Deliverable D4.1
Integration of Planning Systems

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1. Executive Summary

This report constitutes the deliverable *D4.1 Integration of Planning Systems* of the work package *WP 4 Development - Integration of planning systems and processes including cross-border planning*. It is based on input from the activities performed in tasks 4.1, 4.2, 4,3, 4.4, and 4.5 including the specification of detailed Use Cases, requirements and interfaces to support and improve the planning process facilitated by network capacity management systems (CMS) used by the Railway Infrastructure Managers (IM) in Europe. The specifications are used for development and set-up of the demonstrations 5.1 to 5.7 of Workstream 1.1. In this context, it will serve as an input document required for the activities performed in the future WP 5 of the MOTIONAL project and the future activities in the next EU-Rail calls to strive for higher TRL and large-scale demonstrations regarding the Technical Enablers

- TE 1 *European cross-border scheduling with international train path planning;*
- TE 2 *Improved capacity allocation using rolling planning and TTR*; and
- TE 6 *Integration of TMS with a) yard capacity planning and b) station capacity planning*.

Within the context of the WP 4, each partner has described a set of high-level Use Cases and high-level requirements for integration of planning systems with other systems including planning systems of neighbouring rail networks, which contributed to the writing of deliverable D3.1. The D3.1 has been used as the starting point for further analysis, and the resulting Use Case description work in WP4 is documented in this D4.1. Interaction meetings and exchange of material with the System Pillar Task 3 and RNE experts as well as with the Flagship Projects of destinations 3 and 5 helped to achieve the required alignment level. As a result, one or more detailed Use Cases referring to each high-level Use Case of D3.1 were specified based on further analysis. Similarly detailed functional and non-functional requirements were identified and specified which were mapped against the high-level requirements associated with the Technical Enablers 1, 2 and 6.

Hence, this document represents a detailed study in addition to D2.3 and D3.1 including the basis for the development of the WS 1.1 demonstrations

- Demo 5.1 (MERMEC*) - Cross-border scheduling.*
- Demo 5.2 (TRV/KTH) - *Handling both, national and cross-border traffic with focus on cross-border freight trains.*
- Demo 5.3 (HACON) - *Interfaces for interaction with external national or central planning applications (TRL 6/7); cross-border planning including Short Timetable Planning and process improvement among actors.*
- Demo 5.4 (TRV/RISE) - *Collaborative yard capacity planning for Technical Enabler 6.*
- Demo 5.5 (HACON) - *Improved capacity allocation and new processes. Integration of new planning processes and the production of standard reports.*
- Demo 5.6 (HACON) - *Integration of traffic management system with network capacity planning. The feedback loop between planning and operation will be jointly demonstrated with WP11 (task 11.3)/ WP 12 and WP 13/14.*
- Demo 5.7 (HACON, TRV/RISE) - *Integration of network capacity planning with yard and station capacity planning. Integration of nodes and lines using specified interfaces.*

2. Abbreviations and acronyms

Abbreviation / Acronym	*Description*
API	Application programming interface
ATT	Annual Timetable (TTR)
B2B	Business-to-Business
CDM	Common Data Model (TMS platform specific)
CI	Common Interface (PCS/RNE)
CMS	Capacity Management System
CSV	Comma-separated values (file format)
DMPS	Digital Maintenance Planning System (ERJU Flagship Area 3)
ECMT	European Capacity Management Tool (RNE)
ERJU	Europe's Rail Joint Undertaking
FA	Flagship Area
FTE	Forum Train Europe
FP	Flagship Project
FRQ	Functional Requirement
GA	Grant Agreement
GDPR	General Data Protection Regulation
GUI	Graphical User Interface
HLR	High-Level Requirement
IAMS	Integrated Asset Management System (Wave 1 project in ERJU Flagship Area 3)
IM	Infrastructure Manager
IT	Information Technology
JSON	JavaScript Object Notation
LM	Line Manager
LTP	Long Term (Capacity) Planning
MAWP	Multi-Annual Work Programme
NDA	Non-disclosure agreement
NFRQ	Non-functional Requirement
OJP	Open Journey Planning (API)
PCS	Path Coordination System (hosted by RNE)
PTO	Public Transport Operator
R-CDM	Rail Collaborative Decision Making
RDMP	Research Data Management Plan
RFC	Rail Freight Corridor
RNE	RailNetEurope
RP	Rolling Planning (TTR)
RU	Railway Undertaking
SG	Sub-Group
SP	System Pillar
STP	Short Term (Capacity) Planning

SW	Software
TAF/TAP TSI	Technical Specification for Interoperability, Application Freight/Passenger (Renamed in 2024 to *Telematics TSI*)
TCR	Temporary Capacity Restriction
TE	Technical Enabler
TeM	Terminal Manager
TM	Traffic Manager
TMS	Traffic Management System
TRL	Technical Readiness Level
TTR	Timetable Redesign (RNE)
TSI	Technical Specification for Interoperability
UC	Use Case
UML	Unified Modelling Language
WP	Work Package
YCS	Yard Coordination System
YM	Yard Manager
YMS	Yard Management System
XML	Extensible Markup Language

3. Introduction and Background

The present document constitutes the Deliverable D4.1 "Integration of Planning Systems" of the Flagship Project 1 – [MOTIONAL] as described in the EU-RAIL MAWP[1].

Within the framework of the Innovation Pillar FP 1 - "Network management planning and control & Mobility Management in a multimodal environment and digital enablers" (MOTIONAL) of the Europe's Rail Joint Undertaking (ERJU), Work Package (WP) 4 focuses on the specification, detailed design and Use Case definitions for the development of TE 1, TE 2 and TE 6. This includes the development of suitable interfaces and decision support modules to enable integrated capacity planning for European Infrastructure Managers (IMs) and to establish connections to relevant external processes and systems. Special emphasis is placed on cross border planning, tactical and short-term timetable planning.

The developments are expected to enable broad capacity allocation across Europe and new processes such as the RNE TTR concept and allow station and yard capacity to be considered at the network level. The goal of an overarching System Pillar is to deliver a safe and secure standardised European railway architecture – towards this goal the System Pillar steers the Innovation Pillar by providing architectural and operational concepts in terms of high-level requirement specifications. Under the guidance of the System Pillar, the Innovation Pillar develops desired new technologies and, when appropriate, also delivers more refined requirement specifications. The results of the Innovation Pillar feed back into the System Pillar, thereby informing, and possibly adapt, the work of the System Pillar.

Within this context, in WP 4 a set of **European standard requirements** have been developed for integration of planning systems and related processes including cross-border planning. This considers the TSIs, especially Telematics (TAF/TAP) TSIs or RNE tools, concepts and European railway harmonisation documents (such as the PCS IT central tool, the TTR concept or the RNE harmonisation Handbooks). The new regulation proposal 2023/443 on the use of railway infrastructure capacity in the single European railway area was also considered by the WP. This regulation aims at strengthening EU cross-border coordination and ensuring a coherent process of digitalisation across Member States.

WP 4 is associated with the following Technical Enablers (TE) from the Multi-Annual Work Programme (MAWP) of the ERJU:

- Technical Enabler 1 (TE 1): European cross-border scheduling with international train path planning [TRL 6/7].
- Technical Enabler 2 (TE 2): Improved capacity allocation using rolling planning and TTR [TRL 6/7].
- Technical Enabler 6 (TE 6): Integration of TMS with a) yard capacity planning and b) station capacity planning [TRL 5/6].

The following chapters of the report are based on input of Tasks 4.1, 4.2, 4.3, 4.4 and 4.5 of WP 4, in which standardised requirements for TE 1, 2 and 6 are developed. The development of the requirements was guided by a set of high-level requirements and specifications previously derived in WP 3 (Task 3.1) in which specifications for high-level Use Cases and demonstrators of WP 4-WP

[1] https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_MAWP_final.pdf

9 are developed for Work Stream 1.1: "Planning" of MOTIONAL.

In accordance with the WP-structure given in the MOTIONAL GA, the Tasks and Subtasks of the WP 4 have been performed:

- **Task 4.1: Technical preparatory work**

  This Task is related to the preparatory work and is divided into 4 specific Subtasks

  - In **Subtask 4.1.1** preparatory technical work related to the WP, Task and Partner internal activities were addressed. The different tasks were identified and periodic WP meetings were held lead by the WP Leader to align the activities and planning.
  - Collaborative work of all involved partners in **Subtask 4.1.2** was performed to coordinate all required generic system engineering activities addressing interoperable Data Structures, Architecture, Interfaces and processes included in the scope of WP 4. This activity was supported by regular meetings together with the System Pillar / RNE to align with existing harmonization results and current TSI drafts such as Telematics TSI (TAF/TAP) and existing and new regulation proposals on the use of railway infrastructure capacity in the single European railway area which inter alia, have been identified and analysed in the next Subtask 4.1.3.
  - The **Subtask 4.1.3** comprised all WP 4 activities related to the state-of-the-art analysis including external sources as well as the related activities carried out within the Shift2Rail projects with a focus on IP5 for freight and yard related matters. More details will be given in chapter 3. The activities also included alignment meetings with other FP of EU-Rail, especially FP5-TRANS4M-R (Freight, deliverables D25.1, D25.2), FP3-IAM4RAIL (Asset Management and maintenance, deliverable D8.1) also in context with feeding WP 3 and its results. This contributed to securing the achievement of technical targets of WP 4, as well as the whole program.
  - The activities in **Subtask 4.1.4** provided the basis for development and demonstration activities to be performed in WP 5, including identification and acquisition of technical components, identification and acquisition and import of required data, and physical set-up and integration of technical components including integration test, following the activities of WP 2. Contributions in this context have been made to WP 2 deliverables, especially about used data sets for D2.1 Research Data Management Plan and technical demonstrator set-up for D2.4 Demonstration Strategy.
- **Task 4.2: Interfaces for interaction with external national or central planning applications**

  The activities lead to results that will contribute to a harmonised, borderless and mixed-traffic operations within the European networks and corridors.

  This Task consists of two Subtasks: **Subtask 4.2.1** in which the definition of the detailed Use Cases for coherent national or central planning applications were performed, based on the input from WP 3, and **Subtask 4.2.2 which** provided the detailed design of interfaces and processes[2] based on the Use Cases of Subtask 4.2.1 to plan cross-border traffic including Short-Term-Planning requests and automated capacity allocation both for national and cross- border freight paths and passenger

[2] In this case, we use TAF/TAP (Telematics) TSI which is an available public specification.

time table alignment.

- **Task 4.3: Improved capacity allocation and new processes**

  The results of these activities will enable European-wide capacity allocation and consideration of new processes in planning.

  This Task consists of two Subtasks: **Subtask 4.3.1** covered the definition of the detailed Use Cases based on the input from WP 3, and **Subtask 4.3.2** in which the requirement specifications and development for integration of new processes in capacity planning and creation of standard reports including cross-border planning were included. This Subtask included the assessment and consideration of existing concepts like e.g., the TTR concept of RNE.

- **Task 4.4 Integration of traffic management system with network capacity planning**

  The activities focused on the integration of TMS with the planning system to facilitate the implementation of an interface to feedback information from operations to the planning systems and to publish updated, commercial timetables to TMS, as a complementary activity of WP 13/14 and WP 8/9.

  This Task consists of two Subtasks: **Subtask 4.4.1** which covered the definition of the detailed Use Cases based on the input from WP 3, and **Subtask 4.4.2** for detailed specification and development of interfaces based on the defined Use Cases.

- **Task 4.5 Integration of network capacity planning with yard and station capacity planning**

  The activity results will enhance railway network capacity assessment and planning based on the input from yard and station capacity, with relation to FP5 activities. A demonstrator cross- border node Malmö for network - yard/terminal was assessed and planned for this purpose. Ambition and content have been contributed to WP 3, WP 11 and FP 5. Additionally, the option of setting up a demonstrator with connection between FP 1 and FP 5 was analysed and planned for.

  This Task consists of two Subtasks: **Subtask 4.5.1** in which the definition of the detailed Use Cases based on the input from WP3 was performed, and **Subtask 4.5.2** which included the specification, design and development of processes, methods and interfaces for Integration of nodes and lines (including local and cross-border context) in the capacity planning.

The next sections of this report are structured as follows: Chapter 4 provides information on how results from projects of the previous Europe's Rail programme Shift2Rail have been used, Chapter 5 describes the objective/aim of this report and the work undertaken in WP 4, Chapter 6 explains the methodology, i.e. how the detailed requirements and Use Cases were developed, Chapter 7 defines the detailed Use Cases based on the input from WP 3, Chapter 0 contains the specification of the requirements associated with the different topics defined in the tasks of WP 4 (Task 4.2, 4.3, 4.4 and 4.5) and Chapter 0 draws the conclusions on the work done on WP 4.

4. Results from Shift2Rail

The demonstration 5.4, Yard Coordination System (YCS), extends the work previously done in Shift2Rail projects. In Shift2Rail, yard-line-yard interactions and the related (planning) processes and automation possibilities were investigated, and a first prototype for a collaborative planning system was developed and tested in a workshop with real end-users. In MOTIONAL WP 4 and WP 5 a new YCS prototype is developed that can receive live data from a TMS system. User comments from the previous projects are considered for the development of the next prototype, in which a more advanced planning support is implemented.

5. Objective/Aim

The aim of this report is to present the outcomes of the work package WP 4 within the Europe's Rail project FP1-MOTIONAL. In WP 4, detailed Use Cases and requirements were compiled and specified for the Technical Enablers 1, 2 and 6. The documented specifications are included in the present report, paving the way for related development of prototypes and demonstrations in the succeeding work package WP 5.

Being in alignment with the MOTIONAL GA, the main objectives of WP 4 are associated with the development of the Technical Enablers 1, 2 and 6. These are dedicated to deliver future railway processes and solutions with seamless cross-border planning, decision support and integrated systems/modules.

The WP4 activities aim to address coherence with external national or central planning applications in the context of cross-border planning by interfacing based on representative Use Cases for long-term timetable planning (towards next period's timetable) and short-term timetable planning (planning during the current period). This specifically aims on supporting a European-wide capacity allocation considering station and yard capacity on the network level and to support new processes such as outlined by the TTR concept by FTE/RNE (RNE TTR.2023) and the related new capacity regulation proposal (EC 443/2023.2023).

6. Methodology

In this chapter, a detailed overview of how the detailed requirements and Use Cases delivered in this report were developed, is presented.

