ERTMS in Italy: 
The Baseline 2 and Baseline 3 experience

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ERTMS in Italy: State of the art

**ERTMS on Corridors** (3000km)
- A
- B
- C
- D

**ERTMS on High Speed/High Capacity Network**
- 750 Km ETCS L2 in operation (200tr/day)
- 450 Km ETCS L2 in construction (2017)

Benefit for integration of two Italian ETCS Project:
- HS/HC
- Corridors

ERTMS Corridors investment reuse RFI network technology GSM-R & SCMT (Eurobalise + Encoder) already in operation (11000km)

Pilot Line Baseline 3 overlapped on national system
- ETCS L2 Corr D Pioltello - Treviglio
- ETCS L1 + Radio Infill (Sicily)
- ETCS L2 + public bearer and Satellite (Sardinia)
- ETCS L1 LS Swiss Cross Border
Migration to ERTMS: EU Obligation and Opportunities

**Baseline 2**

- Ertms for High Speed lines:
  - Torino – Naples (in operation)
  - Treviglio Brescia (2016) – Venezia
  - Roma Firenze only with ERTMS (2018)
  - Napoli – Bari;
  - Milano Genova;
  - Roma Naples – upgrading from 2.2.2 to Baseline 230d (2016)

**Baseline 3**

- Ertms for conventional lines
  - Corridors EU: 3000km (2020)
  - Decision 2012/88/EU (CCS TSI) - 7.3.2.5 Annex III: 4000 km
  - Performaces:
    - Increase capacity in Node
    - increase speed intercity lines
  - Technological Opportunities for low cost Regional lines
In Milano node we have an intersection between the two Corridors A and D and also High Speed Torino Venezia. Milano Greco is the Control Room where will be placed the ETCS Level 2.

**Benefit for integration of two Italian ETCS Project: HS/HC and Corridors**

Example Milano Greco: the same ETCS L2 Central Control Room for:

- Corridor D Pilot Line (construction)
- Corridor D (tendering)
- Corridor A Milano – Chiasso (tendering)
- HS/HC Treviglio Brescia (construction)
- HS/HC Milano Torino (in operation moving from Torino)
The Hispeed fleet is based on SRS ETCS 230d.

The freight or Eurocity train for ERTMS on conventional lines will be based on baseline 3.

HOW TO MANAGE IT?

- **Existing High Speed Fleet Compliant with hi-speed 230d network**
  - Use of STM-SCMT on Baseline 3 lines

- **Freight train Compliant with baseline 3 lines**
  - Technically allowed to run on Hispeed Network using SVM (an iway not planned)
ERTMS Migration principle overlapping existing Class B SCMT

SCMT uses Eurobalises and Encoder … ERTMS uses them also with GSM-R….

**ETCS L1 o L2 Full Supervision**
- Means Cab Signalling
- Using Continuous or semi continuous information by GSM-R

**ETCS L1 Limited Supervision**
- Means No Cab Signalling
- Without a semi continuous information by GSM-R
  (BL 3.4.0)

**SCMT**
- Means No Cab Signalling
- Without a semi continuous information by track coded infill
ERTMS BASELINE 2 on HS Italian network

• In commercial operation since 2005

• 750 KMs equipped by ERTMS/ETCS Level 2 without fall back at 300km/h

• 2.3.0d (ETCS) trackside system compliant

• 180 trains per day

• 5’ potential headway

• 180 ERTMS train

• ERTMS manage a real commercial competition
INTEGRATION AMONG RBCs and OBCs (Ansaldo and Alstom)

- ETR 500
- E402B
- E403
- ETR 1000 new fleet

- (n°100) Ansaldo OBC
- (n°160) Alstom OBC
- (n°5) Ansaldo RBC
- (n°6) Alstom RBC

ERTMS/ETCS level 2 Integration Safety Case

- Torino – Milano
- Milano-Bologna
- Bologna-Firenze
- Roma-Napoli

ETR 500
ETR 600
ETR 610
ETR 485
MITSUI 186 AGV
The trackside ERTMS Baseline implemented will be the **baseline 3** because it offers better performance and it’s particularly suitable for the freight traffic for the following main reasons:

