C4R

Capacity for Rail

Towards an affordable, resilient, innovative and high-capacity European Railway System for 2030/2050

Report on migration scenarios/paths for selected real sites/corridors

Submission date: 30/11/2017

Deliverable 53.3

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement n° 605650

Collaborative project SCP3-GA-2013-60560
Increased Capacity 4 Rail networks through enhanced infrastructure and optimised operations
FP7-SST-2013-RTD-1

Lead contractor for this deliverable:

- IK

Project coordinator

- Union Internationale des Chemins de fer, UIC

Collaborative project SCP3-GA-2013-60560

Increased Capacity 4 Rail networks through enhanced infrastructure and optimised operations

FP7-SST-2013-RTD-1

Deliverable D5.3.3

Report on migration scenarios/paths for selected real sites/corridors

Due date of deliverable: 31/09/2016

Actual submission date: 30/09/2017

Dissemination Level		
PU	Public	**PU**
PP	Restricted to other program participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Lead contractor for this deliverable .... **IK**

Acronyms and Abbreviations

The following list provides definitions for acronyms and abbreviations and for terms used in this document:

CBA	Cost-Benefit Analysis
IMs	Infrastructure managers
LCC	Life-Cycle Costs
RAMS	Reliability, Availability, Maintainability and Safety
RFC	Rail Freight Corridor
3ARC	Affordable, Adaptable, Automated, high Capacity

Table of content

Executive Summary

This deliverable describes important aspects of migration and explain possible migration paths and cases for upgrading ballasted tracks on rail freight corridors (RFCs) by slab track developed in C4R.

Upgrading the track on a highly loaded rail freight corridor, where the use of slab track make sense, is a very challenging task for migration. The basis for the decision are criteria like

- Capacity bottleneck due to track availability and high maintenance
- Availability of alternative routes
- Proofed slab track available for given boundaries or
- Homogeneous and stable support conditions

Especially the availability of alternative route is one of the key factors for a successful migration. If all criteria are given, the selection of the appropriate type of slab track must be chosen. Pre-fabricated slab track or such with slab made of asphalt are suitable for fast and seamless upgrade.

This deliverable also points out the complexity of the railway system, the problems induced by long lasting assets and the possible need for upgrading the whole corridor. Huge investments are often necessary to achieve real step changes. It is therefore proposed to subsidy the railway system to support European solutions and step changes.

1 Objectives

The objective of this deliverables is to describe and validate the migration paths with respect to the C4R innovations based on real RFCs.

Due to complexity of the analysis carried out in WP5.3 and WP5.4 which are the input for this deliverable and the remaining time the migration was exemplary developed only for the slab track developed in SP1.

2 Migration

The different deliverables of C4R describe the results of C4R from technical and economic point of view. Now it's time to think about the installation of results which provides benefits.

This is the task of migration. Migration of innovations – especially if we talk about step changes is a very challenging task. If we look at some results of C4R like slab track or increased axle load these solutions strongly impact the infrastructure. Depending on the boundary conditions strong investments and impacts on the operation must be considered. Where slab track are local decisions, solutions like 25t axle loads or longer trains are relevant for the whole corridor. The total benefit is only given, if the solution is applied for the whole corridor. Thus, this deliverable will mainly focus on migration from ballasted track to slab track.

Figure 1 summarizes innovations developed or analyzed in C4R and points out the impact on infrastructure and the impact during migration on investment and operation.

	Impact on infrastructure	Investment	Operation
Slab Tack	Rebuilding of track, sub-structure	++	++
New S&C's	Rebuilding of S&C's	++	+
25t Axle Load	Upgrade to E5, sub-structure, bridges	+++	+++
Longer Trains	Sidings, axle counter, bridges, signalling	++	+
Increased Speed	Maintenance of track, power supply	0 - +	0 - +
Terminal Upgrades	Rebuilding and upgrade of assets	+++	+
New Monitoring System	Sensors, data acquisition, evaluation	+	0
Optimized freight wagons	none	0	0

Most C4R solution will impact the infrastructure, related investment and operation

Impact during migration
0 - small
+ - noticeable
++ - medium
+++ - strong

FIGURE 1-SELECTION OF C4R SOLUTIONS

Most of the solutions will impact the infrastructure and the related investments and operation. For a successful implementation of these solutions migration is the most important aspect.

