

European Rail Traffic Management System ERTMS

Overview

ERTMS Seminar 2008, part E

- A Scope of ERTMS, background, legal and normative base
- B GSM-R railway communication system
- C ETCS (1): Objective, project history, functionality and system architecture
- D ETCS (2): Subsystems, system development, available products
- E ETCS (3): Migration strategy, status of implementation**
- F Eur-Optirails, further developments of ERTMS, business opportunities



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Part E: ETCS - Migration strategies, status of implementation

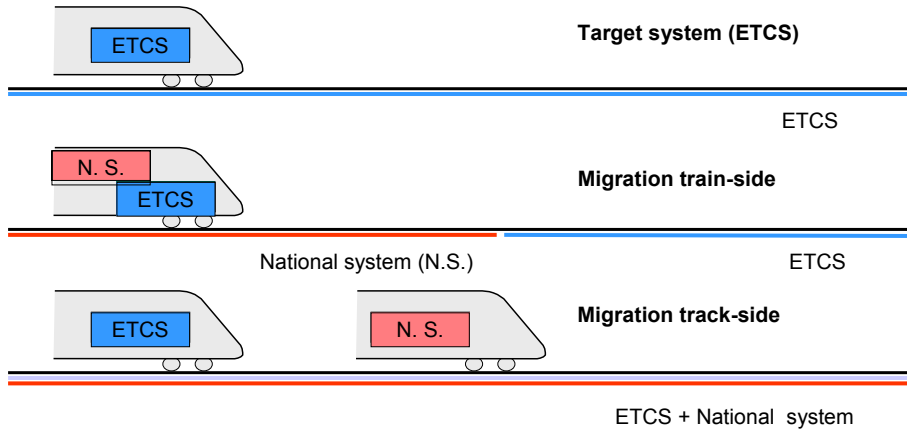
Content of part E

1. Migration strategies for ETCS
2. National ETCS implementation projects in Europe
3. ETCS on European corridors
4. ETCS outside Europe



European Rail Traffic Management System ERTMS ETCS migration strategies

Basic possibilities for the ETCS migration



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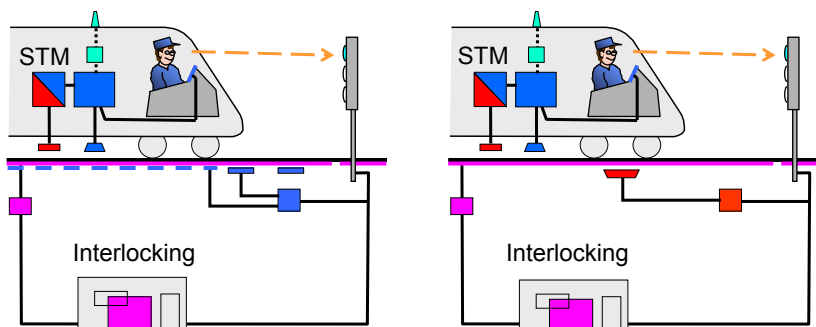
E3

European Rail Traffic Management System ERTMS ETCS migration train side

Eurocab with Specific Transmission Module STM

Line with ETCS

Line with national system

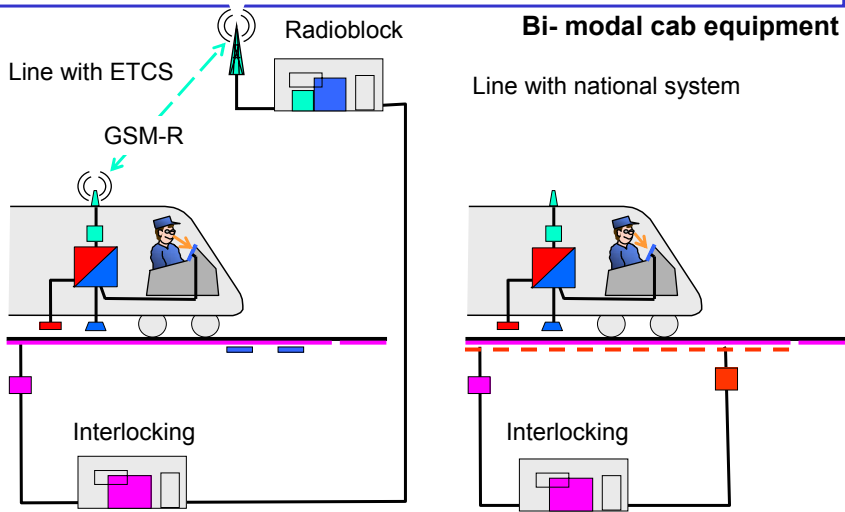


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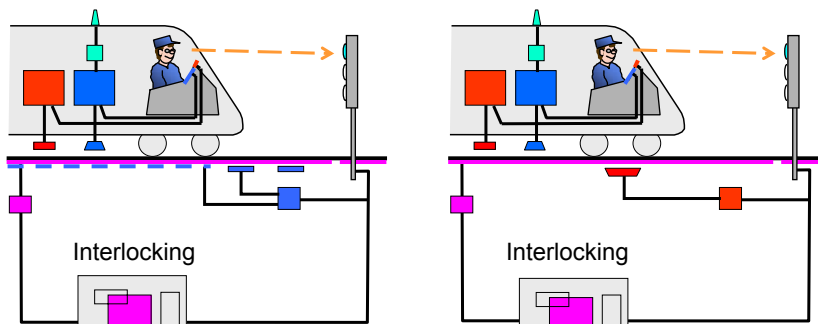
E5

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Use of legacy cab equipments in parallel to Eurocab

Line with ETCS

Line with national system



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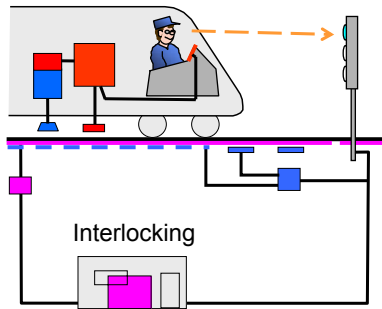
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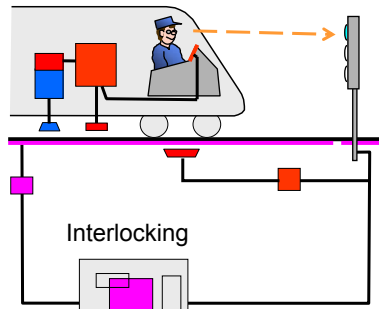
European Rail Traffic Management System ERTMS ETCS migration train side