- additional International Train Categories;
- additional parameterization braking curves;
- use of "permitted braking distance" for managing the application of ETCS L1 on traditional signalling;
- adoption of the CR 818 (which avoids the braking for inconsistent BG) for the management of Balise groups containing only national data (SCMT PK44);
- optimization of the Infill Radio functionality (CR 742);

The "Level 2" solution is considered as the best choice for the Italian parts of the Corridors which require to preserve or to increase existing Lines performances, while in some other cases (large shunting areas and complex installations) also the "Level 1" solution will be implemented.
ERTMS Overlapping Migration strategy: Almost maintain the same performance of
- Relay Interlocking + Axle Counter (12000km)
- SCMT (Encoder & Eurobalises)
- GSM-R

Cost

L1LS
No speed indication

L1LS
speed indication
With Radio Infill

L1 FS
With Radio Infill

Level 1
RFI ATP/ATC ClassB Overlapping Strategy

Existing Block / Existing IXL

New Electronic IXL or New Electronic interface

Legacy Signalling Systems

SSC

SCMT

ATP National Systems

ETCS L1

ETCS L1 + Radio Infill

ETCS L2

ATC Interoperable Systems
ERTMS Overlapping Migration strategy: Maintain the same performance of
• Bacc (Blocco Automatico a Correnti Codificate 4500km)
• Electronic or Relay Interlocking
• SCMT (Encoder & Eurobalises)
• GSM-R
Baseline 3 ERTMS: first step

The first stone is the realization of 4 Pilot projects designed to define, test and consolidate, on small sections, the system specifications of ETCS Level 1 and 2 over Class B, with the aim to facilitate and accelerate the subsequent phase of corridors realization and have the elements to do the best technical choices.

The ERTMS Pilot Projects on Italian conventional lines:

- **ETCS Level 2 implementation on the existing National system (SCMT) on the section: Milano Lambrate – Treviglio along the Corridor D.**

- **ETCS Level 1 implementation on the existing National system (SCMT) on the section: Sciara - Cammarata in Sicily**

- **ERSAT (ERTMS Satellite) ETCS Level 2 implementation on the regional railway trial site in Sardinia (Section Cagliari – San Gavino)**

- **ETCS Level 1 Limited Supervision implementation on the existing Cross Border Italy Switzerland Corridor A.**
The Pilot Line consists of ETCS Level 2 implementation (baseline 3) in parallel to the existing National system (SCMT).

The section is: Milano Lambrate – Pioltello – Treviglio (about 30 km), along the Corridor D, where RBC connection will be realized with different types of interlockings.


An IXLs renovation project is under way on the Torino-Padova line, which is part of Corridor D route.

As a result, there is a need to coordinate the Pilot project activities with the Torino-Padova ongoing investment project so that a full testing of traditional (electro-mechanical or relaybased) and new (computer- based) interlockings is achieved.
Baseline 3 ERTMS: first step

- 35 KM electrified double track
- coded circuit (BAcc) with lateral signals
- new generation multistation IXL
- 1 SUPPLIER
  (for both trackside & Onboard)
- maximum speed = 180 km/h
- EC Co-funding
It should be emphasized that the Pilot Line, once completed the experimental work, it may be used, subject to minimum reconfiguration, as an integral part of the Corridor D, maintaining the location of the central post at 'Milano Greco, the same place where it will be also controlled the axis of Corridor A.

The end of project is foreseen for December 2015.

By Decision C(2008)7888 of 10.12.2008 amended by Decision C(2011) 3250 dated 6.5.2011 the European Commission approved the grant of a financial contribution requested by the EEIG for Corridor D, for the project of common interest “ERTMS Implementation on the Railway Corridor D (Valencia - Budapest)” (no. 2007-EU-60120-P), that for the RFI part consists in the installation of a fully interoperable system in a Pilot Line inside corridor D route based on ERTMS.
Level 1 + RIU Baseline 3 ERTMS: first step

Figures on L1 + RI Pilot line

- 38 KM electrified single track
- axle counter
- electrical IXL
- 2 SUPPLIERS (for both trackside & On board)
- maximum speed = 130 km/h
Level 1 Limited Supervision in Italy: RFI - SBB Cross Border

ERTMS L1 Limited Supervision:
Without cab signalling, vital Linking every signal
Complete functionalities of L1: almost same protection of SCMT
The ERSAT regional railway trial site in Sardinia

