



## Defining engineering design requirements to address operational scenarios for ERTMS infrastructure systems

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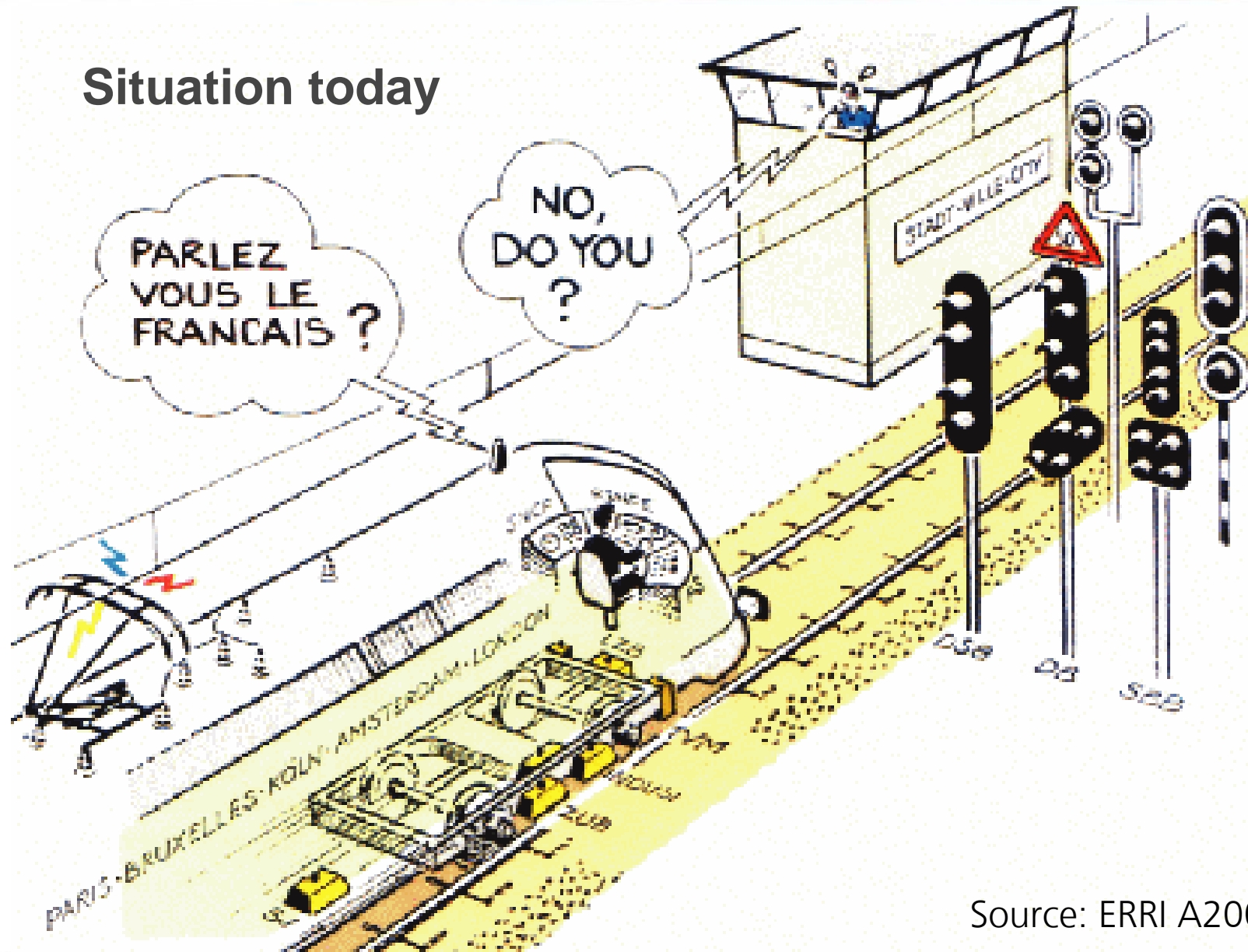
## Overview