Use of “reverse STM”

Line with ETCS

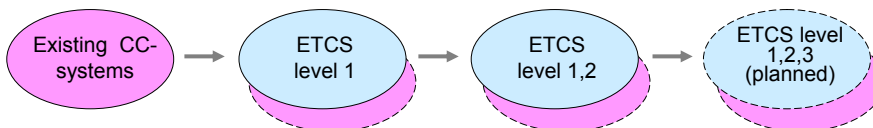


Line with national system



European Rail Traffic Management System ERTMS ETCS migration trainside

Conclusion regarding ETCS implementation onboard



ETCS is upgradeable from level 1 to 3.

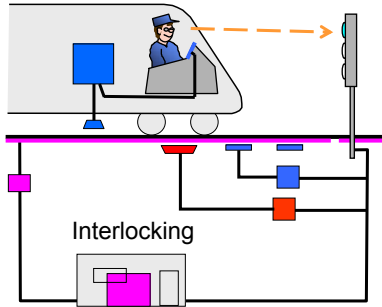
Existing CC-systems can be used in parallel during the migration phase.



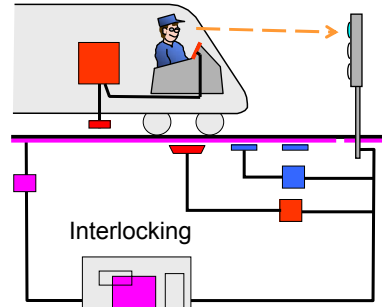
European Rail Traffic Management System ERTMS ETCS migration track side

ETCS level 1 with national system in parallel

Train with ETCS



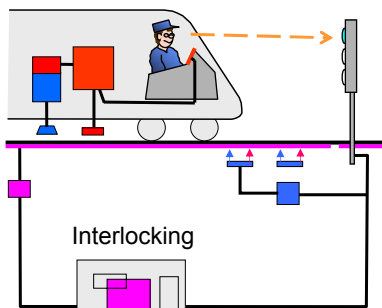
Train with national system



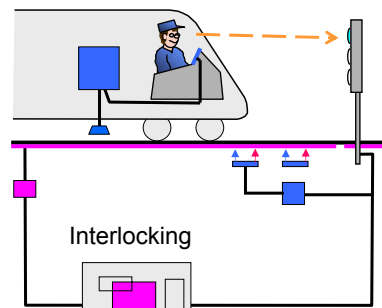
European Rail Traffic Management System ERTMS ETCS migration track side

ETCS level 1 with national telegram package

Train with national system
and ETCS data transmission



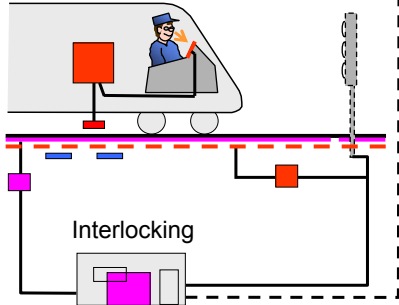
Train with ETCS



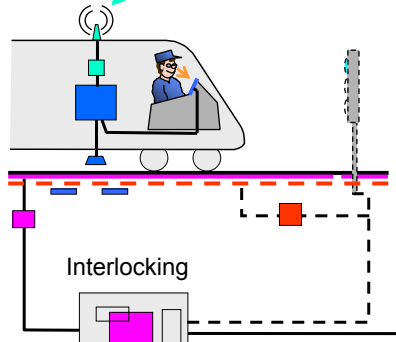
European Rail Traffic Management System ERTMS ETCS migration track side

ETCS level 2 mit with national system in parallel

Train with national system



Train with ETCS level 2



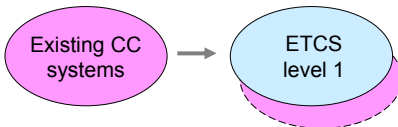
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European Rail Traffic Management System ERTMS ETCS migration track side

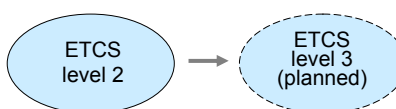
Level 1 strategy



- Line-side signals
- No adaptation of interlocking
- Existing CC-system can be used in parallel during the migration phase

Level 1 can be installed and operated relatively easy in parallel to the legacy signalling installation. The track side migration is in general achievable by maintaining the legacy system in operation. The new mode Limited supervision will facilitate this even more.

Level 2 strategy



- No line-side signals
- Use of GSM-R
- New interlocking or adaptation of existing interlocking
- No existing CC-system on track-side

Level 2 is optimal for lines and stations with new signalling installations. Thereby, pure ETCS operation with cab signalling is recommended.



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National ETCS projects in Europe

The middle term priority for ETCS depends on the following factors:

Interoperability: How far is the railway system involved into international traffic?

High speed: Is a new cab signalling system necessary for new lines? (Vmax > 160 km/h)

Safety: Is it necessary to increase the safety of the rail by using a performant Train control command system?

Modernisation of lines and nodes: Are there any trackside programs for new construction or modernisation of the signalling?

Modernisation of the vehicles: Are there any programs for buying or modernisation of locomotives or motor coaches?



