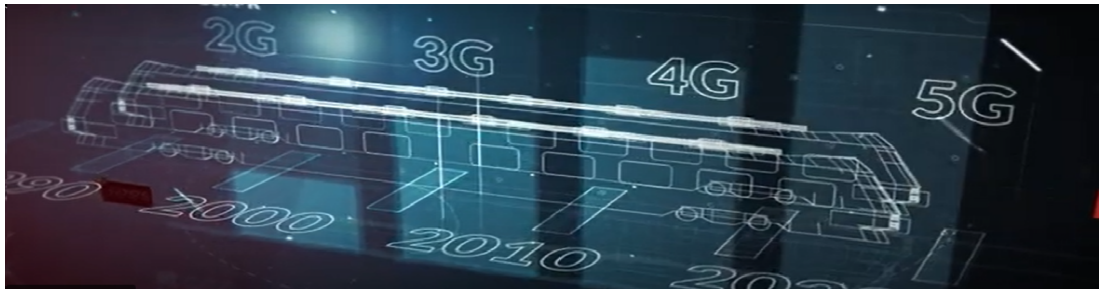
Migration towards *FRMCS (2025-2035)*

Readiness for the future Radio Mobile Communication System (FRMCS),

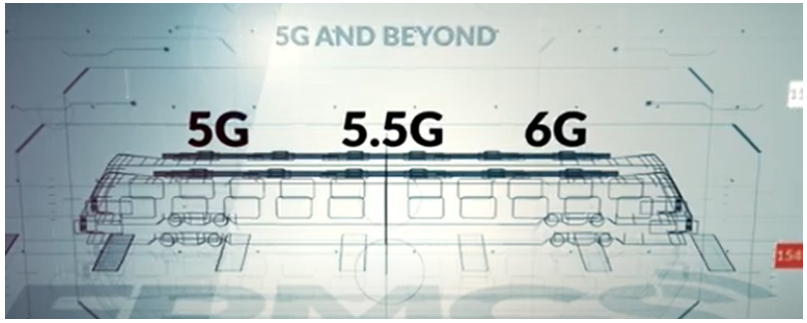
Increase volume of data → To enable new functionalities as ATO, IoT, Smart Maintenance

Replace GSM-R : today deployed over 130.000 km in Europe and 210.000 kn Worldwide

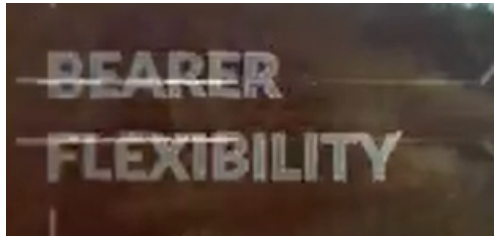
GSM-R phase out 2030



Global Com Standard



Compatible with WIFI, public 5G, Satellite



Based on IP protocol
Flexible
INTEROPERABLE

Thank you.

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GRUPPO FERROVIE DELLO STATO ITALIANE

Informazione ad uso interno