Looking at the targets from the roadmaps or the future demands, which are partly shown in **Figure 2** innovative track construction are necessary to fulfil these targets. But the decision process has to take into account where to upgrade with which construction and to decide about the migration strategy.

Demand	2015	2030	2050
Timeslots for maintenance - MTTR	100%	50%	50%
Planned & unplanned unavailability - MDT	100%	50%	< 1h/d
Specific CO2 emissions (incl. embodied)	100%	80%	50%
Resilience to severe weather conditions (measured by infrastructure down-time)	100%	<75%	<50%
LCC (NPV)	100%	90%	80%

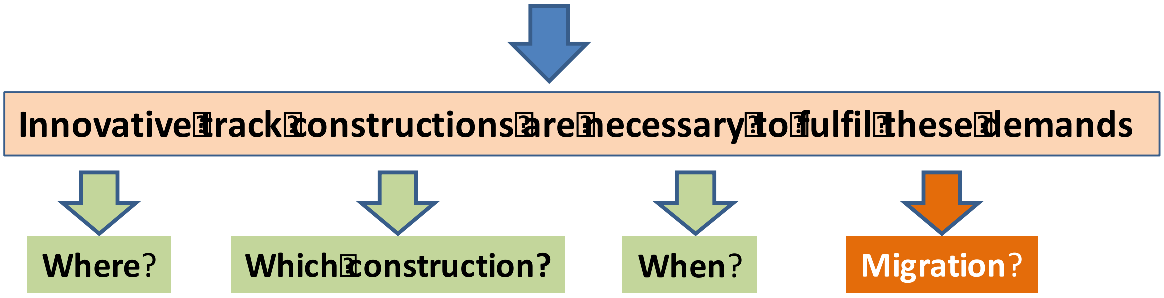


FIGURE 2- DEMANDS ON THE FUTURE RAILWAY WITH RESPECT TO THE TRACK

3 Migration from Ballasted to Non-Ballasted Track

The decision about the upgrade of track and the migration to slab track must consider several aspects, like the results of a CBA. To reduce financial and technical risks the decision should analyse aspects like the homogeneity of sub-structure or the availability of alternative routes during the upgrade. Figure 3 shows some important aspect which must be considered in the decision process.

FIGURE 3-DECISION CRITERIA FOR UPGRADING WITH SLAB TRACK

The availability of alternative route is one of the most important aspects for a successful migration. The problem on the RCF from Rotterdam to Genoa clearly shows the real situation of the railway system. In this case a tunnel which was in construction below the tracks of the RFC collapse and the section must be closed for 52 days.

Since alternatives route are not available the blocking of the line causes big impact on the transport of freight in whole Europe and causes lot of additional costs.

