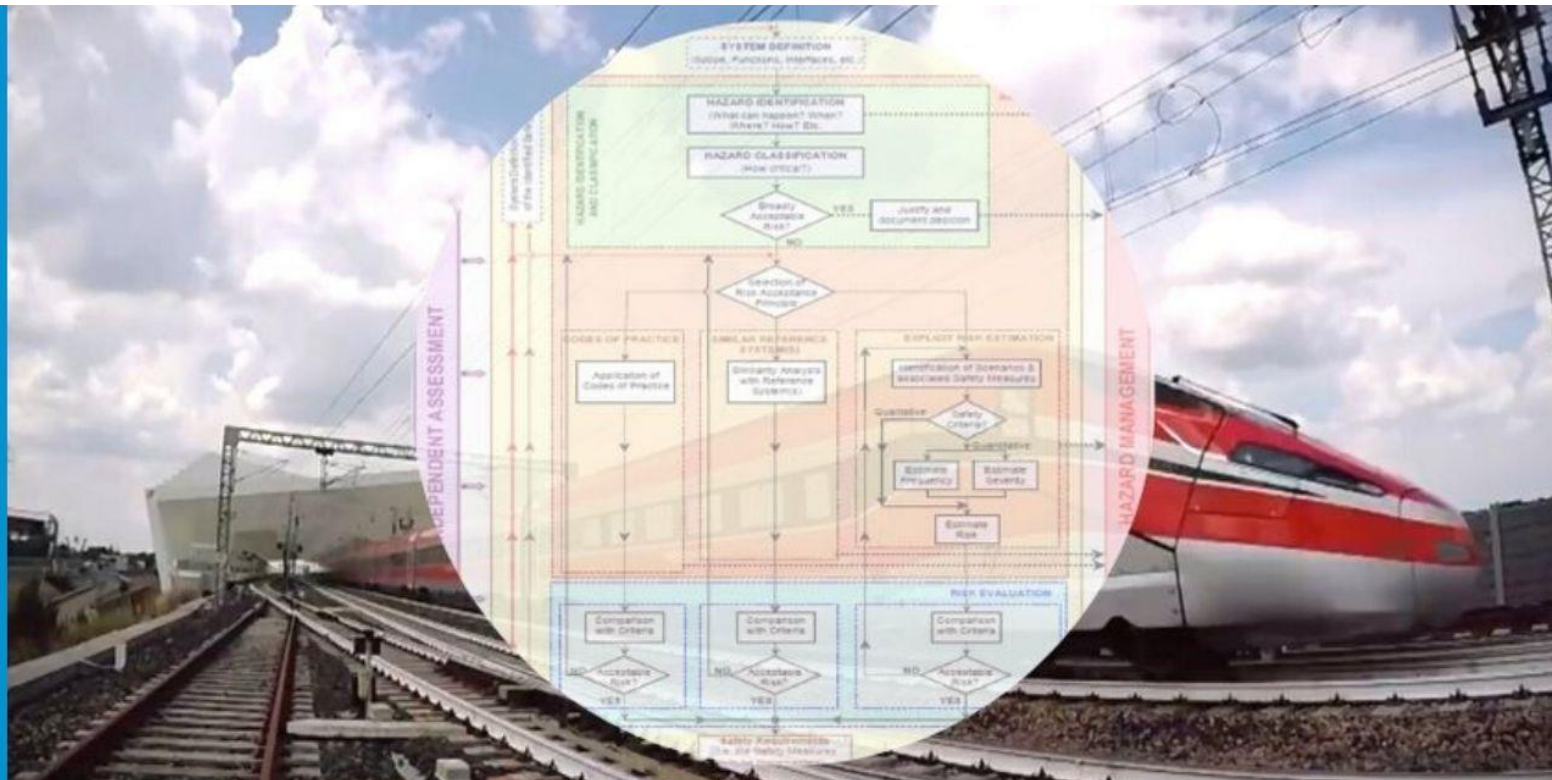




## 2.1 SPECIFICHE TECNICHE D'INTEROPERABILITÀ



”  
**ESPERTO  
VALUTAZIONE DEL RISCHIO E  
VERIFICA CE  
DEI SOTTOSISTEMI FERROVIARI**  
CORSO DI FORMAZIONE  
“

**ERA**

*Gaetano Imperato*

8 settembre 2020



# From national visions to European interoperability



## YESTERDAY

**International Agreements**

(COTIF, AGC, AGTC,...)

+

**International Rules**

(UIC, RIV, RIC,...)

+

**National Rules**

(With or without mutual recognition)

## TODAY

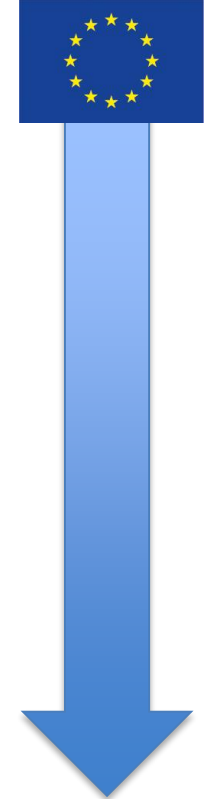
**European Specifications**

+

**European Standards**

+

**National Rules**



# Background and legal framework

## Background and legal framework

1991

- Council Directive 91/440/ECC on the development of the Community's railways

1996

- Directive 96/48: Interoperability of the trans-European **(TEN) high-speed rail system**

2001

- **1<sup>st</sup> railway package**: Interoperability Directive 2001/16 (covering **CR TEN network**)

2004

- **2<sup>nd</sup> railway package**: Interoperability Directive amended (covering TEN network), **Safety Directive** 2004/49/CE and Regulation 881/2004 (**European Railway Agency** created)

2007

- **3<sup>rd</sup> railway package**: passenger rights better guaranteed, opening of the market for international railway services (from January 2010), European license for train drivers