- **Introduction**
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- **Specifying design requirements for trackside subsystems**
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- **Perspective**





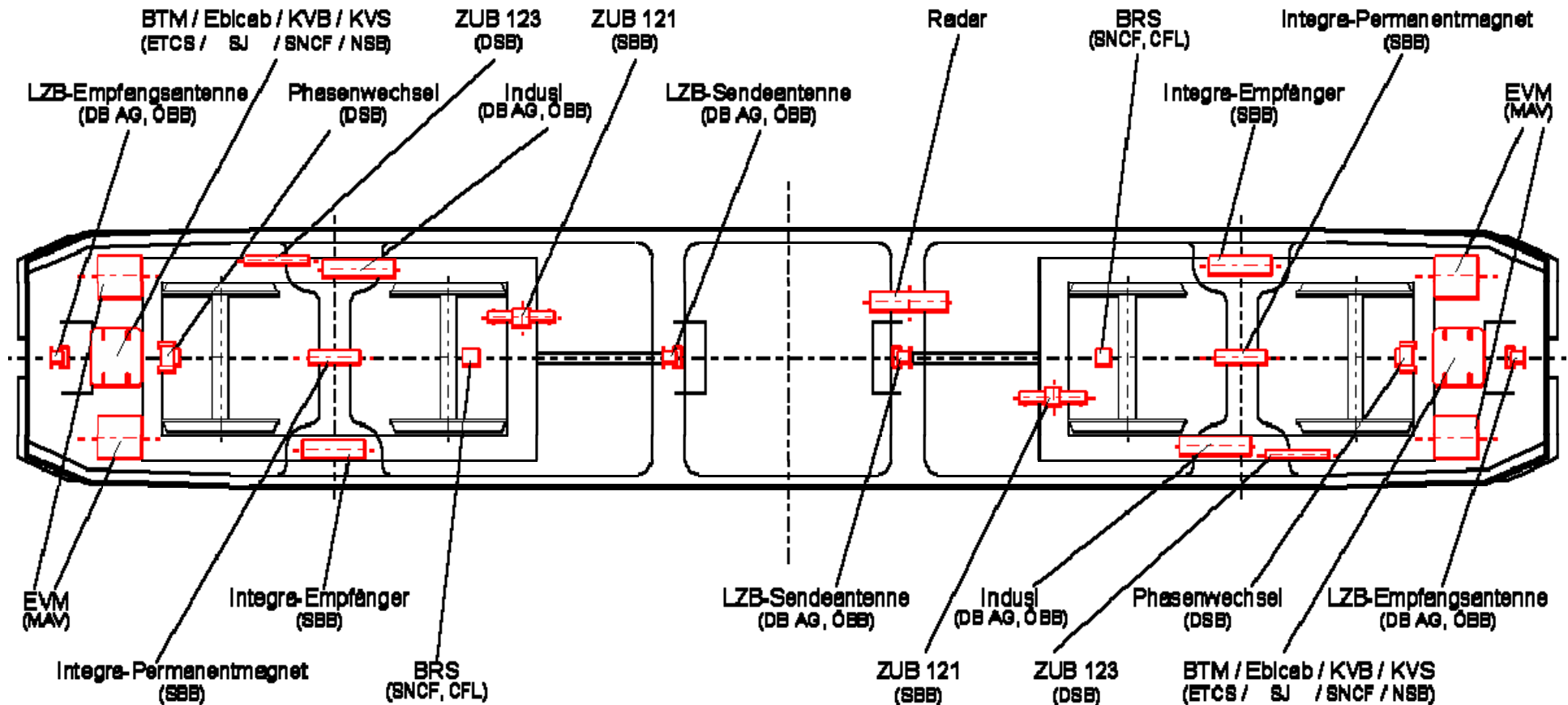
## Situation today



Source: ERRI A200



## Harmonisation by fulfilling all national requirements



24 Antennas leading to effort in investment, space and maintenance!



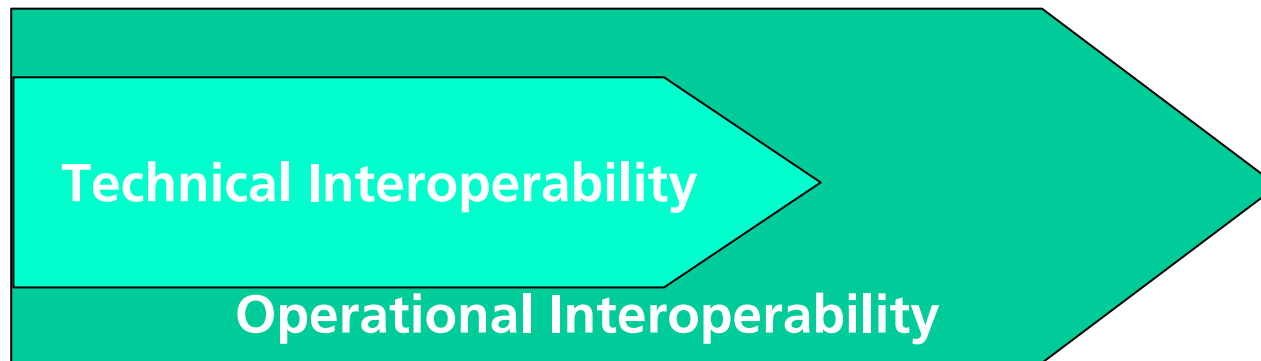


## Introduction

- **ERTMS/ETCS is the coming standard for train control in Europe.**
- **Technical interoperability is ensured by the UNISIG specification (“List of Madrid”).**
- **National rules and regulations for operation will be used on the new ETCS lines without or only with small modifications.**
- **Harmonising operational rules is still needed to reach operational interoperability.**
- **Safety and dependability are assessed today due to national regulations.**

ERTMS: European Rail Traffic Management System  
ETCS: European Train Control System

## Interoperability is harmonisation of technology as well as operation



### **Technical Interoperability :**

- specification of the data exchange between on board and trackside systems
- functional specification of the systems
- definition of the non-functional characteristics, e.g. RAMS

### **Operational Interoperability:**

- harmonised rules for safe normal (and later fall-back) operation
- harmonised use of the system: e. g. marker boards and written forms



## Harmonising operational rules

- **Definition of the domain:**
  - Types of trains: push/pull, multiple units, etc.
  - Roles of the personnel: signaller, driver, etc.
  - Etc,
- **Defining generic scenarios:**
  - Start a train
  - Running in normal operation
  - Etc.
- **Work done:**
  - EEIG ERTMS Users Group: Functional Analysis, scenarios, etc.
  - EuroInterlocking: trackside scenarios



# Harmonisation needs time

Former Deutsche Bundesbahn DS 301

Former Deutsche Reichbahn DV 301

## Railway Operation Procedures:

- described in national rules and regulations as well as knowledge
- national different
- description only as text and figures
- Validation by use
- Comparison only partially possible
- no „purification“ of obsolete aspects possible due to feedback effects