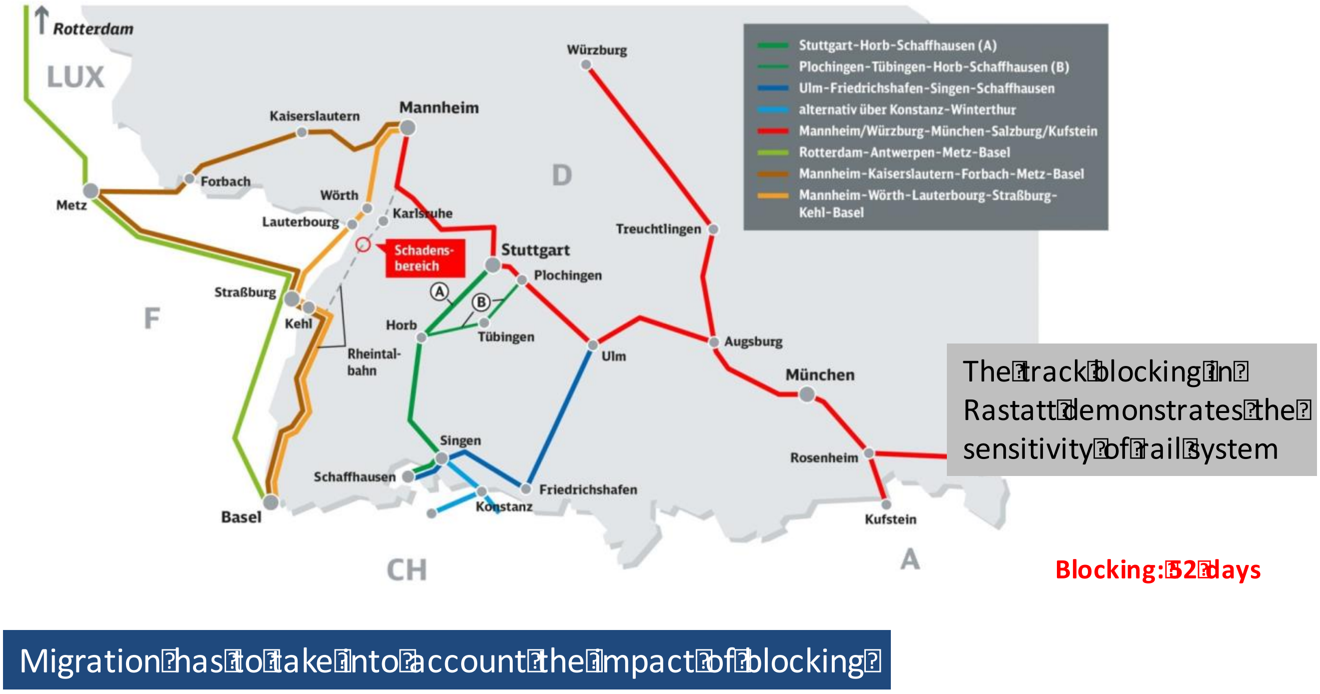


FIGURE 4-IMPACT OF TRACK BLOCKING ON RAIL FREIGHT TRANSPORT

As mentioned before the migration from ballasted to slab track depends among others on the type of construction. For a fast and successful migration, the right construction must be chosen to upgrade in a short time with lowest risk and high quality.

Figure 5 shows the comparison of compact slab track, pre-fabricated slab track and two types of ballasted track for different applications. The slab track developed in C4R is from the type pre-fabricated. As the pre-fabricated solution provides a good overall performance this type is suitable for migration.

C4R

Type / Aspect	Compact	Pre-fabricated	Ballast standard	Ballast optimized
New construction	++	++	++	++
Renewal	o	+	++	++
Earth structure	+	++	++	++
Bridge	+	+	++	++
Tunnel - single track	+	++	-	-
- double track	++	++	+	+
Sensitivity for installation failures	medium	low	very low	very low
Repair of rail support	-	+	++	++
Degree of mechanizing	medium	good	excellent	excellent

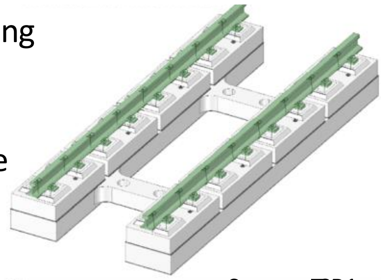
FIGURE 5- COMPARISON OF APPLICATION OF SLAB TRACK AND BALLASTED TRACK

3.1 ASSUMPTIONS AND CASES FOR UPGRADING OF TRACK.

Erreur ! Source du renvoi introuvable. summarizes the assumption that were made for the migration s cenario.

Assumptions and Requirements

- Installation of slab track on an existing RCF
- Section length: 50 km double track
- Optimized installation procedure to minimize track blocking
- Use of existing ballast for HBL, drainage, ...
- Improvement of sub-structure is necessary on 30% of line
- **New track construction – SP1 solution**
- No experience with slab track for freight or heavy haul lines



Source: SP1

Cases

- Case 1 – alternative routes are available
- Case 2 – alternative routes are not available

Two cases are considered

- Case 1 – alternative routes are available
- Case 2 – alternative routes are not available

The first case assumes, that alternatives routes are available, which provide nearly the same capacity as the main track of the rail freight corridor.