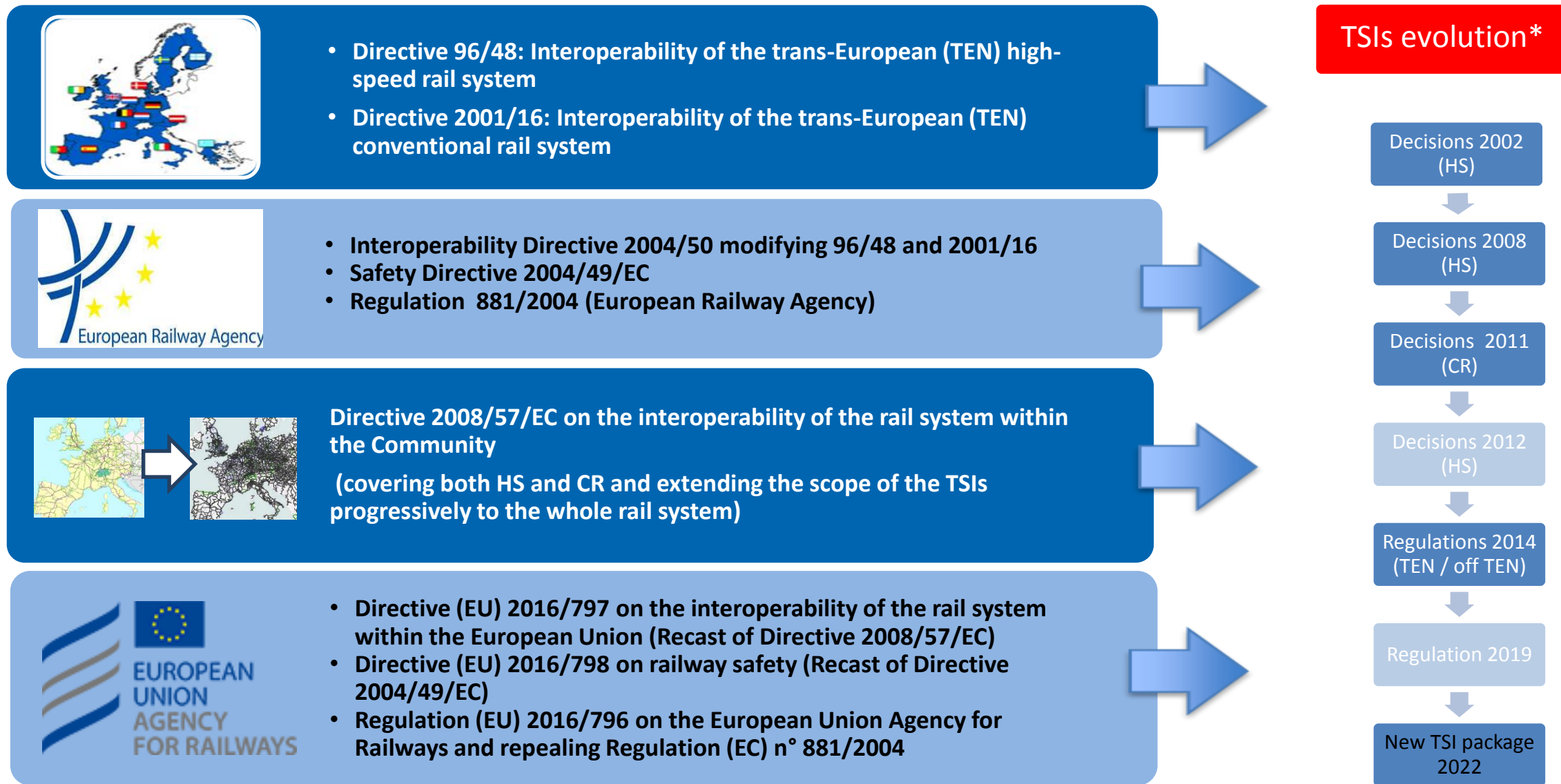
2008

- Interoperability Directive 2008/57/EC (**covering the entire Union railway network**)
- Directive 2008/110/EC amending the Safety Directive (ECMs introduced)

2016

- **4<sup>th</sup> railway package (technical pillar)**: major revision of ERA regulation, Interoperability and Safety directives: new roles and responsibilities for ERA, single safety certificate and improved vehicle authorisation process

# Interoperability directives – Safety directives and ERA Regulation



\*e.g. INF/ENE TSIs

This Directive establishes the conditions to be met to achieve **interoperability** within the **Union rail system** in a manner compatible with Directive (EU) 2016/798 in order to define an **optimal level of technical harmonisation**, to make it possible to facilitate, improve and develop rail transport services within the Union and with third countries...



Directive  
EU  
2016/797

Art. 1

- (2) **‘interoperability’** means the ability of a rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance;
- (5) **‘subsystems’** means the structural or functional parts of the Union rail system, as set out in Annex II;
- (7) **‘interoperability constituents’** means any elementary component, group of components, subassembly or complete assembly of equipment incorporated or intended to be incorporated into a subsystem, upon which the interoperability of the rail system depends directly or indirectly, including both tangible objects and intangible objects;

- (9) **‘essential requirements’** means all the conditions set out in Annex III which must be met by the Union rail system, the **subsystems**, and the **interoperability constituents**, including **interfaces**;
- (11) **‘technical specification for interoperability’** (TSI) means a specification adopted in accordance with this Directive by which each **subsystem** or **part of a subsystem** is covered in order to meet the essential requirements and ensure the interoperability of the Union rail system;
- (12) **‘basic parameter’** means any regulatory, technical or operational condition which is critical to interoperability and is specified in the relevant TSIs;