The chapter starts with a description of the mapping of high-level requirements and their links to WP 5 demonstrations, a work mainly performed within WP 3. The high-level requirements are further specified and clarified in detailed Use Cases and requirements, which is described in Chapters 6.4 and 0. The chapter ends by describing the review phase. Finally, the aim of the chapter is to give confidence to the reader that the requirements and Use Cases presented in Chapter 7 and Chapter 0 are aligned with the grant agreement and in line with the work of the rest of Motional.

6.1. Mapping of High-Level Requirements

In the project proposal, seven technical enablers (TEs) were linked to Workstream 1.1 Planning work packages WP 4/WP 5, WP 6/WP 7 and WP 8/WP 9. The technical enablers relevant for WP 4/WP 5 are:

- TE 1: European cross-border scheduling with international train path planning.
- TE 2: Improved capacity allocation using rolling planning and TTR.
- TE 6: Integration of TMS with a) yard capacity planning and b) station capacity planning.

In WP 3, the TE are further described and specified. High-level requirements (HLR) were also set up for each TE with the purpose of describing in which areas progress is to be expected for WP 3-9. The HLR for TE 1, TE 2 and TE 6 are presented here. For other HLR and a further description of the technical enablers, see deliverable D3.1.

6.1.1. High-Level Requirements for TE 1

Regarding TE 1: European cross-border scheduling with international train path planning, MOTIONAL should support:

a) Smooth integrated path coordination (via RNE PCS) by national capacity planning systems of IMs (TE 1a).
b) RFC management functions with a transparent view on RFC capacity allocation (TE 1b).
c) International path planning with national planning systems in line with TTR (TE 1c).
d) The capability for harmonised/integrated cross-border planning on macroscopic level and on detailed microscopic level track/signaling level (routing, timing, conflict detection and resolution., TCR regulation) (TE 1d).
e) Input to harmonised planning rules or paradigms in national planning including request and response deadlines to achieve adaptation to market demands but still allowing preparation of tailor-made paths if national or regional realities advise or require them (TE 1e).
f) Allowing for increased reactivity and pre-alignment in cross-border path planning and coordination (TE 1f).
g) Visibility of TCR behind the border; timing up to destination station behind the border to feed initial pre-aligned internal path request in PCS (speed up coordination times), especially for freight traffic (TE 1g).

All High-level requirements TE1a-g are addressed within WP 4/WP 5.

6.1.2. High-Level Requirements for TE 2

Regarding TE 2: Improved capacity allocation using rolling planning and TTR, MOTIONAL should support:

a) Principles for how to reserve capacity in different time periods (annual, rolling planning etc.), in a transparent, social-economic efficient and market-friendly way. (TE 2a).
b) Principles for valuation of traffic, both between and within segments for conflict solving and reservation of rolling planning capacity. (TE 2b).
c) Suggestions on how IMs can and need to act in order to have sufficient knowledge of the railway market at any given point in time to be able to allocate and assign capacity throughout the timetable process. (TE 2c).
d) Capability to integrate data from operations for improving path quality. (TE 2d).

All high-level requirements TE 2a-d are addressed within WP 4/WP 5.

6.1.3. High-Level Requirements for TE 6

Regarding TE 6: Integration of TMS with a) yard capacity planning and b) station capacity planning, MOTIONAL should support:

a) Perform an extended data exchange with terminals, ports and freight forwarders to provide relevant data for customers (TE 6a).
b) Where applicable, make use of TAF/TAP compliant data exchanges (extensions could be required) (TE 6b).
c) Receive updated capacity plans from line-based CMS/TMS (including train paths and TCR) (TE 6c).
d) Communicate track reservations (stabling, parking, ...) to CMS and TMS (TE 6d).
e) Communicate yard delays and consist/consist changes or rolling stock limitations to TMS (TE 6e).
f) Communicate track assignment changes for trains to CMS and TMS (TE 6f).
g) Communicate shunting activities with impact on lines to CMS and TMS (TE 6g).
h) Communicate path changes (also international, PCS based) down to local planning systems to adapt local planning and feedback constraints/alternative options to line planning (TE 6h).
i) Receive updated information from planners of adjacent operations, e.g., operations at a multi-modal terminal (TE 6i).
j) Support re-planning of track allocations in hand-over yards (TE 6j).
k) Communicate track allocation changes to planners of adjacent operations, e.g., operations at a multi-modal terminal (TE 6k).
l) Compute an integrated rolling stock stabling plan that contains parking of trains, shunting between station and yard (and vice versa), and the capacity scheduling for cleaning and inspection activities in related tracks (TE 6l).

High-level requirements TE 6a-k are addressed within WP 4/WP 5 while TE 6l is addressed in WP 6/7, see Deliverable 6.1.

6.2. Links to Demonstrators of WP5 Partners

With HLR specified and assigned to each work package, each HLR has to be mapped to one or several demonstrations. In WP 4/5, there are seven demonstrations planned, which together shall address all HLR for WP 4/5. Some requirements are included in only one demonstration, while other requirements are addressed in several demonstrations. The reason for this is that even if a demonstration is set up for a specific HLR, it may also fulfil others just to get the demonstration working for its main purpose. Some HLR are also written relatively vague, which allows multiple demonstrations fulfilling them. One example is TE 1e, where the demonstration shall give *Input to harmonised planning rules or paradigms in national planning*, which many of the demonstrations in WP 4/5 intend to do. The requirements specified in Chapter 7) are fulfilled at the same time by different demonstrations in relation to different sub-requirements of the same HLR. Table 1 shows an overview of which demonstrator addresses which HLR.

Table 1. Mapping between Demonstration and high-level requirement (HLR)

Demo No.	Tehnical Enabler TE	BEN.	Description of Demonstration	TE1							TE2				TE6										
				a	b	c	d	e	f	g	a	b	c	d	a	b	c	d	e	f	g	h	i	j	k
5.1	TE1	MER	Cross-border scheduling	Y	Y		Y	Y	Y																
5.2	TE1	TRV AE-KTH	International co-ordination of residual capacity in an early ad hoc stage		Y		Y	Y	Y																
5.3	TE1	HAC	Interfaces for interaction with external national or central planning applications	Y	Y	Y		Y	Y	Y															
5.4	TE6	TRV (A.E.-RISE)	Collaborative yard capacity planning												Y		Y						Y	Y	Y
5.5	TE1, TE2	HAC	Improved capacity allocation and new processes.					Y			Y	Y	Y												
5.6	TE2, TE6	HAC	Integration of traffic management system with network capacity planning.											Y					Y	Y					
5.7	TE6	HAC	Integration of network capacity planning with yard and station capacity planning.													Y	Y	Y		Y	Y	Y		Y	

6.3. Use case specification

With mapped HLR and TE, the next step was to write Use cases for each demonstration to exemplify which problem the demonstration is meant to solve and to explain the demonstration in more detail. High-level Use cases for each demonstration were provided in D3.1. These have been further specified in D4.1, Chapter 7. Each Use Case describes which partner(s) is performing the demonstration, relationships to other tasks/flagships, affected actors and involved

components. It also describes the events of the Use Case: Use case trigger, pre-conditions, input, result and final state. In total, each detailed Use Case description gives a good overview of the demonstration. In WP 4/5, there are 17 Use Cases in total.

6.4. Detailed requirement specification

Each HLR is in D4.1 detailed into one or several requirements, which is shown in Chapter 0. Each requirement describes a specific functionality that is crucial to meet all HLR of each demonstration. The requirements can be either functional or non-functional, however, most of them are functional requirements with respect to targeted TRL 4 in WP 4.

To obtain a good structure and overview, all requirements use the same template with pre-defined headlines. The headlines are Demonstration, Requirement, Type, Priority, Main goal, Assumptions, Specification, Additional information and Background and Open topics. The requirements are grouped by task of the GA and they are traced with the demonstrations where they are covered. In each demonstration in WP 5, there will be an evaluation to check if all requirements are met and consequently also if the HLRs are met. In total, there are 45 requirements in WP 4/5.

6.5. Alignment with RNE, SP, other FP, WP and other stakeholders

Regular interaction meetings and document sources made available with respect to SP / RNE cooperation have been used to communicate and align the Use Cases and demonstrations planning in WP 4. The focussed topics included, inter alia, the handling of path requests for international trains, the Timetable Redesign approach (RNE TTR.2023) of RNE, now reflected by the new EC Regulation proposal on the use of railway infrastructure capacity in the single European railway area (EC 443/2023.2023), as well as the CMS/TMS integration topic aligned with Task 3 of EU-Rail's System Pillar.

Inside the FP1-MOTIONAL project, the WP 4 alignment covers demo integration needs between SG 1 and SG 2 work packages such as enabled by the close collaboration between WP 4 Demo 5.4 and WP 11 Demo 12.8 planning and development. YCS is designed and implemented in both WPs, but the WP 4 work focused on planning support while the WP 11 work focused on the connection between YCS and a TMS. For example, conflict rules and conflict resolution strategies were developed and implemented in WP 4, while all technical details regarding the YCS and TMS connection were handled in WP 11, including e.g. information synchronization and security. Issues on how live data from the TMS should be visualised and affect the track allocation plan is covered by both WPs in collaboration. The innovative integration of a traffic management system (TMS) with a national network capacity planning system (CMS) is enabled by alignment of specification and development of demo 5.6 in WP 4 and demos 12.7 and 14.3 of SG 2 (WS 1.2) as prepared in the WP 11/12 and 13/14. This will allow joint demonstrations especially regarding the feedback of operational information back to the capacity planning.

In FP5-TRANS4M-R WP 27 the question of how YCS can support dynamic dispatching was investigated. The focus was to understand to what extent the YCS track allocation decision support can be extended to also ensure that the shunting movements required for the different activities

are not in conflict with other shunting movements and/or train arrivals/departures. The final result from WP 27 is a requirements specification for this functionality. Simulations for the freight corridor Malmö-Alnabru are also a part of FP5-TRANS4M-R WP 26. In that WP, the objective of the Use Case is to balance the capacity utilization between Malmö terminal and the line. FP5 WP 26 will look at the departure yard congestion and use departure delay predictions to plan new (updated) departure times that is expected to improve reliability of arrivals to Alnabru terminal. There will be coordination between the simulations in WP 5 and FP 5 WP 26.

Further alignment with the Seamless Planning WP26 of the FP5-TRANS4M-R project was achieved by sharing Use Cases and requirements with respect to WP 4 demos 5.3 and 5.7 for cross-border planning and yard integration demonstrations.

6.6. Review phase and finalization

The last phase of the D4.1-work was the review phase. The activities in this phase ensured a good and even quality of the deliverable. An early internal review was performed by the partners Ineco and Mermec already during July-August 2024. The content of the document was compared to the GA and earlier preparation document (e.g., Deliverable 3.1) and potential misalignment was pointed out. General text quality, alignment between the different partners and report structure were also checked.

After the review, the document was updated and corrected according to the review comments before being sent in for official review process within and outside FP 1 MOTIONAL.

7. Use Cases

Use cases are important measures to give end-users, stakeholders and others a good picture of in what context the demonstration works and under what conditions. They also work as a measure for evaluating the demonstration.

In this chapter, detailed Use Cases for all demonstrations in WP 4/WP 5 are presented. The base for the Use Cases is the high-level Use Case template, presented in (MOTIONAL D3.1.2023) but it is expanded with more information: required input, expected result, final state of the system, the sequence of how the Use Case is performed, eventual flow charts or diagrams, expected implementation date and involved components. Together, this gives a detailed view of the Use Case that will be demonstrated in WP 5. Some demonstrations have one single Use Case, which cover many different parts, while other demonstrations have several Use Cases that together gives the holistic picture of the demonstration.

The Use Cases act as representative and realistic cases to under which conditions the demonstrations will work and what they will do. In chapter 7, each WP 4 task described in the GA task has an own section and all detailed Use Cases related to one High-Level Use Case given in D3.1 are collected in one subsection. Chapter 7.1 presents Use Cases for interaction between planning systems, Chapter 7.2 presents the Use Cases for capacity allocation (e.g. TTR related development), Chapter 7.3 presents Use Cases for interaction between CMS and TMS and Chapter 7.4 presents Use Cases for station/yard planning and its integration with line planning.

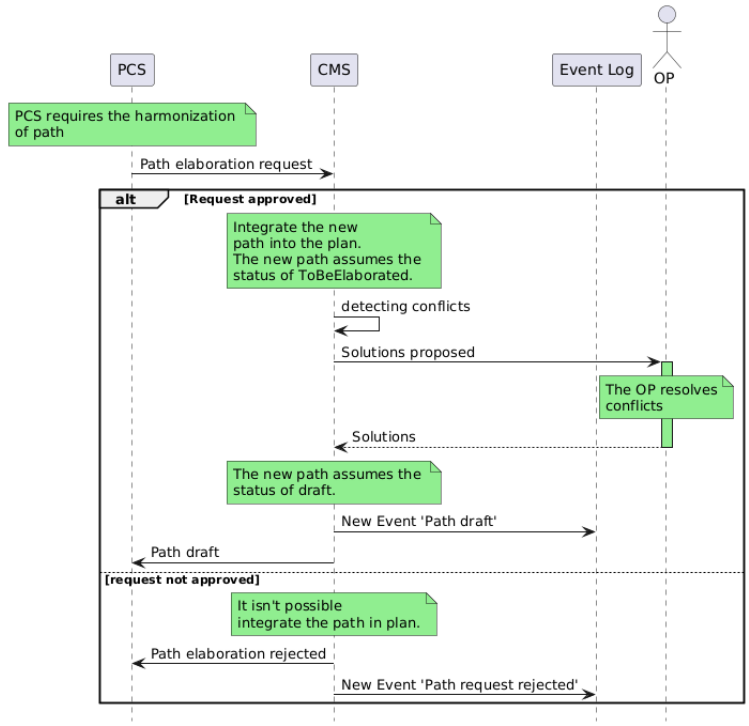
7.1. Use Cases for interaction with external national or central planning applications (Task 4.2)

In task 4.2 there are three demonstrations with a total of 11 Use Cases. Each Use Case is presented in a separate subsection.