Figure 6 shows the installation phases and estimated time periods to upgrade from ballasted to slab track taken into account the assumptions above.

Starting from C4R innovation from SP1 a phase for approval of track constructions is necessary This will take up to 4 years. The planning phase depends on local boundary conditions and will take up to 2 years. We assume a high grade of automation. This makes it possible to upgrade 50 km of track in app. 135 days. The re-investment is about 75 Mio. € for each track.

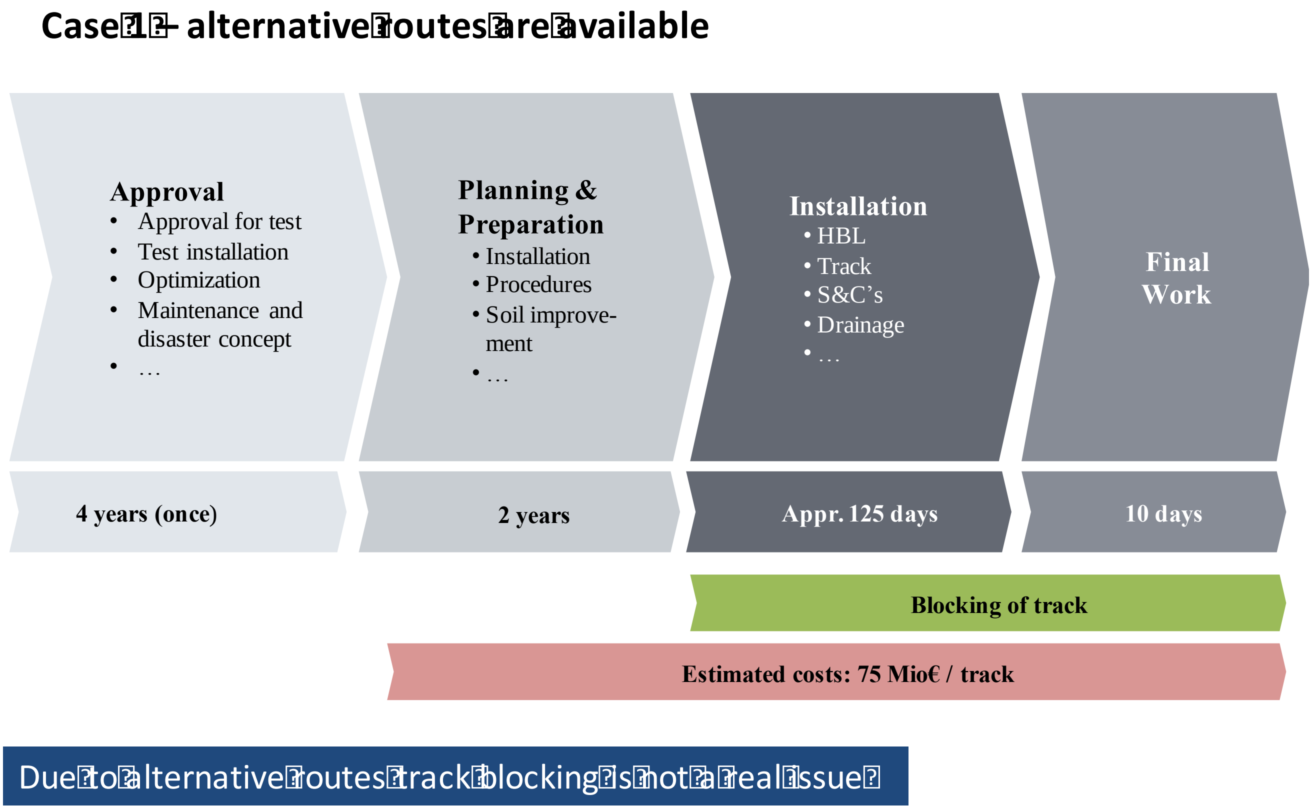


FIGURE 6-INSTALLATION OF SLAB TRACK - CASE 1

In the 2nd case alternatives routes are not available the planning and preparation has to take this into account and to improve alternative routes. The time and re-investment for upgrading strongly increase.

