



***Bombardier's Solutions for Increasing  
Railway Infrastructure Efficiency***

***Poiana Braşov, Romania – February 25-26, 2010***

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# Bombardier's mission on interoperability

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- **Bombardier is committed to maintaining the agreed operational standards and interfaces for ERTMS systems, thereby ensuring that the customer is not tied to any specific equipment**
  
- **We are actively working to promote further standardisation to ensure seamless operation between different suppliers and across country borders**

# Background

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- **From the beginning, in 1991, Bombardier genuinely promoted the idea, initiated by the EU, of a well-defined European standard with open interfaces, to reduce the technical and economical trade barriers throughout Europe.**
- **Among the suppliers within the industry, we are one of the main drivers for open ERTMS standards and are committed to developing the standard into even broader openness.**

# Background

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- **In recent years, Bombardier is clearly in a driving position with regards to the open standardisation of interfaces, the STM concept and the STM interface being a priority.**
- **Today we are ensuring that more and more interfaces are standardised.**
- **After rigorous technical and economical evaluation, Bombardier's balise transmission technology was chosen by the European railways as the basis of ERTMS technology, confirming our position as pioneers in the development of ERTMS technology.**

# ERTMS Level 2: Switzerland

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- **The world's first ERTMS Level 2 line in full commercial operation was brought into service between Olten and Lucerne in 2002.**
- **Our ERTMS L2 solution proved to be reliable and safe, meeting the very high standards set by Swiss Federal Railways, SBB.**
  - Test results show outstanding performance levels of 99.6% availability, reaching standards above conventional signaling systems.



# First successful interoperability trials between different suppliers of ERTMS L2

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- In 2005 a real milestone for ERTMS interoperability was reached with Bombardier's successful interoperability tests: our ERTMS L2 equipment and equipment supplied by two independent UNISIG member companies on the Bev 21 ERTMS lines in The Netherlands.
- Various tests were performed in the presence of representatives from the European Commission and several European railways.
- Bombardier Radio Block Center ↔ Alstom and Siemens Trains
- Bombardier Train ↔ Alstom and Siemens infrastructure

# Interoperability: a reality

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- **Today our ETCS L2 on-board system (Ebicab 2000) is operating on three ERTMS lines with a total length of 240 km:**
  - Havenspoor line – ERTMS L1 – Alstom wayside equipment
  - Betuwe route – ERTMS L2 – Alstom wayside equipment
  - HSL South – ERTMS L1 – Siemens/Thales equipment.
- **Moreover, several STM systems are in operation in Belgium, Germany and The Netherlands.**
- **Several interoperability testings performed in:**
  - Switzerland: Mattstetten-Rothrist L2/Alstom and Loetschberg tunnel L2/Thales.
  - Spain: on several lines with wayside from Alstom, Ansaldo, Invensys, Siemens and Thales.

# Interoperability: a reality

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- **Italy SCMT project case study:**

- More than 10000 km of railway network equipped with ERTMS L1 Eurobalises and encoders.
- Alstom, Ansaldo and Bombardier Eurobalises are interoperable with Alstom and Ansaldo on-board equipment.
- This represents the biggest example of interoperability among suppliers (in operation since 2005).

# The future of Interoperability: ERTMS Regional

(ERTMS Level 3 for Regional lines)

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- **April 2005:**
  - Bombardier received an order from Swedish Banverket to specify a system based on an UIC Functional Requirement Specification
- **December 2006:**
  - Bombardier received an order to develop the ERTMS Regional system and to implement the system on a pilot line
- **Banverket has signed a frame agreement with Bombardier for delivery and maintenance of ERTMS Regional systems for up to 20 years**

# ***Computer Based Interlocking – Project references***

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**Over 270 *EBI* Lock 950 and 150 *EBI* Lock 850 CBIs are in operation around the world, including the world's first CBI in Sweden – in operation since 1978. Other references include:**

- **Over 70 *EBI* Lock 950 installations in Spain**
- **Over 80 *EBI* Lock 950 installations in Russia**
- **Milan Junction and Milan Extension, Italferr, Italy**
- **State Railway of Thailand, Thailand**
- **Mannheim – Rheinau, Deutsche Bahn, Germany**
- **The Netherlands**