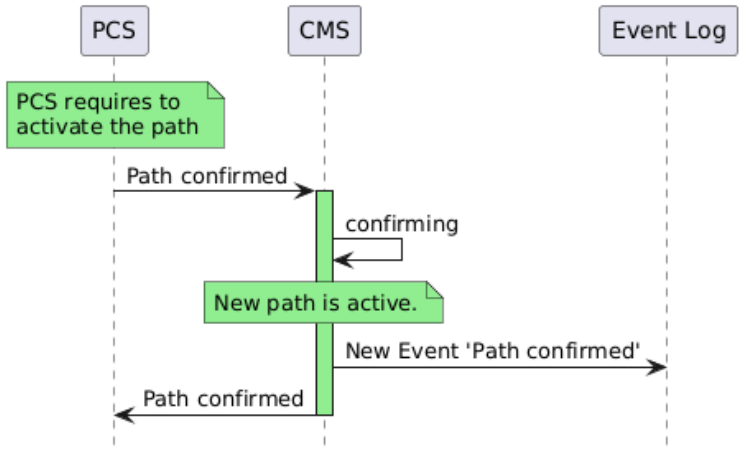
7.1.1. CMS decision support to plan a cross-border path

Name	CMS decision support to plan a cross-border path
ID	FP1-DEMO-5.1-UC-1
Partner	MERMEC
Demonstration associated	Demo 5.1
Description	The CMS operator or an Applicant performs a cross-border path request. All the involved CMS harmonise the final timetable evaluating their local availability and TCR.
Related to task/subtask(s)	Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-17
Impact on other task(s)	
Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”

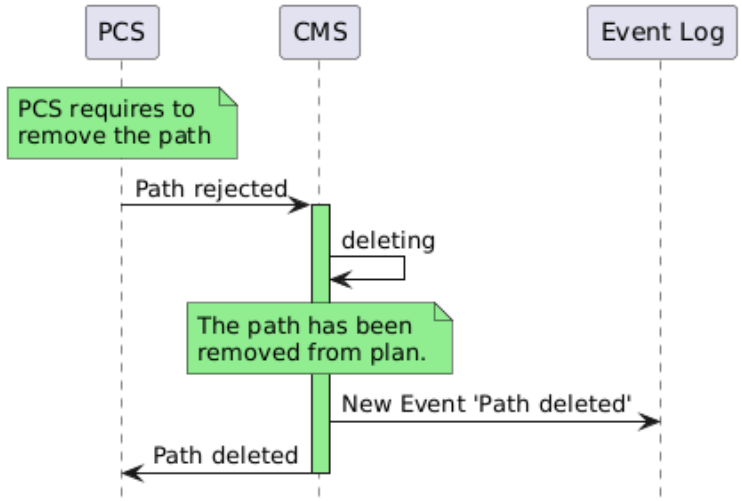
Interactions SP/FP	SP (infrastructure model; cross-border topic)
Actor(s)	CMS Operator/Applicant
Trigger	The CMS Operator or a generic applicant chooses a path using the known macro infrastructure data. The path involves multiple CMS. The PCS submits the international path request to the involved CMS.
Pre-Condition(s)	• The CMS is connected to the PCS. • The CMS uses a macro infrastructure configuration compliant to the PCS.
Input	A new dossier from the PCS.
Result/Requirement	1. An elaborated draft path. 2. An accepted and integrated path included into the timetable.
Final State	A new path inserted into the CMS timetable.
Sequence	1. CMS receives a "Path elaboration" request a. CMS integrates the requested path b. CMS Operator resolves conflicts c. CMS produces a path harmonised with its timetable d. If the path request has been integrated a path draft confirmation is sent, otherwise a path rejected is sent. 2. CMS receives a Path confirmation request. a. CMS updates and confirms the path b. CMS send a paths confirmation message 3. CMS receives a path deletion a. CMS removes the path draft b. CMS sends a path rejected message
Diagram(s)	Path request received:



Path confirmation received:



Path deletion/rejected received:

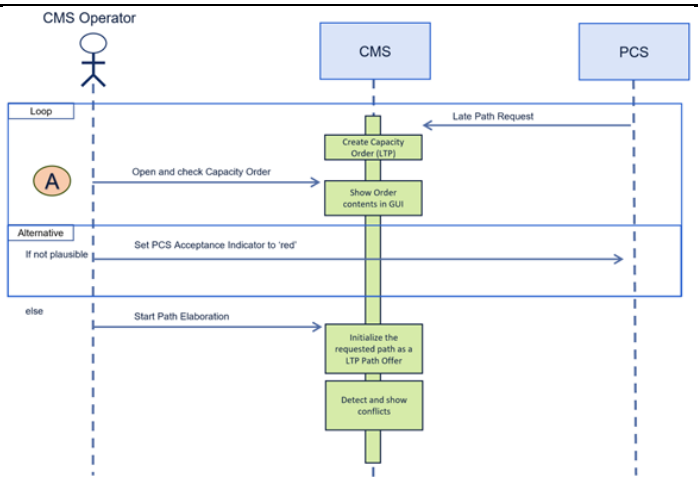


Expected Implementation Date	November 2025
Involved components (System)	CMS-PCS interface, CMS-PCS user interface, Event logger
Responsible partner/person	Angelo Naselli
Notes	Forecast and Conflict detection/resolution module as output of WP 17-WP 18

7.1.2. International late path request placed between X-8 and X-2

7.1.2.1. Receipt of an international late path request

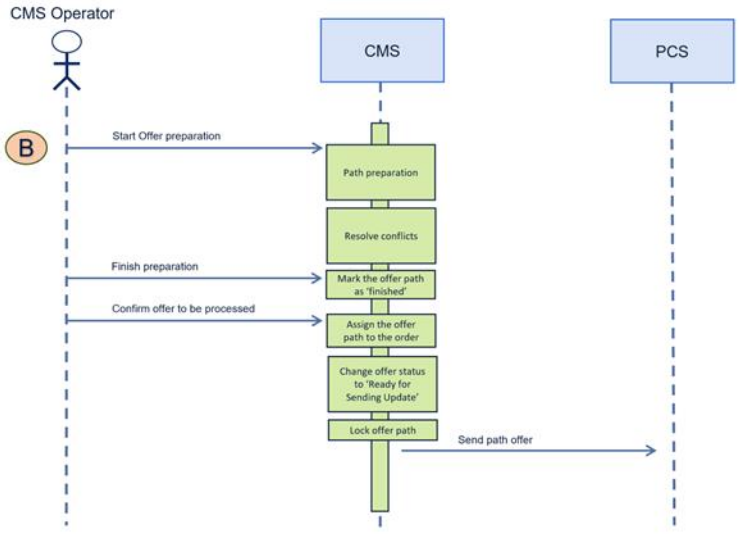
Name	Receipt of an international late path request between X-8 and X-2 from Path Coordination System (PCS; RNE)
ID	FP1-DEMO-5.3-UC-1
Partner	HACON
Demonstration associated	Demo 5.3
Description	An international late (long-term) path request for 4 consecutive weeks on Tuesdays between X-8 and X-2 is received via Path Coordination System (PCS; RNE) and shown in the CMS graphical user interface indicating a capacity conflict in the border/handover location.
Related to task/subtask(s)	Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-1
Impact on other task(s)	
Technical Enabler(s)	TE 1 "European cross-border scheduling with international train path planning"
Interactions SP/FP	SP: cross-border topic, FP 5
Actor(s)	CMS Operator (IM), RU Timetable Planner as a capacity applicant.
Trigger	RU Timetable Planner enters the international path request in PCS and submits it leading to a transfer of the request to the CMS via the Common Interface (CI).
Pre-Condition(s)	• PCS (test installation or simulation) available and connected to the CMS. • Capacity plan in CMS showing capacity objects in border / handover location which will be in conflict with the international path request.
Input	• The path request including its parameters to be entered in PCS.
Result/Requirement	Path request shown in the CMS graphical user interface indicating a capacity conflict in the border/handover location.

Final State	Conflicting path request for an international train in the CMS.
Sequence	1. The CMS receives a Late Path Request for the local national fraction of an international path from PCS 2. The CMS creates a corresponding capacity order in the CMS (LTP) Capacity Plan including the requested path and the Dossier ID of the path in PCS. 3. The CMS Operator opens the order and checks the included path for plausibility. 4. If plausibility is given, the CMS Operator starts the Path Elaboration; otherwise, the CMS Operator sets the national IM's PCS Acceptance Indicator to 'red' and the process restarts with step 1. 5. The CMS automatically initialises the requested path in the (LTP) Capacity Plan as a Path Offer to be processed. 6. The CMS detects and shows a conflict between the requested path and another capacity object in the cross-border location in the national (LTP) Capacity Plan.
Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware • PCS (CI test connector)
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

7.1.2.2. Offer preparation for an international late path request

Name	Offer preparation and submission of a path offer for an

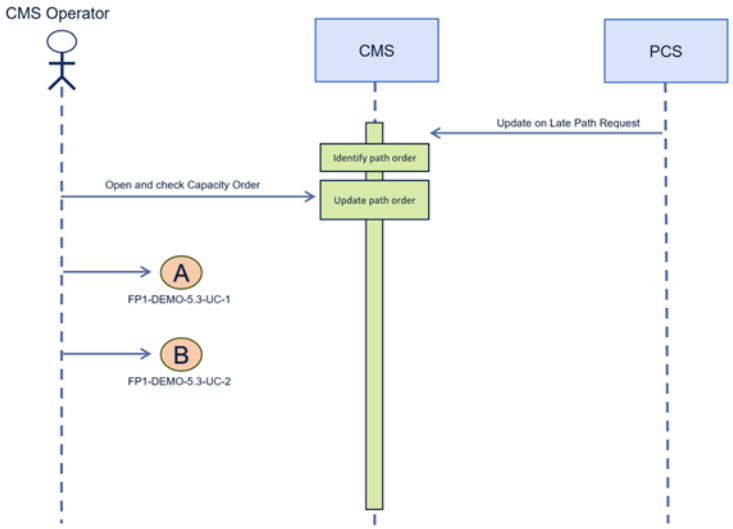
	international late path request between X-8 and X-2 to the Path Coordination System (PCS; RNE).
ID	FP1-DEMO-5.3-UC-2
Partner	HACON
Demonstration associated	Demo 5.3
Description	The capacity conflict in the border/handover location is resolved by the CMS Operator resulting in a changed path with respect to the original request. The changed path is submitted back to PCS as a path offer corresponding to the request.
Related to task/subtask(s)	Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-1
Impact on other task(s)	
Technical Enabler(s)	TE 1 "European cross-border scheduling with international train path planning"
Interactions SP/FP	SP: cross-border topic, FP 5
Actor(s)	CMS Operator (IM)
Trigger	Indicated conflict in received path request.
Pre-Condition(s)	• PCS (test installation or simulation) available and connected to the CMS. • An international late path request for 4 consecutive weeks on Tuesdays between X-8 and X-2 has been received via the Path Coordination System (PCS; RNE) leading to a capacity conflict in the border/handover location, see FP1-DEMO-5.3-UC-1.
Input	• The path request including its parameters to be entered in PCS.
Result/Requirement	The conflict-free path offer is shown in the CMS graphical user interface and the offer status has changed to 'offered'.
Final State	The offered path is shown in a corresponding PCS Dossier for coordination.
Sequence	1. The CMS Operator prepares the path to be offered including resolution of the detected conflict in the (LTP) Capacity Plan considering the national planning rules for LTP. 2. When offer preparation has finished, the CMS Operator marks the offer path as 'preparation finished'. 3. The CMS Operator decides to send the LTP path offer back to PCS by confirming the offer path being assigned to the corresponding order and changing the path offer status to 'Ready for Sending Update".

	4. The CMS establishes a write protection for the path in the (LTP) Capacity Plan and sends the elaborated path offer back to PCS.
Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware • PCS (CI test connector)
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

7.1.2.3. Handling of coordination for an international late path request

Name	Handling of PCS coordination and offer re-submission for an international late path request between X-8 and X-2 received from Path Coordination System (PCS; RNE)
ID	FP1-DEMO-5.3-UC-3
Partner	HACON
Demonstration associated	Demo 5.3
Description	The CMS Operator (IM) uses the PCS to understand the coordination need indicated by the PCS Dossier and adjusts the offered path in the CMS to be re-submitted. The previous path offer is 'destroyed' by the CMS Operator using the PCS system and the adjusted path offer is re-submitted to the PCS in the CMS system.
Related to task/subtask(s)	Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-1
Impact on other task(s)	

Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”
Interactions SP/FP	SP: cross-border topic, FP 5
Actor(s)	CMS Operator (IM)
Trigger	The acceptance indicator of the PCS Dossier corresponding to the international path request indicates the need for coordination (yellow state).
Pre-Condition(s)	• PCS (test installation or simulation) available and connected to CMS. • CMS Operator (IM) has access to PCS. • An offered path based on an international late path request for 4 consecutive weeks on Tuesdays between X-8 and X-2 has been sent to the Path Coordination System (PCS; RNE), see FP1-DEMO-5.3-UC-2 above. • The acceptance indicator of the corresponding PCS Dossier indicates the need for coordination (yellow state).
Input	• Modification of original offer to be re-submitted.
Result/Requirement	Re-submitted offer appearing in the PCS coordination Dossier and yellow state of the Dossier’s acceptance indicator has disappeared.
Final State	Offered LTP path for international train successfully coordinated via PCS.
Sequence	1. The CMS receives from PCS a Path Coordination Update message for an already offered Late Path Request for the local national fraction of an international path. 2. The CMS uses the PCS Dossier ID for identifying the already existing capacity order corresponding to the coordination update in the CMS Capacity Plan. 3. The CMS includes the updated path request given by the coordination update message of the PCS. 4. Go to step 3 of FP1-DEMO-5.3-UC-1 and continue with the steps of FP1-DEMO-5.3-UC-2.