Figure **7** shows the installation steps, time horizon and estimated costs, if alternative routes are improved. In this case the freight transport use the alternative routes during the installation of slab track. The time for improving the alternative route depend on the local conditions. To reduce the time needed for the upgrade it is meaningful to do the Approval and Planning & preparation Phases in parallel. The estimated costs are much higher than for the first case, but at the end of the day the reliability and capacity of the whole corridor increases due to the upgrade to ballasted tracks and due to the improvements on alternative routes.

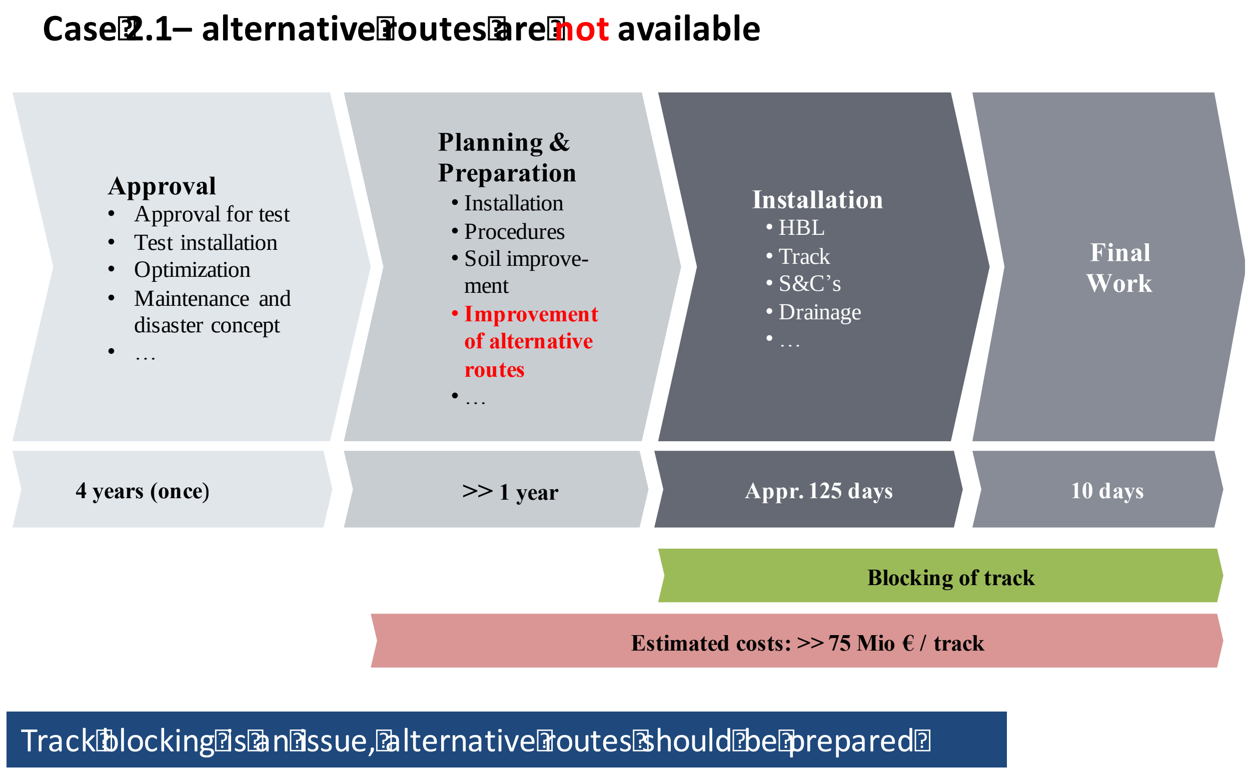


Figure 7-Installation of slab track - Case 2.1

Figure 8 shows a possible scenario, where alternative routes are not available. In this case the installation of slab track will be spitted in 10 sections of 5 km. The time where the track in not available will increase and the cost are app. double as high as for case 1.