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# ***EBI Lock 950 R4* – fourth generation of computerized Interlockings**

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*EBI Lock 750/850*



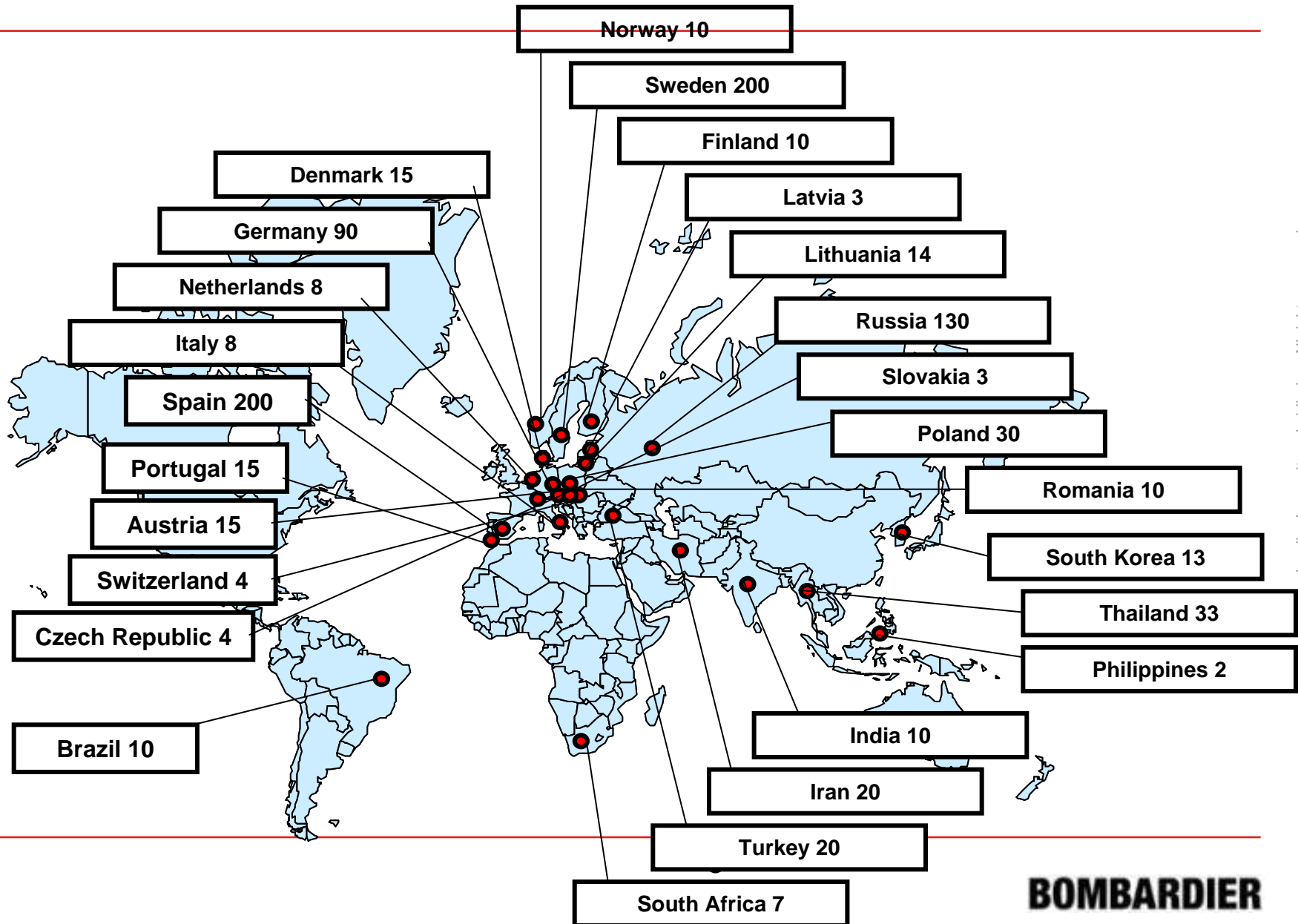
*EBI Lock 950 R3*

- **In order to meet the growing requirements of capacity, availability and HW platform independence Bombardier has developed a fourth generation *EBI Lock*, electronic railway interlocking, using highly reliable and proven industry standard hardware and operating systems.**