Essential Requirements

Safety

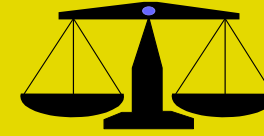
Reliability and  
availability

Health

Environmental  
protection

Technical  
compatibility

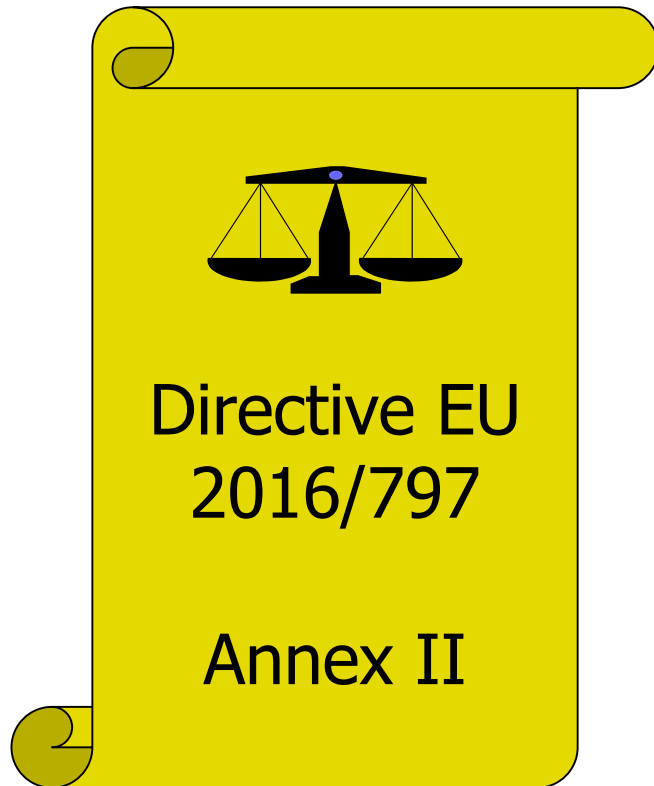
Accessibility



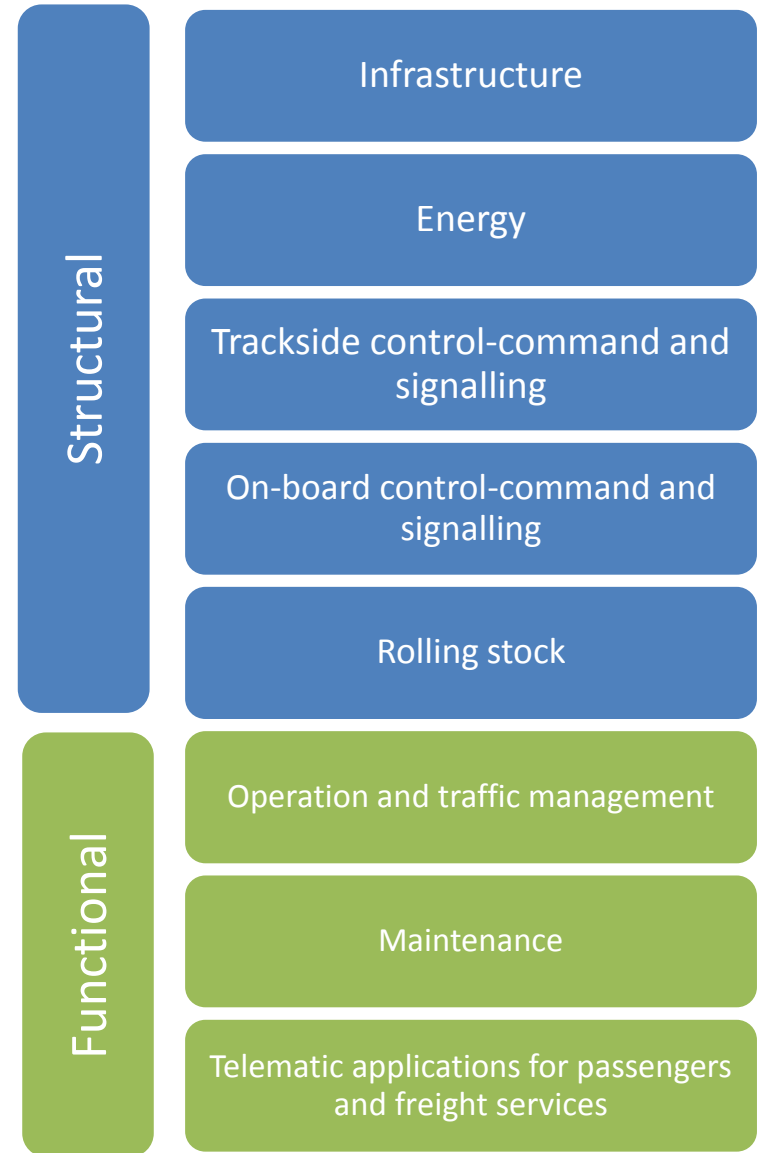
Directive  
EU  
2016/797

Annex III

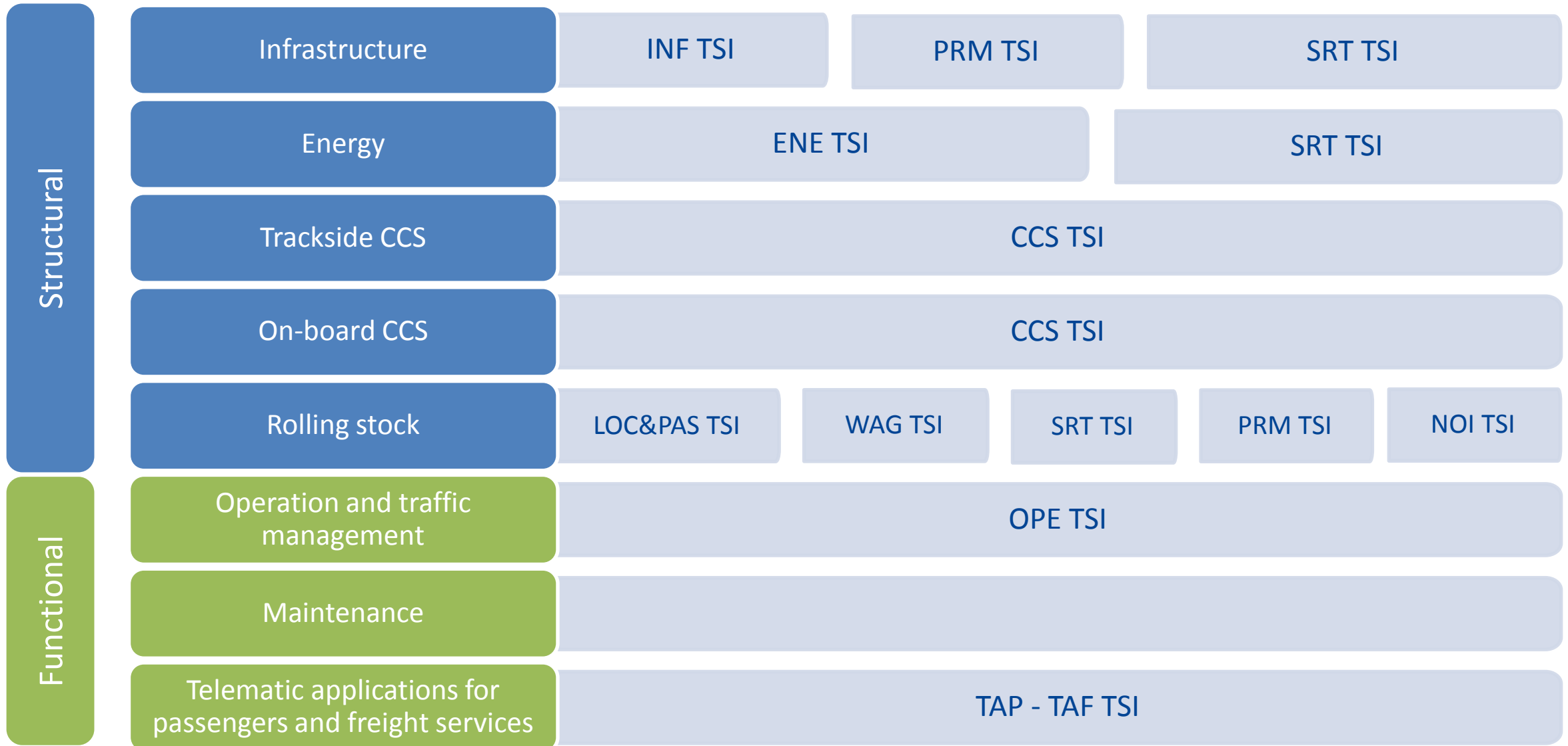
For the purposes of this Directive, the system constituting the **Union rail system** may be broken down into the **subsystems beside**.



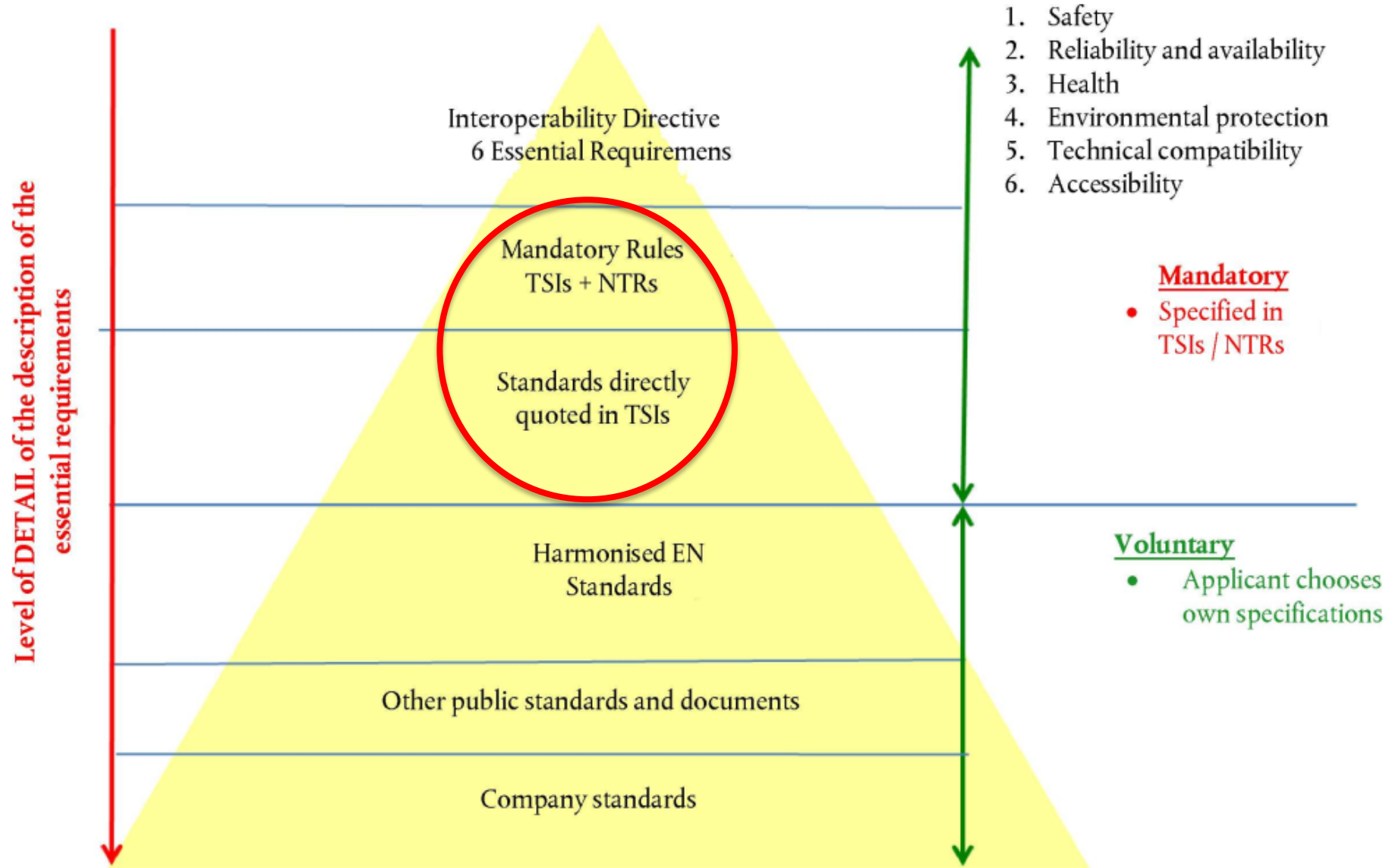
## Subsystems



# Subsystems and Technical Specification for Interoperability



# How to meet the essential requirements?



A **TSI** is a common (harmonized) technical standard specifying the elements of essential requirements\* that need to be harmonized to achieve interoperability

