Europe's Rail

FP6-FutuRe

Cost effective regional lines

Flagship Project FP6 – FUTURE

Delivering innovative rail services to revitalise capillary lines and regional rail services

Final Event

November 4-5th, 2026

Founded by the European Union. Views and opinion expressed are however those of the author(s) and do necessarily reflect those of the Union. Neither the European Union nor the Granting Authority can be held responsible for them. This project has received funding from the European Union's Horizon Europe's research and Innovation program me under Grant Agreement No 101101962

Antitrust statement

While some activities among competitors are both legal and beneficial to the industry, group activities of competitors are inherently suspect under the antitrust/ competition laws of the countries in which our companies do business.

Agreements between or among competitors need not be formal to raise questions under antitrust laws. They may include any kind of understanding, formal or informal, secretive or public, under which each of the participants can reasonably expect that another will follow a particular course of action or conduct. Each of the participants in this initiative is responsible for seeing that topics which may give an appearance of an agreement that would violate the antitrust laws are not discussed. It is the responsibility of each participant in the first instance to avoid raising improper subjects for discussion, notably such as those identified below.

It is the sole purpose of any meeting of this initiative to provide a forum for expression of various points of view on topics

(i) that are strictly related to the purpose or the execution of the initiative,

(ii) that need to be discussed among the participants of the initiative,

(iii) that are duly mentioned in the agenda of this meeting and

(iv) that are extensively described in the minutes of the meeting.

Participants are strongly encouraged to adhere to the agenda. Under no circumstances shall this meeting be used as a means for competing companies to reach any understanding, expressed or implied, which restricts or tends to restrict competition, or in any way impairs or tends to impair the ability of members to exercise independent business judgment regarding matters affecting competition.

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Prices, including calculation methodologies, surcharges, fees, rebates, conditions, freight rates, marketing terms, and pricing policies in general;

any kind of market allocation, such as the allocation of territories, routes, product markets, customers, suppliers, and tenders;

production planning; marketing or investment plans; capacities; levels of production or sales; customer base; customer relationships; margins; costs in general; product development; specific R&D projects;

standards setting (when its purpose is to limit the availability and selection of products, limit competition, restrict entry into an industry, inhibit innovation or inhibit the ability of competitors to compete);

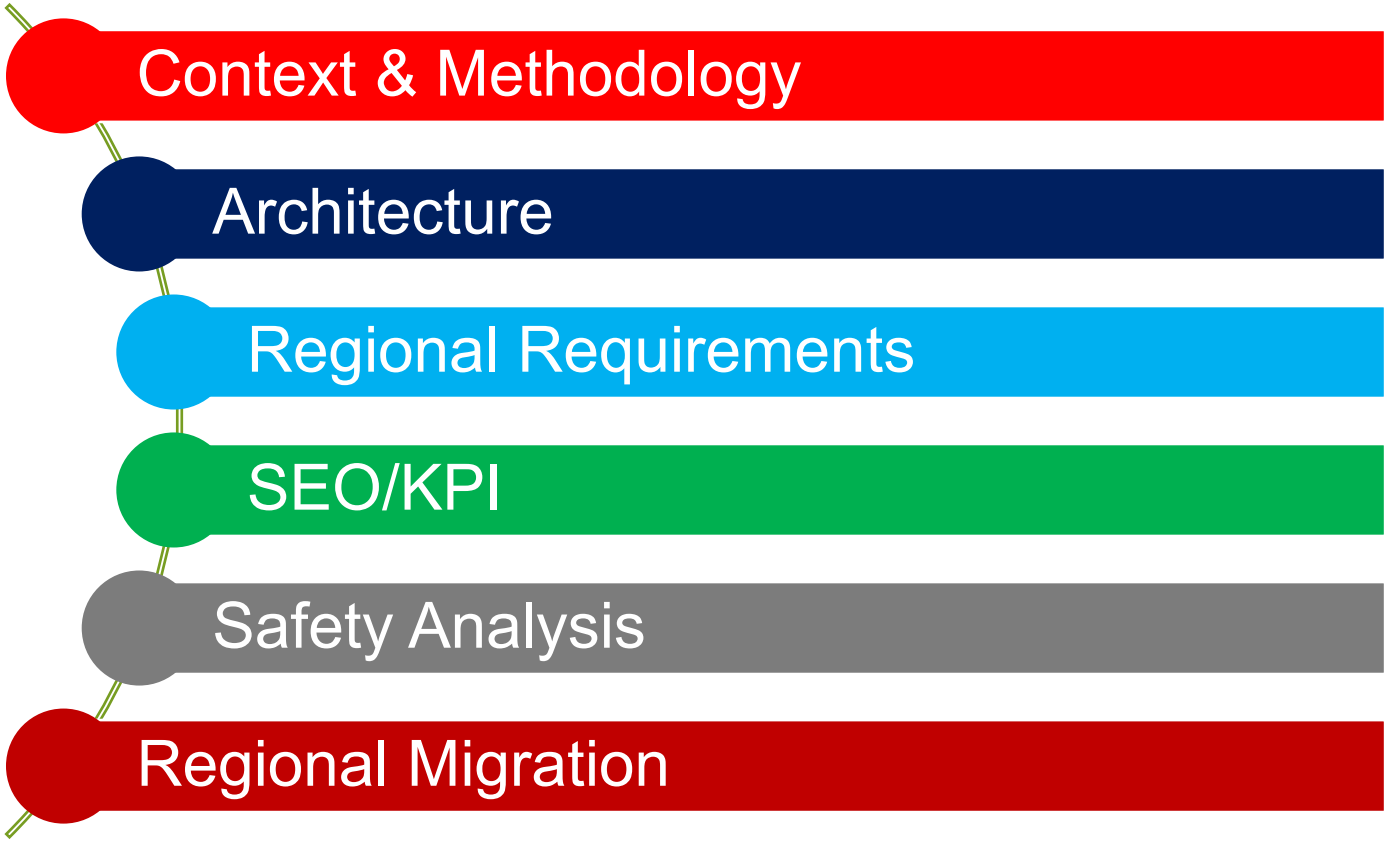
codes of ethics administered in a way that could inhibit or restrict competition;