- Total length: approximately 50 km
- Double track regional line: to test train localization on parallel tracks
- Fixed block (L2) train separation

- **In the scope of ERSAT:**
  - Satellite-based enhanced localization system:
    - Local Area Augmentation network enhancing EGNOS service
    - Multi-constellation receivers, adopting also Galileo early services
    - GNSS-denied Area localisation System
  - Integration with the ERTMS-ETCS system and with a multi-bearer TLC network for data communications with trains
  - Validation and certification of the SIL4 level for train SAT-based localization
  - Independent assessment by a NoBo
  - 14/01/13 MoU signed between ASI and Sardinia Region to finance the project
  - 03/04/14 RFI participate at Call H2020-Galileo-2014-1 for ERSAT EAV project
ERSAT ERTMS - SATELLITE Baseline 3 Level 2/3 Pilot Line

Reference ERTMS architecture with IP-Telecom and GNSS

Protection Level vs travelled distance
ERSAT satellite-based localisation enhancement

ERSAT ERTMS - SATELLITE Baseline 3 Level 2 Pilot Line

Space Segment
- Multi-constellation SAT
- Local Area Augmentation System for Railway

User Segment
- SIL 4 EGNSS-based Enhanced Localisation for Railway

Ground Segment
- EGNOS Wide Area Network
- EWAN

ERSAT ERTMS SATELLITE Baseline 3 Level 2 Pilot Line

ERSAT satellite-based localisation enhancement
ERSAT Baseline 3 Level 2 Pilot Line

ERSAT REFERENCE Architecture

**SPACE SEGMENT**

**GPS-GALILEO**

**Euoradio IP Parallel TLC Multiple Carrier Management**

**Positive Test in the Field**

**EGNOS**

**Radio Block Center (RBC)**

**TALS**

**EDAS**

**Local AIMN**

**RS 1**

**RS 2**

... **RS n**

**Localization functions (SIL4)**

- Confidence interval for train separation
- Start of Mission
- Parallel track ambiguity resolution

**TALS**: Track Area Localization System
**AIMN**: Augmentation and Integrity Monitoring Network
**RS**: Reference Station
**EDAS**: EGNOS Data Access Service
Progetto ERSAT: il contesto europeo: Roadmap

Project supported by ASI-Regione Sardinia as Test Site for ERTMS L2, L3 with satellite localization

Synergy between ERSAT, Shift2Rail and EGNOS-GALILEO

ERSAT
ERTMS-ETCS Test Site

EGNOS-GALILEO upgrade for rail

3InSat

SATLOC

GRAIL 2

2012 2013 2014 2015 2016 2017

Early Services

Operations (incl. extensions, replenishments)

Stable signals

Reference GSA presentation

Progetto ERSAT: il contesto europeo: Roadmap
ERTMS Baseline 2 Level 2 Project Ongoing

ETCS L2 Upgrading BL2 High Speed Roma - Napoli Alstom

- Tendering: 10% in 2014, 10% in 2016, 30% in 2014
- Project: 50% in 2015
- Realization: 10% in 2017
- Authorization: 0%

ETCS L2 BL2 High Speed Treviglio - Brescia Ansaldo STS

- Tendering: 10% in 2014, 10% in 2016, 30% in 2014
- Project: 50% in 2015
- Realization: 10% in 2018
- Authorization: 0%

ETCS L2 BL2 High Speed Roma - Firenze

- Tendering: 10% in 2014, 10% in 2016, 30% in 2014
- Project: 50% in 2015
- Realization: 10% in 2017
- Authorization: 0%
ERTMS Baseline 3 Project Ongoing

ETCS L1 BL3 + Radio Infill Pilot Line Sicily ECM and Mermec
2015, 2012

ETCS L2 BL3 Pilot Line Corridor D Pioltello Treviglio Ansaldo STS
2016, 2013

ETCS L2 BL3 + Satellite Localization and independent TLC Carrier Pilot Line Sardinia

ETCS L1 BL3 Limited Supervision Pilot Line Iselle-Domodossola Ranzo - Luino Corridor A
2016, 2014

ETCS L2 BL3 Milano - Chiasso Corridor A
2016, 2014

ETCS L1 + Radio Infill BL3 Domodossola - Novara Corridor A Bombardier TI
2015, 2016, 4/2014

Tendering  Project  Realization  Authorization