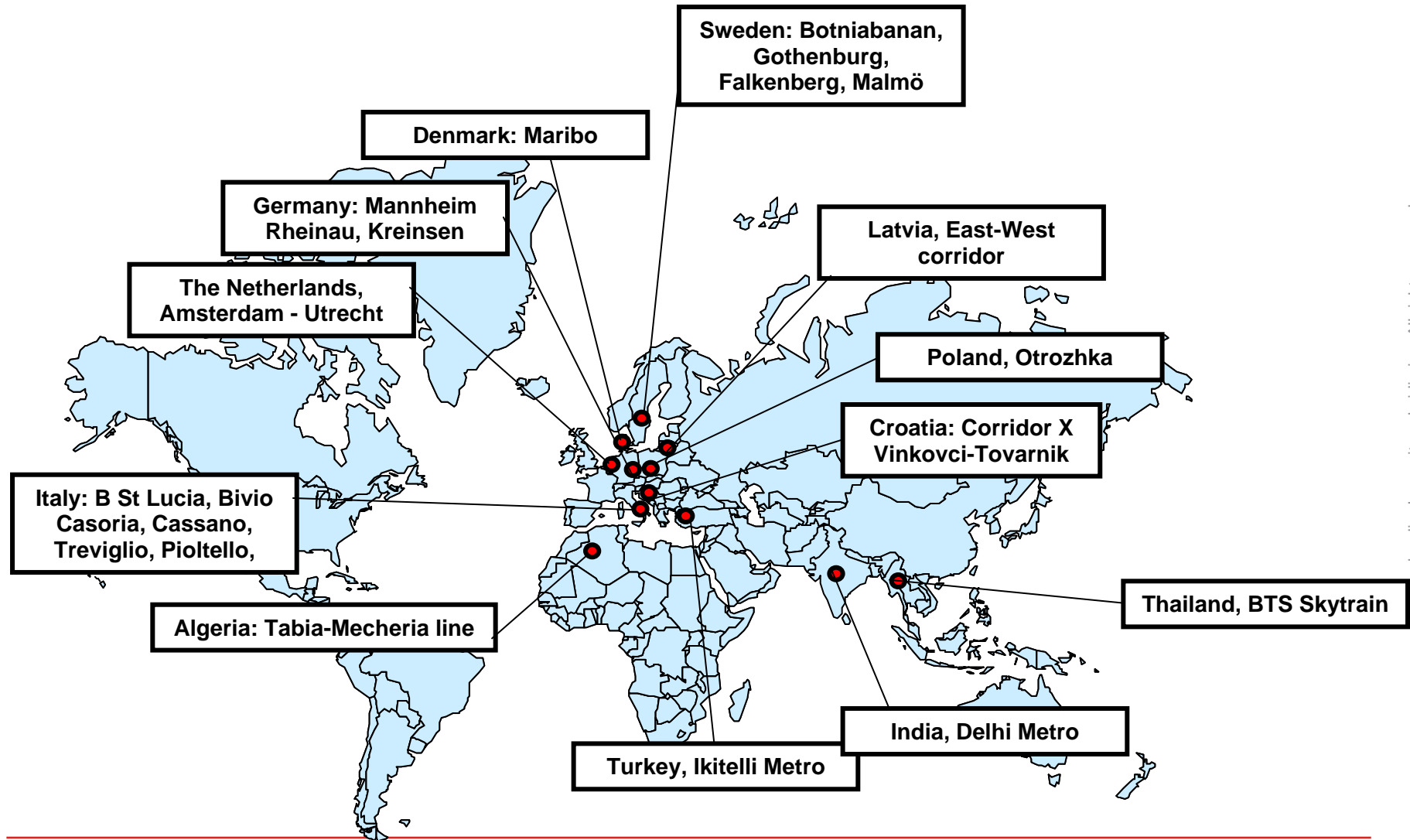
*EBI Lock 950 R4*

# EBI Lock installed base



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# EBI Lock 950 R4 first installations