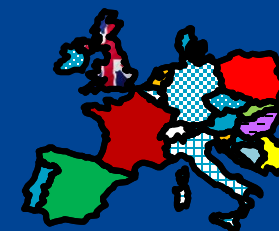


- Safety, reliability and availability, health, environmental protection, technical compatibility, accessibility

TSIs relate to

- + structural subsystems (infrastructure, rolling stock, energy, CCS), or
- + functional subsystems (maintenance, traffic operation and management, telematics applications for passengers and freight services)

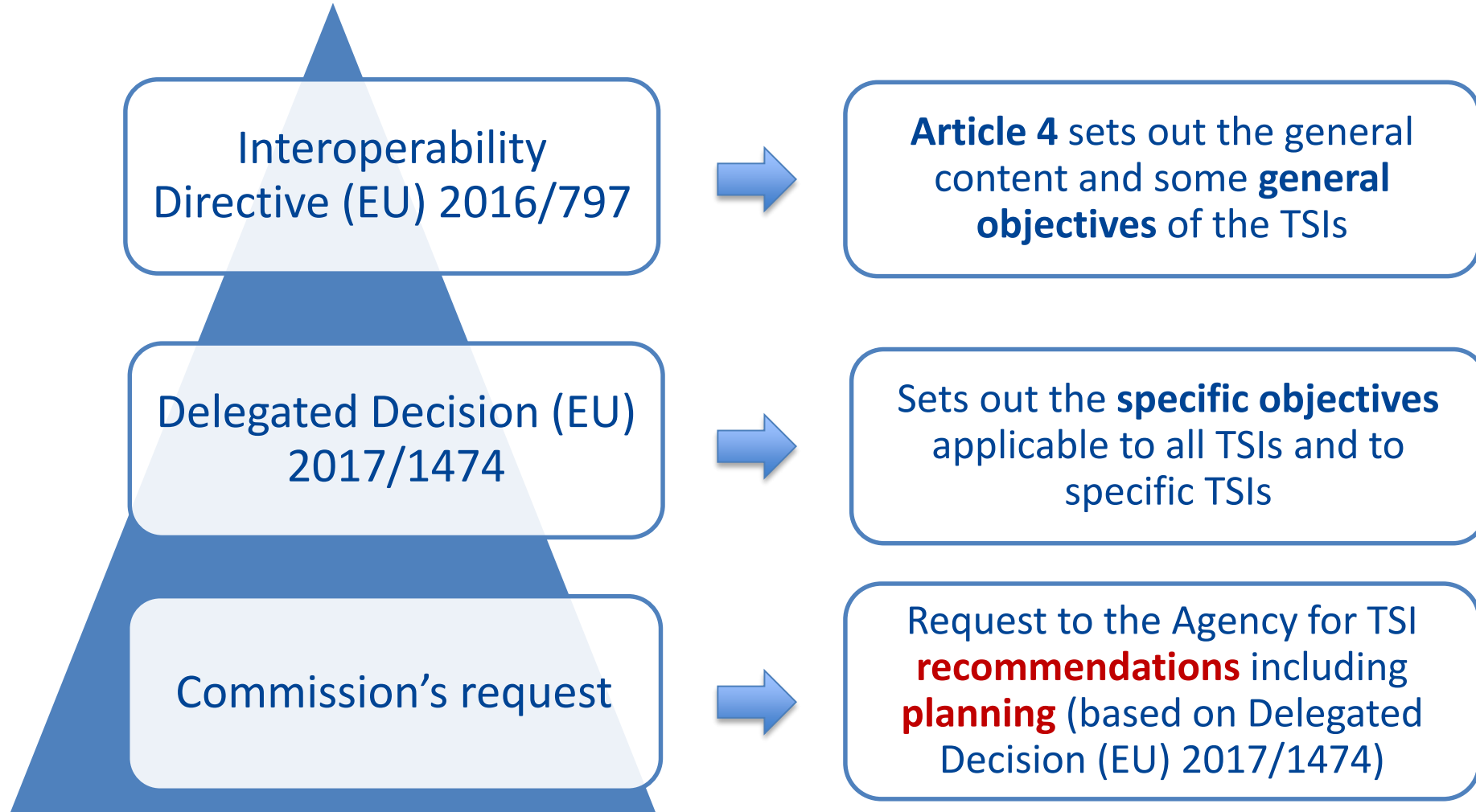
The TSI framework is supplemented by national rules (NRs)



# Content and drafting of TSIs

Content and drafting of TSIs

Art. 4 and Art. 5 IoD



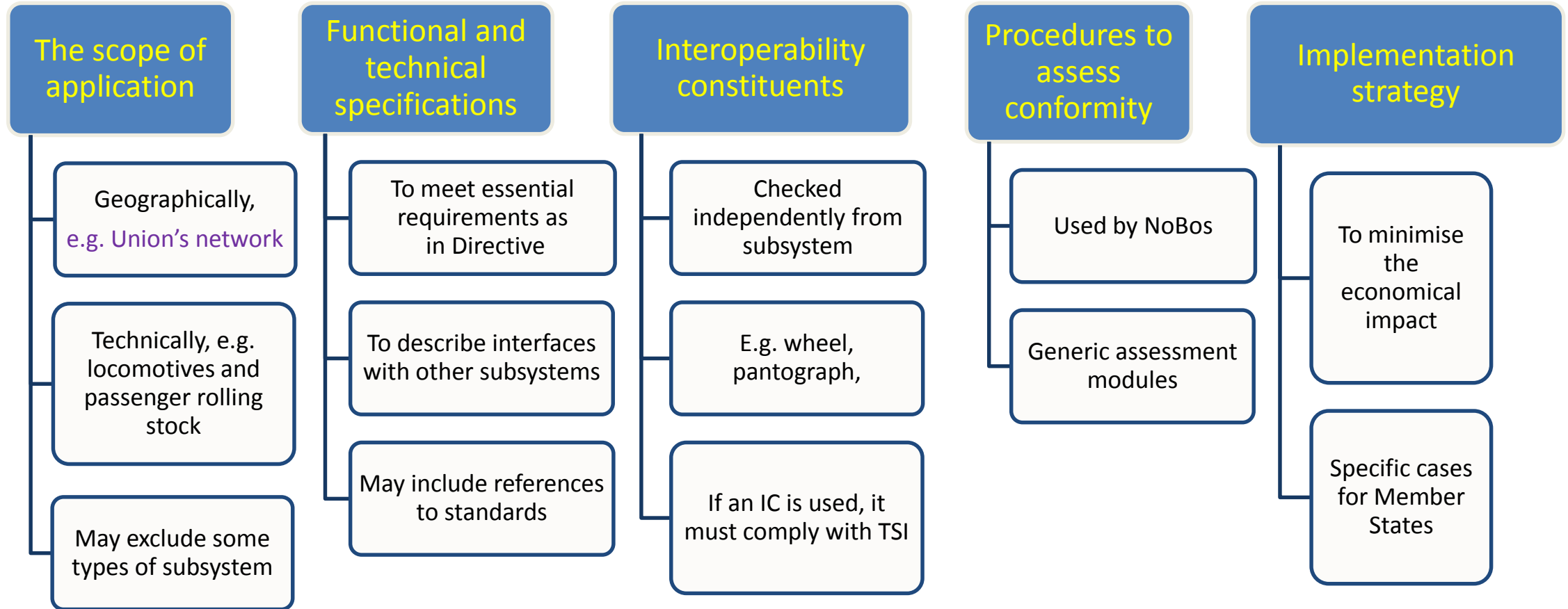
- Art 4.3 indicates aspects to be addressed by each TSI
- Art 4.4 requires to indicate the **target system** by each TSI
- Art 4.5 requires to retain the compatibility of existing rail system (**Specific cases** if needed)
- Art 4.6 refers to **Open points**
- Art 4.8 addresses references to European or international standards or specifications by TSI as **mandatory**



Directive EU  
2016/797

Art. 4





Both requirements & assessment procedures are mandatory

### **Digital rail**

The next revision must build on digitalisation and innovations and accompany the rail system transformation towards a significantly more efficient and cost-effective system, paving the way for automation and enhancing system capacity.