group boycotts;

validity of patents;

ongoing litigations.

Content transversal topics



Context & Methodology

Regional rail: challenges, limitations, needs

CHALLENGES

Economic & operational

Keep operations of lower usage lines viable and affordable

Social & service-related

Access to jobs and essential services from peripheral regions

STAKEHOLDER NEEDS

Infrastructure managers

Lower lifecycle costs without compromising safety

Railway undertakings

Affordable and reliable operations and rolling stocks

Passengers

Reliable, well-connected journeys with better customer information

Territories

Sustainable regional lines connectivity through links to the core networks and to the local transport

CURRENT LIMITATIONS

Cost & system complexity

Conventional rail systems can be too costly for regional lines.
Fragmented control systems increase technical complexity and integration effort

Network & service gaps

Past closures of regional lines leave network potential unused.
Revitalisation requires better service integration and affordable infrastructure upgrades, considering radio connectivity gaps and limited accessibility of trackside equipment.

Context & Methodology

expected contribution

Simpler CCS, integrated control centre and adapted trackside assets.

Automation and digitalisation, rolling-stock concepts tailored to regional lines.

Scalable, interoperable solutions to revitalise lines

Support multimodal connections, customer-information and service concepts that improve satisfaction.

Lower total cost of ownership (CAPEX and OPEX)

Higher productivity

Improved reliability and customer satisfaction

High service quality and operational safety remain essential.

Context & Methodology

Shared design concept for regional rail

Architecture	System design defines functions and system architecture ofregional rail systems
Requirements	Give all demonstrators a shared technical and operational basis.
Safety targets	Safety analysis of R2DATO signalling automation andMOTIONAL digital enablers for use on regional lines.
Performances	Assess performance targets (KPI) towards grant agreement goals
Deployment	Plan an EU synchorised migration strategy on regional lines

Aligned with ERJU design and deployment guidelines

Context & Methodology

Solution for regional rail

Coordination	Active link with other projects to define a baseline architecture to enable the integration of FA6 demostrators
System Design	Defined regional rail requirements with focus on a feasible, scalable, compatible and innovative system.
SEO/KPI	Analysed performance indicators with regional cost reduction as the main objective.
System safety	Completed a formal **system safety assessment for the regional rail context.**
Migration	Addressed the complexity of introducing a **multi-steps strategy** for regional lines.

Architecture

metodology

G1 connected regional lines A shared design, checked against the demonstrators

Comparative analysis	Define interfaces	Build demonstrators	Check integration
Compare outputs from otherWPs or initiatives.	Define how the main systems exchange information.	Develop solutions for each regional line context.	Check each solution against the shared design.

