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FOSTER RAIL

Future of Surface Transport Research Rail

Coordination and Support Action

Grant Agreement No 605734

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Deliverable D5.3

Report from "pre-requirements and implementation groups"

WP	5	Fostering innovation and partnerships: ERRAC and SHIFT²RAIL
Task	5.2	Innovation Packages (IPs) requirement specifications and R&D coordination

Dissemination level[1]	PU
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[1] Dissemination level: **PU** = Public, **PP** = Restricted to other programme participants (including the JU), **RE** = Restricted to a group specified by the consortium (including the JU), **CO** = Confidential, only for members of the consortium (including the JU)

[2] Nature of the deliverable: **R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

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1. Executive Summary

FOSTER-RAIL is a EU coordination and support action project under the 7th Framework Programme designated to support ERRAC (European Rail Research Advisory Council) in defining research needs for their strategies and programmes in order to realise the objectives of the Europe 2020 strategy.

The Foster Rail Work Package 5 (WP5) “Fostering innovation and partnerships: ERRAC and SHIFT^{2}RAIL” relies on the implementation of the proposed joint undertaking for research, development and innovation for rail (under the acronym: SHIFT^{2}RAIL). One objective of the WP5 was to create/manage under the ERRAC umbrella the so-called “pre-system requirements and implementation groups” of the future SHIFT^{2}RAIL to embrace the business needs for the entire sector.

The purpose of this deliverable is to describe the activities carried out within WP5 associated to the task 5.2 “Innovation Packages (IPs) requirement specifications and R&D coordination”. The main objective of this task was to provide a framework under which the creation of “system pre-requirements groups” for each SHIFT^{2}RAIL Innovation Package could be established.

Within the proposal for establishing the initiative known as “SHIFT^{2}RAIL”, the need to establish the business needs of the sector and how they lead to future functional requirements of the system to be taken into account in the Research & Innovation planned within SHIFT^{2}RAIL and Horizon 2020 is an important step.

A first introduction of this deliverable was provided with the deliverable D5.2 “Report from pre-requirements and implementation groups”, while this deliverable represents the summary of all the pre-requirements actions that ended with the meeting held on 19th September 2014. All those actions will continue within the proper working groups of the Joint Undertaking SHIFT^{2}RAIL (e.g. User Requirements Working Groups, Implementation and Deployment Working Groups, System Integration Working Groups). Moreover in order to preserve this important backup initial work, a cooperation tool to store the data has been created (please refer to the deliverable D5.7 “Internal platform communication”).

The deliverable D5.3 describes:

- The organisation of the Work Package 5 partners to address the setting-up of the pre-requirements and implementation groups: Restructuring, contribution received, current status and finalization;
- The role of the committee created under Work Package 5;
- The four matrixes delivered by Work Package 5

2. Description of Deliverable

2.1 Restructuring, contribution received, current status and finalisation

It was decided to combine the Foster Rail WP5 task 5.2 “Innovation Packages (IPS) requirement specifications and R&D coordination” with the SHIFT²RAIL preparation phase. Therefore Foster Rail WP5.2 partners have organised combined meetings with the promoters leading the SHIFT²RAIL preparatory phase. This combined group was named **SHIFT²RAILextended system group**.

The reason for this internal restructuration comes from the fact that the initially foreseen “pre-requirement groups, one per each IP” was impossible implement by UIC and UITP, due to the lack of experts availability from their members, interest or for some others reasons (e.g. internal association organisation).

The WP5.2 partners considered therefore important to try to activate the work that the task 5.2 was supposed to produce with the incorporation of the WP5.2 and the UNIFE coordinated initiative SHIFT²RAIL preparatory phase, where the involved companies were actually meeting and working.

The meetings in May 2014 and September 2014 were therefore attended not only by UNIFE, UIC and UITP but also by the Operators and Infrastructure Managers involved in SHIFT²RAIL, as well as by the IP coordinators.

Input was received from the following stakeholders:

- CAF provided a feedback on the TCMS example of functional requirements that SNCF provided during the previous phase
- Thales provided as well an example for the High Speed matrix requirement
- Ferrovie dello Stato (FS) provided an entire fill in of the four matrix with functional requirements

The FS full documentation allowed the discussion to continue but the difficulty in agreeing on a level of functional requirement to be provided become evident.

UIC suggested simplifying the exercise for the mainline part providing the Challenge2050 document and Rail technical Europe document as a basis for the exercise.

Given the impossibility for the mainline operators – even if driven by motivated companies – to reach a common interpretation on the level of the input required as EU input, it was agreed to collect all the input knowing that it will serve as a basis for the future SHIFT²RAIL Joint Undertaking work, which should allow for a good amount of flexibility as the EU users will have different level of requirements, also based on different TDs.