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# ***INTERFLO 250***

ERTMS Level 1 solution

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# ERTMS Level 1

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- Movement Authority and speed profile from controlled *Eurobalises*
- Full ATP supervision
- Train detection by track circuits or axle counters
- Fixed block signalling
- Enhancement of existing signalling system
- Optional in-fill (balises, radio or Euroloop)



# INTERFLO 250 – ERTMS Level 1

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- ERTMS/ETCS Level 1 solution comprising all the trackside, onboard and CTC functionalities required for main line operations
- Can be applied as an overlay to existing signalling system providing increased levels of safety
- Functionality according to UNISIG 2.3.0 D
- Designed for highest safety levels – CENELEC SIL 4



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# **INTERFLO 250 – ERTMS L1 - Project references**

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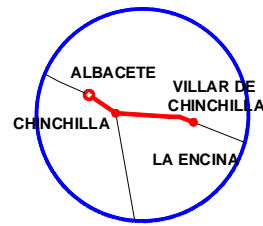
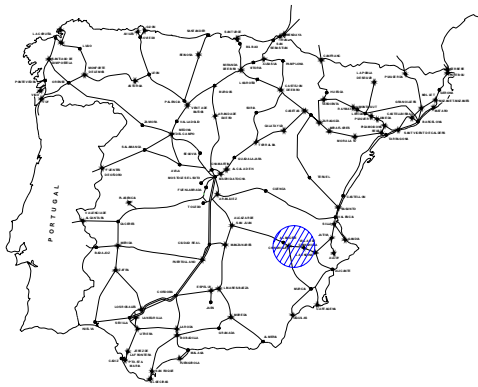
- Albacete - Villar de Chinchilla - La Encina, Spain
- ATP, Taiwan Rail Administration, Taiwan
- SCMT Project, Rete Ferroviaria Italiana, Italy
- Korean National Railroad, Korea
- Arlanda Express Airport Link, Arlandabanan, Sweden
- Oresund Link, Sweden – Denmark
- Vinkovci to Tovarnik, Corridor X, Croatia



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# INTERFLO 250 - Project References

## Spain



- Line length: 90Km
- 600 Eurobalises
- 100 LEUs
- 4 EBICAB 2000 systems
- Commissioned 2003

## Italy

- Equipped line length: 2500 km
- 25000 Eurobalises
- 3000 Line Encoder Units (LEU)
- Installation test and commissioning of the system
- First line in service 2005



# INTERFLO 250 - Project References

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## Taiwan



- Line length: 1200 km of
- 156 stations
- 768 EBICAB 2000 systems,
- 13000 balises
- 2000 LEU
- In commercial operation since 14 July 2005

## South Korea – KNR

- Line length: 760 kilometres
- 78 stations
- 413 EBICAB 2000 Systems
- 7000 balises
- 2260 complete LEU's
- In service since 2007