G1 CCS Architecture is aligned with System Pillar output

G2: indipendent low density lines

The CCS architecture defines flexible high-level functions and interfaces without prescribing specific technologies or physical solutions.

Architecture
Regional Line approach

Modular and scalable shared design for G1/G2 lines across five thematic functional areas

Thematic area	G1 Connected regional lines	G2 Independent low-density lines (passengers and freight services)
A1 CCS and services	ETCS interoperability, seamless access services to main lines	Simplified control centre GNSS and digital maps
A2 Train-to-trackside radio communication	FRMCS standard communications	Public 5G and satellites as backup
A3 Trackside-to-trackside communication	Connections between CCS, control centres and field devices tailored to specif G1 / G2 needs	
A4 Wayside assets	Reuse of existing infrastructure	Minimal wayside equipment Train-centric approach where feasible
A5 Rolling stock	Regional vehicles with lower weight and alternative propulsion	

Shared benefits

Lower lifecycle cost

Scalable automation

Improved punctuality and passenger information

Regional connectivity

Regional Requirements
Key result

Common baseline	Operational, functional and non-functional requirements cover signalling, communications, wayside assets, services and rolling stock.
G1 / G2 applicability	The project tailored the common baseline to G1 and G2 regional lines demonstrators
Demonstrator evidence	A traceability matrix links high-level requirements to detailed demonstrator requirements and supports coverage assessment.
Liaisons	A structured interaction with the System Pillar and other FlagshipProjects was successfully maintained throughout the process.
TSI evolution	Stop-on-request, adhesion management and safe train positioning for future TSI specifications (CRs)

Regional Requirements Traceabilty Matrix

Req ID in 2.2	Definition	Rationale	Req ID 3.1 & 8.1	Req ID 3.2 & 8.3	Req ID 3.3 & 8.4	Req ID 3.4 & 8.5	Req ID 3.5 & 8.6	Req ID in 4.1 & 4.2 & 9.1
ORSG 16	[illegible] be lowered.	Reducing staff interventions is synonymous with efficiency and repeatability of operations.	Not covered	Not covered	Not covered	Not covered	Fun. Req 62	Not covered
ORSG 17	The safety level of the new system introduced in the specific line shall not be reduced compared to the current safety level of the system already implemented.	For lines very low-cost lines, solutions, without must not compromise the need for standardization and safety	Not covered	Not covered	Not covered	Not covered	Not covered	Not covered
ORSG 18	The CCS system shall be able to manage both passengers and freight service.	No additional Rationale need. self-explanatory requirement.	Not covered	Not covered	Not covered	Not covered	Fun. Req 12	Not covered
ORSG 19	Radio holes areas shall be managed.	For the telecommunications area, both trackside-train and trackside-trackside radio communication solutions are explored.	R_01_1_5_1	R_01_2_05_03_01	Not covered	Not covered	Not covered	Not covered
ORSG 20	The CCS system shall be able to command and control level crossing in a safe, simple, and cost-effective way.	Furthermore, the management of an advanced level crossing, in general of an integrated level crossing management solution is also presented. ((Safety Integrity Level 4 – SIL4) / wireless level crossing)	Not covered	Not covered	Not covered	Not covered	Not covered	REQ_WP4_4.1.2_C_2024