UITP requested UNIFE a specific format explaining the TD, so that their members could complete the four matrix. Unfortunately also on UITP members’ side no input from the members was received.

On the meeting on 19 September 2014 it was suggested to hold the meetings and the deliverable at the current status, giving the high work load that some companies will have in responding to the call for SHIFT²RAIL Associated Members. In addition the European Commission is setting up the SHIFT²RAIL structure and it is expected a continuation of this work under the official framework of the SHIFT²RAIL Joint Undertaking.

The European Commission agreed to finalise the deliverable as it stands, reporting what has been and has not been achieved compared to the objectives reported on previous deliverable – in particular the fill in of the Excel file of pre-requirements per SPD(markets)/IP/TD

2.2 Briefing note describing the role of the committee

Within the proposal for establishing the initiative known as "SHIFT²RAIL", the need to establish the business needs of the sector and how they lead to future functional requirements of the system to be taken into account in the Research & Innovation activities planned within SHIFT²RAIL and Horizon 2020, is an important step.

Ensuring the involvement of the operators and users of the rail system is essential as these stakeholders will be operating and in some cases maintaining the solutions that the industrial companies, involved in SHIFT²RAIL, will as a result integrate into the products that they place on the European and worldwide markets.

These steps have a three phase cycle of: **requirements** (the inception – at high level for the SHIFT²RAIL proposal, and in details for the annual technical programme once SHIFT²RAIL will be running), **quality assurance** (the during, once SHIFT²RAIL will be running) and **implementation** (the conclusion, once SHIFT²RAIL is running, of the system level testing of the innovations created in the IPs) with this latter also taking the form of a collective appraisal of the results, leading to the specification of new voluntary interface standards and, in some cases, changes to existing standards and regulations that support the overall objective of system interoperability.

This work has been started within the structure of the FOSTER RAIL project, which will put in place a framework that can act as a catalyst for the work that will need to be undertaken for the duration of the SHIFT²RAIL programme.

In FOSTER RAIL, it was planned to establish a structure of "Pre-Requirements Groups" for each of the technical areas addressed by the SHIFT²RAIL proposal – one group for each of the "Innovation Programmes".

Involving the European region of the UIC (incorporating the ROC contribution of both CER and EIM), UNIFE and UITP as well as the interested members of those associations, it is anticipated to structure this framework as follows:

➔ **LEADERSHIP and INVOLVED STAKEHOLDERS**

- UIC will lead the management of this process and the creation of the working groups
- UNIFE and UITP will play a significant role in the development of this activity and in causing it to happen
- These associations and their interested members will be invited to nominate experts to participate in the work

➔ **SCOPE**

The Pre-Requirements Groups will develop and deliver the following activities:

- An outline work programme to enable the development of the functional requirements
- Determine the business needs which can be input to the SHIFT²RAIL Innovation Programmes
- Determine those that will not be part of the SHIFT²RAIL initiative and which will be helpful to the FOSTERRAIL route mapping activity and implementation of the previous ERRAC roadmaps
- Play a key role in delivering the functional requirements for the SHIFT²RAIL Innovation Programmes so as to better focus their proposal for research and innovation activities
- Establish the first ideas of a quality assurance framework for the SHIFT²RAIL work programme. This being to ensure that the functional requirements that are fed into the SHIFT²RAIL Innovation Programmes Research & Innovation activities and that the assessed KPIs will reflect the added value to business of rail transport.

➔ **SHIFT²RAIL**

It should be noted that once the SHIFT²RAIL programme is started, these "Pre-Requirements Groups" will then become "Requirements and Implementation Groups" and will be responsible for the following activities:

- Ensuring that the business needs of the European rail operating community (Railway Undertakings and Infrastructure Managers) are identified and made available to the relevant innovation programmes for the refinement of the annual working programme (in terms of operational and maintenance requirements)

- Creation and management of an impact management tool able to check in a continuous manner throughout the duration of SHIFT²RAIL, the progress made towards the accomplishment of the measurable objectives (KPIs) and compliance with the operational and maintenance requirements
- Establishment and management of a standardisation plan thus ensuring that the deliverables for the innovation program and the key interfaces with other systems and sub-system are identified and developed
- Contribution to the development of standards (e.g. interface standardisation) and suggestions for changes in European regulations, TSIs and European Standards, on the basis of pre-standard documents that these groups will produce.
- Collaboration with other system groups and with the ad hoc working parties created within SHIFT²RAIL for the management of the interfaces between the sub-systems concerned

2.3 Four matrixes

Here below the example (draft) of High Speed coming from the input of one participant.
Similar matrixes are available for the Regional, Urban/suburban and Freigth case scenario.
All input can be downloaded on the cooperation tool, given that it is still in its draft form – no validation by the group – it is not the final deliverable as intended in the proposal.