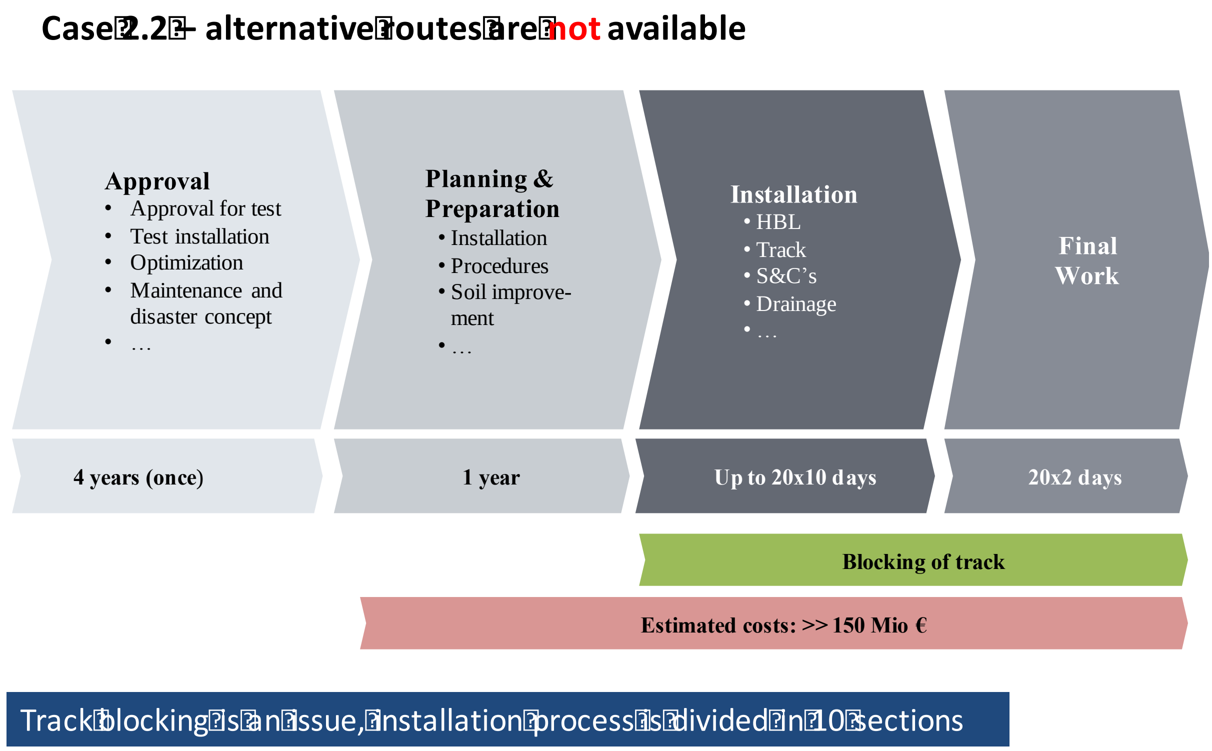


Figure 8-Installation of slab track - Case 2.2

3.2 Sequence for Upgrading Ballasted Track by Slab Track

This diagram in **Figure 9** shows how the sequence of upgrading ballasted tracks with slab track could look like. But high automation and professional work is necessary to keep this. But this will be only possible for high quantities structures which means lot of re-investment.