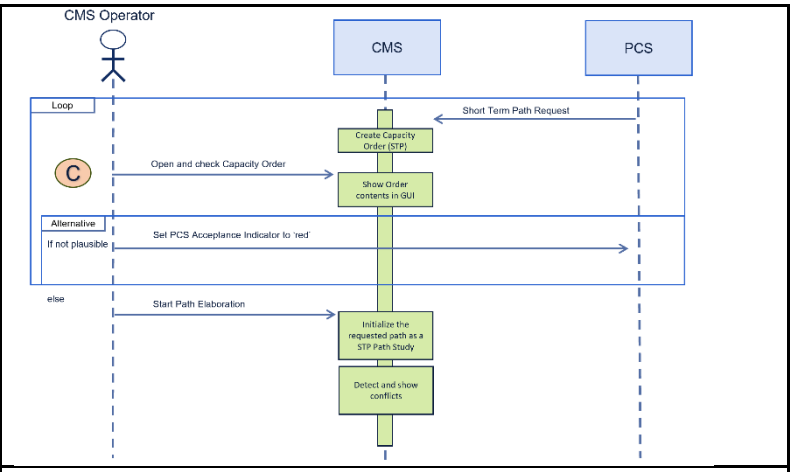
Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware • PCS (CI test connector)
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

7.1.3. International path request placed after X-2 and before X+12)

7.1.3.1. Receipt of an international short-term path request

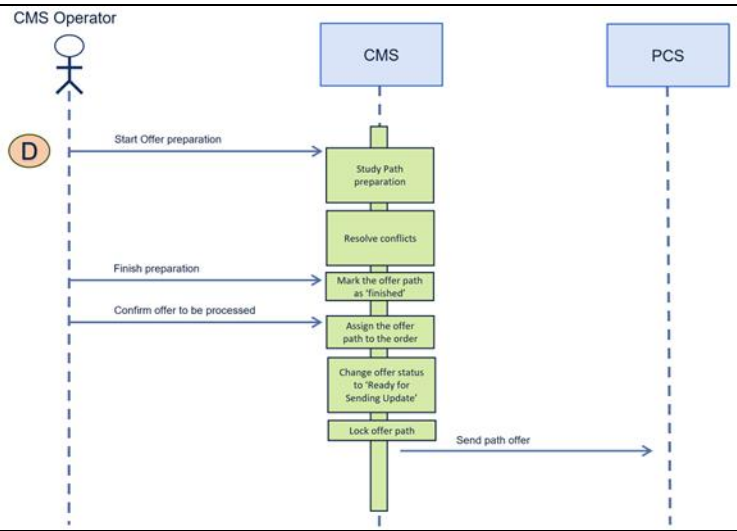
Name	Receipt of an international short-term path request between X-2 and X+12 from the Path Coordination System (PCS; RNE)
ID	FP1-DEMO-5.3-UC-4
Partner	HACON
Demonstration associated	Demo 5.3
Description	An international (short-term) path request for one day between X-2 and X+12 is received via the Path Coordination System (PCS; RNE) and shown in the CMS graphical user interface indicating a capacity conflict in the border/handover location.
Related to task/subtask(s)	Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-2
Impact on other task(s)	
Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”

Interactions SP/FP	SP: cross-border topic, FP 5
Actor(s)	CMS Operator (IM), RU Timetable Planner as a capacity applicant.
Trigger	The RU Timetable Planner enters the international path request in PCS and submits it leading to a transfer of the request to the CMS via the Common Interface (CI).
Pre-Condition(s)	• PCS (test installation or simulation) available and connected to CMS. • Capacity plan in CMS showing capacity objects in border / handover location which will be in conflict with the international path request.
Input	The path request including its parameters to be entered in PCS.
Result/Requirement	Path request shown in the CMS graphical user interface indicating a capacity conflict in the border/handover location.
Final State	Conflicting short-term path request for an international train in the CMS.
Sequence	1. The CMS receives a short term (STP) Path Request for the local national fraction of an international path from PCS. 2. The CMS creates a corresponding capacity order in the CMS (STP) Capacity Plan including the requested path and the Dossier ID of the path in PCS. 3. The CMS Operator opens the order and checks the included path for plausibility. 4. If plausibility is given, the CMS Operator starts the Path Elaboration; otherwise, the CMS Operator sets the national IM's PCS Acceptance Indicator to 'red' and the process restarts with step 1. 5. The CMS automatically initialises the requested path in the (STP) Capacity Plan as a Study Path to be processed. 6. The CMS detects and shows a conflict between the requested path and another capacity object in the cross-border location in the national (STP) Capacity Plan.

Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware • PCS (CI test connector)
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

7.1.3.2. Offer preparation for an international short-term path request

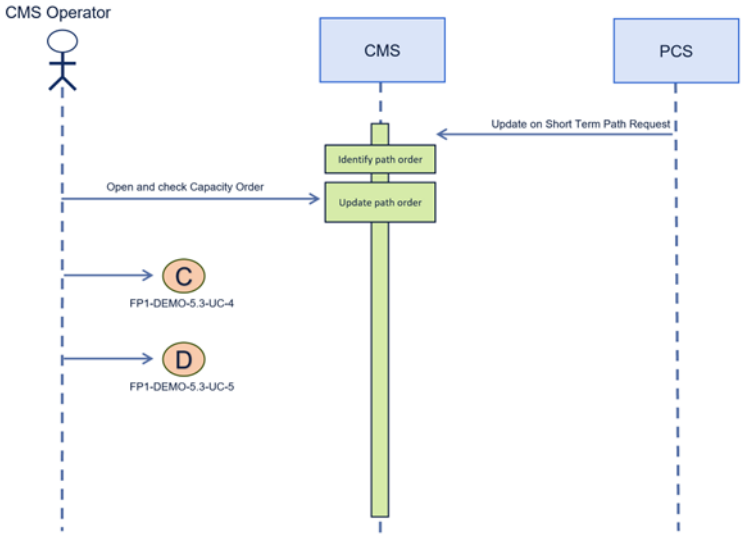
Name	Offer preparation and submission of a path offer for an international short-term path request between X-2 and X+12 to the Path Coordination System (PCS; RNE).
ID	FP1-DEMO-5.3-UC-5
Partner	HACON
Demonstration associated	Demo 5.3
Description	The capacity conflict in the border/handover location is resolved by the CMS Operator resulting in a changed path with respect to the original request. The changed path is submitted back to the PCS as a path offer corresponding to the request.
Related to task/subtask(s)	Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-1
Impact on other task(s)	
Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”
Interactions SP/FP	SP, FP 5
Actor(s)	CMS Operator (IM)
Trigger	Indicated conflict in received path request.

Pre-Condition(s)	• PCS (test installation or simulation) available and connected to CMS. • An international short-term path request for one day between X-2 and X+12 has been received via the Path Coordination System (PCS; RNE) leading to a capacity conflict in the border/handover location, see FP1-DEMO-5.3-UC-4.
Input	• The path request including its parameters to be entered in PCS.
Result/Requirement	The conflict-free path offer is shown in the CMS graphical user interface and the offer status has changed to 'offered'.
Final State	The offered short-term path is shown in a corresponding PCS Dossier for coordination.
Sequence	1. The CMS Operator prepares the Study Path to be offered including resolution of the detected conflict in the (STP) Capacity Plan considering the national planning rules for STP. 2. When offer preparation has finished, the CMS Operator marks the offer path as 'preparation finished'. 3. The CMS Operator decides to send the STP path offer back to PCS by confirming the offer path being assigned to the corresponding order and changing the path offer status to 'Ready for Sending Update". 4. The CMS establishes a write protection for the path in the (STP) Capacity Plan and sends the elaborated path offer back to PCS.
Diagram(s)	
Expected Implementation Date	2025-11-30

Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware • PCS (CI test connector)
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

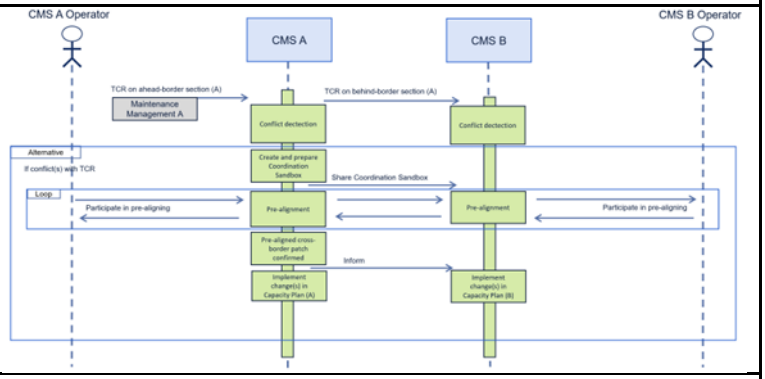
7.1.3.3. Handling of the coordination for an international short-term path request

Name	Handling of the PCS coordination and offer re-submission for an international short-term path request between X-2 and X+12 received from the Path Coordination System (PCS; RNE)
ID	FP1-DEMO-5.3-UC-6
Partner	HACON
Demonstration associated	Demo 5.3
Description	The CMS Operator (IM) uses the PCS to understand the coordination need indicated by the PCS Dossier and adjusts the offered path in the CMS to be re-submitted. The previous path offer is 'destroyed' by the CMS Operator in the PCS system and the adjusted path offer re-submitted to the PCS in the CMS system.
Related to task/subtask(s)	Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-1
Impact on other task(s)	
Technical Enabler(s)	TE 1 "European cross-border scheduling with international train path planning"
Interactions SP/FP	SP: cross-border topic, FP 5
Actor(s)	CMS Operator (IM)
Trigger	The acceptance indicator of the PCS Dossier corresponding to the international path request indicates the need for coordination (yellow state).
Pre-Condition(s)	• PCS (test installation or simulation) available and connected to CMS. • CMS Operator (IM) has access to PCS. • An offered path based on an international short-term path request for one day between X-2 and X+12 has been sent to the Path Coordination System (PCS; RNE), see FP1-DEMO-5.3-UC-5 above.

	• The acceptance indicator of the corresponding PCS Dossier indicates the need for coordination (yellow state).
Input	• Modification of original offer to be re-submitted.
Result/Requirement	Re-submitted offer appearing in the PCS coordination Dossier and yellow state of the Dossier's acceptance indicator has disappeared.
Final State	Offered path for international STP train successfully coordinated via PCS.
Sequence	1. The CMS receives from PCS a Path Coordination Update message for an already offered short-term Path Request for the local national fraction of an international path. 2. The CMS uses the PCS Dossier ID for identifying the already existing capacity order corresponding to the coordination update in the CMS Capacity Plan. 3. The CMS includes the updated path request given by the coordination update message of the PCS. 4. Go to step 3 of FP1- DEMO-5.3-UC-4 and continue with the steps of FP1-DEMO-5.3-UC-5.
Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware • PCS (CI test connector)
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

7.1.4. Showing and handling of impact of imported TCR

Name	Showing and handling of the impact of imported Temporary Capacity Restrictions (TCR) on the currently planned paths for international freight trains
ID	FP1-DEMO-5.3-UC-7
Partner	HACON
Demonstration associated	Demo 5.3
Description	The CMS planning application shows a new or changed imported TCR. The impact of the TCR on paths for international freight trains can be identified and is handled by the CMS Operator. 1. Local TCR causes changes to path(s) at/behind the border (handover) location; 2. Behind-the-border-TCR causes changes to path(s) in local network.
Related to task/subtask(s)	Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-3
Impact on other task(s)	
Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”
Interactions SP/FP	SP/RNE: cross-border topic, FP 5
Actor(s)	CMS Operator
Trigger	Received capacity restriction (TCR) affecting a cross-border track section with international freight trains.
Pre-Condition(s)	Two CMS A and B of neighbouring IMs are active and sharing the cross-border line section up to the next major node on the territory of the opposite CMS/IM.
Input	• TCR (via Interface) • Alignment decisions (via interface and HMI)
Result/Requirement	Pre-aligned and updated Capacity Plans.
Final State	Up-to-date and aligned Capacity Plans in both CMS.
Sequence	1. Starting point: Cross-border path for an international freight train planned from IM/CMS A to IM/CMS B without conflicts. 2. A short-term maintenance need is arising in the CMS A and covered by a TCR received by both CMSs A and B which is affecting the cross-border train. 3. The CMS A informs CMS B about the need for change in the capacity plan by creating a change scenario (‘sandbox’) in the capacity plan and sharing it with CMS B.

	4. Pre-alignment of both IM/CMS of the required changes to the capacity plan including the affected cross-border train by jointly working on the change scenario. 5. Pre-alignment concluded by CMS A Operator confirmation of the agreed change in the change scenario making it effective which is leading to the capacity plan updated on both sides of the border.
Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software • Required integration services • CMS hardware featuring two CMS program instances
Responsible partner/person	HACON/Rolf Gooßmann
Notes	Expected identification of harmonization needs of national Planning rules – shared view (IMs / RNE). Expected input to SP/RNE in relation to TCR specification. Expected Freight Corridor (RFC) view being enabled making TCR impact and suggested international path changes transparent as resulting from this Use Case.

7.1.5. Cross-border ad hoc planning with fixed trains

Name	Cross-border ad hoc planning with fixed trains
ID	FP1-DEMO-5.2-UC-1
Partner	TRV A.E. KTH
Demonstration associated	Demo 5.2
Description	Timetable planners need support to make judgements when processing requests for ad hoc train path insertions or change requests, minor or major, for existing train paths. In this Use Case, we consider a static scenario in which none of the existing trains can be adjusted or modified while searching for residual

	capacity for inserting a single train path. The Use Case will be demonstrated between Malmö and Alnabru freight yards or on a subsection of this line.
Related to task/subtask(s)	Demonstration 5.7, Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-7
Impact on other task(s)	Tasks 4.1, 4.2, 5.2.1
Technical Enabler(s)	TE 1 "European cross-border scheduling with international train path planning"
Interactions SP/FP	FP 5 WP 26
Actor(s)	Timetable planners at IMs and RUs (as a capacity applicants), as well as yard managers (YM).
Trigger	RU requests a new train path, or YM requests a new departure time for an existing train. These requests could be triggered by short notice changes in the yard planning or change in demand. Expected time horizon is within a few days before operation, but longer time horizons can also be handled.
Pre-Condition(s)	An initial (feasible) timetable exists.
Input	• The initial timetable. • Requested departure or arrival time interval. • Sequence of stations. • Train type (timing load). • Minimal running times. • Stops (station, and dwell time) requested by RU.
Result/Requirement	Available capacity is visualised in the graphical timetable and a few possible train paths are proposed based on different objectives.
Final State	Timetable planner selects or constructs a new train path, which is communicated to YMS.
Sequence	1. RU/YM requests a new train path or changes in an existing train. 2. The demonstrator computes available capacity and a set of possible train paths. 3. One of the possible train paths is selected. 4. The timetable is updated. 5. Changes are communicated to YMS and RU.
Diagram(s)	N/A Not any added value since the UC is describing a new method rather than information flow.
Expected Implementation Date	2026-04-30
Involved components (System)	RailSys simulation software, setup with infrastructure

	model, a base timetable including train models. Script based framework for generating train paths and assessing available capacity.
Responsible partner/person	Kristian Persson, Trafikverket Hans Sipilä, KTH Johan Högdahl, KTH
Notes	-

7.1.6. Cross-border ad hoc planning with adjusted adjacent trains

Name	Cross-border ad hoc planning with adjusted adjacent trains
ID	FP1-DEMO-5.2-UC-2
Partner	TRV A.E. KTH
Demonstration associated	Demo 5.2
Description	Timetable planners need support to make judgements when processing requests for ad hoc train path insertions or change requests, minor or major, for existing train paths. In this Use Case, we consider a dynamic scenario in which existing trains can be adjusted or modified when searching for residual capacity for inserting a single train path. Other freight trains may be adjusted to some degree, also passenger trains may get smaller adjustment but subject to any delivery commitments. The Use Case will be demonstrated between Malmö and Alnabru freight yards or on a subsection of this line.
Related to task/subtask(s)	Demonstration 5.7, Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-8
Impact on other task(s)	Tasks 4.1, 4.2, 5.2.1
Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”
Interactions SP/FP	FP 5 WP 26
Actor(s)	Timetable planners at IMs and RUs (as a capacity applicants), as well as yard managers (YM).
Trigger	RU requests a new train path, or YM requests a new departure time for an existing train. These requests could be triggered by short notice changes in the yard planning or change in demand. Expected time horizon is within a few days before operation, but longer time horizons can also be handled.
Pre-Condition(s)	An initial (feasible) timetable exists.