SYSTEM PLATFORM DEMONSTRATIONS
HIGH SPEED/MAINLINE

SPD	Objectives	Targets	KPIs	Target/indicator %	System requirements	Links SR
HIGH SPEED/MAINLINE	System Capacity	70%	Passengers per Metre of Train Length	35	600-650 passengers for 200 m train with comfort similar to actual	
			Increased Line Occupancy	65	double the train running in actual infrastructure. Lower track access charge of 40%	
	System Reliability	30	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	60	reduction to 25 % of actual values	
			Increased reliability through the better design, implemention and monitoring of infrastructure	40	Mandatory also for trains.	
	LCC	23%	Reduction in capital costs (infrastructure)	15		
			Reduction in capital costs (Rolling Stock	15	reduction of 20% of actual cost of rolling stock and 50% of LCC	
			Reduction in maintenance costs (infrastructure)	30		
			Reduction in maintenance costs (Rolling Stock)	30	reduction of 40% of actual cost of rolling stock maintenance	
			Reduction in Energy consumption	10	Reduction of 20% of actual cost of energy	

SHIFT²RAIL INNOVATION PROGRAMME 1
HIGH CAPACITY TRAINS
HIGH SPEED/MAINLINE

TD	Description	Targets	KPIs	Improvement indicator	Functional Requirements	LINKS FR
TD 1.1 Traction Drives	More efficient and lighter traction drives using the new generation of electronic material. New power electronics able to control motors at a higher frequency, based on emerging Silicon Carbide semi-conductors, a step change in energy efficiency, reliability and LCC.	System Capacity	ngers per Metre of Train	x	Increase of space available for passenger (600-650 in 200 m train)	
			ncreased Line Occupanc	x	Reduce wheight to limit braking distance and use shorter sections	
		System Reliability	Reduction in the number of In-service failures per million kms in a specific	x	reduction to 25 % of actual values	
			Increased reliability through the better design, implemention and monitoring of	x	This is a must also for rolling stock	
		LCC	Reduction in capital costs (infrastructure)	x		
			Reduction in capital costs (Rolling Stock	x	20% Reduction of cost of traction equipment (no fun, no or limited cooling	
			Reduction in maintenance costs (infrastructure)	x		
			Reduction in maintenance costs (Rolling	x	reduction to 40 % of actual values	
			Reduction in Energy consumption	x	reduce of 50 % energy loss in traction, reduce wheight of 20 % to reduce traction	
TD 1.2 Wireless Train Control and Management System (TCMS)	Wireless technologies to reduce cabling and complexity, improve reliability of communications between cars and between vehicles. New high safety architectures, remove train lines. Distributed computing for higher reliability. Improved sensoring. Reduce cost and commissioning	System Capacity	Passengers per Metre of Train Length	x	Increase of space available for passenger (600-650 in 200 m train)	
			Increased Line Occupancy	x	Reduce wheight to limit braking distance and use shorter sections; make	
		System Reliability	Reduction in the number of In-service failures per million kms in a specific	x	reduction to 25 % of actual values	
			Increased reliability through the better design, implemention and monitoring of	x	mandatory to reach target also for rolling stock	
		LCC	Reduction in capital costs (infrastructure)	x		
			Reduction in capital costs (Rolling Stock	x	reduction of 20% of actual cost of rolling stock and 50% of LCC	
			Reduction in maintenance costs (infrastructure)	x	train makes diagnosis to infrastucture: 10% reduction of track access	
			Reduction in maintenance costs (Rolling	x	reduction to 30 % of actual cost of maintenance	
			Reduction in Energy consumption	x	Reduce wheight of 50 % to reduce traction need.	
TD 1.3 Car body-shells	Lighter car bodyshell structures with the same cost, safety, repairability and performance of present metallic car bodyshells, by incorporating composite materials into either a hybrid or 100% composite structures. Ideal for producing pre-assembled components.	System Capacity	Passengers per Metre of Train Length	x	Increase of space available for passenger (600-650 in 200 m train)	
			Increased Line Occupancy	x	Reduce wheight to limit braking distance and use shorter sections	
		System Reliability	Reduction in the number of In-service failures per million kms	x		
			Increased reliability through the better design, implemention	x		
		LCC	Reduction in capital costs (infrastructure)	x	reduction of 20% of actual cost of rolling stock and 50% of LCC	
			Reduction in capital costs (Rolling Stock	x	reduction of 20% of actual cost of rolling stock and 50% of LCC	
			Reduction in maintenance costs (infrastructure)	x		
			Reduction in maintenance costs (Rolling	x		
			Reduction in Energy consumption	x	Reduce wheight of 20 % to reduce traction need.	
TD 1.4 Running gears	Optimised bogie materials, such as lightweight materials. Sensoring Functionality (health and usage monitoring can be enabled and condition-based maintenance can be employed rather than scheduled). Active Suspension and bogie control technology.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x		
		System Reliability	Reduction in the number of In-service failures per million kms	x	reduction to 20% of actual values	
			Increased reliability through the better design, implemention	x	Here CBM is hardly used to reach target	
		LCC	Reduction in capital costs (infrastructure)	x	train makes diagnosis to infrastucture: 10% reduction of track access	
			Reduction in capital costs (Rolling Stock	x		
			Reduction in maintenance costs (infrastructure)	x	train makes diagnosis to infrastucture: 10% reduction of track access	
			Reduction in maintenance costs (Rolling	x	CBM reduce LCC to 40 %	
			Reduction in Energy consumption	x	Reduce wheight of 20 %	
TD 1.5 Brakes	Brake energy storage and recuperation. Reduced wear and tear. Advanced frictionless braking technologies. Advanced brake control handling low adhesion situation. Increased reliability. Target stop braking. Weight reduction and size of components to be built. inAir supply	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	Stop distance reduced contribution to 100	
		System Reliability	Reduction in the number of In-service failures per million kms	x	Reduction to 75% of actual failure	
			Increased reliability through the better design, implemention	x	CBM used to reach the target	
		LCC	Reduction in capital costs (infrastructure)	x		
			Reduction in capital costs (Rolling Stock	x	reduction of 20% of actual cost of rolling stock and 50% of LCC	
			Reduction in maintenance costs (infrastructure)	x		
			Reduction in maintenance costs (Rolling	x	Reduce maintanance cost of 35%	
			Reduction in Energy consumption	x	Reuse energy from braking	
TD 1.6 Doors	Comfort improvement. PRM & safety solutions. Intelligent systems. Energy & axle load optimization.	System Capacity	Passengers per Metre of Train Length	x	600-650 pax in 200 m	
			Increased Line Occupancy	x		
		System Reliability	Reduction in the number of In-service failures per million kms	x	reduction to 40 % of actual values	
			Increased reliability through the better design, implemention	x	use CBM to reach the target	
		LCC	Reduction in capital costs (infrastructure)	x		
			Reduction in capital costs (Rolling Stock	x	reduction of 20% of actual cost of rolling stock and 50% of LCC	
			Reduction in maintenance costs (infrastructure)	x		
			Reduction in maintenance costs (Rolling	x		
			Reduction in Energy consumption	x		