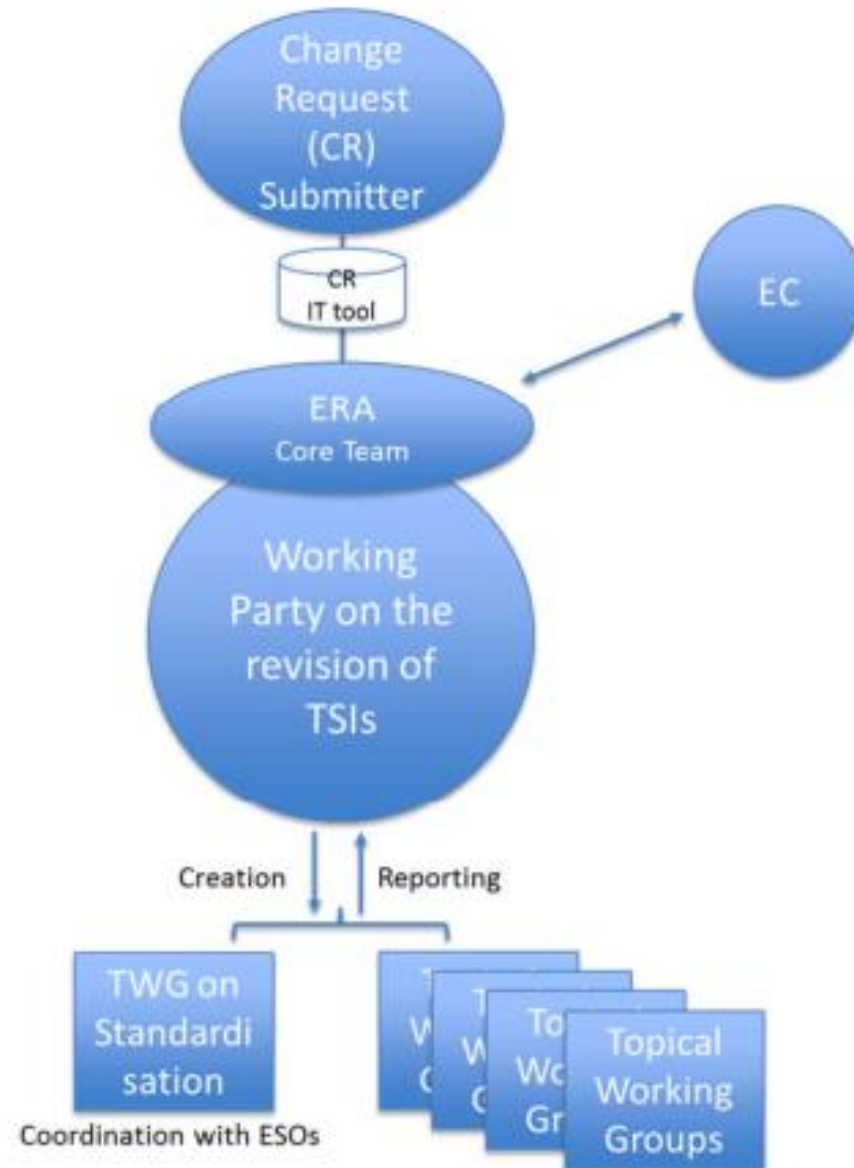
### **Green freight**

In the 2011 White Paper on Transport, the EU set the objective to shift 30 % of long-distance road freight to more energy-efficient transport modes such as rail or inland waterways by 2030 and 50 % by 2050.

Despite the ambitious objectives set in the 2011 White Paper, the modal share of rail freight in all land transport has remained stagnant since the early 2000s at around 16–19 % while the share of road freight remains very high (76 %) (Eurostat).

Under the green freight objective, the 2022 revision must further remove barriers to freight and support uptake of more environmental friendly technologies.

# Organisational structure of the CCM



# TSI Infrastructure

## TSI Infrastructure

- **TSI infrastructure** is an **Annex** to the Commission Regulation (EU) No 1299/2014 of 18 November 2014 on the technical specifications for interoperability relating to the ‘infrastructure’ subsystem of the rail system in the European Union.
- The Regulation (EU) No 1299/2014 has been amended by Commission Implementing Regulation (EU) 2019/776 of 16 May 2019
- A consolidated version is available in the [link](#)

- Section 1: Technical and Geographical scope.
- Section 2: indicates its **intended scope** (e.g. SRT and PRM excluded).
- Section 3: lays down **essential requirements** for the infrastructure and part of the maintenance subsystems.
- Section 4: establishes the **functional** and **technical specifications** to be met by the infrastructure and part of the maintenance subsystems and its interfaces vis-à-vis other subsystems.
- Section 5: specifies the **interoperability constituents**.
- Section 6: states which procedures are to be used in order to assess the **conformity of the interoperability constituents** or the **EC verification of the subsystem**.
- Section 7: indicates the **strategy for implementing this TSI** and the **Specific Cases**.
- Appendixes: **A, B, C, D, E, F, G, H, I, J, K, M, N, O, P, Q, R, S, T**.

The INF TSI concerns the **infrastructure subsystem** and **part of the maintenance subsystem** of the Union rail system defined respectively in points **2.1 and 2.8 of Annex II to Directive (EU) 2016/79**:

### 2.1. Infrastructure

The track, points, level crossings, engineering structures (bridges, **tunnels\***, etc.), rail-related elements of stations (including entrances, platforms, zones of access, service venues, toilets and information systems, as well as their **accessibility features for persons with disabilities and persons with reduced mobility\*\***), safety and protective equipment.

### 2.8. Maintenance

The procedures, associated equipment, logistics centres for maintenance work and reserves providing the mandatory corrective and preventive maintenance to ensure the interoperability of the Union rail system and guarantee the performance required.

\* Covered by **TSI SRT**

\*\* Covered by **TSI PRM**

The technical scope is further defined in **Article 2(1), 2(5) and 2(6) of the Regulation (EU) 1299/2014**:

2 (1): The TSI shall apply to all **new, upgraded or renewed ‘infrastructure’** of the rail system in the European Union as defined in point 2.1 of Annex II to Directive (EU) 2016/797 of the European Parliament and of the Council.

2 (5): The TSI shall apply to networks with the following **nominal track gauges**:  
1 435 mm, 1 520 mm, 1 524 mm, 1 600 mm and 1 668 mm.