Input	• The initial timetable. • Requested departure or arrival time interval. • Sequence of stations. • Train type (timing load). • Minimal running times. • Stops (station, and dwell time) requested by RU. • Allowed adjustments of other trains.
Result/Requirement	Available capacity is visualised in the graphical timetable and a few possible train paths are proposed based on different objectives. Necessary changes for other trains are visualised.
Final State	Timetable planner selects or constructs a new train path, which is communicated to YMS.
Sequence	1. RU/YM requests a new train path or changes in an existing train. 2. The demonstrator computes available capacity and a set of possible train paths. 3. One of the possible train paths is selected. 4. The timetable is updated. 5. Changes are communicated to YMS and RU.
Expected Implementation Date	2026-04-30
Involved components (System)	RailSys software, setup with infrastructure model, a base timetable including train models. Script based framework for generating train paths and assessing available capacity.
Responsible partner/person	Kristian Persson, Trafikverket Hans Sipilä, KTH Johan Högdahl, KTH
Notes	-

7.1.7. Cross-border ad hoc planning and simulation

Name	Cross-border ad hoc planning and simulation
ID	FP1-DEMO-5.2-UC-3
Partner	TRV A.E. KTH
Demonstration associated	Demo 5.2
Description	Timetable planners need support to make judgements when processing requests for ad hoc train path insertions or change requests, minor or major, for existing train paths. This Use Case builds on the previous ones, but simulation is added as a tool for assessing the

	robustness of different train path insertion alternatives. Either a macroscopic or microscopic simulation tool will be used here.
Related to task/subtask(s)	Demonstration 5.7, Tasks 4.1, 4.2, 5.2, 5.2.1
Related UC ID(s) in WP3	UC-FP1-WP3-9
Impact on other task(s)	Tasks 4.1, 4.2, 5.2.1
Technical Enabler(s)	TE 1 "European cross-border scheduling with international train path planning"
Interactions SP/FP	FP 5 WP 26
Actor(s)	Timetable planners at IMs and RUs (as a capacity applicants), as well as yard managers (YM).
Trigger	A set of proposed timetables has been created (UC-FP1-WP3-8/9).
Pre-Condition(s)	A set of proposed timetables exists.
Input	• The proposed timetables. • Delay distributions for primary delays.
Result/Requirement	Punctuality and delays are computed, visualization of simulation outcome in graphical timetable.
Final State	Timetable planner selects or constructs a new train path, which is communicated to YMS.
Sequence	1. Steps 1 and 2 in Use Case UC-FP1-WP3-8/9 has been carried out. 2. The generated timetables are simulated. 3. One of the possible train paths is selected based on the simulation outcome. 4. The timetable is updated. 5. Changes are communicated to YMS and RU.
Diagram(s)	N/A Not any added value since the UC is describing a new method rather than information flow.
Expected Implementation Date	2026-04-30
Involved components (System)	RailSys software, setup with infrastructure model, a base timetable including train models. Script based framework for generating train paths and assessing available capacity. RailSys is used for the actual simulation blocks.
Responsible partner/person	Kristian Persson, Trafikverket Hans Sipilä, KTH Johan Högdahl, KTH
Notes	

7.2. Use Cases for improved capacity allocation and new processes (Task 4.3)

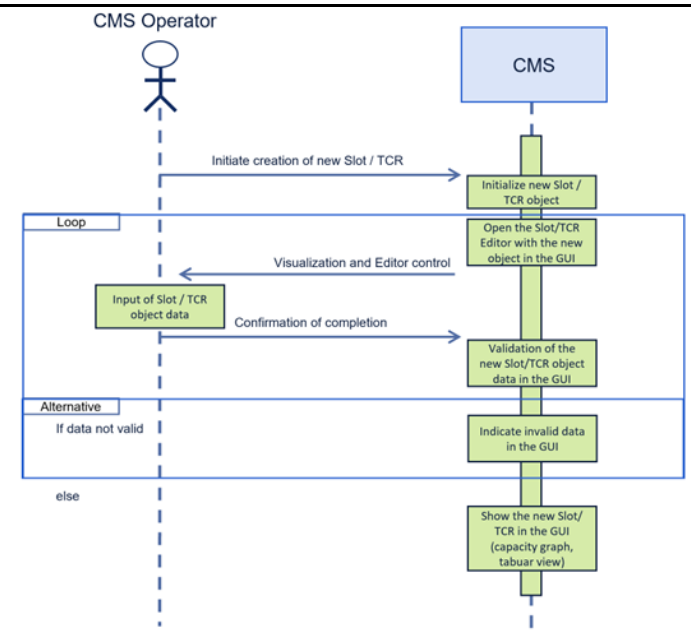
In task 4.3 there is one demonstration with a total of 6 Use Cases, performed by Hacon. Each Use Case is presented in a separate subsection.

7.2.1. Planning and allocation of capacity for different planning horizons

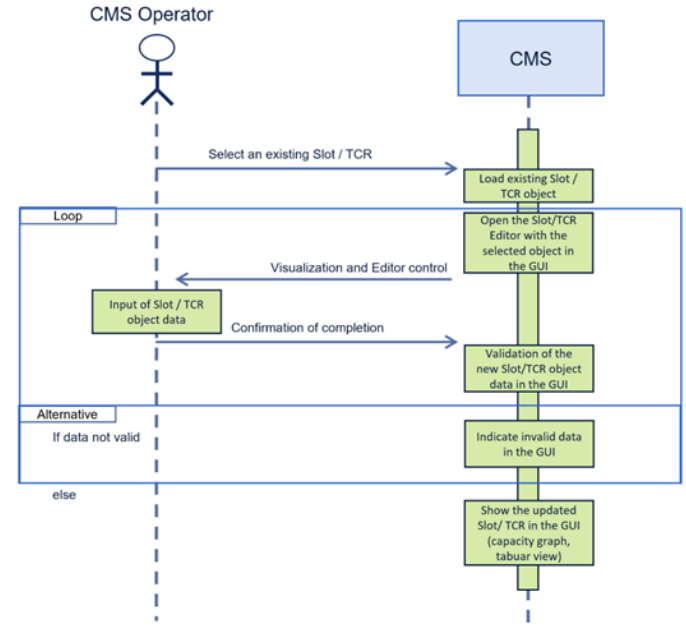
7.2.1.1. Train path envelopes (Slots) and TCR

Name	Planning and allocation of capacity for different planning horizons - RNE train path envelopes (Slots) and TCR
ID	FP1-DEMO-5.5-UC-1
Partner	HACON
Demonstration associated	Demo 5.5
Description	The CMS Operator creates, changes and deletes a train path envelope (Slot) and a TCR in the CMS.
Related to task/subtask(s)	Tasks 4.1, 4.3, 5.2, 5.2.2
Related UC ID(s) in WP3	UC-FP1-WP3-4
Impact on other task(s)	
Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”, TE 2 “Improved capacity allocation using rolling planning and TTR”
Interactions SP/FP	SP/RNE: Timetable Re-Design (TTR)
Actor(s)	CMS Operator (IM)
Trigger	The CMS Operator has received the request for applying the required action(s) on the slot or TCR.
Pre-Condition(s)	CMS with accessible editor being opened-up for applying the required action(s).
Input	The CMS Operator has received the parameters for the requested new/changed/deleted slot or TCR.
Result/Requirement	Applied changes indicated in the CMS graphical user interface.
Final State	Actions successfully applied in the CMS and visible in its graphical user interface.
Sequence	A) Create a new slot / TCR 1. The CMS Operator initiates creation of a slot / TCR via the User Interface of the CMS capacity plan editor module. 2. The CMS opens an empty form for entering required information about the new slot/TCR.

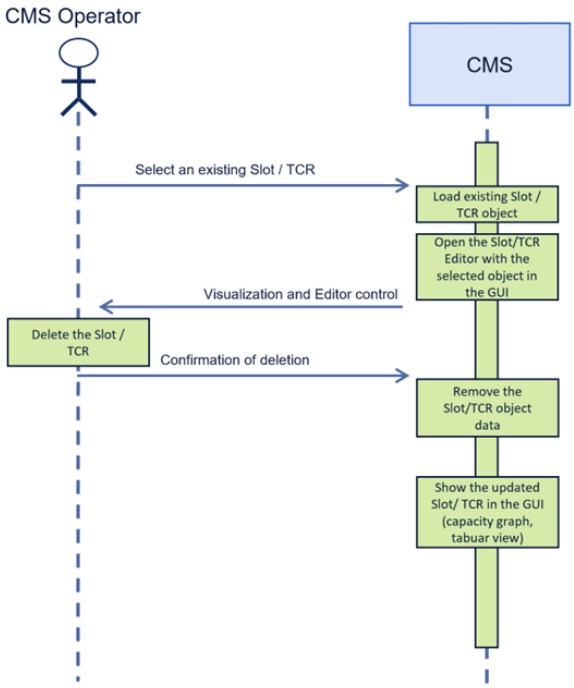
	3. The CMS Operator uses the received parameters to enter the data required for a new slot / TCR. 4. The data is automatically validated by the CMS. The CMS indicates graphically invalid information. 5. If data is invalid, the CMS Operator corrects or adapts the entered data until it is valid. 6. The CMS shows the resulting new slot / TCR in the views (capacity graph, tabular views) 7. End B) Update an existing slot / TCR 1. The CMS Operator selects an existing slot / TCR via the User Interface of the CMS capacity plan editor module. 2. The CMS opens a form including the selected slot/TCR with existing information about it. 3. The CMS Operator changes or amends the information about the selected slot/TCR. 4. Continue with A4 above. C) Deletion of an existing slot / TCR 1. The CMS Operator selects an existing slot / TCR via the User Interface of the CMS capacity plan editor module. 2. The CMS opens a form including the selected slot/TCR with existing information about it. 3. The CMS Operator deletes selected slot/TCR using e.g., a menu function. 4. The CMS updates the views (capacity graph, tabular views) not showing anymore the deleted slot / TCR. 5. End
Diagram(s)	A)


CMS Operator
CMS
Initiate creation of new Slot / TCR
Initialize new Slot / TCR object
Loop
Open the Slot/TCR Editor with the new object in the GUI
Visualization and Editor control
Input of Slot / TCR object data
Confirmation of completion
Validation of the new Slot/TCR object data in the GUI
Alternative
If data not valid
Indicate invalid data in the GUI
else
Show the new Slot/ TCR in the GUI (capacity graph, tabuar view)

B)


CMS Operator
CMS
Select an existing Slot / TCR
Load existing Slot / TCR object
Loop
Open the Slot/TCR Editor with the selected object in the GUI
Visualization and Editor control
Input of Slot / TCR object data
Confirmation of completion
Validation of the new Slot/TCR object data in the GUI
Alternative
If data not valid
Indicate invalid data in the GUI
else
Show the updated Slot/ TCR in the GUI (capacity graph, tabuar view)

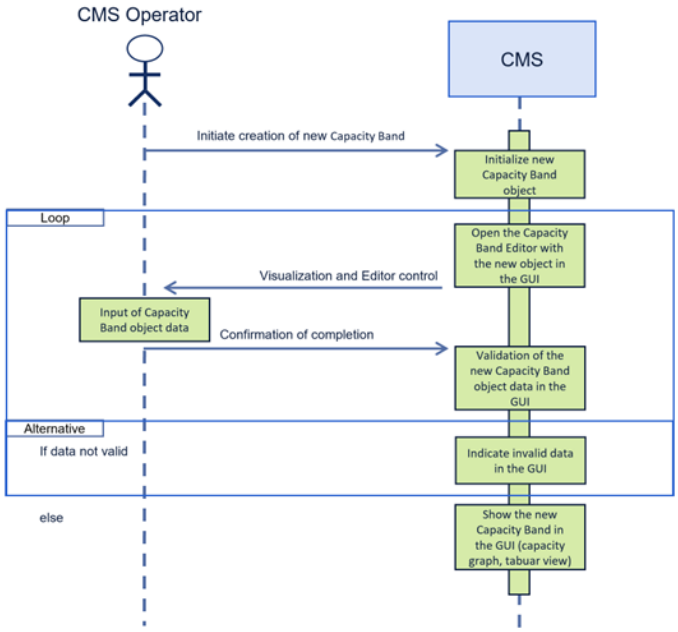
C)

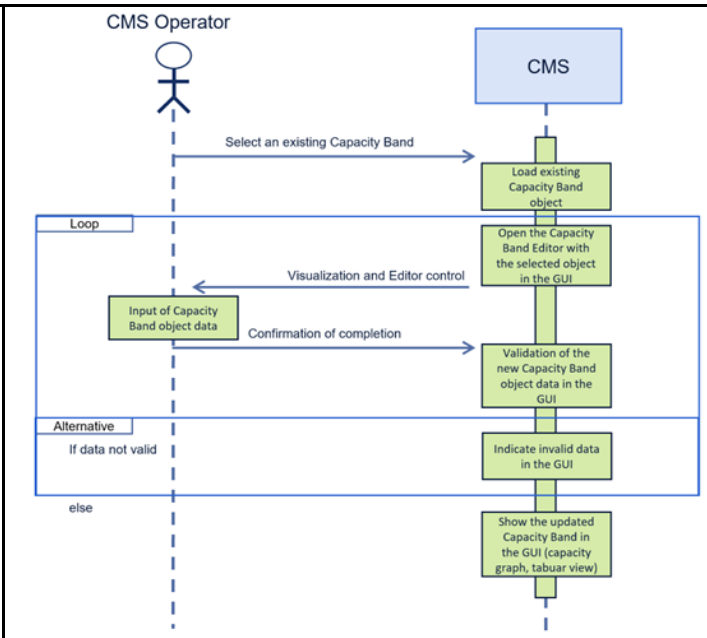
	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware
Responsible partner/person	HACON/Rolf Gooßmann
Notes	Expected identification of harmonization needs of national Planning rules – shared view (IMs / RNE).