SHIFT²RAIL INNOVATION PROGRAMME 2
ADVANCED TRAFFIC MANAGEMENT AND CONTROL SYSTEMS
HIGH SPEED/MAINLINE

TD	Description	Targets	KPIs	Improvement indicator	Functional Requirements	LINKS FR
TD2 Railway network capacity increase (ATO up to GoA4)	Increase the network utilisation and decrease operator's costs by adding ATO on all types of main lines including evolutions to CBTC functionalities. It will also save energy and improve dramatically the sustainable development.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	optimization in each typoligy of railway infrastructure almost 100% of existing occupancy	
		System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x	Minimize Number of minute/year of failure of TD2. Service failure cause almost 1 train delay . Blocking failure cause almost 2 train Blocked	
			Increased reliability through the better design, implemention and monitoring of infrastructure	x	monitoring with a related system for retrofit system requirement management of TD2	
		LCC	Reduction in capital costs (infrastructure)	x	50% in a medium scale of time, 10 year , existing cost of investment for TD2 in a station and line	
			Reduction in capital costs (Rolling Stock	x	almost of 50% of existing cost in a medium scale of time, 10 year , of investment for Rolling Stock for TD2	
			Reduction in maintenance costs (infrastructure)	x	almost of 50% of existing cost in a medium scale of time, 10 year , of infrastructure maintenance for TD2	
			Reduction in maintenance costs (Rolling Stock)	x	almost of 50% of existing cost in a medium scale of time, 10 year , of rolling stock maintenance	
			Reduction in Energy consumption	x	Evidence of criteria in order to minimize almost of 50% of existing Energy consumption	
TD3 - Line capacity increase through moving fluid block and smart switching and crossing	Reduce the headway between trains allowing more trains on a given main line, especially on High Speed Lines and long distance mainly-freight lines. Evolutions to CBTC functionalities. Smart switching & crossing is bringing intelligence to individual points on main lines at junctions or pairs of points linking one track to the other on dual track lines to allow a train to run on the opposite track e.g. for overpassing or in case of track works or perturbations.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	optimization in each typoligy of railway infrastructure almost 100% of existing occupancy	
		System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x	of TD3. Service failure cause almost 1 train delay . Blocking failure cause almost 2 train Blocked	
			Increased reliability through the better design, implemention and monitoring of infrastructure	x	monitoring with a related system for retrofit system requirement management of TD2	
		LCC	Reduction in capital costs (infrastructure)	x	50% in a medium scale of time, 10 year , existing cost of investment for TD2 in a station and line	
			Reduction in capital costs (Rolling Stock	x	almost of 50% of existing cost in a medium scale of time, 10 year , of investment for Rolling Stock for TD2	
			Reduction in maintenance costs (infrastructure)	x	almost of 50% of existing cost in a medium scale of time, 10 year , of infrastructure maintenance for TD2	
			Reduction in maintenance costs (Rolling Stock)	x	almost of 50% of existing cost in a medium scale of time, 10 year , of rolling stock maintenance	
			Reduction in Energy consumption	x	Evidence of criteria in order to minimize almost of 50% of existing Energy consumption	
TD5 - On-board train nitegrity (each mobile locates itself with SIL4)	Detect train integrity in a dependable and fail-safe manner. Provide SIL-4 fail-safe information on train length and train completeness. Eliminate conventional track-side train detection equipment.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	optimization in each typoligy of railway infrastructure almost 100% of existing occupancy	
		System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x	of TD5. Service failure cause almost 1 train delay . Blocking failure cause almost 2 train Blocked	
			Increased reliability through the better design, implemention and monitoring of infrastructure	x	monitoring with a related system for retrofit system requirement management of TD5	
		LCC	Reduction in capital costs (infrastructure)	x	50% in a medium scale of time, 10 year , existing cost of investment for TD5 in a	
			Reduction in capital costs (Rolling Stock	x	almost of 50% of existing cost in a medium scale of time, 10 year , of investment for	
			Reduction in maintenance costs (infrastructure)	x	almost of 50% of existing cost in a medium scale of time, 10 year , of infrastructure	
			Reduction in maintenance costs (Rolling Stock)	x	almost of 50% of existing cost in a medium scale of time, 10 year , of rolling stock	
			Reduction in Energy consumption	x	almost of 50% of existing Energy consumption	
TD8 - Virtually-coupled train sets (to optimize line throughput)	Increase the length of a train to allow more passengers and/or freight to pass in a given time. Today, to serve several stations along a line, some trains have to stop at some stations and this leads to capacity limitation.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	Maximize by TD8 adoption the train optimization in each typoligy of railway infrastructure almost 100% of existing occupancy	
		System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x	Minimize Number of minute/year of failure of TD8. Service failure cause almost 1 train delay . Blocking failure cause almost 2 train Blocked	
			Increased reliability through the better design, implemention and monitoring of infrastructure	x	Introduce a performance system monitoring with a related system for retrofit system requirement management of TD2	