ORSG 21	Only the modifications to the interlocking strictly needed to allow the achievement of the KPI of FutuRe (reduction of the number of TTDs and removal of light signals, including shunting signals) shall be performed.	The harmonisation of the interlocking rules or a standardised interface between the interlocking and the RBC is not deemed in the scope of FP6-FutuRe.	Not covered	Not covered	Not covered	Not covered	Not covered	Not covered
ORSG 22	To reduce the number of Trackside Train Detection Devices, the train must be equipped with a TIMS and a Train Length Determination Device.	With these new subsystems it is expected to achieve a reduction of Total Cost of Ownership and increase the system availability.	Not covered	Not covered	Not covered	Not covered	Fun. Req 1	Not covered
ORSG 23	To reduce the number of Balise Groups, the train must be equipped with an innovative train positioning system.	With these new subsystems it is expected to achieve a reduction of Total Cost of Ownership and increase the system availability.	Not covered	Not covered	Not covered	Not covered	Not covered	Not covered
ORSG 24	The system shall be designed to achieve the KPIs that are relevant for the specific line, giving the precedence to the ones chosen by the specific application.	Some KPIs may be in contrast, for example high punctuality and low cost. The generic application must be able to achieve the expected KPIs.	Not covered	Not covered	Not covered	Not covered	Not covered	Not covered
ORSG 25	The new devices foreseen for regional lines applications shall have a low cost and an acceptable level of availability (for example not many false alarms of train integrity loss).	No additional Rationale need. self-explanatory requirement.	Not covered	Not covered	Not covered	Not covered	Not Fun. Req 1	Not covered
ORSG 26	Regional trains and regional lines are expected to be fitted with an ATO system which enables the automatic driving of the train on a specific Grade of Automation (GoA2, GoA3/4), thus increasing the energy efficiency of the system, as well as its punctuality and passenger ergonomics.	The implementation of ATO aims at reducing the Total Cost of Ownership.	R_01_1_1_1 R_01_1_1_2 R_01_1_8_6	Not covered	Not covered	Not covered	Not covered	Not covered
ORSG 27	TMS shall interface with the applicable CCS/ATP/ATO.	No additional Rationale need. self-explanatory requirement.	R_01_1_1_1	Not covered	Not covered	Not covered	Not covered	Not covered
ORSG 28	Regional lines must be fitted with a public radio network for safety communications, which contributes to the reduction of the Total Cost of Ownership.	No additional Rationale need. self-explanatory requirement.	Not covered	Not covered	Not covered	Not covered	Not covered	Not covered
ORSG 29	Global performance on a line is to be considered: if a major CCS update is to be done on a regional line, the need of passing loops can be assessed at the same time.	Single track performance is tightly linked with crossing possibilities, an overall performance assessment should be made to improve a service. This shan't be an obligation.	Not covered	Not covered	Not covered	Not covered	Not covered	Not covered
ORSG 30	Linked with ORSG 29: Modularised solutions of the CCS for defined typical track layout should be defined.	This may help region to choose the rightest solution for each line.	Not covered	Not covered	Not covered	Not covered	Not covered	Not covered
ORSG 31	The new CCS shall be designed to evolve with future technologies (late integration).	No additional Rationale need. self-explanatory requirement.	Not covered	Not covered	Not covered	Not covered	Not covered	Not covered
ORSG 32	The CC Trackside shall not use light signals.	Reducing TCO.	Not covered	R_01_2_12_15_01	Not covered	Not covered	Not covered	Not covered