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National ETCS projects in Europe

Justification
for ETCS in
various
countries

Country	Interoperability	High speed/ High capacity	Safety	Renewal of signalling	Renewal of rolling stock
Austria	10	6	5	6	6
Belgium	8	10	8	7	4
Bulgaria	8	5	10	6	4
Czech Republic	8	2	10	4	2
Denmark	8	2	4	2	2
France	6	8	2	4	4
Germany	6	8	2	2	4
Great Britain	2	7	8	7	2
Hungary	8	2	7	8	4
Italy	9	9	7	6	6
Luxembourg	10	2	8	4	6
Netherlands	8	10	7	7	6
Poland	10	8	10	9	6
Romania	8	6	8	8	6
Slovakia	8	6	8	4	2
Slovenia	10	8	10	8	8
Spain	9	8	10	6	7
Serbia	8	8	8	8	8
Sweden	4	8	2	5	6
Switzerland	10	10	2	7	5

Legend: Low = 0, High = 10



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National ETCS projects in Europe

ETCS
projects
commis-
sioned
end 2007

Land	Strecke/ ETCS Level	Strecken-länge Km	Anzahl Fahrzeuge
Belgien	- Antwerpen – Holländische Grenze/ Level 2	50	4
	- Liège – Deutsche Grenze/ Level 2	50	
Deutschland	Berlin – Halle/Leipzig/ Level 2	135	24
Frankreich	Paris – Beaudrecourt/ Level 2	300	35
Griechenland	- Athen SKA – Flughafen/ Level 1	40	
	- Athen SKA – Korinth – Kiato/ Level 1	110	
Holland	- Rotterdam – Zevenaar / Level 2	110	50
	- Amsterdam – Belgische Grenze/ Level 2	93	
	- Amsterdam – Utrecht/ Level 2	30	
Italien	- Rom – Neapel/ Level 2	200	170
	- Turin – Novara/ Level 2	90	
Luxembourg	60% des Netzes/ Level 1	142	10
Österreich	Wien – Ungarische Grenze/ Level 1	67	13
Rumänien	Bukarest – Campina/ Level 1	92	
Schweiz	- Bern – Olten/ Level 2	45	587
	- Lötschberg Basistunnel/ Level 2	35	
Spanien	- Madrid – Zaragoza – Barcelona/ Level 2	670	401
	- Cordoba – Antequera/ Level 2	100	
	- Zaragoza – Huesca/ Level 1	80	
	- Madrid – Valladolid/ Level 2	200	
	- Madrid – Toledo/ Level 2	25	
Ungarn	Budapest – Österreichische Grenze/ Level 1	190	17



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National ETCS projects in Europe: Austria

Decision of the ÖBB board in September 2001:

- Installation of ETCS Level 1 in the A-network (2475 km)
- Pilot-installation on the Vienna-Budapest line.
- Track-side installation of ETCS Level 1 in parallel to the existing PZB/INDUSI- equipment.
- Installation of ETCS Level 1 on new locomotives.
- Existing (old) locomotives don't have to be equipped with ETCS because they can run further with INDUSI.
- The realisation of ETCS Level 1 is contracted to Alcatel Austria and Siemens.

Update on current situation



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National ETCS projects in Europe: Belgium

Decisions of the board of the Belgian railways in April 2001:

- The new lines Antwerp- border to the Netherlands and Lüttich-German border will be equipped with ETCS level 2.
- The rest of the conventional network gets ETCS level 1; until the end of 2006 50% of the lines have to be completed. International lines, lines on junctions and/or lines with high traffic have highest priority. By this the safety of the rail-traffic should be increased.
- The supply of track-side ETCS level 1 equipment has been contracted to Ansaldo and Siemens.



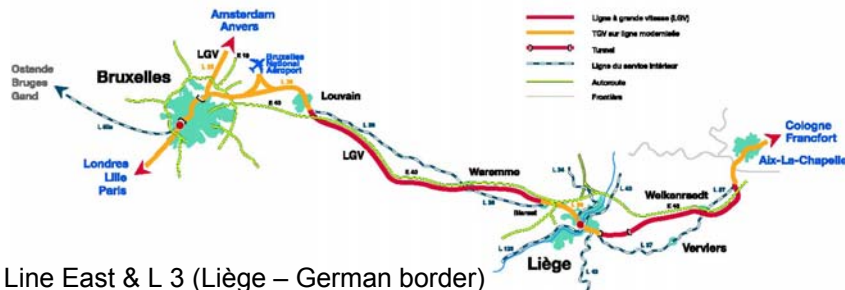
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National ETCS projects in Europe: Belgium



- Brussels - Leuven : existing refurbished tracks run at 200 kph
- Leuven – Ans : new tracks run at 300 kph (L 2)
- Ans – Liège : existing tracks, stop in Liège-Guillemins (renewed station)
- Liège – German border : new tracks run at 250 kph, before entering Germany on existing tracks (L 3)



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National ETCS projects in Europe: Belgium



Line North & L 4 (Antwerp – Dutch border)

- Brussels – Antwerp : existing refurbished tracks run at 160 kph
- In Antwerp, a tunnel under the city is built to allow the high speed trains to stop in Antwerp Main Station and then to join the new high speed line to The Netherlands
- Antwerp – Dutch border : new tracks run at 300 kph (L 4)
- At Dutch border the line is connected to HSL Zuid



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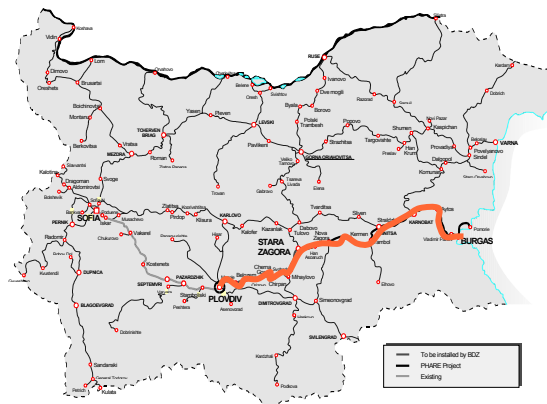
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National ETCS projects in Europe: Bulgaria

ETCS level 1 on the line Sofia-Burgas in Bulgaria



- Worldwide first commercial ETCS implementation on Sofia - Burgas line
- date of contract with Alcatel Austria: 01.01.1999
- date of completion: 31.12.2001
- Scope:
250 km of line,
25 stations,
131 vehicles



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National ETCS projects in Europe: Bulgaria



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National ETCS projects in Europe: Bulgaria



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National ETCS projects in Europe: France

The French ministry of railways intends to equip the new line „TGV Est“ with a combination of the systems TVM 430 and ETCS level 2.

The lately ordered new high-speed trainsets TGV Est are equipped with a Bi-modal onboard unit produced by Ansaldo: TVM 430/ ETCS level 2

For existing high-speed lines, an evaluation is ongoing on how far the capacity of the line can be increased by using ETCS.