### Status DB AG 2005 after more than 10 years of common operation!

DS 301	DV301
<p>3a. Ist das Signalbild nicht zu erkennen oder ist es zweifelhaft, ist die Bedeutung desjenigen Signalbildes anzunehmen, das die größere Vorsicht erfordert.</p> <p>Zusatz: Das gilt auch, wenn hörbare Signale nicht deutlich wahrgenommen werden</p> <p>(9) Lichtsignale, an deren Standort bei erloschenem Signalbild zu halten ist, sind durch Mastschilder kenntlich.</p> <p>4. Die Mastschilder sind</p> <p>a) weiß-rot-weiß, wenn bei gestörtem Signal Züge nur auf schriftlicher Befehl des Fahrdienstleiters oder auf Ersatzsignal, Falschfahrt, Auftragssignal oder Vorsichtsignal Rangierfahrten nur mit mündlicher Zustimmung des für das Signal zuständigen Wärters weiterfahren dürfen,</p>	<p>§ 1 (7) Wird im Einzelfall ein Signal nicht deutlich wahrgenommen, muss die Bedeutung angenommen werden, die die größte Vorsicht erfordert.</p> <p>§ 1 (8) Die durch Signale vorgeschriebenen Geschwindigkeiten gelten, sofern nicht im Fahrplan, durch einen anderen schriftlichen Auftrag (La, Befehl, Fahrplan-Mitteilung) oder durch andere Signale eine niedrigere Geschwindigkeit vorgeschrieben wird.</p> <p>§ 1 (10) Lichtsignale, an denen Halt gezeigt werden kann, sind durch Mastschilder gekennzeichnet, die das Verhalten bei Halt zeigendem oder gestörtem Signal vorschreiben. Die Mastschilder können rückstrahlend sein.</p> <p>§ 1 (11) An einem durch</p> <ul style="list-style-type: none"> <li>- ein weiß-rot-weißes Mastschild bzw.</li> <li>- ein Mastschild mit einem mit der Spitze nach oben weisendem roten Dreieck auf weißem Grund gekennzeichneten Lichthauptsignal, das Halt zeigt oder gestört ist, dürfen Züge nur auf Ersatzsignal, Vorsichtsignal, Linksfahrersatzsignal, schriftlichen Befehl oder - bei M-Tafel - auf mündlichen bzw. fernmündlichen Auftrag vorbeifahren.</li> </ul>





## New demands on infrastructure subsystems

- Overall Interoperability is ensured by the on board subsystem of ETCS.
- Performance is defined mainly by the trackside parts of ETCS: RBC, Infill, Loops, etc .
- Migration via ETCS Net and the corridor concept => modular concepts and flexible combination are needed e.g. filling gaps between Level 2 areas with ETCS Level 1 Limited Supervision.
- Current performance must be kept or surpassed with ETCS.
- Complete new lines with specific requirements have to be integrated in existing networks, e.g. the tunnels AlpTransit Lötschberg and Gotthard.

RBC: Radio Block Centre  
ETCS: European Train Control System



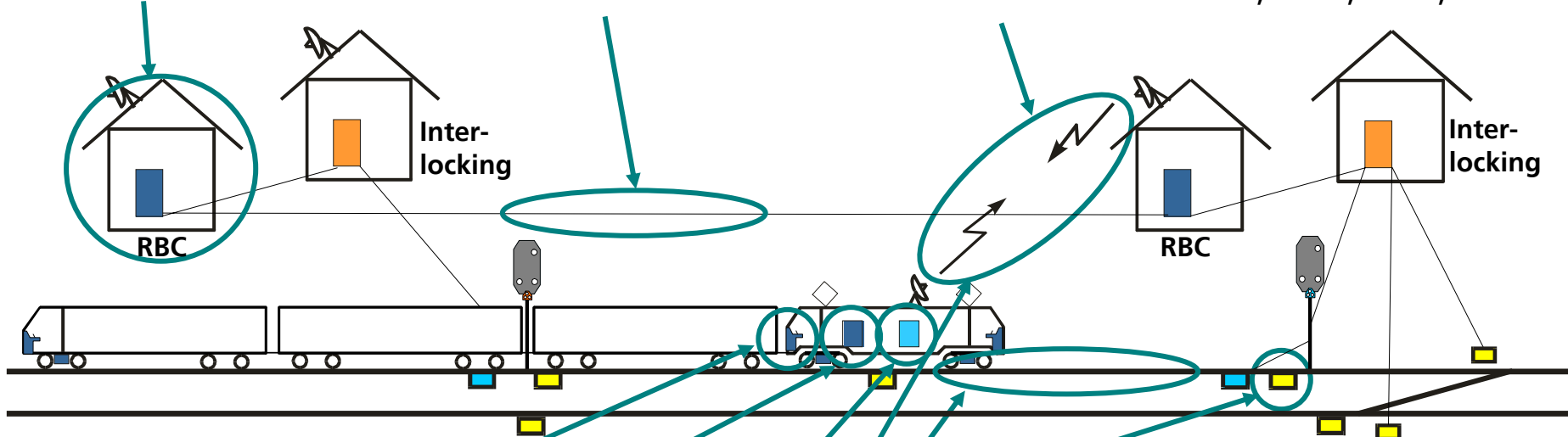
## Existing specifications for the system as well as for on board and trackside subsystems

