ERTMS for High Density in Urban Nodes

Principles of ERTMS L2 System with high density functionality in the main RFI urban railway nodes
ERTMS in Italy: Obbligation and Opportunities

ERTMS (ETCS+ GSM-R)

- **High Speed Network**
  - Level 2 (Baseline 2)
  - Without fallback

- **High Density Urban Nodes**
  - Level 2 / Level 3 (Baseline 3)
  - Overlapped to National CCS

- **Freight & Passenger Tent-T Corridors**
  - Level 1 / Level 2 (Baseline 3)
  - Overlapped to National CCS

- **Low density Lines**
  - Level 2 / Level 3 (Baseline 3)
  - Satellite & Public Bearer

10 years In Operation and always in Evolution

- **2016 UpGrading 230d Ro Na**
- **2016 Treviglio Brescia**
- **2018 Roma Firenze**
- **2020 Brescia - Verona**

In realization

- **2018**: HD Rome and Milan Node (headway 3’)

**Virtual Section by Train Integrity Detection**

In realization

- **2015**: Pilot Line Corr D
- **2016**: Ranzo Luino, Domo Iselle
- **2017**: Domo Novara
- **2018**: Milano Chiasso
- **2020**: Novara –Villa Opicina; Fortezza Verona; Milano Genova

Pilot Line in Sardinia

**ERSAT** merging two EU project (Galileo and ERTMS) for Interoperable Virtual Balise concept
ERTMS Migration at 2030
CCS A and B in Italy: System Evolution for Interoperability and Intraoperability

Trackside ETCS BL2
2005-2020 1100km

High Speed Network
To-Mi-Na
Ro-Fi
Tr-Brescia

Trackside ETCS BL2+STM
200 HS Fleet

Trackside SCMT
2003-2008 11000km

SSB SCMT
5000 fleet

SSB SCMT/SSC
1000 Fleet

Trackside ETCS BL3+STM
from 2016

CNs and EU/TEN-T Network
High Density by ERTMS on Urban Nodes
New High Speed Lines from 2020

Trk SSC
2005-2006
4000km

Trk ETCS BL3
Other IM Network
2019

SSB ETCS BL3

SSB ETCS BL3+STM

Other IM Network
2019
ERTMS/ETCS L2 overlapped at (Class B) SCMT

*For CNCs and High Density (HD) in Urban Nodes*

**L2+L3 ETCS functionalities For High Density**

Existing BTS GSM-R

SCMT Train

ETCS Train

RBC

ETCS L2 Telegram

Packet 44 (SCMT Data)

Existing Class B (SCMT) Eurobalises and Encoder
Architecture Principle

ERTMS AREA

ERTMS Area (NO HD)

No ERTMS Area

Block

Solution Interface line/station

IXL

E-IXL: Electronic Interlocking
E-Block: Electronic Block
## Train Integrity

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualifier for train integrity status</td>
<td>Qualifier, identifying the train integrity information available. The related safe train length information is given by L_TRAININT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length of variable</th>
<th>Minimum Value</th>
<th>Maximum Value</th>
<th>Resolution/formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 bits</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Special/Reserved Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No train integrity information available</td>
</tr>
<tr>
<td>1</td>
<td>Train integrity confirmed by integrity monitoring device</td>
</tr>
<tr>
<td>2</td>
<td>Train integrity confirmed by driver</td>
</tr>
<tr>
<td>3</td>
<td>Train integrity lost</td>
</tr>
</tbody>
</table>
High Density: a new opportunity with ERTMS L2 + OB train integrity

ETCS or SCMT Train 2
Track circuit x occupied
Virtual Track Circuits 1, 2 and 3 not involved
ETCS or SCMT Train 2
Track circuit x free
Virtual Track Circuits 1, 2 and 3 not involved

SCMT Train 1
Track circuit x+1 free

Virtual Track Circuits 1, 2 and 3 not involved
ETCS Train 4
Virtual Track Circuit 1 free available for ETCS Train 4
Virtual Track Circuit 2 occupied
Virtual Track Circuit 3 free available for ETCS Train 3
Track circuit x+1 free

ETCS Train 6
Track circuit x occupied
Virtual Track Circuit 1 free available for ETCS Train 6
Virtual Track Circuit 2 and 3 occupied
Track circuit x+1 occupied
High Density main elements

Pre conditions for the High Density Function:
• ERTMS L2 Baseline 3
• The train running first (train 1) connected with RBC and with train integrity function active on-board
• Position report (after a Virtual Track Circuit) valid including the confirmation of the Train Integrity checked on-board
• The train 2, following the train 1, connected with RBC
• The signal c) with the symbol X active

Track circuit section x
Virtual Overlap

ETCS Train 2
ETCS Train 1
Overlap
Virtual Track circuit s 1 and 2 (section x)

a) Section x occupied
b) or
1) The train in front to the signal is not an ERTMS train and there isn’t any available MA for that train
Driver is asked to look outside and follow indication provided by signals.
2) The train in front to the signal is an ERTMS train and there isn’t any available MA after the signal
Virtual track section 1 not yet cleared or an SCMT train is still occupying section x.
c) Line where ERTMS is over posed to the national signalling system
**Train Integrity** (On Board Function)
HD ERTMS System Requirement for Train and for EVC ERTMS/ETCS

HD ERTMS have to guarantee the high density headway only for chain of trains with this minimum characteristics (Gamma Trains):

- Max length a 200 m;
- time delay for breaking system application < 4.5 s.
- 140 % Weith Breaking;
- 1.0 m/s² average deceleration for EB in the speed range 0-100 km/h

The Train using the HD ERTMS functionalities must be use ETCS EVC BL3 R2 with:

- the “ETCS smart sleeping” functionality (without the breaking of the train in case of losing connection with tail EVC)
- Position Report (Q_length parameter) to RBC to check the safe tail of the train.
- Cab Radio for GPRS and MT with professional Filter against interferences
- 0.9 the parameter of “rolling stock correction factors”
Increase Average Speed: Emi Path and virtual overlap

<table>
<thead>
<tr>
<th>N° of sections</th>
<th>L- Movement Authority</th>
<th>Distance EoA – SL (overlap)</th>
<th>Nominal Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>350 m</td>
<td>≥ 50 m</td>
<td>30 km/h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥ 100 m</td>
<td>40 km/h</td>
</tr>
<tr>
<td>2</td>
<td>700 m</td>
<td>≥ 50 m</td>
<td>85 km/h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥ 100 m</td>
<td>90 km/h</td>
</tr>
<tr>
<td>3</td>
<td>1050 m</td>
<td>≥ 50 m</td>
<td>120 km/h</td>
</tr>
</tbody>
</table>
Different ERTMS Levels, Baselines and Suppliers Guarantee the System integration: lab ERTMS IM (RFI)

EVCs BL3

High Speed ETCS L2 Baseline 2.3.0.d

Corridors TEN-T and High Density ETCS L2 BL3

Corridors TENT e ETCS L1 BL3