7.2.1.2. Long-term capacity agreements and capacity partitioning

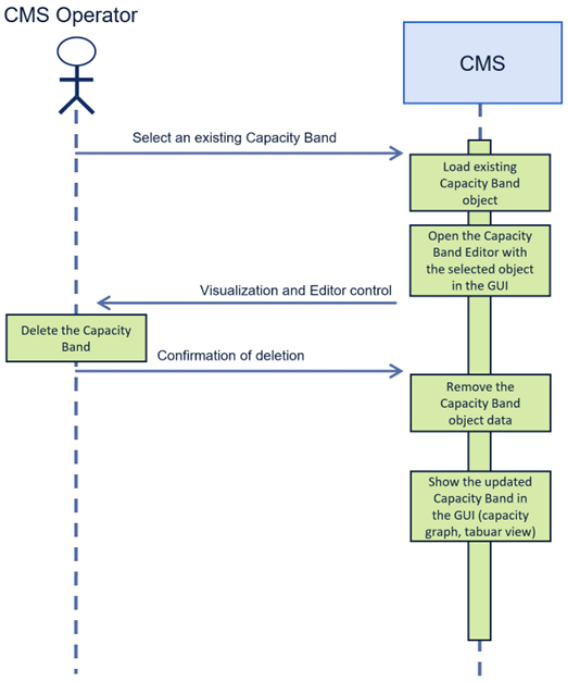
Name	Planning and allocation of capacity for different planning horizons - Long-term capacity agreements and capacity partitioning
ID	FP1-DEMO-5.5-UC-2
Partner	HACON
Demonstration associated	Demo 5.5
Description	The CMS Operator creates, changes and deletes a Capacity Band which together with TCR (see FP1-DEMO-5.5-UC-1) are the basic constituents of the Capacity Model used for supporting the long-term capacity agreements and capacity partitioning with the CMS.
Related to task/subtask(s)	Tasks 4.1, 4.3, 5.2, 5.2.2
Related UC ID(s) in WP3	UC-FP1-WP3-4
Impact on other task(s)	

Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”, TE 2 “Improved capacity allocation using rolling planning and TTR”
Interactions SP/FP	SP/RNE: Timetable Re-Design (TTR)
Actor(s)	CMS Operator (IM)
Trigger	The CMS Operator has received the request for applying the required action(s) on the Capacity Band.
Pre-Condition(s)	CMS with accessible editor being opened-up for applying the required action(s).
Input	The CMS Operator has received the parameters for the requested new/changed/deleted Capacity Band.
Result/Requirement	Applied changes indicated in the CMS graphical user interface.
Final State	Actions successfully applied in the CMS and visible in its graphical user interface.
Sequence	A) Create a new Capacity Band 1. The CMS Operator initiates creation of a Capacity Band via the User Interface of the CMS capacity plan editor module. 2. The CMS opens an empty form for entering required information about the new Capacity Band. 3. The CMS Operator uses the received parameters to enter the data required for a new Capacity Band. 4. The data is automatically validated by the CMS. The CMS indicates graphically invalid information. 5. If data is invalid, the CMS Operator corrects or adapts the entered data until it is valid. 6. The CMS shows the resulting new Capacity Band in the views (capacity graph, tabular views) 7. End B) Update an existing Capacity Band 1. The CMS Operator selects an existing Capacity Band via the User Interface of the CMS capacity plan editor module. 2. The CMS opens a form including the selected Capacity Band with existing information about it. 3. The CMS Operator changes or amends the information about the selected Capacity Band. 4. Continue with A4 above. C) Deletion of an existing Capacity Band

	1. The CMS Operator selects an existing Capacity Band via the User Interface of the CMS capacity plan editor module. 2. The CMS opens a form including the selected Capacity Band with existing information about it. 3. The CMS Operator deletes selected Capacity Band using e.g., a menu function. 4. The CMS updates the views (capacity graph, tabular views) not showing anymore the deleted Capacity Band. 5. End
Diagram(s)	A)  B)



C)



Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware
Responsible partner/person	HACON/Rolf Gooßmann
Notes	Expected identification of harmonization needs of

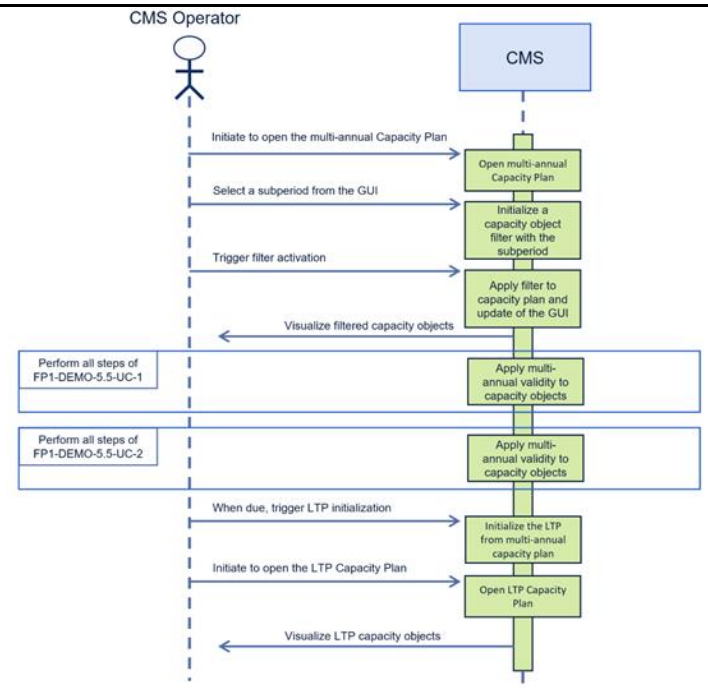
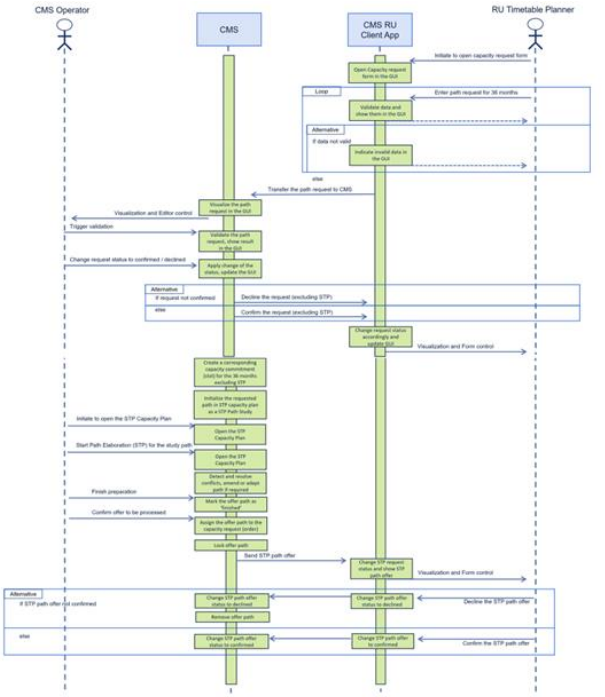
	national Planning rules – shared view (IMs / RNE).

7.2.1.3. Rolling Planning process and conjunction to annual allocation

Name	Planning and allocation of capacity for different planning horizons - Rolling Planning process and conjunction to annual allocation
ID	FP1-DEMO-5.5-UC-3
Partner	HACON
Demonstration associated	Demo 5.5
Description	a) General rolling planning capability in CMS: The CMS Operator creates, changes and deletes a multi-annual Capacity Band, train path and TCR supporting the Rolling Planning process in a multi-annual (rolling) capacity plan. For the next timetable period to be prepared for starting the related LTP path allocation process, the capacity objects are initialised from the multi-annual capacity plan and adapted or converted (slots into paths) for the corresponding LTP timetable period without impacting the multi-annual plan. b) Multi-annual (rolling planning) capacity request by RU: The RU timetable planner submits a multi-annual (rolling planning) capacity request with validity of 36 months for being answered by the CMS Operator (IM) with a path offer for the current (STP) timetable period and a capacity commitment (slot) for the upcoming timetable periods.
Related to task/subtask(s)	Tasks 4.1, 4.3, 5.2, 5.2.2
Related UC ID(s) in WP3	UC-FP1-WP3-4
Impact on other task(s)	
Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”, TE 2 “Improved capacity allocation using rolling planning and TTR”
Interactions SP/FP	SP/RNE: Timetable Re-Design (TTR)
Actor(s)	CMS Operator (IM), RU Timetable Planner as a capacity applicant.
Trigger	a) The CMS Operator has received the request for • applying the required action(s) in the multi-annual capacity plan; and • applying the required adaptations for the next LTP period. b) The RU timetable planner has received the request for

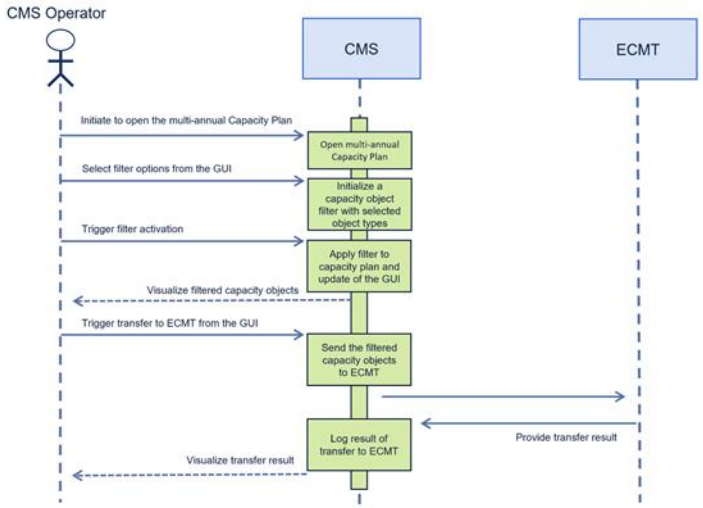
	preparing and submitting a multi-annual capacity request to the IM.
Pre-Condition(s)	CMS with accessible editor being opened-up for applying the required action(s).
Input	a) The CMS Operator has received the parameters for • the requested new/changed/deleted Capacity Band, train path and TCR in the multi-annual capacity plan; and • the required adaptations for the next LTP period. b) The RU timetable planner has received the details for the multi-annual capacity request.
Result/Requirement	a) Applied changes indicated in the CMS graphical user interface. b) Multi-annual capacity offer prepared and made available to the RU.
Final State	a) Actions successfully applied in the CMS and visible in its graphical user interface. b) Multi-annual capacity offer available to the RU.
Sequence	a) Based on the received request, the CMS Operator applies required actions in the multi-annual capacity plan and the plan for next LTP period. 1. The CMS Operator opens the CMS with the multi-annual capacity plan. 2. The CMS Operator selects a subperiod from the CMS User Interface for filtering the capacity objects featuring at least one valid day of the selected period. 3. The CMS views are updated showing capacity objects with at least one valid day of the selected period. 4. The CMS Operator performs all steps of FP1-DEMO-5.5-UC-1 or FP1-DEMO-5.5-UC-2 respectively, using a multi-annual validity of the capacity objects including valid days of the next LTP period. 5. The CMS Operator uses the CMS to initialise the next LTP period from the multi-annual capacity plan. 6. The CMS adapts or converts the multi-annual capacity objects (e.g., slots into paths) to initialise the LTP capacity plan. 7. The CMS Operator opens the CMS for planning of the next LTP period. 8. The new/changed/deleted capacity objects with relevance for the next LTP period are correctly shown in the CMS views. b) Multi-annual (rolling planning) capacity request by RU:

	1. The RU timetable planner uses a CMS-RU client application to submit a multi-annual (rolling planning) path request with validity of 36 months. 2. The CMS Operator sees the received request in the respective CMS view(s) for the rolling capacity plan. 3. The CMS Operator uses the CMS to validate the request and if successful, create a corresponding capacity commitment (slot) for the 36 months excluding the current STP period. 4. The CMS Operator opens the CMS for planning the current STP period. 5. The CMS Operator identifies the requested multi-annual path in the STP period. 6. The CMS Operator confirms the request or, if required, a. the CMS Operator adapts or amends the requested path b. the CMS applies all changes to the STP period only. c. the CMS Operator offers it to the RU d. the RU timetable planner uses the CMS-RU client application to accept the offer or to decline it, possibly repeating the request procedure (for the STP path or the complete multi-annual path). 7. End
Diagram(s)	a) Based on the received request, the CMS Operator applies required actions in the multi-annual capacity plan and the plan for next LTP period

	 b) Multi-annual (rolling planning) path request by RU 
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware
Responsible partner/person	HACON/Rolf Gooßmann
Notes	Expected identification of harmonization needs of national Planning rules – shared view (IMs / RNE).

