

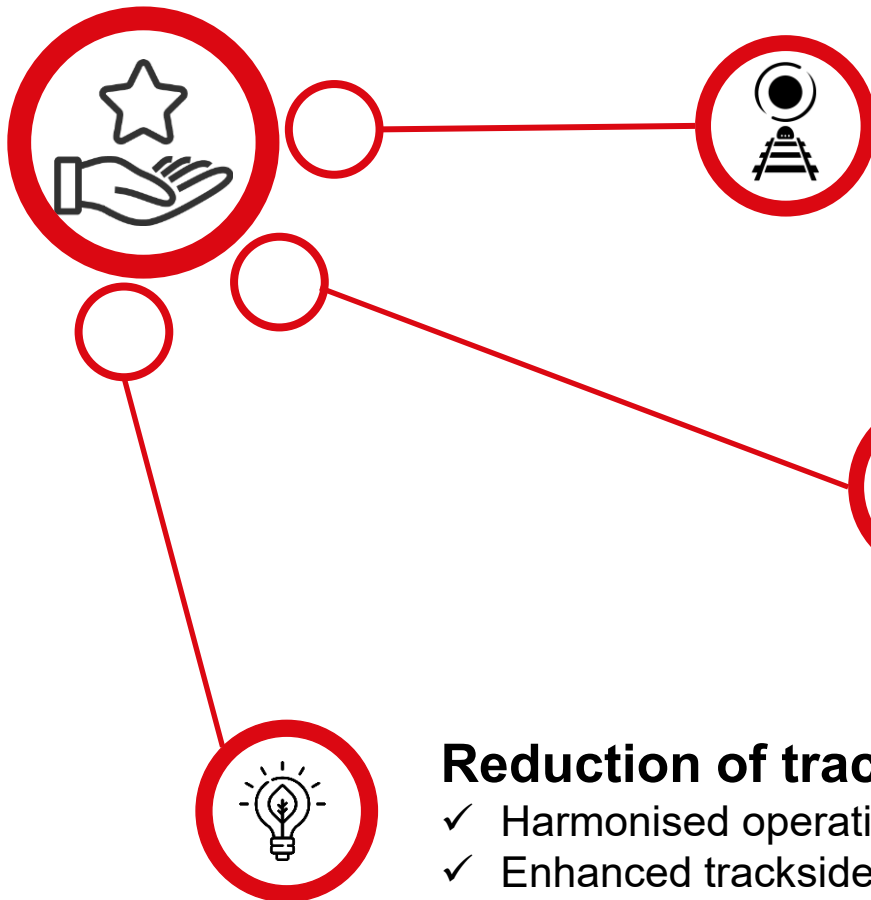
# ETCS on-board cost drivers, supplier's view

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- ETCS on-board systems are highly modular
  - EVCs are designed as highly modular construction kits with various mandatory or optional circuit boards for different purposes, which communicate with other subsystems (BTM, DMI, JRU, GSM-R, odometry sensors...)
  - Clearly defined and standardized interfaces reduce the cost of system integration (i.e. SS-119).
- Need to evaluate the impact of introducing new modules in the lifecycle costs of the Project
  - A CBA should be performed and only modules, for which a clear benefit has been demonstrated should be introduced.
  - This analysis should consider the safe integration of the module considering SIL4 requirements and the overall costs of the HW among other aspects.
  - Success case: one common bus enables introduction of new technologies.
- Interchangeability presents additional challenges
  - Interoperability
  - Train interface
  - Space envelope specs
  - Supplier responsibilities



### **Stability of Requirements**

- ✓ Establish a clearly defined and stable core, modifiable only under strict, predefined conditions.
- ✓ Ensures that investments are secure and have a longer lifespan.

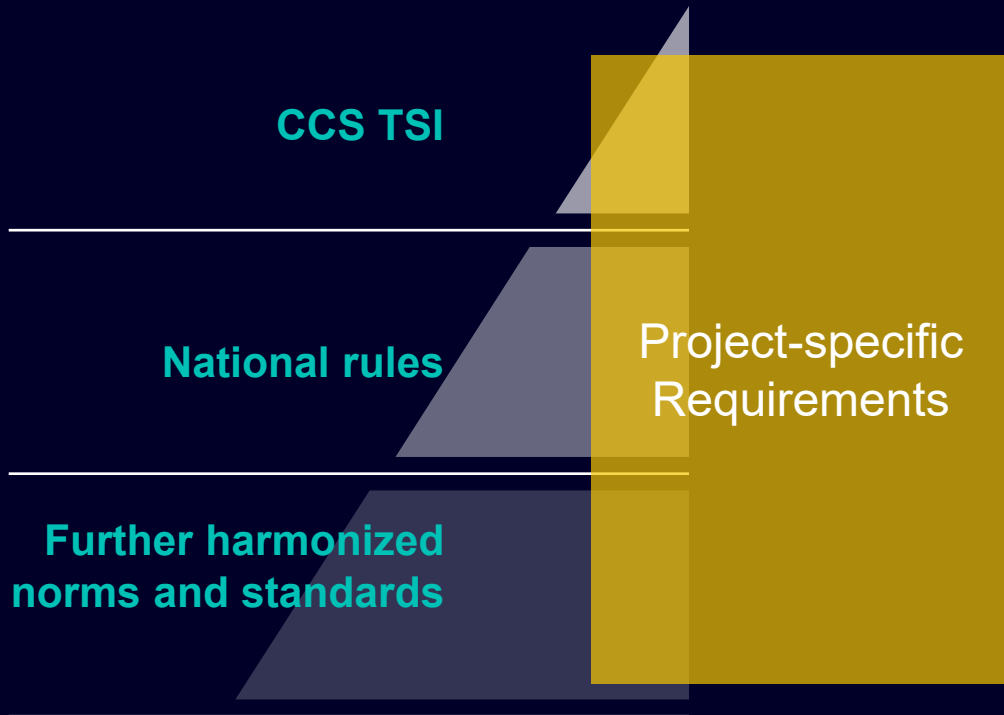
### **Maturity of requirements**

- ✓ A TRL threshold before legal enforcement of new requirements will reduce the volume of later change request for error corrections.