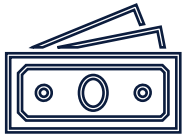
T2.2 | WP2 COM applicability | T3.1&T8.1 | T3.2&T8.3 | T3.3&T8.4 | T3.4&T8.5 | T3.5&T8.6 | T4.3 | T5.1 | T5.2 | T6.1 | T6.2 | T6.4 | T6.5 | 4.1-4.2-9.1 | 4.2-9

As shown in the figure, the matrix maps the requirement to the relevant WP, and the associated demonstrator is indicated within that WP.

SEO/KPI
"why" FP6

Make regional lines more sustainable

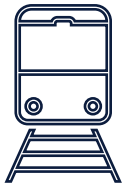
Make regional lines more attractive to final users



Reducing TCO **costs**



Improving **competitiveness**



Reinforcing the **role** of rail



Meeting Evolving **Customer Needs**

Reduce **CAPEX** and **OPEX for trackside and vehicles**

Reduce energy **consumption**

Increase **availability**

Increase **punctuality**

KPI targets

SEO/KPI

“how to prove” FP6 achievements

Common methodology

- Definition of reference baseline
- Definition of baseline figures

Measurement using demos’ results

- Determination of figures from demo results
- Comparison against baseline figures

SEO/KPI

FP6 evaluation overview

			Demo 01 (N/A)	Demo 02	Demo 03 (withdr.)	Demo 04	Demo 05	Demo 06	Demo 07	Demo 08	Demo 09	Demo 10	Demo 11	Demo 12 (N/A)	Demo 13	Demo 14	Demo 15	Demo 16	Demo 17	Demo 18	Demo 19	Demo 20	Demo 20bis	Demo 21	Demo 22	Demo 23 (N/A)	Demo 24	Demo 25 (withdr.)	Demo 26	Demo 27	Demo 28	Demo 28bis	Demo 29	Demo 30	Demo 31	Demo 32	Demo 33	Demo 34 (N/A) (*)	Nu Demo 1 (theoretic analyzir)	Nu Demo 2 (theoretic analyzir)
SEO/KPI 01	Overall reduction of the Total Cost of Ownership (CAPEX and OPEX) of the CCS system	Expected decrease by targeting 25%.							Quantitative D8.3	Quantitative D8.3	Qualitative D8.3	Quantitative D8.3				Qualitative D8.5	Qualitative	Qualitative	Quantitative D8.5	Qualitative D8.5	Qualitative D8.5							Quantitative D9.7				Quantitative D9.10 D5.2	Quantitative D9.12	Quantitative D10.4	Quantitative D10.4						
SEO/KPI 02	Reduced the CAPEX of radio network	Expected decrease by targeting 15%.																										Quantitative D9.8	Quantitative D9.9										
SEO/KPI 03	Increased system availability due to reduced trackside asset failure and more reliable CCS	Expected increase by targeting 10%							Quantitative D8.3	Qualitative D8.3	Qualitative D8.3	Quantitative D8.3					Maar	Qualitative	Quantitative D8.5	Qualitative D8.5	Qualitative D8.5									Quantitative D9.10 D5.2		Quantitative D10.4	Quantitative D10.4						
SEO/KPI 04	Reliable and effective fail-safe onboard train integrity, train length detection and train positioning	Expected increase reliability by targeting 15%							Quantitative D8.3		Qualitative D8.4	Quantitative D8.3				Quantitative D8.5	Qualitative	Qualitative	Quantitative D8.5	Qualitative D8.5	Qualitative D8.5																		
SEO/KPI 05	Overall reduction of OPEX and CAPEX	Expected decrease by targeting 15%		Qualitative D8.1		Qualitative D8.2		Qualitative D8.2	Quantitative D8.3	Quantitative D8.3	Qualitative D8.5	Quantitative D8.3	Quantitative D8.4		Qualitative D8.4	Qualitative D8.5	Qualitative	Qualitative	Quantitative D8.5	Qualitative D8.5	Qualitative D8.5						Quantitative D9.7		Quantitative D9.8 (**)	Quantitative D9.9	Quantitative D9.10 D5.2	Quantitative D9.12	Quantitative D10.4	Quantitative D10.4	Qualitative D11.3	Qualitative D11.3	Qualitative D11.3			Qualitative D3.11
SEO/KPI 06	Optimized energy consumption and higher punctuality through ATO over ERTMS targeting GoA4	Expected decrease of energy consumption by targeting 10%		Quantitative D8.1		Qualitative D8.2	Qualitative D8.2 [***]	Qualitative D8.2																														
SEO/KPI 07	Optimized punctuality	Expected increase by targeting 15%		Quantitative D8.1		Qualitative D8.2	Qualitative D8.2 [***]	Qualitative D8.2					Qualitative D8.4		Quantitative D8.4																					Qualitative D11.3	Qualitative D11.3				
SEO/KPI 08	Reduced OPEX costs/km for trackside railway assets	Expected decrease by targeting 5%							Quantitative D8.3	Qualitative D8.3	Qualitative D8.5	Quantitative D8.3				Qualitative D8.5	Maar	Qualitative	Quantitative D8.5	Qualitative D8.5	Qualitative D8.5	Qualitative D3.2		Qualitative D3.1			Quantitative D9.7		Quantitative D9.8 (**)	Quantitative D9.9	Quantitative D9.10 D5.2	Quantitative D9.12	Quantitative D10.4	Quantitative D10.4				\		Qualitative D3.11
SEO/KPI 09	Increased energy efficiency for trackside railway assets	Expected [energy consumption] decrease by targeting 5%																				Quantitative D9.2	Quantitative D9.2	Quantitative D9.3	Quantitative D9.4		Quantitative D9.7			Quantitative D9.9									
SEO/KPI 10	Reduced vehicle CAPEX & OPEX through innovative, modular and lighter design, valid for the transport of goods as well	Expected decrease by targeting 5% CAPEX and OPEX, in a LCC perspective and transport of goods improvement																																			Quantitative D10.2	
SEO/KPI 11	Passenger vehicles development will aim for step changes in weight reduction, while being tailored to higher requirements of the tracks	Expected decrease up to 10% of weight reduction and for some parts of the vehicle up to 50%																																			Quantitative D10.2	
SEO/KPI 12	Improved energy efficiency of railway assets	Expected increase of energy efficiency by targeting 15%		Qualitative D8.1		Qualitative D8.2		Qualitative D8.2														Quantitative D9.2	Quantitative D9.2	Quantitative D9.3														

Safety Analysis

About

The purpose of this task was to identify security/safety problems related to the architecture to be implemented.