# ***INTERFLO 450***

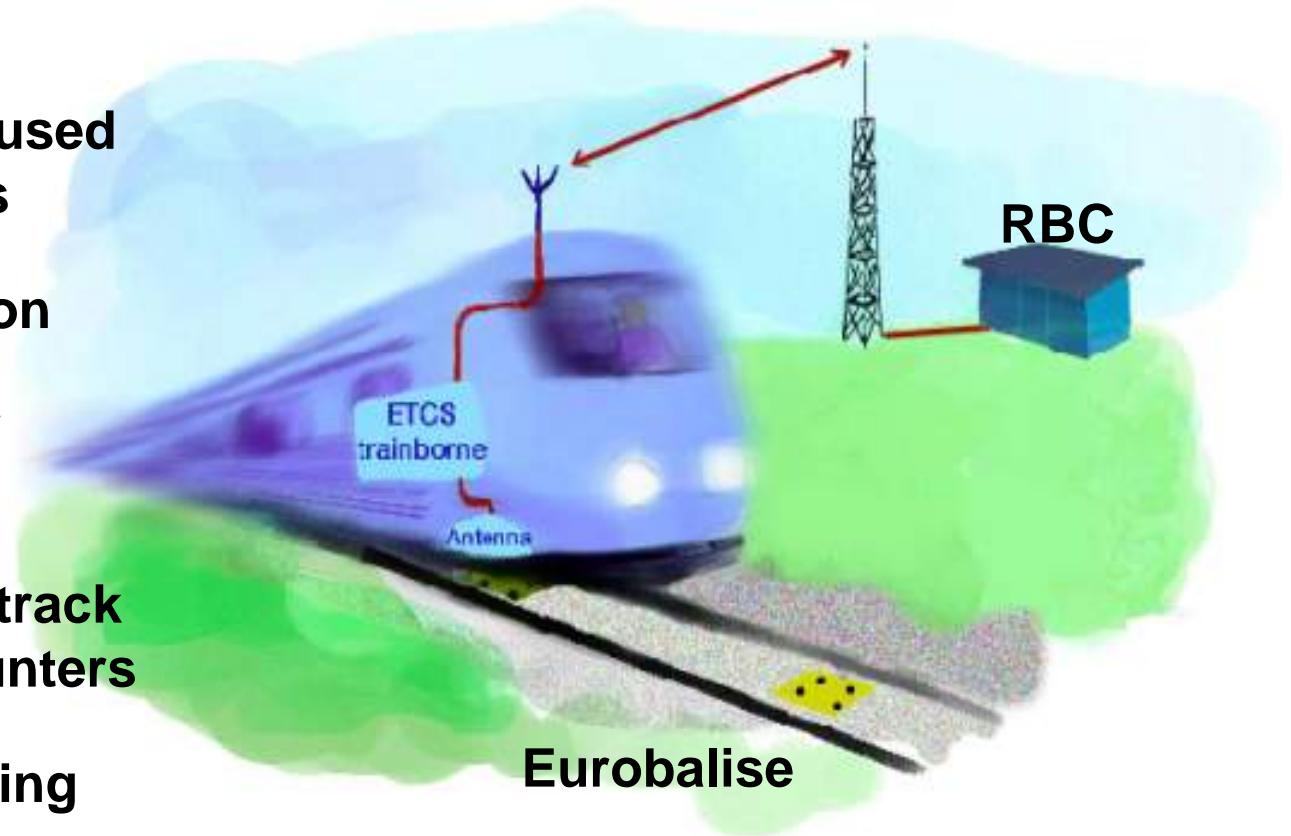
ERTMS Level 2 solution

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## ERTMS Level 2

- Movement Authority and speed profile from *RBC*, transmitted via radio (GSM-R)
- Fixed *Eurobalises* used as reference points
- Full ATP supervision
- Optical signals *not* required
- Train detection by track circuits or axle counters
- Fixed block signalling



# ***INTERFLO 450 – ERTMS Level 2***

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- ERTMS/ETCS Level 2 solution comprising all the trackside products required for main line operations;
- *INTERFLO 450* reduces trackside equipment thus reducing wayside and maintenance costs;
- Functionality according on UNISIG 2.3.0d;
- Designed for highest safety levels – CENELEC SIL 4.



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# INTERFLO 450 – ERTMS Level 2

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**INTERFLO 450 has the following system characteristics:**

- Cab signalling system displaying permitted, actual and target speeds and movement authority on graphical alphanumeric display;
- ATP receives information through *EBI* Com radio block centre via GSM and Eurobalises;
- *EBI* Track train detection by track circuits or axle counters;
- *EBI* Screen control rooms handles train supervision;
- *EBI* Lock computer-based interlocking.



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# ***INTERFLO* 450 – ERTMS Level 2 - Project references**

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**Bombardier Transportation provided the world's first *INTERFLO* 450 ERTMS Level 2 line in commercial operation, in Switzerland in April 2002**

- Olten – Lucerne, SBB, Switzerland;
- Amsterdam-Utrecht, ProRail, The Netherlands;
- Bothnia Line, Botniabanan, Sweden;
- Wuhan-Guangzhou-Line, China.