### **Reduction of trackside diversity**

- ✓ Harmonised operational and trackside engineering rules.
- ✓ Enhanced trackside predictability will reduce effort required for ETCS on-board design, testing, and maintenance.
- ✓ Enables the optimization of ETCS System Compatibility (ESC) checks

# Customer Requirements add one-time and recurring costs to products



## Operational Requirements, e.g.:

User-related (e.g. driver, maintainer, commissioner)  
Track-related (customer-specific usecases)  
Advanced connectivity & diagnostics

## PRAMSS Requirements, e.g.:

Performance  
Reliability, Availability  
Maintainability  
Safety, Security

## Architectural Requirements, e.g.:

Grouping / ungrouping of IOCs  
More modular vs. more integrated design  
Amendments / adaptations of interfaces

### Direct impact on costs (One-Time):

- Impact analysis (CCS TSI compliance, interoperability, safety)
- Function implementation (=> product variant)
- V&V, Assessment

### Indirect impact on costs (Lifecycle):

- Product variant must be kept until project phase-out (>30 yrs)
- Until then, each variant adds test, integration and assessment costs to all future developments.

## Limited competition vs. market fragmentation:

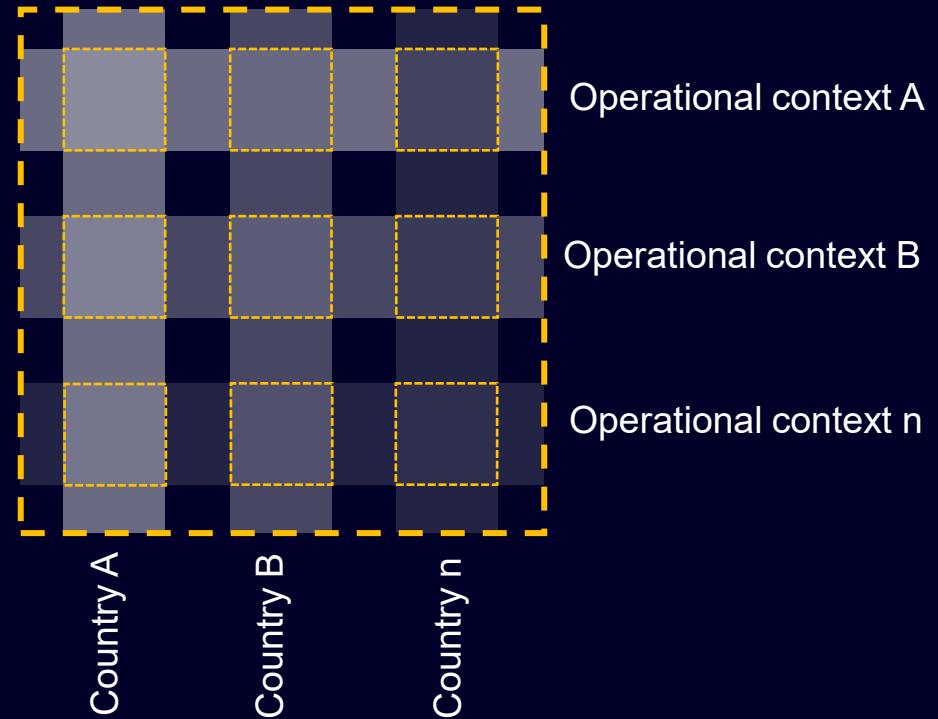
There is a gap between modular specification and project reality

DMT considers “limited competition” to be a cost driver.

This is associated with the **complexity of the ERTMS system** and with **vehicle integration challenges**, esp. for retrofits.

UNISIG sees yet another influence:

 **Market fragmentation**



### Priorities for reducing market fragmentation

- Adoption of harmonized operational processes
- Decommissioning of class B systems
- Further reduction of national rules

**Need for integration with TCMS**



**Dependency on a single supplier**

**Development of alternative solution**

**Lack of documentation**

- Availability of train schematics
- Availability of electrical schematics
- Availability of neumatic schematics



**Increased engineering effort**

- 3D scans
- Reverse engineering
- Iterations and redesigns

# Conclusions

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## Modularity

- ▶ ETCS on-board systems are highly modular
- ▶ Need to evaluate the impact of introducing new modules in the lifecycle costs of the Project
- ▶ Interchangeability presents additional challenges

## Requirements

- ▶ Stability & Maturity
- ▶ Reduction of trackside diversity

## Market Fragmentation

- ▶ Customer Requirements add one-time and recurring costs to products
- ▶ Adoption of harmonized operational processes, Decommissioning of class B systems, Further reduction of national rules would reduce market fragmentation

## Retrofit projects

- ▶ Integration with TCMS & availability of documentation and plans

For more information, we refer to the *Signal & Draht* article about *ETCS on-board cost drivers* (edition 4/2026).