2 (6): **Metric gauge** is excluded from the technical scope of this TSI

The **geographical scope** of this TSI is defined in Article 2(4) of the Regulation (EU) No 1299/2014:

The TSI shall apply to the **network** of the **Union rail system** as described in Annex I of Directive (EU) 2016/797 **with the exclusion** of cases referred to in Article 1(3) and (4) of Directive (EU) 2016/797



3. This Directive shall not apply to:
  - (a) metros;
  - (b) trams and light rail vehicles, and infrastructure used exclusively by those vehicles;
  - (c) networks that are functionally separate from the rest of the Union rail system and intended only for the operation of local, urban or suburban passenger services, as well as undertakings operating solely on those networks.
4. Member States may exclude from the scope of the measures implementing this Directive:



Table 1

Basic Parameters of the infrastructure subsystem corresponding to the essential requirements

TSI point	Title of TSI point	Safety	Reliability Availability	Health	Environ- mental protection	Technical compati- bility	Accessi- bility
4.2.3.1	Structure gauge	1.1.1, 2.1.1				1.5	
4.2.3.2	Distance between track centres	1.1.1, 2.1.1				1.5	
4.2.3.3	Maximum gradients	1.1.1				1.5	
4.2.3.4	Minimum radius of horizontal curve	1.1.3				1.5	
4.2.3.5	Minimum radius of vertical curve	1.1.3				1.5	
4.2.4.1	Nominal track gauge					1.5	
4.2.4.2	Cant	1.1.1, 2.1.1				1.5	1.6.1
4.2.12.4	Water restocking	1.1.5	1.2	1.3.1		1.5	
4.2.12.5	Refuelling	1.1.5	1.2	1.3.1		1.5	
4.2.12.6	Electric shore supply	1.1.5	1.2			1.5	
4.4	Operating rules		1.2				
4.5	Maintenance rules		1.2				
4.6	Professional qualifications	1.1.5	1.2				
4.7	Health and safety conditions	1.1.5	1.2	1.3	1.4.1		

- 4.1. Introduction
- 4.2. Functional and technical specifications of infrastructure subsystem
- 4.3. Functional and technical specification of the interfaces
- 4.4. Operating rules
- 4.5. Maintenance rules
- 4.6. Professional qualifications
- 4.7. Health and safety conditions

(...)

(2) The limiting **values set out in this TSI are not intended to be imposed as usual design values**. However the design values must be within the limits set out in this TSI.

(3) The **functional and technical specifications** of the infrastructure and part of the maintenance subsystems and their interfaces, as described in points 4.2 and 4.3, **do not impose the use of specific technologies** or technical solutions, except where this is strictly necessary for the interoperability of the Union rail system.

(4) **Innovative solutions** for interoperability which do not fulfil the requirements specified in this TSI and/or which are not assessable as stated in this TSI require new specifications and/or new assessment methods. In order to allow technological innovation, these **specifications and assessment methods shall be developed by the process for innovative solutions described in Article 10**.

(5) Where reference is made to EN standards, any variations called, unless otherwise specified in this TSI **'national deviations' in the EN do not apply**

(....)

Table 2

Performance parameters for passenger traffic

Traffic code	Gauge	Axle load [t]	Line speed [km/h]	Usable length of platform [m]
P1	GC	17 (*)	250-350	400
P2	GB	20 (*)	200-250	200-400
P3	DE3	22,5 (**)	120-200	200-400
P4	GB	22,5 (**)	120-200	200-400
P5	GA	20 (**)	80-120	50-200
P6	G1	12 (**)	n.a.	n.a.
P1520	S	22,5 (**)	80-160	35-400
P1600	IRL1	22,5 (**)	80-160	75-240

Table 3

Performance parameters for freight traffic

Traffic code	Gauge	Axle load [t]	Line speed [km/h]	Train length [m]
F1	GC	22,5 (*)	100-120	740-1050
F2	GB	22,5 (*)	100-120	600-1050
F3	GA	20 (*)	60-100	500-1050
F4	G1	18 (*)	n.a.	n.a.
F1520	S	25 (*)	50-120	1050
F1600	IRL1	22,5 (*)	50-100	150-450

If a new line is intended to be operated by passenger trains with speed of 250 km/h, local commuter trains with speed of 120 km/h and heavy freight trains in the night.

What is the best combination of traffic codes?

Table 2

Performance parameters for passenger traffic

Traffic code	Gauge	Axle load [t]	Line speed [km/h]	Usable length of platform [m]
P1	GC	17 (*)	250-350	400
P2	GB	20 (*)	200-250	200-400
P3	DE3	22,5 (**)	120-200	200-400
P4	GB	22,5 (**)	120-200	200-400
P5	GA	20 (**)	80-120	50-200
P6	G1	12 (**)	n.a.	n.a.
P1520	S	22,5 (**)	80-160	35-400
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Table 3

Performance parameters for freight traffic

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F3	GA	20 (*)	60-100	500-1050
F4	G1	18 (*)	n.a.	n.a.
F1520	S	25 (*)	50-120	1050
F1600	IRL1	22,5 (*)	50-100	150-450

Then, the TSI category of line for this case would simply be P2-P5-F1

The line shall then have to be designed in order to fulfil the envelope of performance parameters for this category:

Gauge: GC (from F1)

Axle load: 22,5 t (from F1)

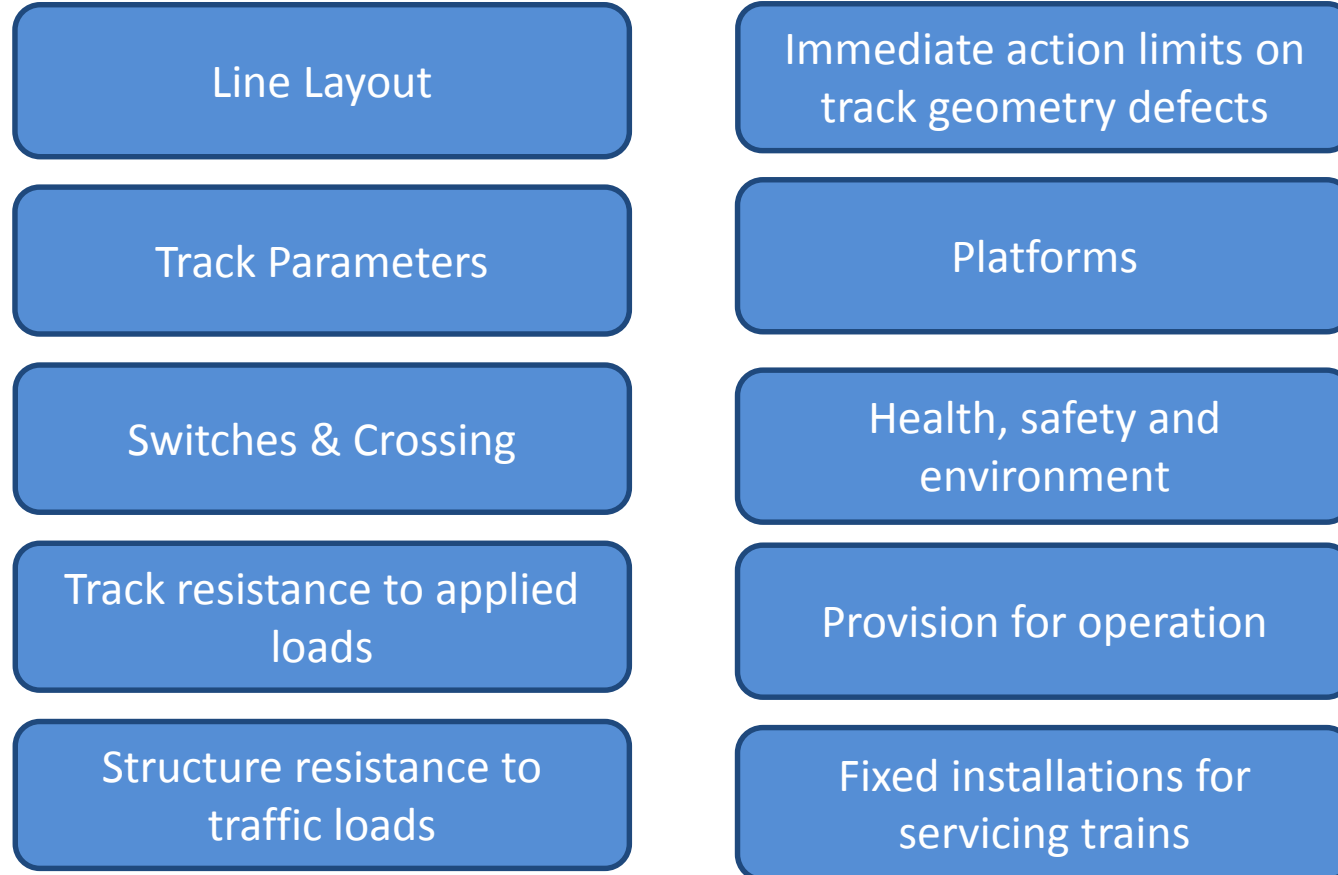
Line speed: 200 - 250 km/h (from P2)