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# INTERFLO 450 – Project references

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## Switzerland (Olten-Luzern)

- Line length: 35 km double-track
- 9 stations
- 1 RBC
- 220 fixed balises
- 59 vehicles, 5 types



## China (WuGuang DPL)



- Line length: 1000 km, doubletrack
- 120 vehicles
- 9 RBCs
- 9 *EBIComs*

# INTERFLO 450 – Project references

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## Sweden (Botniabanan)

- Line length: 190 km
- 22 stations
- 1 EBICom (RBC)
- 1 EBIScreen (CTC)
- 600 Eurobalises



## The Netherlands (Amsterdam-Utrecht)



- Line length: 35 km (four-track)
- 2 EBIComs (RBC)
- 8 EBILocks
- 400 Eurobalises

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# ***INTERFLO* 550 – Regional ERTMS**

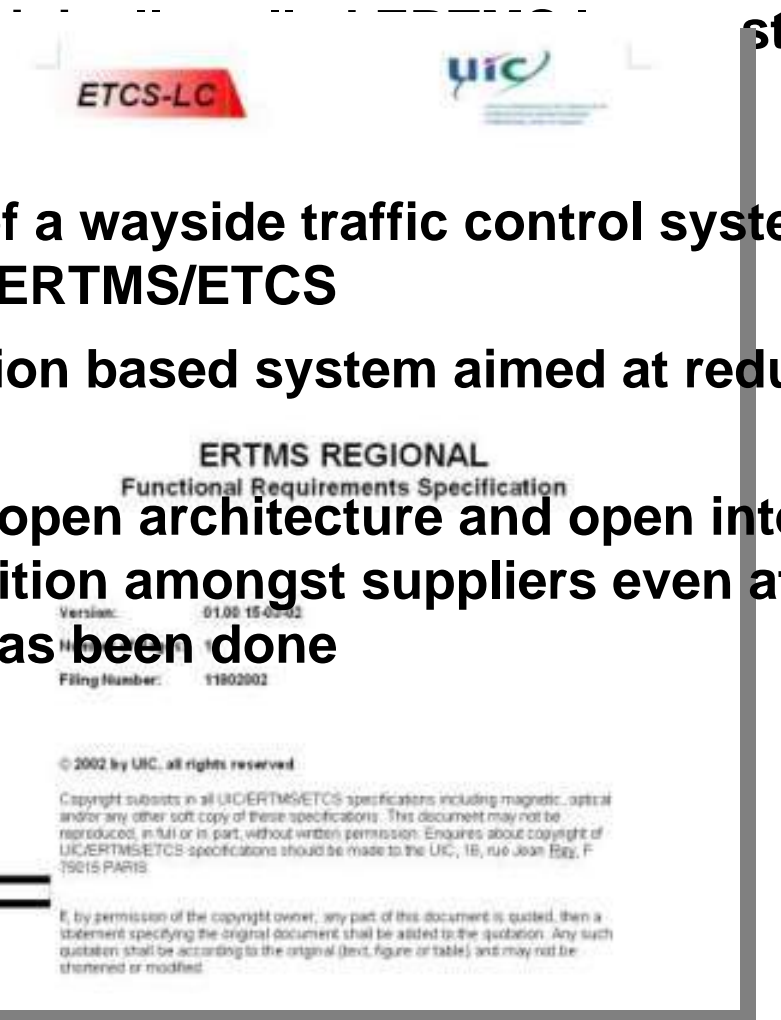
ERTMS Level 3 for regional lines

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# What is Regional ERTMS?