		LCC	Reduction in capital costs (infrastructure)	x	Evidence of criteria in order to minimize of 50% in a medium scale of time, 10 year , existing cost of investment for TD8 in a station and line	
			Reduction in capital costs (Rolling Stock	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of investment for Rolling Stock for TD8	
			Reduction in maintenance costs (infrastructure)	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of infrastructure maintenance for TD8	
			Reduction in maintenance costs (Rolling Stock)	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of rolling stock maintenance	
			Reduction in Energy consumption	x	Evidence of criteria in order to minimize almost of 50% of existing Energy consumption	
TD6 - 0 on site testing (control command in demonstrators)	Any bug appearing during on-site testing or –even worse- during operation costs up to 10 times -or more- the cost and effort to fix it in comparison with its management and fixing during the development phase in lab. The objective is to target "Zero on-site testing" by simulating all the steps needed with simulation tools and demonstrators.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	Maximize by TD6 adoption the train optimization in each typoligy of railway infrastructure almost 100% of existing occupancy	
		System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x	Adopting TD6 give evidence criteria fo minimize Number of minute/year of failure of each IP2 TD. Service failure cause almost 1 train delay . Blocking failure cause almost 2 train Blocked	
			Increased reliability through the better design, implemention and monitoring of infrastructure	x	Introduce a performance system monitoring with a related system for retrofit system requirement management of TD6	
		LCC	Reduction in capital costs (infrastructure)	x	Evidence of criteria in order to minimize of 50% in a medium scale of time, 10 year , existing cost of investment in a station and line by adopting TD6	
			Reduction in capital costs (Rolling Stock	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of investment for Rolling Stock by adopting TD6	
			Reduction in maintenance costs (infrastructure)	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of infrastructure maintenance by adopting TD6	
			Reduction in maintenance costs (Rolling Stock)	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of rolling stock maintenance	
			Reduction in Energy consumption	x	Evidence of criteria in order to minimize almost of 50% of existing Energy consumption	
TD7 - Formal methods and standardisation for smart signalling systems	Standardisation of engineering and operational rules will allow quick and easy implementation of signalling system, test and commissioning, then easy and friendly training of operators (signallers, drivers, maintainers, etc.) and, afterwards, a smooth operation in all circumstances including for trains passing from one infra owner to another one. The other part is to formally specify the whole architecture of the control-command system and its components and their environment on one side, and their functional operation requirement on the other side. Also including standardised interfaces between crucial parts of the system.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	Maximize by TD7 adoption the train optimization in each typoligy of railway infrastructure almost 100% of existing occupancy	
		System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x	Minimize Number of minute/year of failure of TD7. Service failure cause almost 1 train delay . Blocking failure cause almost 2 train Blocked	
			Increased reliability through the better design, implemention and monitoring of infrastructure	x	Introduce a performance system monitoring with a related system for retrofit system requirement management by TD7	
		LCC	Reduction in capital costs (infrastructure)	x	Evidence of criteria in order to minimize of 50% in a medium scale of time, 10 year , existing cost of investment in a station and line by adopting TD7	
			Reduction in capital costs (Rolling Stock	x	Evidence of criteria by adopting TD7 in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of investment for Rolling Stock	
			Reduction in maintenance costs (infrastructure)	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of infrastructure maintenance by adopting TD7	
			Reduction in maintenance costs (Rolling Stock)	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of rolling stock maintenance	
			Reduction in Energy consumption	x	Evidence of criteria in order to minimize almost of 50% of existing Energy consumption	
TD1 - Adaptable communications for all railways	New communication solution for supporting train control applications (in terms of architecture, system, products) by definition of Quality of Service and flexible interface to signalling architecture, as well as associated Business Model.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	Maximize by TD1 adoption the train optimization in each typoligy of railway infrastructure almost 100% of existing occupancy	
		System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x	Minimize Number of minute/year of failure of TD1. Service failure cause almost 1 train delay . Blocking failure cause almost 2 train Blocked	
			Increased reliability through the better design, implemention and monitoring of infrastructure	x	Introduce a performance system monitoring with a related system for retrofit system requirement management of TD1	
		LCC	Reduction in capital costs (infrastructure)	x	Evidence of criteria in order to minimize of 50% in a medium scale of time, 10 year , existing cost of investment for TD1 in a station and line	
			Reduction in capital costs (Rolling Stock	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of investment for Rolling Stock for TD1	