Overall system: subsets 026, 040, 041, 054, 055, 076, 108, 023, 030

RBC: subset **?**, 032

RBC-RBC: subset 039

Infill: subsets 046, 047, 048, 032



DMI: subset 033, *WGA9D*

EuroBalise: subsets 036, 049, 032

OBU: subsets 026, 027, 076, 108, 031

EuroLoop: subsets 043, 044, 045, 050

STM: subsets 035, 056, 057, 058, 059

EuroRadio: subsets 037, 038, 093, 032, 060

DMI: Driver Machine Interface

OBU: On Board Unit



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STM: Specific Transmission Module

RBC: Radio Block Centre



## Specifying design requirements for trackside subsystems

- **Consistent representation of onboard as well as trackside operational rules is needed as basis.**
- **The trackside subsystem of ETCS bridges the gap between route protection and train control on board functionality and communication defined by European standards.**
- **Functional requirements must be specified together with non-functional requirements as performance and RAMS.**
- **This work must be done already for the tendering process!**
- **The final performance of the ERTMS system is limited mainly by the trackside subsystem.**

RAMS: Reliability Availability Maintainability Safety



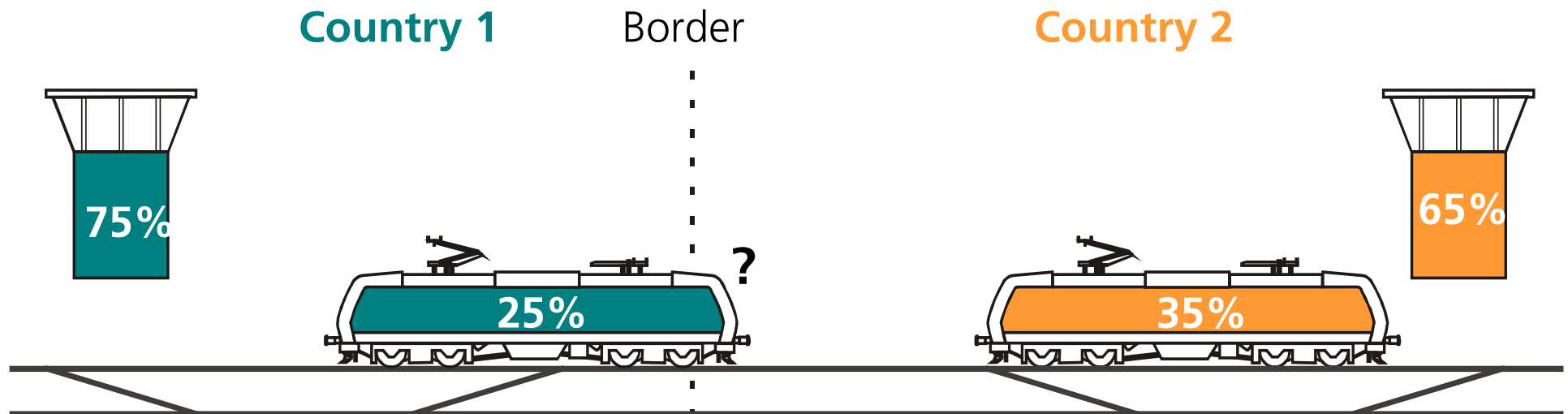
## Harmonising safety and dependability (RAMS)