Fundamental : Directive (EU) 2016/798

1

- System definition: objectives, functionalities, environment, limits and interfaces
- Identification and classification of safety events

2

- Assessment and classification of associated risks
- Definition of safety requirements

3

- Selection of the risk acceptance principle
- Definition of requirements according to the field of application

4

- Identification of mitigation measures for each risk until it is considered acceptable
- Demonstration of compliance

Tailormade methodology for FP6

1. Is it innovative and safety related?

Requirement	Innovative	Safety-relevant	Significance verdict	Rationale
Information required to operate under ATO shall cover the full length of the radio-hole area	No	Yes	Assessment required	Safety-relevant but not novel; consequence, complexity, monitoring and reversibility require expert judgement before a verdict can be reached. Deferred to full significance pass.
There shall be communication between the obstacle-detection system and ATO on-board	Yes	Yes	Significant	Failure consequence high (undetected obstacle → collision); novel safety function; high complexity; low reversibility.
The ATO-OB informs ATO-TS of brake application due to object detection	Yes	Yes	Significant	Failure consequence high (loss of this information degrades situational awareness and response); novel function dependent on obstacle detection (additionality with the row above); moderate complexity.

2. For each identified innovative solution with a safety impact, a comprehensive analysis is carried out using the SATO pattern:

Step 1: Risk Identification
- **Interface**: Identify system, subsystem, or component boundaries involved.
- **Operating phase**: Specify the phase of operation when the risk occurs.
- **Additional information**: Provide context or supporting details.
- **Safety event**: Describe the specific hazardous event or trigger.
- **Consequences**: Outline the potential impacts or outcomes of the safety event.

Step 2: Danger Evaluation
- **Frequency**: Estimate how often the hazard or event occurs.
- **Severity**: Determine the impact magnitude of the consequences.
- **Acceptability**: Evaluate the initial level of risk acceptability based on frequency and severity.

Step 3: Safety Analysis
- Analyze root causes, mechanisms, or detailed safety impacts of the identified risk.

Step 4: Solutions (Mitigation Strategies)
- **Technical**: Hardware, design, or engineering controls.
- **Operational**: Procedures, training, or operational controls.
- **Regulation**: Compliance, standards, or policy requirements.
- **Other**: Any additional corrective actions.

Step 5: New Acceptability
- Re-evaluate and confirm the residual risk acceptability level after implementing the proposed solutions.

Regional Migration

Migration has been analysed on two levels:

- at a higher level for a representative technical enabler (HL3/HTD Train integrity/length) so that it can be further extended to all the WP3/8 TEs.

- at a lower level describing the migration strategy from laboratory tests to field tests of demonstrators in FUTURE.

Regional Migration

High-level methodology

Strategy 1: Incremental

Strategy 2: All at once

Evaluated with respect to

-- very negative impact
- negative impact
= neutral or evaluation not possible
+ positive impact
++ very positive impact
N/A not applicable

Examples (not to be considered as exhaustive) of comparison criteria are:

a) Economic benefit for IM
b) Economic benefit for vehicle owner
c) Harmonisation of on-board and trackside deployment plan
d) Impact on operational rules
e) Impact on keeping the line in operation
f) Impact on TSI
g) Financing mean
h) Product availability
i) Need for compensation measures in case benefits do not apply to all actors
j) Saving existing investments/obsolescence of existing products
k) European and national obligations
l) Integration with remaining subsystems
m) Geographical dimension of the migration
n) Dependencies among different TE when migration affects more TEs
o) Impact on performances

Regional Migration

High-level methodology

Item	Comparison criteria	Migration Strategy 1	Migration Strategy 2	Explanation
a)	Economic benefit for IM	-	++	Strategy 2 is less cost efficient for trackside because for Strategy 1 it implies a double trackside upgrade, a double operational rules upgrade, and postpones the benefit of full removal of TTD.
b)	Economic benefit for vehicle owner	-	--	For Strategy 1 the upgrade of the fleet with the train integrity/train length function can be spread longer in time
c)	Harmonisation of onboard and trackside deployment plan	+	-	The migration of the fleet is independent of the trackside implementation; therefore, it can be planned
d)	Impact on operational rules	--	-	Strategy 2 implies a double operational rules upgrade

Strategy 1 incremental and 2 all at once impact assessed according to the first 4 comparison criteria

Regional Migration

Low-level methodology

- The WP3/8 Demonstrators were identified which were taken from laboratory environments to field tests – in total 8 demonstrators
- Adjustments of operational CCS rules and operational rules were assessed
- Migration plan were indicated for the demonstrators' purposes

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