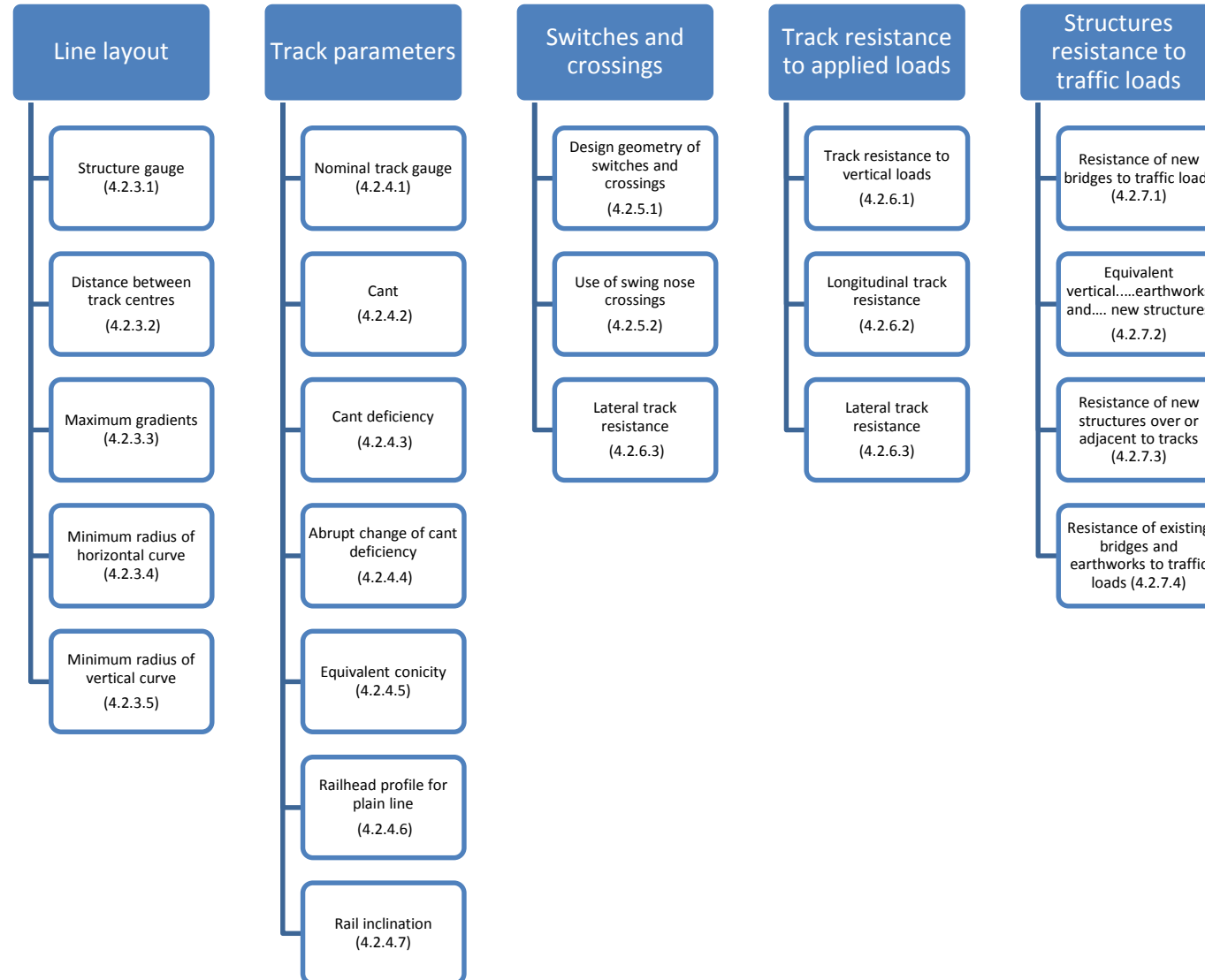
Usable length of platform: 200 – 400 m (from P2)

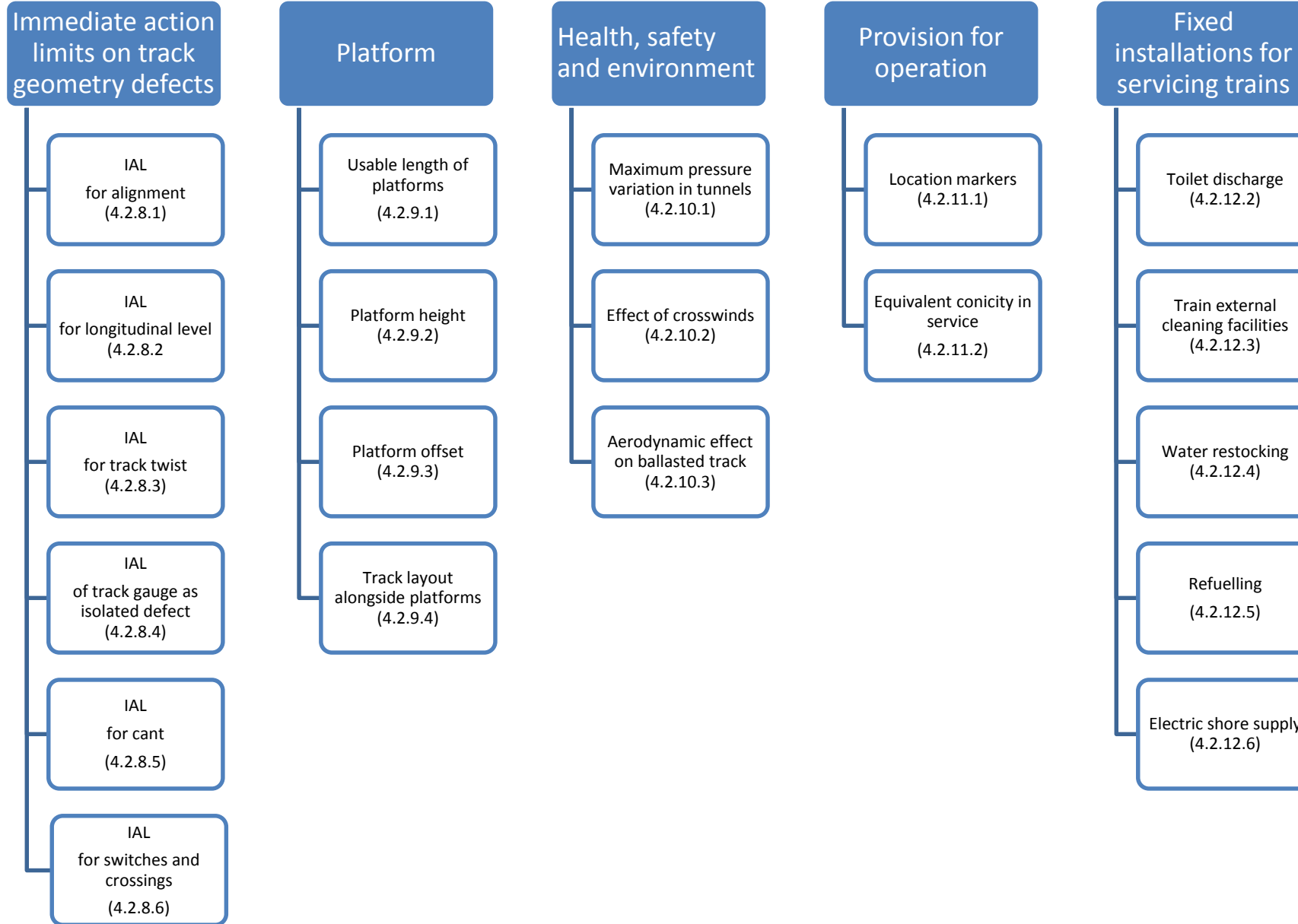
Train length: 740 – 1050 m (from F1)