			Reduction in maintenance costs (infrastructure)	x	Evidence of criteria in order to minimize almost of 200% of existing cost in a medium scale of time, 10 year , of infrastructure maintenance for TD1	
			Reduction in maintenance costs (Rolling Stock)	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of rolling stock maintenance	
			Reduction in Energy consumption	x	Evidence of criteria in order to minimize almost of 50% of existing Energy consumption	
TD4 - Advanced fail-safe train positionning (satellite...)	New train detection system based only on satellite information i.e. independent from track-side. That system will report precisely where each mobile is ("location"). For a train, its fail-safe location will de facto be available.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	Maximize by TD4 adoption the train optimization in each typoligy of railway infrastructure almost 100% of existing occupancy	
		System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x	Minimize Number of minute/year of failure of TD4. Service failure cause almost 1 train delay . Blocking failure cause almost 2 train Blocked	
			Increased reliability through the better design, implemention and monitoring of infrastructure	x	Introduce a performance system monitoring with a related system for retrofit system requirement management of TD4	
		LCC	Reduction in capital costs (infrastructure)	x	Evidence of criteria in order to minimize of 50% in a medium scale of time, 10 year , existing cost of investment for TD4 in a station and line	
			Reduction in capital costs (Rolling Stock	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of investment for Rolling Stock for TD4	
			Reduction in maintenance costs (infrastructure)	x	Evidence of criteria in order to minimize almost of 100% of existing cost in a medium scale of time, 10 year , of infrastructure maintenance for TD4	
			Reduction in maintenance costs (Rolling Stock)	x	Evidence of criteria in order to minimize almost of 50% of existing cost of TD4 in a medium scale of time, 10 year , of rolling stock maintenance	
			Reduction in Energy consumption	x	Evidence of criteria in order to minimize almost of 50% of existing Energy consumption	
TD11 - Network Attached object controller	More and more signalling/control-command equipment devices are installed in very remote areas with difficult access for servicing. Development of an autonomous, complete, intelligent, self-sufficient smart equipment ("box") able to connect with any wayside object and communicating device (by radio, satellite...) in the area.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	Maximize by TD11 adoption the train optimization in each typoligy of railway infrastructure almost 100% of existing occupancy	
		System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x	Minimize Number of minute/year of failure of TD11. Service failure cause almost 1 train delay . Blocking failure cause almost 2 train Blocked	
			Increased reliability through the better design, implemention and monitoring of infrastructure	x	Introduce a performance system monitoring with a related system for retrofit system requirement management of TD11	
		LCC	Reduction in capital costs (infrastructure)	x	Evidence of criteria in order to minimize of 70% in a medium scale of time, 10 year , existing cost of investment for TD11 in a station and line	
			Reduction in capital costs (Rolling Stock	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of investment for Rolling Stock for TD11	
			Reduction in maintenance costs (infrastructure)	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of infrastructure maintenance for TD11	
			Reduction in maintenance costs (Rolling Stock)	x	Evidence of criteria in order to minimize almost of 70% of existing cost in a medium scale of time, 10 year , of rolling stock maintenance of TD11	
			Reduction in Energy consumption	x	Evidence of criteria in order to minimize almost of 50% of existing Energy consumption	
TD12 - Cyber System security	To achieve the highest level of cyber-security against any significant threat for the signalling systems. On-line Key Management is essential for the operational safety of the railway. A reliable, easy-to-test & commission, easy-to-operate by all parties, easy-to-maintain KMS is of paramount importance to achieve an efficient, secure and safe railway system.	System Capacity	Passengers per Metre of Train Length	x		
			Increased Line Occupancy	x	Maximize by TD12 adoption the train optimization in each typoligy of railway infrastructure almost 100% of existing occupancy	
		System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x	Minimize Number of minute/year of failure of TD12. Service failure cause almost 1 train delay . Blocking failure cause almost 2 train Blocked . Increase the level of security of open communication	
			Increased reliability through the better design, implemention and monitoring of infrastructure	x	Introduce a performance system monitoring with a related system for retrofit system requirement management of TD12	
		LCC	Reduction in capital costs (infrastructure)	x	Evidence of criteria in order to minimize of 50% in a medium scale of time, 10 year , existing cost of investment for TD12 in a station and line	
			Reduction in capital costs (Rolling Stock	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of investment for Rolling Stock for TD12	
			Reduction in maintenance costs (infrastructure)	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of infrastructure maintenance for TD2	
			Reduction in maintenance costs (Rolling Stock)	x	Evidence of criteria in order to minimize almost of 50% of existing cost in a medium scale of time, 10 year , of rolling stock maintenance	
			Reduction in Energy consumption	x	Evidence of criteria in order to minimize almost of 50% of existing Energy consumption	