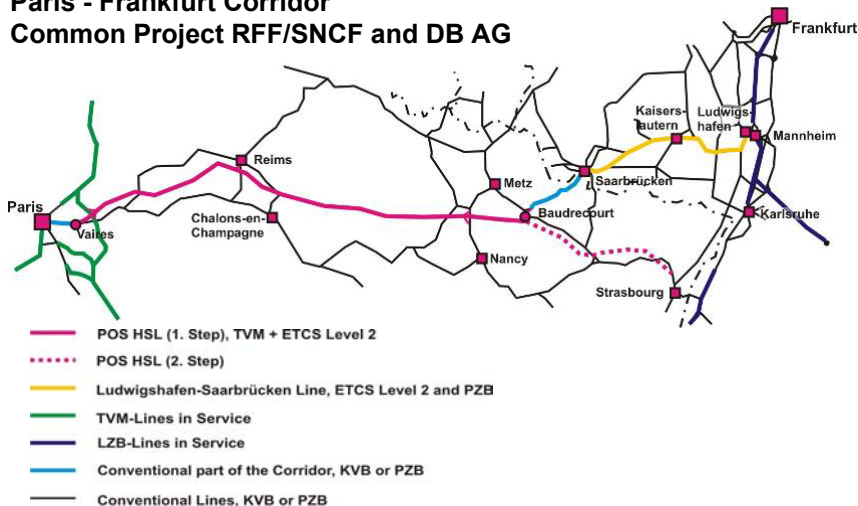
There are not yet exact plans for the regular network. More interesting are corridor lines. A possibility is ETCS level 2 for parts of the network with low capacity and ETCS level 1 Limited Supervision for the rest and the stations.



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National ETCS projects in Europe: France

Paris - Frankfurt Corridor Common Project RFF/SNCF and DB AG



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National ETCS projects in Europe: France

General requirements

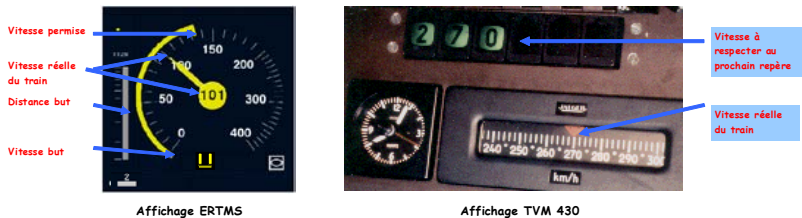
For East European line operator: one signalling system, same block section, no difference between two types of train

For ERTMS driver: his train is an ERTMS train as on any ERTMS line in Europe

For TVM Driver: his train is a TVM train as on any TVM line.

For system design and validation : only one process

Ergonomics for the driver



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National ETCS projects in Europe: Germany

In Germany, ETCS will be introduced in first priority on the following lines:

- Berlin- Halle/ Leipzig (ETCS level 2)
- Aachen- Belgian border (ETCS level 1)
- Mannheim- Saarbrücken (ETCS level 2)
- Nürnberg- Ingolstatt (ETCS level 2)

The PZB will remain in use on all lines. To support the migration, a double-equipment ETCS level 2 and LZB is planned in the central part of the network.

From an international point of view it would be interesting to equip border crossing lines which are connected to the central network with ETCS.



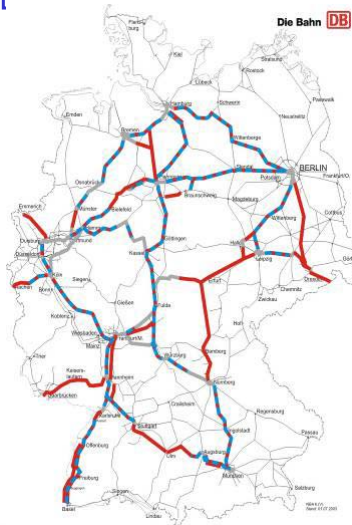
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National ETCS projects in Europe: Germany



**Planned ETCS-line equipment in 2021
for High-Speed Lines (HSL)**

 ETCS line equipment
 parallel ETCS and L2B
 gaps to be closed
 (with ETCS L1 LS?)

total length	4.800 km
HSL (V>160 km/h)	4.100 km
gaps	ca. 700 km
In detail	
L2B+ETCS L2	2.500 km
ETCS L2	1.600 km



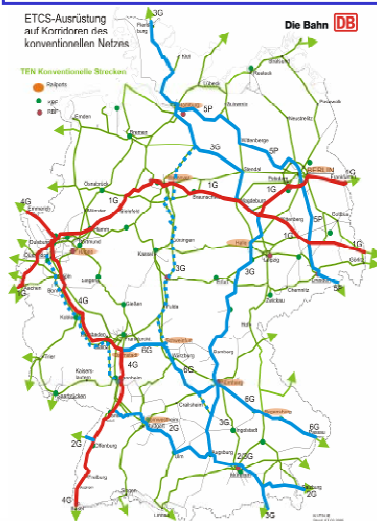
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National ETCS projects in Europe: Germany



**ETCS-corridors for
freight**

- 1G Aachen - Horka/Frankfurt(O)**
- 2G Kehl - Salzburg**
- 3G Flensburg - Kufstein**
- 4G Emmerich - Basel**
- 5P Hamburg - Bad Schandau**
- 6G Darmstadt - Passau**

Priority corridors



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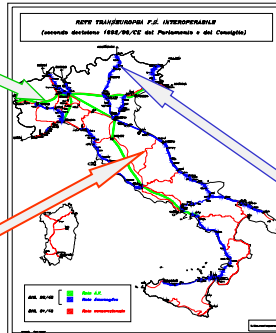
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General RFI migration strategy to ERTMS/ETCS

RFI
is carrying out
interoperability on
the new lines of its
High Speed network

RFI
is going to carry out
interoperability also
on part of its
conventional network



RFI
Considers as essential a
quick realization of
interoperability on the
lines connecting the italian
HS/HC with the european
network (**Cross border
lines - corridors**)

Interoperability will be
afterwards realized on
other "Amenagées" lines

RFI migration strategy gives the highest priority to the corridors



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Speed records

Torino-Novara



Roma-Napoli



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National ETCS projects in Europe: Italy

SCMT (Sistema per il controllo della marcia dei treni)

Interested network: 10.500 km

Interested rolling stocks: 3400 units

SCMT with BACC (4.500 Km):

Encoders with switching balises to send routes signals aspects and non - switching balises to send line parameters, temporary speed restrictions and reduce odometer error.