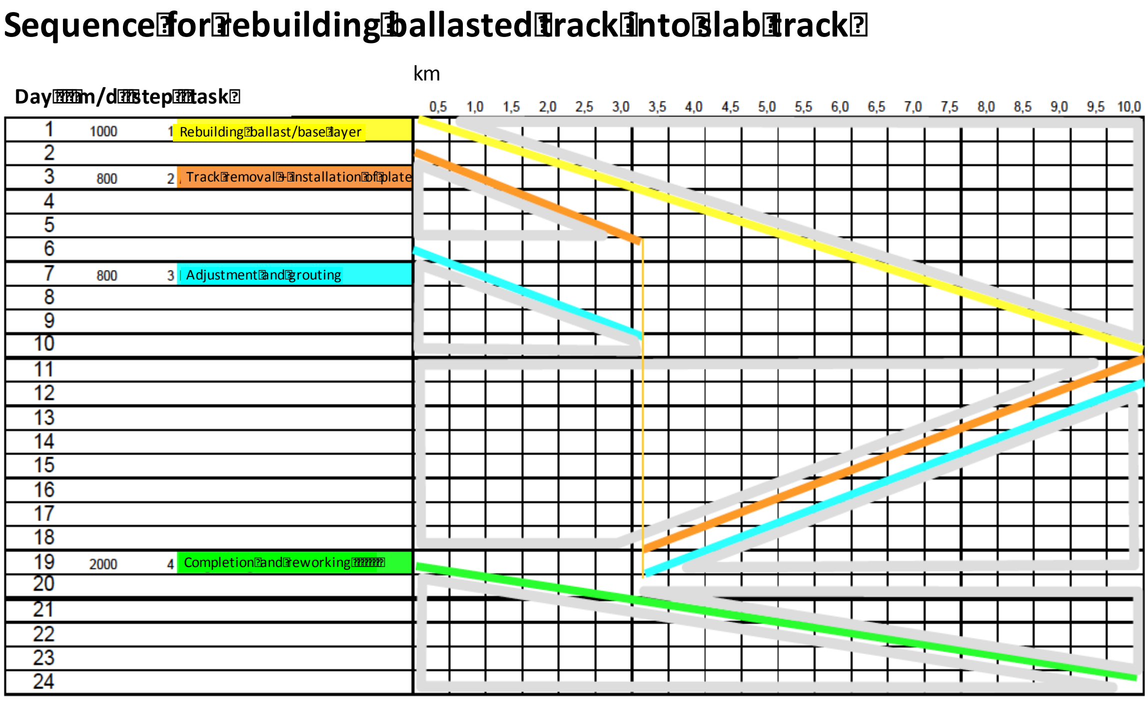


Figure 9-Sequence for Rebuilding Track

3.3 Necessary Improvements for Upgrading Track

To upgrade ballasted tracks with slab track on highly loaded RFC's several improvements are necessary. Below are some of these improvements summarized.

Necessary improvements for upgrading the track

- Automated installation procedures with high quality output
- Automated correction of track geometry like in ballasted tracks
- Proofed repair and renewal concepts
- Cost reduction
- …

4 Conclusions

Table 1 summarizes the targets of C4R, which are based on the roadmaps and description of works.

The red marked targets highlight some challenging targets which are linked to the infrastructure. Especially the 20% reduction in LCC by 2050 with respect to increased demands needs step changes and a different thinking than today. This reduction requires new track constructions and maintenance approaches and therefore a straight forward migration strategy. Changing the infrastructure is the most challenging task, the deliverable therefore concentrated on the migration from ballasted track to slab track.

TABLE 1 – TARGETS OF C4R

1. Affordability	T1.1.	20% decrease in infrastructure Life-Cycle Cost (LCC) by 2050
	T1.2.	50% decrease in Train Operating Costs (TOC) by 2050
	T1.3.	50% decrease in specific CO_2 emissions, including embodied carbon, by 2030
	T1.4.	Elimination of operating noise problem sites by 2050
2. Adaptability	T2.1.	Freight rolling stock adaptable to cope with different freight containers by 2050
	T2.2.	Fully interoperable bundling of freight rolling stock by 2050
	T2.3.	Infrastructure adaptable to new operational requirements from traffic demand by 2050
3. Resilience	T3.1.	80% reduction of train delays due to Extreme Weather events by 2050
	T3.2.	80% reduction of train delays due to Infrastructure Failures by 2050
4. Automation	T4.1.	Automated rail freight system by 2050
	T4.2.	50% reduction of track unavailability due to monitoring & inspections by 2050
5. High Capacity	T5.1.	100% increase in overall freight capacity by 2050
	T5.2.	100% increase in overall passenger capacity by 2050

It was shown, that this migration is possible but several requirements must be fulfilled. Rebuilding a track under the rolling wheels on a rail freight corridor need alternative routes and fully automated installation processes.