- A UIC initiative,



- Specification of a wayside traffic control system that uses the capabilities of ERTMS/ETCS
- A communication based system aimed at reducing the life cycle cost
- A system with open architecture and open interfaces to enable competition amongst suppliers even after the initial procurement has been done

# ERTMS Regional

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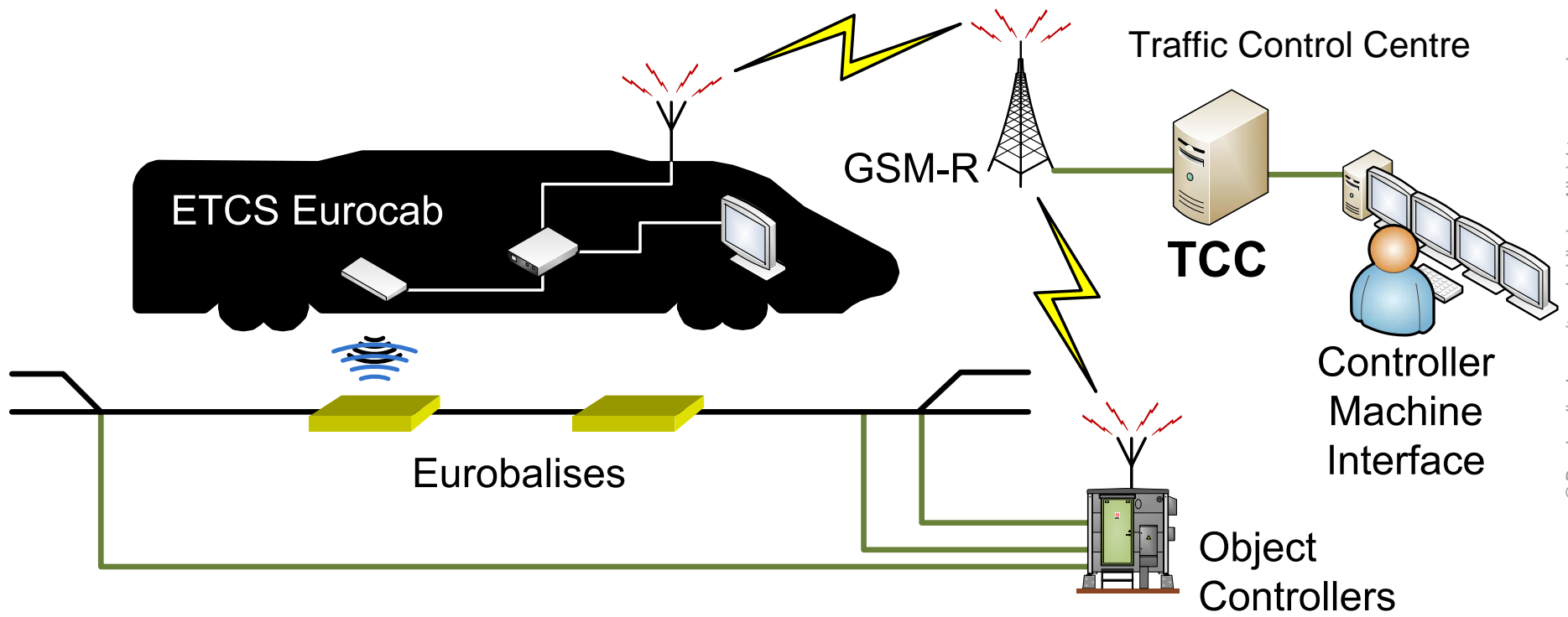
# Cost Effectiveness

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- Utilises the onboard system from ERTMS/ETCS
- Minimises use of wayside installations by using modern communications technology



# ERTMS Regional – system architecture



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# Västerdalsbanan – the Pilot line today

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## Repbäcken–Malung

134 km

6 stations

Max speed 90 km/h

16 train/day (8 passenger, 8 freight)

9 dispatchers

Not electrified

No Centralized Traffic Centre

No ATP

33 level crossings

GSM/R is used for voice communication

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# Conclusions

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- **By implementing ERTMS technology on regional lines as described, traffic on regional lines can be maintained with:**
  - reduced operational cost
  - increased capacity
  - improved safety
- **Lines with the Regional solution can be integrated in the European ERTMS network and further extend the reach of cross border traffic into the regional network**
- **The open architecture of the Regional solution allows for integration with other systems such as maintenance planning tools and opens possibilities for better coordination between operators of rail and other types of transport**