SCMT without BACC (6.000 Km):

Encoders with switching balises to send both routes and block signals aspects and non - switching balises to send line parameters, temporary speed restrictions and reduce odometer error.



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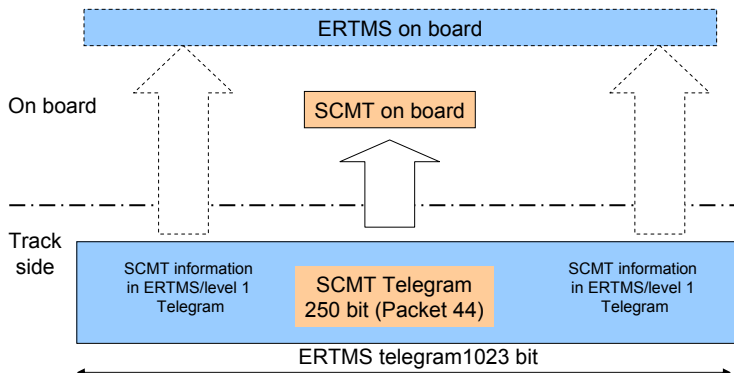
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National ETCS projects in Europe: Italy

SCMT uses Eurobalises with national telegram packet



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National ETCS projects in Europe: Italy

Migration from SCMT towards ETCS level 1

The use of the SCMT telegram encapsulated into Eurobalise p.44 allows to use the same Balise / LEU both for the national and for the ETCS telegrams.

The national trains will run with cab signaling when the continuous track circuit information is available

The national trains will run without cab signaling if only discontinuous information are available.

International trains will run with ETCS level 1.

Things to do:

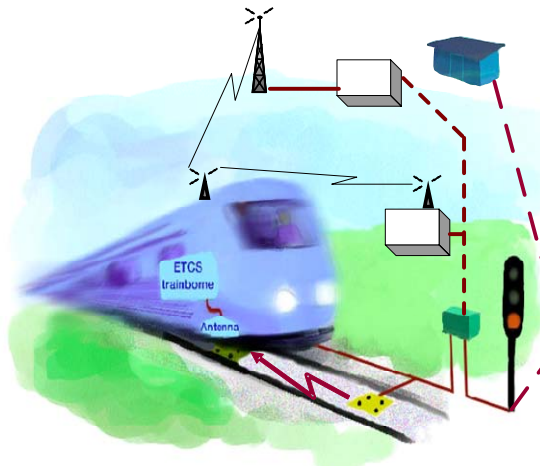
- add the ERTMS telegrams in the SCMT Eurobalise
- substitute some fixed eurobalises with the switchable ones
- reduction of the number of informative points in the axel counter block
- additional conditions to the encoders
- small additional number of switchable informative points



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National ETCS projects in Europe: Italy

Radio infill solution

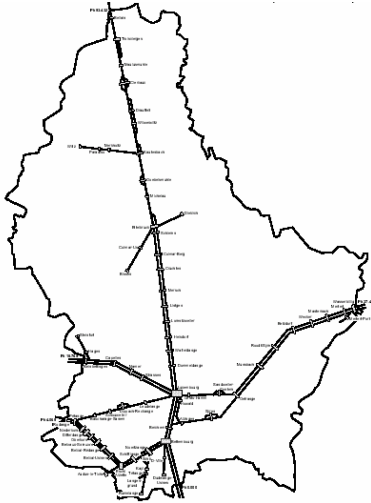


For obtaining with ETCS the same performance as with SCMT, an infill device is necessary at least on the lines with BACC.

RFI is promoting therefore the development of GSM-R radio infill devices.



European Rail Traffic Management System ERTMS National ETCS projects in Europe: Luxembourg



Luxembourg needs ETCS basically for improving safety and interoperability.

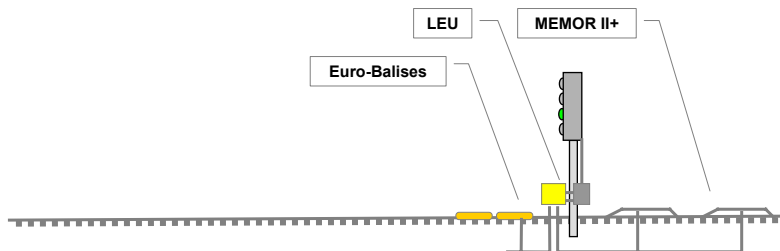
The board of Luxembourg railways has signed a contract at the end of 2002 with Alcatel to equip the complete network with ETCS level 1. The project will be finished within 5 years.

With Alstom a contract has been signed, to equip 10 rail cars with ETCS level 1.



European Rail Traffic Management System ERTMS National ETCS projects in Europe: Luxembourg

Technical Migration for ETCS Level 1



- No direct interface between LEU and the Interlocking
- Signal information picked up by 2 current sensors for each lamp
- LEU also controls during migration MEMOR II+



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Lineside Electronic Unit



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Implementation Strategy

- First step:
 - National implementation of GSM-R
 - ETCS level 2 Implementation on “Megaprojects”:
 - Betuweroute (2005)
 - High-Speed Line-South (2006, Siemens/Alcatel)
 - Amsterdam – Utrecht (mixed signalling, 2006, Bombardier)
- Second step:
 - Implementation of ETCS level 2 on existing lines for capacity increase (2005 ->)



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The three Dutch Megaprojects

Betuweroute



Amsterdam - Utrecht



HSL Zuid



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Requirements for the Spanish rail network according to the infrastructure construction plan for 2000- 2007:

- ◆ Reduction of travelling times:
 - 4 hours maximum connection time from Madrid to any other Regional Capital
 - 6 hours 30 min. maximum connection time from Barcelona to any other Regional Capital
- ◆ To increase the railways market share up to 30 %
- ◆ To improve the whole railways market:
 - From 10 million passengers. to 30 million passengers for long distance displacements
 - From 24 million passengers to 30 million passengers for regional displacements
- ◆ Major economic return