SHIFT²RAIL INNOVATION PROGRAMME 3

COST EFFICIENT HIGH CAPACITY INFRASTRUCTURE

HIGH SPEED/MAINLINE

	TD		Targets	KPIs	Improvement indicator	Functional Requirements	LINKS FR
S&C	TD1 - Improvement of existing S&C	Iterative development of existing S&C with new materials, new embedded Monitoring systems, new fail safe locking techniques.	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		
	TD2 - Mechatronic S&C	Radical new S&C design. Adaptive self adjusting. Enabled by mechatronic steering trains. New switch mechanisms. Nano materials (rail steel).	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		
Track	TD 3 - Track - Medium Term	Bottom-up approach starting with the “traditional” ballast/sleeper system. The next step is more radical redesigns of components and subsystems. This implies innovative rail grades, fastening systems and sleepers	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		
	TD4 - Track - Long term	Focusing on entirely new solutions will instead set out from a top-down approach. Define a vision of the perfect track. Here the best of the features of a ballasted track (fast installation, low installation costs) are combined with the best features of a slab-track solution (low geometry deterioration, high	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		
	TD5 - Proactive Bridge and Tunnel Assessment and repairing/upgrading	New alternative methods for tunnel and bridge inspections and new enhanced reparing and upgrading methods. The new reparing and upgrading methods will meet new demands like less traffic disturbance, quick to implementation and possible to use with short track assess time.	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		
Intelligent Maintenance	TD6 - The Dynamic Railway Information Management System	Able to store, process and manage dynamic heterogeneous information to provide input not only to the maintenance but also to other railway tasks.	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		
	TD7 - The Railway Integrated Measuring and Monitoring System	Composed by an integrated set of cutting-edge on-board, wayside and remote-sensing asset-specific measuring and monitoring sub-systems.	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		
	TD8 - The Intelligent System Maintenance Engineering and Strategies	Aimed at condition based and/or predictive system maintenance.	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		
Energy efficiency	TD9 - Integrated DC power supply system	DC traction power as basis for Railway Power Micro-Grids. Energy Regeneration Systems & Optimised network Control. Integration of energy storage systems & controlled inverter DC-substations for integration in Virtual DC Power Plants.	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		
	TD10 - Integrated AC power supply system	Optimised investment & operation influence for AC Rail power supply with industry frequency. Balancing single phase railway load to 3-phase grid at substation. Preventing phase separations on line to improve rail operation.	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		
	TD11 - Smart metering for a railway distributed energy resource management system	Based on the Distributed Energy Ressources Management concept. Creation of a Railway DERMS and Virtual Power Plant integrating measurements and previsions from trains, substations and auxiliary loads.	System capacity	Passengers per Metre of Train Length	x		
				Increased Line Occupancy	x		
			System reliability	Reduction in the number of In-service failures per million kms in a specific subsystem affecting operation	x		
				Increased reliability through the better design, implemention and monitoring of infrastructure	x		
			LCC	Reduction in capital costs (infrastructure)	x		
				Reduction in capital costs (Rolling Stock	x		
				Reduction in maintenance costs (infrastructure)	x		
				Reduction in maintenance costs (Rolling Stock)	x		
				Reduction in Energy consumption	x		