Finally, **Figure 10** express, that the railway is a complex system with strong dependencies to different parts. This means a change of this system like addressed in the solutions of C4R will impact different parts of the system. The complexity increases if we look for RFC and the interoperability. The long-lasting assets are also an aspect that should be considered. The innovation cycles are very long and the compatibility with the existing system, modules or components complicate further developments not to speak of step changes.

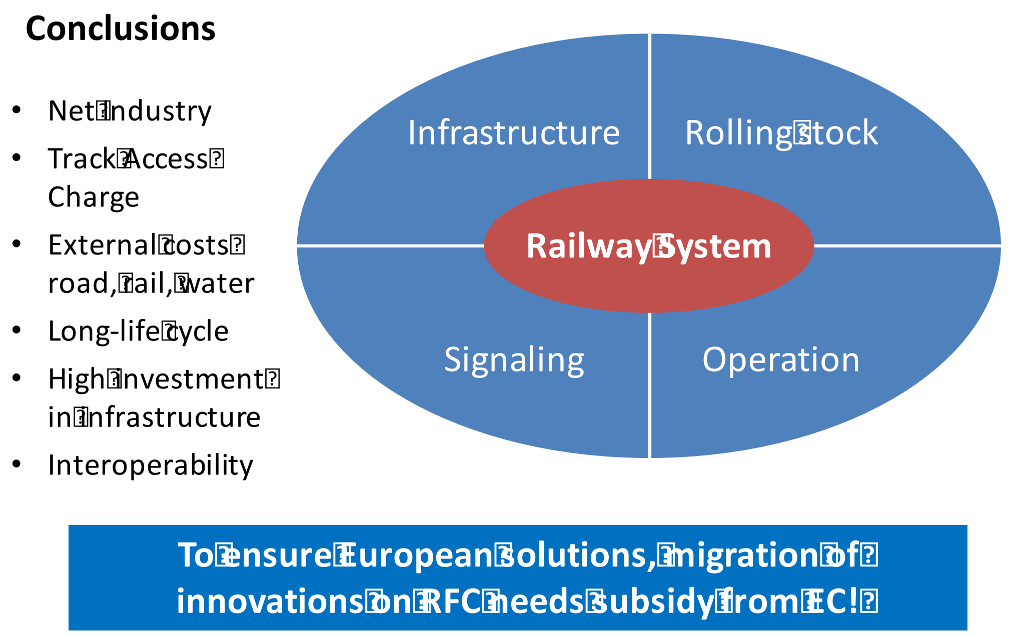


FIGURE 10-THE RAILWAY AS SYSTEM AND THE DEPENDENCIES

To improve the sector innovations must be implemented on the whole corridor. This will lead to high investment in the infrastructure which the IM's are not able to handle. Therefore, step changes and relevant migration in a European context will be only possible if the external costs of different modes are considered and the EC and national governments will subsidize the rail sector like done for the road sector.

5 References

[1] Modern rail modern Europe - TOWARDS AN INTEGRATED EUROPEAN RAILWAY AREA, European Communities, 2008

[2] Erweiterte Wirtschaftlichkeitsanalyse für Eisenbahnverkehrsunternehmen, MAEKAS-Projekt-bericht Nr. 16, 2009

[3] SWIFTLY Green, Mapping of the current status of the Stockholm-Palermo corridor, 2014.

[4] Study on TEN-T Core Network Corridor "Rhine–Alpine"; Final Report, 2014.

[5] C4R, D51.1 Railway road map – paving the way to an affordable, resilient, automated and adaptable railway, 2017.

[6] C4R, D5.1.2 Interim milestones to achieve step-changes in Railway capacity and performance for passengers and freight, 2017.

[7] C4R, D5.3.2 Migration scenarios and paths, 2017.

[8] C4R, D5.4.2/3 Assessment of technologies and scenarios, 2017.