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System requirements

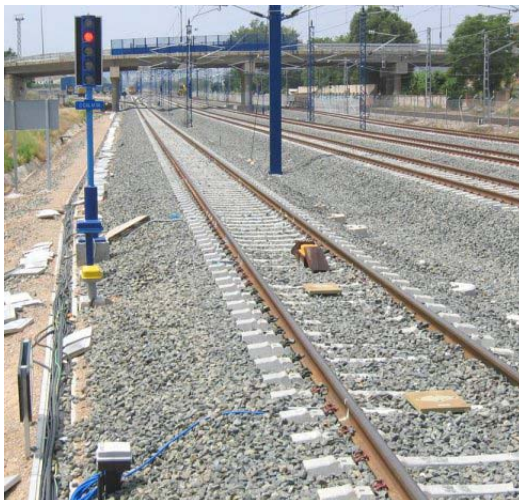
MODE	PERFORMANCE	REQUIREMENTS	PRODUCTS	REMARKS
Continuous transmission with GSM-R	350 km/h 2' 30	ETCS 2	Full supervision by RBC	Block length 1500 m
Fall Back intermittent transmission with Eurobalise	300 km/h 5' 30	ETCS 1	SEI LEU EUROBALISES	Radio failure Block length 6 Km
Non Equipped Trains	220 Km/h 8'	ASFA	SEI ASFA + Wayside Signals	Block length 6 Km



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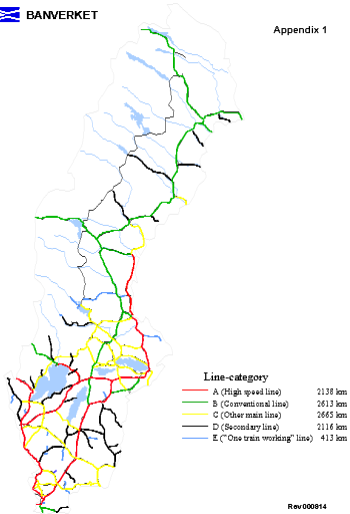
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National ETCS projects in Europe: Sweden

BANVERKET

Appendix 1



Rev000014

ETCS Level 2 will be first introduced in Sweden on the new Botnia line (250 km, mixed traffic)

Sweden is the main promoter of the ETCS level 3 based concept „ETRMS regional“. A call for tender for a first secondary line is in preparation.

For the onboard equipment, a contract of development for a STM Ebicab has been awarded to Ansaldo in the beginning of 2003.



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National ETCS projects in Europe: Sweden

Update on new contracts for train equipment



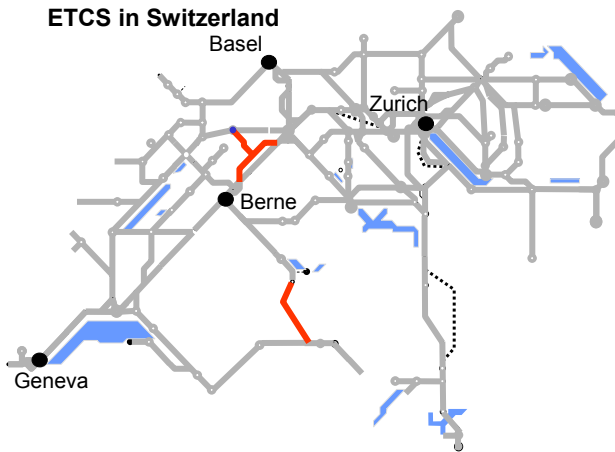
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E44

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ETCS in Switzerland



- Two ETCS level 2 lines in operation:
 - NBS Berne - Olten
 - LBL Lötschbergtunnel
- 600 vehicles ETCS equipped (incl. 19 ICEs, ETR470 and ETR610)
- Investment in ETCS: 400 M€
- Alstom, Thales, Bombardier and Siemens systems
- Interoperability ensured
- > 3million Km ETCS L2 experience



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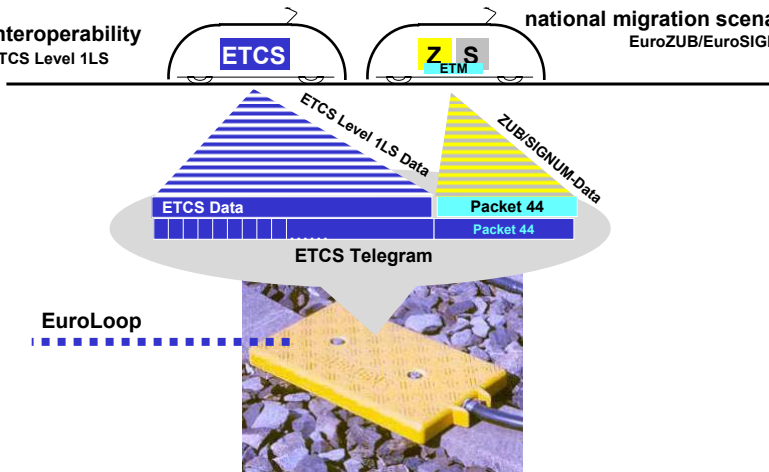
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Interoperability
ETCS Level 1LS

national migration scenario
EuroZUB/EuroSIGNUM



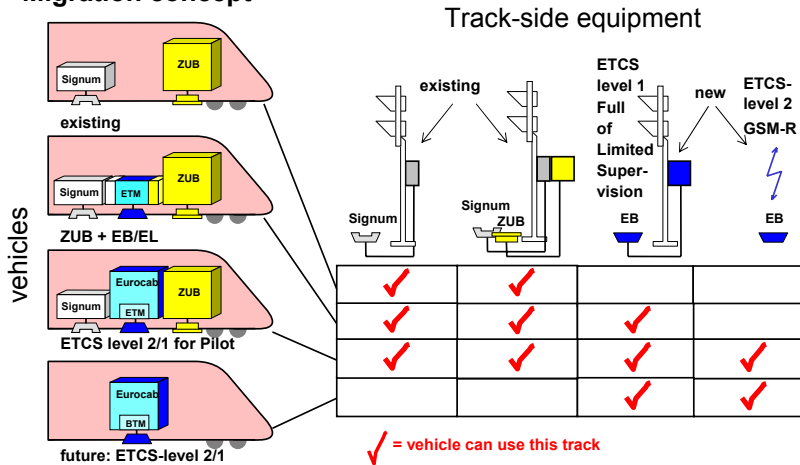
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European Rail Traffic Management System ERTMS National ETCS projects in Europe: Switzerland