SHIFT²RAIL INNOVATION PROGRAMME 4

SEAMLESS ATTRACTIVE RAILWAY TRANSPORT SYSTEM

HIGH SPEED/MAINLINE

	TD	Description	Targets	KPIs	Improvement indicator	Functional Requirements	LINKS FR
Travel Companion	TD 5 Travel Companion	The travel companion will help passengers to effectively travel seamlessly throughout Europe by providing a hassle free interface to the European travel industry.	System capacity	Increase the total number of passengers and increase the multimodal usage (supporting	X		
			System reliability	Reduce and facilitate the users time spent planning travel; less time spent searching and booking tickets, less	X		
			LCC	Increase the overall occupancy rate with limitation of peak and off peak periods (reducing costs)	X		
Multimodal seamless travel	TD2 - Travel shopping	Eliminating difficulty and risk from multimodal travel shopping. Providing comprehensive choice of trip solutions combining relevant modes of transport and associated services, with relevant comparison criteria. Converting travel intentions into travel execution.	System capacity	Increase the total number of passengers and increase the multimodal usage (supporting	X		
			System reliability	Reduce and facilitate the users time spent planning travel; less time spent searching and booking tickets, less	X		
			LCC	Increase the overall occupancy rate with limitation of peak and off peak periods (reducing costs)	X		
	TD 3 - Ticketing	Manage all European travellers entitlements in a consistent and open way. Provide all services necessary for the entitlements lifecycles (booking, issuance, information, billing, payment and settlement, validation, control, exchange, refund, etc.). Instant and	System capacity	Increase the total number of passengers and increase the multimodal usage (supporting	X		
			System reliability	Reduce and facilitate the users time spent planning travel; less time spent searching and booking tickets, less	X		
			LCC	Increase the overall occupancy rate with limitation of peak and off peak periods (reducing costs)	X		
	TD 4 Trip tracker	Providing intelligent information to the customer about the impact of service disruptions on their entire multimodal itinerary. Propose re-accommodation options if itinerary is impacted.	System capacity	Increase the total number of passengers and increase the multimodal usage (supporting	X		
			System reliability	Reduce and facilitate the users time spent planning travel; less time spent searching and booking tickets, less	X		
			LCC	Increase the overall occupancy rate with limitation of peak and off peak periods (reducing costs)	X		
Technical framework	TD1 - Interoperability framework	Insulate business applications from the underlying mechanics of interoperability across an open-ended, ever-expanding network of connected, linked data and services. Automate the discovery and linking of data and service resources. Automate the integration of existing	System capacity	Increase the total number of passengers and increase the multimodal usage (supporting	X		
			System reliability	Reduce and facilitate the users time spent planning travel; less time spent searching and booking tickets, less	X		
			LCC	Increase the overall occupancy rate with limitation of peak and off peak periods (reducing costs)	X		
	TD6 - Business analytics	Travel Intelligence framework for service lifecycle continuous improvement of rail-centric travel experience. Setting, Planning, Tracking and Optimizing S2R target strategic KPIs. Enabling Rail&Transport operators with multichannel Travellers Relationship	System capacity	Increase the total number of passengers and increase the multimodal usage (supporting	X		
			System reliability	Reduce and facilitate the users time spent planning travel; less time spent searching and booking tickets, less	X		
			LCC	Increase the overall occupancy rate with limitation of peak and off peak periods (reducing costs)	X		
Coordination and demonstration	TD7 - Coordination & demonstration	Coordinate with the other TDs as an integrated project with the relevant architecture design methodology. Ensure that the overall production of the TDs can be deployed as an integrated demonstrator of end-to-end seamless travel across Europe.	System capacity	Increase the total number of passengers and increase the multimodal usage (supporting capacity)	X		
			System reliability	Reduce and facilitate the users time spent planning travel; less time spent searching and booking tickets, less time spent waiting for the transport mode and rearranging the journey (increasing quality of service);	X		
			LCC	Increase the overall occupancy rate with limitation of peak and off peak periods (reducing costs)	X		