## Chapter 4.2 - Functional and technical specifications of subsystem

The **Basic Parameters**, characterising the **infrastructure subsystem**, are grouped according to the **following aspects**:









- Interfaces with the **rolling stock subsystem (LOC&PAS TSI and WAG TSI)**
- Interfaces with the **energy subsystem (ENE TSI)**

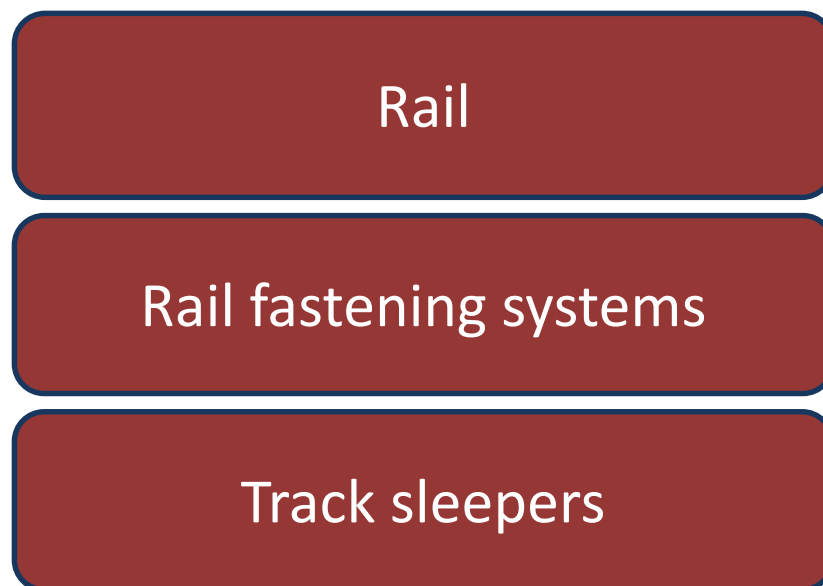
### 4.3.2. *Interfaces with the energy subsystem*

*Table 17*

**Interfaces with the energy subsystem**

Interface	Reference Infrastructure TSI	Reference Energy TSI
Gauge	4.2.3.1 Structure gauge	4.2.10 Pantographs gauge

- Interfaces with the **control command and signaling subsystem (CCS TSI)**
- Interfaces with the **operation and traffic management subsystem (OPE TSI)**



- (7) 'interoperability constituents' means any elementary component, group of components, subassembly or complete assembly of equipment incorporated or intended to be incorporated into a subsystem, upon which the interoperability of the rail system depends directly or indirectly, including both tangible objects and intangible objects;

## Modules (Decision 2010/713/EU) and particular assessment procedures are identified for:

- Interoperability Constituents:**

*Table 20*  
Modules for conformity assessment to be applied for interoperability constituents

Procedures	Rail	Rail fastening system	Track sleepers
Placed on the EU market before entry into force of relevant TSIs	CA or CH	CA or CH	
Placed on the EU market after entry into force of relevant TSIs	CB + CC or CB + CD or CB + CF or CH		

*Appendix A*  
Assessment of interoperability constituents

*Table 36*  
Assessment of interoperability constituents for the EC declaration of conformity

Characteristics to be assessed	Assessment in the following phase			
	Design and development phase			Production phase Manufacturing process + product test
	Design review	Review of manufacturing process	Type test	
5.3.1 The rail				Product quality (series)
5.3.1.1 Railhead profile	X	n.a.	X	X
5.3.1.2 Rail steel	X	X	X	X
5.3.2 The rail fastening systems	n.a.	n.a.	X	X
5.3.3 Track sleepers	X	X	n.a.	X

- Infrastructure subsystems:**

6.2.2. *Application of modules*

For the EC verification procedure of the infrastructure subsystem, the applicant may choose either:

- (a) Module SG: EC verification based on unit verification, or
- (b) Module SH1: EC verification based on full quality management system plus design examination.

*Appendix B*

Assessment of the infrastructure subsystem

*Table 37*  
Assessment of the infrastructure subsystem for the EC verification of conformity

Characteristics to be assessed	New line or upgrading/renewal project		Particular assessment procedures
	Design review	Assembly before putting into service	
	1	2	3
Structure gauge (4.2.3.1)	X	X	6.2.4.1
Distance between track centres (4.2.3.2)	X	X	6.2.4.2

- Application of TSI to **new railway lines** vs **existing railway lines**
- National Implementation plan ( to be developed by MSs)
- Specific cases:
  - (a) ‘P’ cases: permanent cases;
  - (b) ‘T’ cases: temporary cases, where it is recommended that the target system is reached by 2020

### **‘P’ (permanent) cases**

- 7.7.10.1. Platform offset (4.2.9.3)
- 7.7.10.2. Equivalent conicity (4.2.4.5)
- 7.7.10.3. Equivalent conicity in service (4.2.11.2)

Appendix A	—	Assessment of interoperability constituents
Appendix B	—	Assessment of the infrastructure subsystem
Appendix C	—	Technical characteristics of track design and switches and crossings design
Appendix D	—	Conditions of use of track design and switches and crossings design
Appendix E	—	Capability requirements for structures according to traffic code
Appendix F	—	Capability requirements for structures according to traffic code in the United Kingdom of Great Britain and Northern Ireland
Appendix G	—	Speed conversion to miles per hour for Ireland and the United Kingdom of Great Britain and Northern Ireland
Appendix H	—	Structure gauge for the 1 520 mm track gauge system
Appendix I	—	Reverse curves with radii in the range from 150 m up to 300 m
Appendix J	—	Safety assurance over fixed obtuse crossings
Appendix K	—	Basis of minimum requirements for structures for passenger coaches and multiple units
Appendix M	—	Specific case on the Estonian network
Appendix N	—	Specific cases of the Hellenic network
Appendix O	—	Specific case on the Ireland and United Kingdom of Northern Ireland networks
Appendix P	—	Structure gauge for the lower parts for the 1 668 mm track gauge on the Spanish network
Appendix Q	—	National technical rules for UK-GB Specific Cases
Appendix R	—	List of open points
Appendix S	—	Glossary
Appendix T	—	List of referenced standards

## *Appendix R*

### **List of open points**

- (1) Immediate action limits for isolated defects in alignment for speeds of more than 300 km/h (4.2.8.1).
- (2) Immediate action limits for isolated defects in longitudinal level for speeds of more than 300 km/h (4.2.8.2).
- (3) The minimum allowed value of distance between track centres for the uniform structure gauge IRL3 is an open point (7.7.18.2).
- (4) EN Line Category — Associated Speed [km/h] for Traffic codes P1 (multiple units), P2 (multiple units), P3a (multiple units), P4a (multiple units), P1520 (all vehicles), P1600 (all vehicles), F1520 (all vehicles) and F1600 (all vehicles) in Appendix E, Tables 38 and 39.
- (5) Route Availability Number — Associated Speed [miles/h] for Traffic codes P1 (multiple units), P2 (multiple units), P3a (multiple units), P4a (multiple units), P1600 (all vehicles) and F1600 (all vehicles) in Appendix F, Tables 40 and 41.
- (6) Rules and drawings related to gauges IRL1, IRL2 and IRL3 are an open point (Appendix O).
- (7) The requirements for mitigating the risk for ballast pick up for speed greater than 250 km/h.



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