Migration concept



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European Rail Traffic Management System ERTMS ETCS on European corridors



Memorandum of Understanding (MOU)
between the European Commission and
the European Railway Associations
(CER – UIC – UNIFE – EIM)
establishing the basic principles
for the definition of an EU deployment
strategy for ERTMS

- In March 2005 all key players for the European railway scene have signed a MoU for the deployment of ERTMS on 6 freight corridors.
- A steering committee has been established for this undertaking, chaired by Karel Vinck
- A common methodology has been agreed in September 2005
- Studies have been completed in March 2006 for all of the corridors.

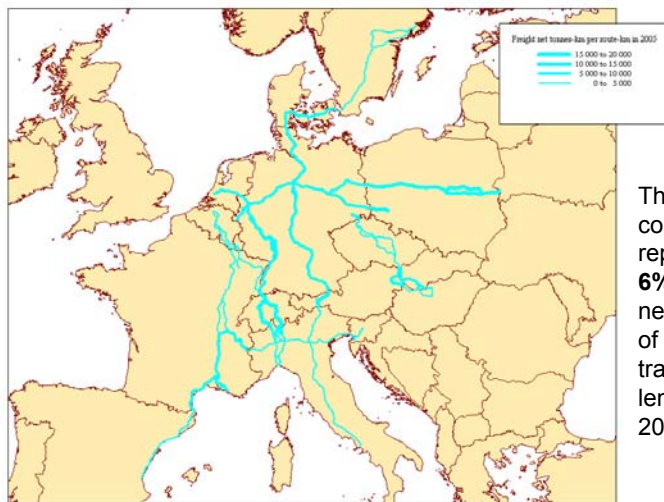


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European Rail Traffic Management System ERTMS ETCS on European corridors



The 6 studied corridors represent about **6%** of the total network but **20%** of the total freight traffic. The total length is about 20'000 km.



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European Rail Traffic Management System ERTMS ETCS on European corridors

Compliance with MoU postulate: "Implementation of the ETCS within the 10-12 years indicative timeframe" (2015-2017)

Corridor A : Rotterdam- Genoa	Rotterdam – Oberhausen: L2 – 2012 Oberhausen – Mannheim: L2 – 2015 Mannheim – Genova: L2/L1 - 2012
Corridor B : Stockholm – Naples	Stockholm – German Border: L1/L2 – 2015 Flensburg – Hannover: L2 after 2020 Hannover – München: L2 after 2020 München – Kufstein: ?? Wörgl – Innsbruck: L2 - 2012 Innsbruck – Verona – Napoli: L1/L2 - 2014
Corridor C : Antwerp-Basel –Lyon	Antwerpen Bettembourg: L1 – 2012 Bettembourg – Basle: L1 – 2009/2010 Athis – Dijon: L1 – 2014 Dijon – Lyon: L1 – 2016/2017



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European Rail Traffic Management System ERTMS ETCS on European corridors

Compliance with MoU postulate: "Implementation of the ETCS within the 10-12 years indicative timeframe" (2015-2017)

Corridor D : Valencia-Lyon – Ljubljana	Valencia – Tarragona – Port-Bou: L1 - 2014 Tarragona – Perpignan: L2 – 2009 Perpignan – Lyon: L1 – 2012/2016 Lyon – Modane – Torino: L1 – 2014 Torino – Milano: L1 – 2012 Milano – Ljubljana: L1 – 2013/2014
Corridor E : Dresden – Prague – Budapest	Dresden – Děčín: L2: 2020 Děčín – Praha – Břeclav: L2: 2010-2011 Břeclav – Bratislava – Budapest: L1/L2: 2015
Corridor F : Duisburg-Berlin- Warsaw-Terespol	German section L2: 2020 Polish sections to be confirmed



European Rail Traffic Management System ERTMS ETCS on European corridors

First costs estimates from the corridor studies:

2007-2013	Rolling stock	ETCS infrastructure
6 corridors	600-800 M€	1000-1400 M€

The EU has earmarked a total of 500 M€ for ERTMS projects in the Transeuropean Networks budget for 2007 -13.



European Rail Traffic Management System ERTMS ETCS on European corridors

Next steps

Example of Rotterdam – Genoa 2012:

- Based on the corridor study, signature of a **Letter of Intent on 3rd march 2006** by the transport ministers setting the calendar for deployment and also...
- Defining an **operational structure** to implement the project
- Requesting the **national safety authorities to cooperate** in order to streamline the certification procedures

Possible model for corridors organisation:

- A **supervising and decision-making structure** with representatives of the ministries concerned
- An **operational structure** of the infrastructure managers to carry out the work. A European Economic Interest Grouping (EEIG) per corridor could be a suitable vehicle
- In addition, a **structured cooperation between the national safety authorities** concerned can help to streamline authorisation procedures



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European Rail Traffic Management System ERTMS ETCS outside Europe: Australia



CityRail (greater Sydney area) -

- 2,546 train services per day
- 900,000 passengers per day
- 1,595km of tracks
- 306 stations

CountryLink -

- 20 daily rail services
- 119 coach services

Human Resources -

- 13,600 employees



RailCorp



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European Rail Traffic Management System ERTMS ETCS outside Europe: Australia

Why ETCS?

- A technology that can deliver specific benefits to RailCorp
 - safety
 - capacity
- Developed specifically to control ATP preventable risks
- Optimal timelines as technology and specifications are already developed
- Available from multiple sources "off the shelf"

The unknowns

- How expensive is it?
- What are the benefits worth?
- What are the issues with implementation?
- Do we have to change any operating rules?
- Is there a migration path to the higher levels?
- What are the options for train location, passenger information, future ATO?