- **Common safety targets and methods must be defined for cross acceptance and European certification and homologation.**
- **Current situation analysis and first definitions given by the projects SamNet and SamRail.**
- **A complete RAMS requirements specification for Europe must be done in the next step to reach a real “European Certification” of systems and subsystems.**
- **First definition of harmonised requirements proposed by the project EuroInterlocking.**
- **The European Railway Agency will play the central role in this process.**



## Harmonising safety and reliability

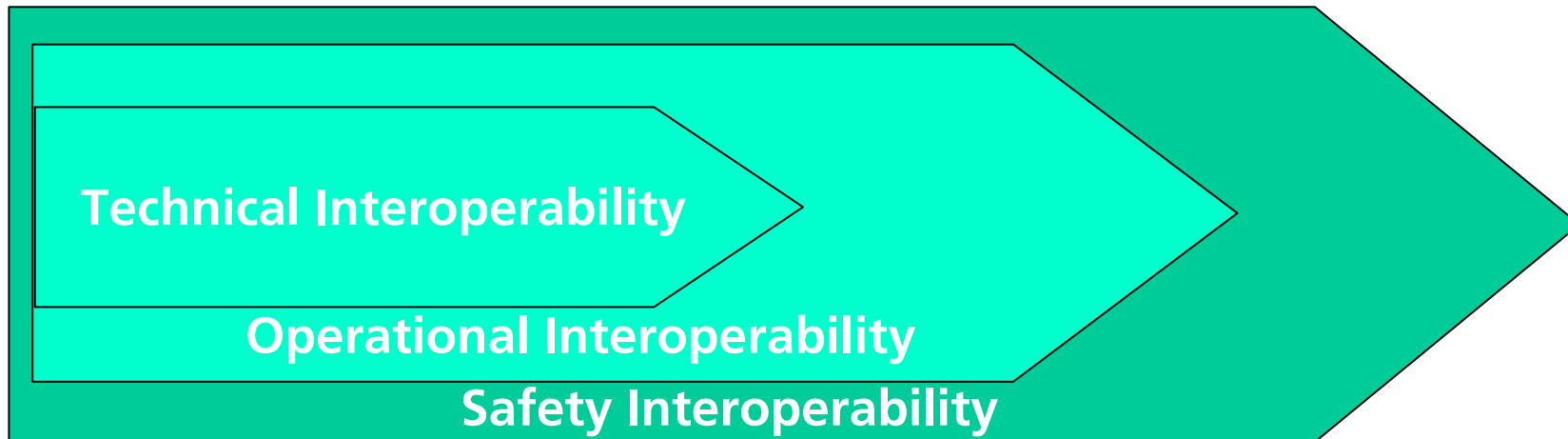
### Example for the safety allocation problem



- Identification and comparison of rules and regulations for safe normal and fallback operation needed.
- Comparison of rules for the allocation and distribution of safety responsibility to trackside and on board.



## Interoperability needs harmonisation of safety



### **Safety Interoperability :**

- specification of the data exchange between on board and trackside subsystems
- functional specification of the system
- definition of the non-functional characteristics



## Perspective

- **Interoperability is needed to keep Railway competitive in Europe.**
- **Interoperability contains several aspects: technical, operational and safety.**
- **On board functionality and communication is well specified at the moment.**
- **The specification of the trackside subsystem functionality of ETCS is still a national task and only a few harmonised specifications are available.**
- **Operational and safety harmonisation started already, bit a long way must still be gone.**
- **Nevertheless: ERTMS will be the future standard!**





## Contact

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**Thank you for your attention!**