ATP Pilot Trial



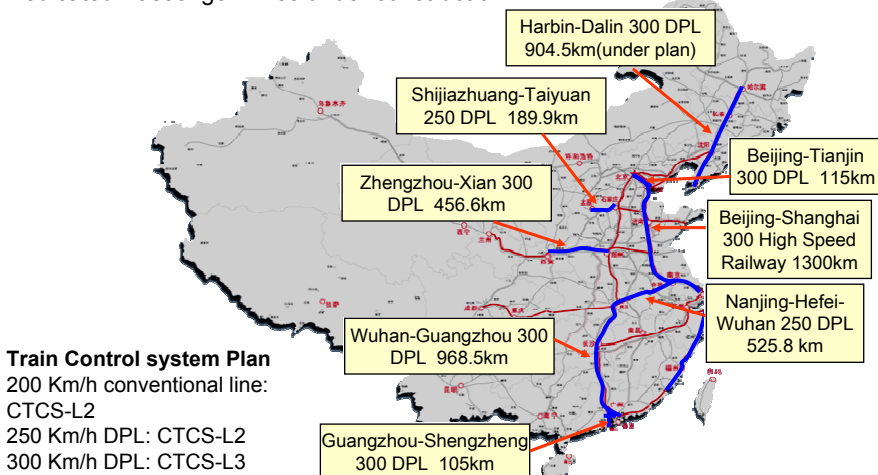
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European Rail Traffic Management System ERTMS ETCS outside Europe: China

Dedicated Passenger Lines under construction



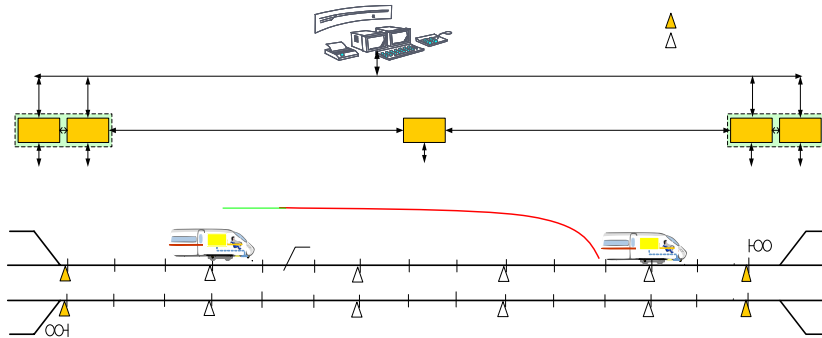
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European Rail Traffic Management System ERTMS ETCS outside Europe: China

CTCSL2 OPERATION CONCEPT



CTCS2 sends movement authority through ZPW2000 track circuit. Onboard equipment controls the train according to track circuit code and balise message.



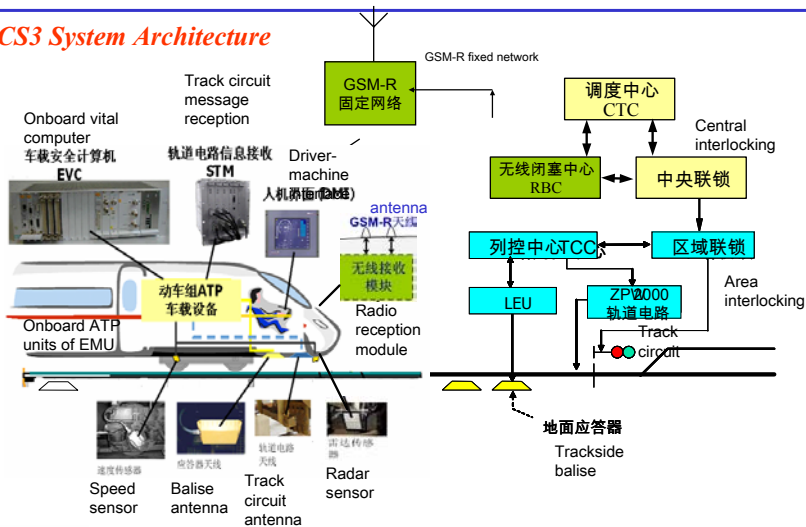
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European Rail Traffic Management System ERTMS ETCS outside Europe: China

CTCS3 System Architecture



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European Rail Traffic Management System ERTMS ETCS outside Europe: India

TPWS (ETCS) pilot lines



- Two routes have been selected for the TPWS evaluation trials
 - In the north New Delhi to Agra
 - one of the busiest trunk routes in India
- In the south Chennai Beach to Gummidipundi
 - one of the busiest suburban routes in India



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European Rail Traffic Management System ERTMS ETCS outside Europe: South Korea



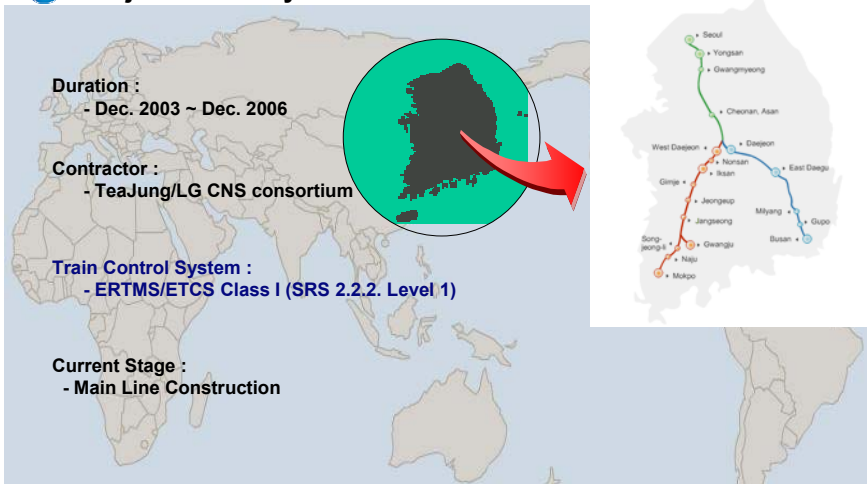
Project summary

Duration :
- Dec. 2003 ~ Dec. 2006

Contractor :
- Teajung/LG CNS consortium

Train Control System :
- ERTMS/ETCS Class I (SRS 2.2.2. Level 1)

Current Stage :
- Main Line Construction



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