7.2.1.4. Interface for supporting ECMT (RNE) integration

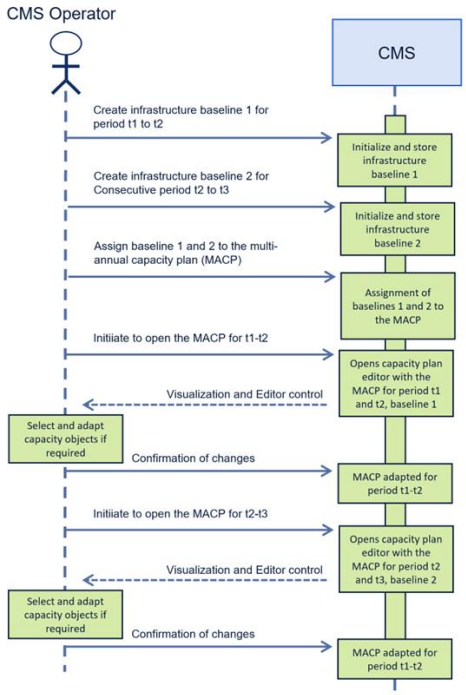
Name	Planning and allocation of capacity for different planning horizons - Interface for supporting ECMT (RNE) integration; see (RNE TTR ECMT.)
ID	FP1-DEMO-5.5-UC-4
Partner	HACON
Demonstration associated	Demo 5.5
Description	The CMS Operator initiates a transfer of Capacity Bands, train paths and TCRs to the ECMT (RNE) based on filter settings being available to restrict the data to be transferred.
Related to task/subtask(s)	Tasks 4.1, 4.3, 5.2, 5.2.2
Related UC ID(s) in WP3	UC-FP1-WP3-4
Impact on other task(s)	
Technical Enabler(s)	TE 1 "European cross-border scheduling with international train path planning", TE 2 "Improved capacity allocation using rolling planning and TTR"
Interactions SP/FP	SP/RNE: Timetable Re-Design (TTR)
Actor(s)	CMS Operator (IM)
Trigger	The CMS Operator has received the request for updating the IM's Capacity Model data in the centralised ECMT (RNE) application.
Pre-Condition(s)	CMS with accessible editor being opened-up for selection of filter settings and triggering the transfer.
Input	The CMS Operator has received the parameters for filtering the data to be transferred.
Result/Requirement	Successful transfer of the filtered data to ECMT using the required data format.
Final State	Transfer to ECMT successfully performed by the CMS or linked integration platform.
Sequence	1. The CMS Operator decides and selects the filter conditions offered by the CMS to define the set of Capacity Bands, train paths or TCRs to be sent to the ECMT (RNE). 2. The CMS Operator triggers the transfer of the capacity objects fulfilling the filter conditions to the ECMT. 3. The CMS logs the preparation of the information to be transferred and the transfer result. 4. The ECMT shows up with the transferred information.

Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware
Responsible partner/person	HACON/Rolf Gooßmann
Notes	The demonstration is depending on ECMT availability at RNE; if the ECMT is not available, a simulation of the interface will be used instead. Expected identification of harmonization needs of national Planning rules – shared view (IMs / RNE).

7.2.1.5. Modelling and handling of planned changes of the infrastructure

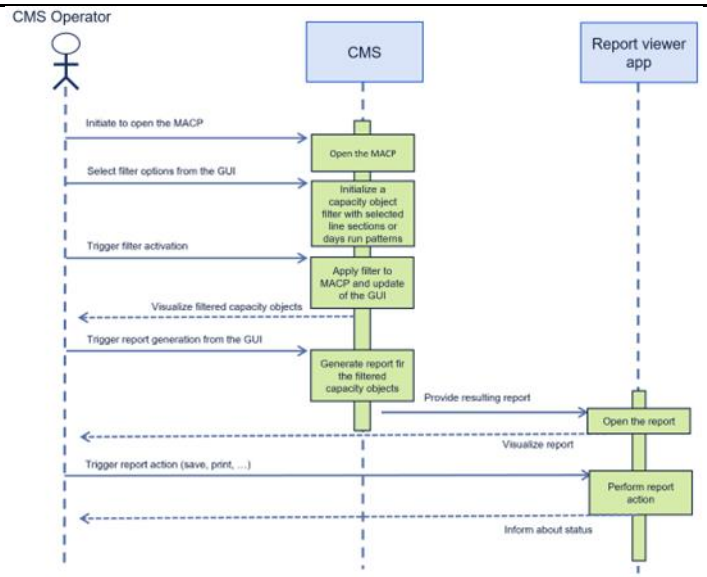
Name	Planning and allocation of capacity for different planning horizons - Modelling and (capacity-)handling of planned changes of the infrastructure
ID	FP1-DEMO-5.5-UC-5
Partner	HACON
Demonstration associated	Demo 5.5
Description	The CMS Operator creates and changes two different infrastructure data baseline versions featuring different, consecutive validity periods. The CMS Operator assigns the different infrastructure data baselines to the multi-annual capacity plan including Capacity Bands, train paths and TCRs and adapts the capacity plan objects being valid for the two baseline periods to the different baselines as needed.
Related to task/subtask(s)	Tasks 4.1, 4.3, 5.2, 5.2.2
Related UC ID(s) in WP3	UC-FP1-WP3-4

Impact on other task(s)	
Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”, TE 2 “Improved capacity allocation using rolling planning and TTR”
Interactions SP/FP	SP/RNE: Timetable Re-Design (TTR)
Actor(s)	CMS Operator (IM)
Trigger	The CMS Operator has received the request for • applying the required action(s) in the infrastructure model; and • applying the required adaptations to multi-annual capacity plan with respect to the validity periods of the infrastructure baselines.
Pre-Condition(s)	CMS with accessible editor being opened-up for applying the required action(s).
Input	The CMS Operator has received the request for • applying the required action(s) in the infrastructure model; and • applying the required adaptations to multi-annual capacity plan with respect to the validity periods of the infrastructure baselines.
Result/Requirement	Applied changes indicated in the CMS graphical user interface.
Final State	Actions successfully applied in the CMS and visible in its graphical user interface.
Sequence	1. The CMS Operator uses the CMS to create and change two different infrastructure data baseline versions featuring different, consecutive validity periods. 2. The CMS Operator assigns the different infrastructure data baselines to the multi-annual capacity plan including Capacity Bands, train paths and TCRs. 3. The CMS Operator adapts the capacity plan objects being valid for the two baseline periods to the different baselines as needed. 4. The CMS shows the multi-annual capacity objects being compliant to the different infrastructure baselines.

Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software including capacity plan editor and graphical views • CMS hardware
Responsible partner/person	HACON/Rolf Gooßmann
Notes	Expected identification of harmonization needs of national Planning rules – shared view (IMs / RNE).

7.2.1.6. Generation of standard reports

Name	Planning and allocation of capacity for different planning horizons - Generation of standard reports
ID	FP1-DEMO-5.5-UC-6
Partner	HACON
Demonstration associated	Demo 5.5
Description	A report can be generated showing the current status of annual and rolling planning volumes on particular line sections for a standard day.
Related to task/subtask(s)	Tasks 4.1, 4.3, 5.2, 5.2.2
Related UC ID(s) in WP3	UC-FP1-WP3-4
Impact on other task(s)	
Technical Enabler(s)	TE 1 “European cross-border scheduling with international train path planning”, TE 2 “Improved capacity allocation using rolling planning and TTR”
Interactions SP/FP	SP/RNE: Timetable Re-Design (TTR)

Actor(s)	CMS operator
Trigger	Request for assessing or documenting the current status of annual and rolling planning volumes on particular line sections for a standard day.
Pre-Condition(s)	CMS accessible for invoking the required report from the graphical user interface.
Input	The CMS Operator has received the request for assessing or documenting the current status of annual and rolling planning volumes on particular line sections for a standard day.
Result/Requirement	Report is generated by the CMS reflecting the required content.
Final State	Report shown in the graphical user interface reflecting the required content.
Sequence	1. The CMS Operator uses the CMS to decide and define filter conditions for particular line sections or standard days run patterns. 2. The CMS Operator uses the CMS to initiate the generation of a filtered report via the CMS User Interface to assess or document the current status of annual and rolling planning volumes. 3. The CMS applies the filter to identify the respective capacity objects and shows them in a report viewer. 4. The CMS Operator uses the report viewer controls to manage (save, print etc.) the report. 5. End
Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software • CMS hardware

Responsible partner/person	HACON/Rolf Gooßmann
Notes	Expected identification of harmonization needs of national Planning rules – shared view (IMs / RNE).

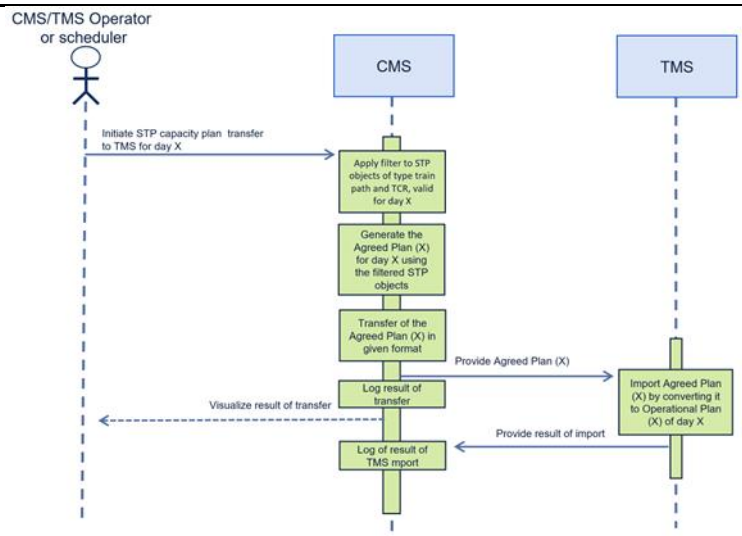
7.3. Use Cases for integration of traffic management system with network capacity planning (Task 4.4)

In Task 4.4 there is one demonstration with a total of 4 Use Cases, performed by Hacon. Each Use Case is presented in a separate subsection.

7.3.1. Data exchange between TMS and national CMS

7.3.1.1. New or changed plan in national CMS sent to TMS

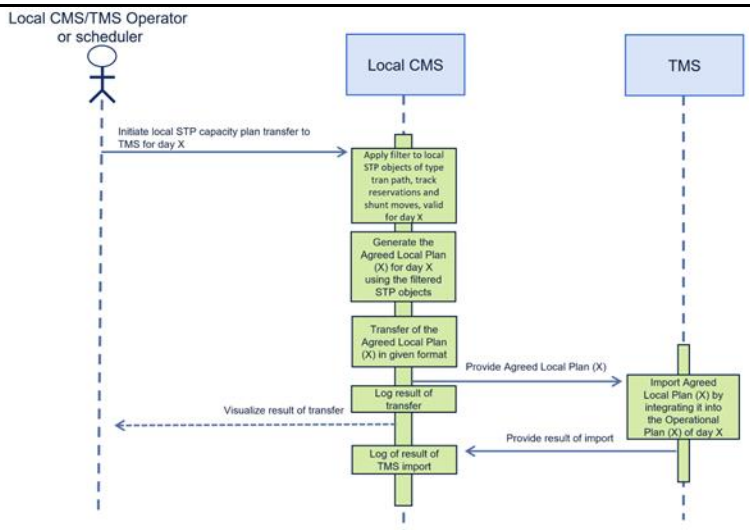
Name	New or changed plan in national CMS sent to TMS
ID	FP1-DEMO-5.6-UC-1
Partner	HACON
Demonstration associated	Demo 5.6
Description	A new or changed capacity plan in the national CMS is sent to the TMS including train paths and TCR.
Related to task/subtask(s)	Tasks 4.1, 4.4, 5.2, 5.2.3
Related UC ID(s) in WP3	UC-FP1-WP3-5
Impact on other task(s)	SP: CMS/TMS interface
Technical Enabler(s)	TE 2 “Improved capacity allocation using rolling planning and TTR”, TE 6 “Integration of TMS with yard /station planning”
Interactions SP/FP	SP/RNE: SP Task 3; TMS-CMS interface
Actor(s)	CMS/CMS Operator TMS/TMS Operator
Trigger	Scheduled or on-demand for a specific operational day
Pre-Condition(s)	• CMS has a valid and agreed plan for the selected operational day. • TMS available to receive the agreed plan for the selected operational day.
Input	A specific operational day for which the agreed plan shall be transferred.
Result/Requirement	TMS has received the agreed plan for the specific operational day from CMS.
Final State	The agreed plan is shown in the TMS as initial operational plan for the specific operational day.

Sequence	1. The CMS system scheduler or a CMS/TMS Operator initiates a transfer of the capacity plan valid for a selected day. 2. The CMS transfer function uses the specific day for filtering train timetables and TCR valid on that day. 3. The CMS transfer function generates the agreed plan including train timetables and TCR for the specific day in a defined format and transfers it to the TMS. 4. The TMS receives the agreed plan transferred by the CMS and stores it as initial Operational Plan for the specific operational day. 5. End
Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software • TMS software • CMS hardware • TMS hardware
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

7.3.1.2. New or changed local plan of yard based local CMS sent to TMS

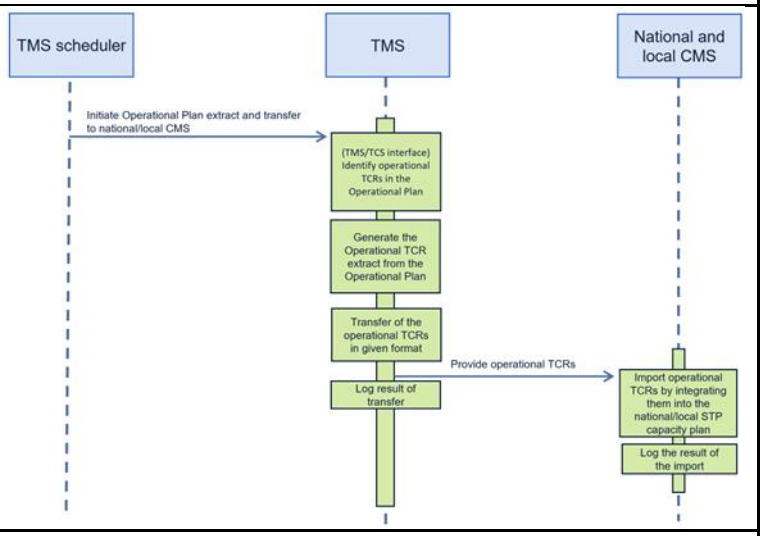
Name	New or changed local plan of yard based local CMS sent to TMS
ID	FP1-DEMO-5.6-UC-2
Partner	HACON
Demonstration associated	Demo 5.6
Description	A new or changed local plan of yard based local CMS is

	sent to TMS, a) train consist b) later arrival in departure track c) earlier arrival in departure track d) track assignment change e) changed or new track reservation f) changed or new shunting activities with impact on lines.
Related to task/subtask(s)	Tasks 4.1, 4.4, 5.2, 5.2.3
Related UC ID(s) in WP3	UC-FP1-WP3-5
Impact on other task(s)	SP: CMS/TMS interface
Technical Enabler(s)	TE 2 Improved capacity allocation using rolling planning and TTR, TE 6 "Integration of TMS with yard /station planning"
Interactions SP/FP	SP/RNE: SP Task 3; TMS-CMS interface
Actor(s)	Yard based local CMS / CMS Operator TMS / TMS Operator
Trigger	Scheduled or on-demand for a specific operational day
Pre-Condition(s)	• Local CMS has a valid and agreed plan for the selected operational day. • TMS available to receive the agreed plan for the selected operational day.
Input	A specific operational day for which the agreed local plan shall be transferred.
Result/Requirement	TMS has received the agreed local plan for the specific operational day from local CMS.
Final State	The agreed local plan is shown in the TMS as part of the initial operational plan for the specific operational day.
Sequence	1. The local CMS system scheduler or a local CMS/TMS Operator initiates a transfer of the local capacity plan valid for a selected day. 2. The local CMS transfer function uses the specific day for filtering capacity objects and assigned information about train consist, later arrival in departure track, earlier arrival in departure track, track assignment change, changed or new track reservation, changed or new shunting activities valid on that day. 3. The local CMS transfer function generates the agreed local plan for the specific day in a defined format and transfers it to the TMS. 4. The TMS receives the agreed local plan transferred by the CMS and stores it as part of the initial Operational Plan for the specific operational day. 5. End

Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• Local CMS software • TMS software • Local CMS hardware • TMS hardware
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

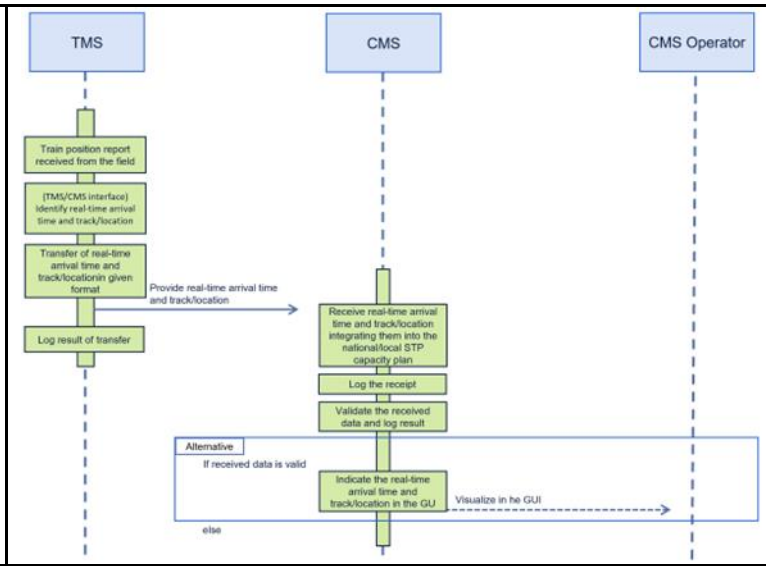
7.3.1.3. New or changed operational TCR in TMS sent to national and local yard-based CMS

Name	New or changed operational TCR in TMS sent to national and local yard-based CMS
ID	FP1-DEMO-5.6-UC-3
Partner	HACON
Demonstration associated	Demo 5.6
Description	A new or changed operational TCR in TMS is sent to national and local yard-based CMS.
Related to task/subtask(s)	Tasks 4.1, 4.4, 5.2, 5.2.3
Related UC ID(s) in WP3	UC-FP1-WP3-5
Impact on other task(s)	SP: CMS/TMS interface
Technical Enabler(s)	TE 2 Improved capacity allocation using rolling planning and TTR, TE 6 “Integration of TMS with yard /station planning”
Interactions SP/FP	SP/RNE: SP Task 3; TMS-CMS interface
Actor(s)	National CMS / CMS operator Yard based local CMS / CMS operator TMS / TMS operator
Trigger	An operational TCR located in an area shared with the

	local CMS is created or changed in the TMS.
Pre-Condition(s)	• The new or changed TCR is located in an area shared with the local CMS. • The local or national CMS is available to receive the new or changed TCR information.
Input	Identified, suitable existing TCR for applying the change or parameters for specifying the new TCR.
Result/Requirement	Local or national CMS has received the new or changed TCR.
Final State	The new or changed TCR is shown in the local or national CMS.
Sequence	1. The TMS system scheduler initiates an extract of the Operational Plan. 2. The TMS/CMS interface identifies the operational TCRs and transfers them in a defined format to the local or national CMS. 3. The national and local CMS receive the TCRs transferred by the TMS and stores them as part of the national or local Capacity Plan. 4. End
Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• Local CMS software • TMS software • Local CMS hardware • TMS hardware
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

7.3.1.4. Up-to-date train position feed-back from TMS to national CMS for deviation detection (track/time)

Name	Up-to-date train position feed-back from TMS to national CMS for deviation detection (track/time)
ID	FP1-DEMO-5.6-UC-4
Partner	HACON
Demonstration associated	Demo 5.6
Description	An up-to-date train position feed-back from TMS is sent to the CMS for deviation detection (track/time) to support the decision making for larger re-planning scenarios.
Related to task/subtask(s)	Tasks 4.4, 5.2, 5.2.3
Related UC ID(s) in WP3	UC-FP1-WP3-5
Impact on other task(s)	SP: CMS/TMS interface
Technical Enabler(s)	TE 2 “Improved capacity allocation using rolling planning and TTR”, TE 6 “Integration of TMS with yard /station planning”
Interactions SP/FP	SP/RNE: SP Task 3; TMS/CMS interface
Actor(s)	National CMS / CMS operator TMS / TMS operator
Trigger	TMS generates a real-time arrival time at a planning location and track.
Pre-Condition(s)	• The TMS has received a train position report from the field associated to a planning location and related track. • Interface connection established between TMS and CMS.
Input	• Train position report from the field
Result/Requirement	The real-time arrival time and track is indicated in the Graphical User Interface (GUI) of the CMS.
Final State	The CMS Operator uses the real-time information to support the decision making for larger re-planning scenarios.
Sequence	1. The TMS sends the real-time arrival time and track of the train at the reported location to the CMS. 2. The CMS receives the real-time arrival time and track of the train. 3. The CMS validates the information and, if successful, indicates it in the GUI of the CMS.

Diagram(s)	
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software • TMS software • CMS hardware • TMS hardware
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

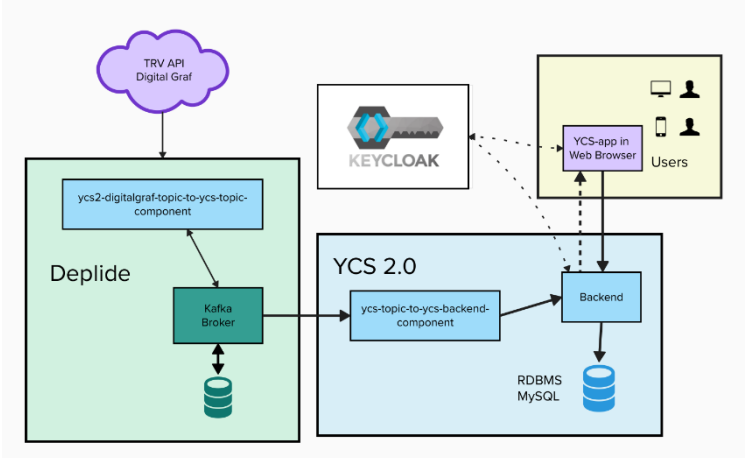
7.4. Use Cases for integration of network capacity planning with yard and station capacity planning (Task 4.5)

In task 4.5 there are two demonstrations with a total of 5 Use Cases, performed by Hacon and Trafikverket/RISE. Each Use Case is presented in a separate subsection.

7.4.1. YCS - Update the initial A/D-yard plan

Name	YCS - Update the initial A/D-yard plan and make it conflict free for the next few hours.
ID	FP1-DEMO-5.4-UC-1
Partner	TRV A.E. RISE
Demonstration associated	Demo 5.4
Description	The LM, YM and TM update the initial plan for the next few hours.
Related to task/subtask(s)	Task 4.5, Task 5.1, 5.2, 5.2.4 and 5.3
Related UC ID(s) in WP3	UC-FP1-WP3-10
Impact on other task(s)	WP 11/12, Task 11.3.8, Task 12.2.8.
Technical Enabler(s)	TE 6 “Integration of TMS with yard /station planning”

Interactions SP/FP	FP 5 (data integration via FP 5 WP 32),
Actor(s)	TMS Operator for the hand-over yard, also called Line Manager – LM, active Yard Manager – YM, active Terminal Manager -TeM, active Train driver, passive TMS Operators for adjacent lines, passive RU, passive
Trigger	LM extends planning horizon in YCS (either the planning horizon in his/her focus or planning horizon of handled data).
Pre-Condition(s)	An initial plan (i.e., arrivals, departures, and the track allocation plan from the planning department) exists for the considered planning period. The plan may have been partly updated already (e.g. by the LM working the previous shift).
Input	Track allocation changes made by the LM. Track allocation requirement changes made by the TeM/YM.
Result/Requirement	The track allocation plan for the A/D-yard is updated (and communicated to TMS).
Final State	The track allocation plan for the hand-over yard has been updated (replanned), partly based on information from planners of adjacent operations. The track allocation changes have been communicated to planners of adjacent operations (the multi-modal terminal, the marshalling yard, TMS). The track allocation plan matches with the actors' intended work activities.

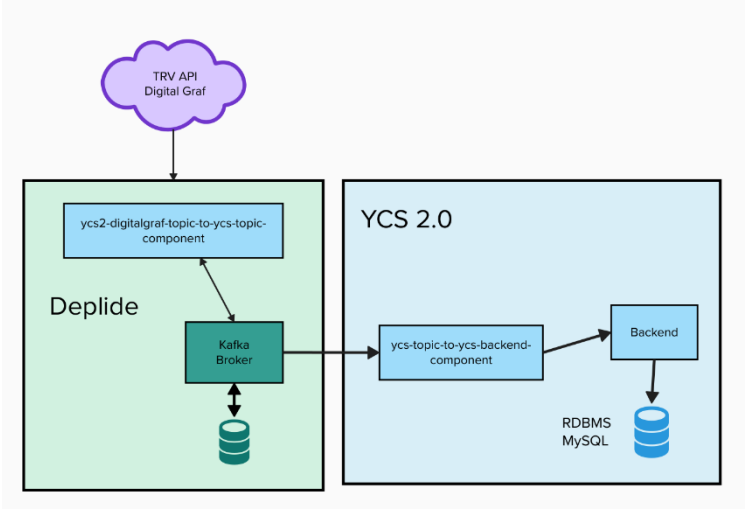
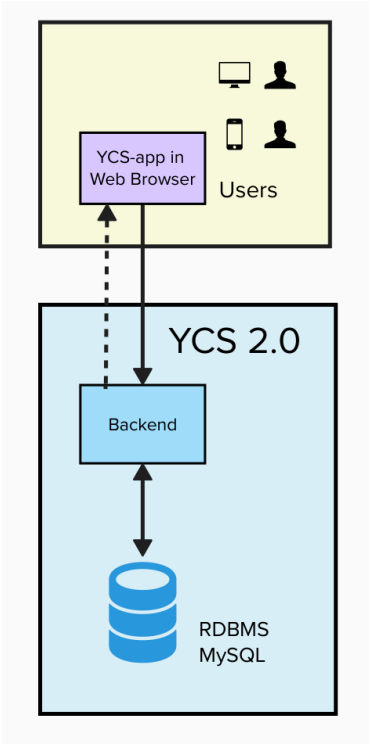
Sequence	1. LM, TeM and YM opens YCS and log in. 2. LM extends planning horizon (mental or digital). 3. LM identifies track allocation conflict or other problem that require the plan to be adjusted. 4. LM changes track allocation to remove conflict/problem. Conflicts are resolved one at a time (with decision support). 5. If a departure time needs to be changed, the LM changes this in the TMS and the change is propagated to YCS (via WP 11). 6. LM loops 3. - 5. until they are satisfied. 7. TeM/YM identifies an unmet track allocation need, track allocation requirement conflict or incorrect track allocation requirement. 8. TeM/YM updates the track allocation requirement to account for need or resolve conflict/inaccuracy. 9. TeM/YM loops 6. and 7. until they are satisfied. 10. LM inspect allocation plan and, if necessary, go back to step 3.
Diagram(s)	 Users (LM, YM and TeM) uses YCS in the Browser. KeyCloak is used for login and authentication control. Deplide integrates to Trafikverket's TMS Digital Graf. YCS 2.0 backend, database and components handles data.
Expected Implementation Date	2026-03
Involved components (System)	YCS - Yard coordination system (developed in WP4/5) Digital Graph – TMS system. Deplide – Data sharing prototype. Kafka – open-source distributed event streaming platform Kubernetes – open source platform for managing containerised workloads and services

	Docker – used to run YCS in Kubernetes Web-browser – used to access YCS. Keycloak – used for user access management. MySQL – program used to maintain a relational database Node.js – web-server
Responsible partner/person	Kristian Persson, Trafikverket Sara Gestrelius, RISE
Notes	This Use Case represents the planning work done during e.g. the beginning of a shift, or after a large disruption has occurred. The actors may need to, e.g., call each other and discuss to find a solution they all find satisfactory. The updated ready-to-depart times may be later than the current planned departure time. However, the departure times are not changed in YCS but rather in the TMS system. Small updates are handled in Use Case 2, 3, 4, 5.

7.4.2. YCS - Update planned arrival times

Name	YCS - Updated planned arrival times.
ID	FP1-DEMO-5.4-UC-2
Partner	TRV A.E. RISE
Demonstration associated	Demo 5.4
Description	Information regarding updated planned arrival times is received from TMS, replanning is triggered. Information propagated to TM/YM, who make secondary responses to this.
Related to task/subtask(s)	Task 4.5, Task 5.1, 5.2, 5.2.4 and 5.3
Related UC ID(s) in WP3	UC-FP1-WP3-11
Impact on other task(s)	WP 11/12, Task 11.3.8, Task 12.2.8.
Technical Enabler(s)	TE6 “Integration of TMS with yard /station planning”
Interactions SP/FP	FP 5 (data integration via FP 5 WP 32),
Actor(s)	TMS Operator for the hand-over yard, also called Line Manager – LM, active Yard Manager – YM, active Terminal Manager -TeM, active Train driver, passive TMS Operators for adjacent lines, passive RU, passive
Trigger	A train arrival time is changed (in TMS).
Pre-Condition(s)	A track allocation plan exists.
Input	Updated arrival time (from TMS, via UC from WP 11).

	Track allocation changes made by the LM. Track allocation requirement changes made by the TeM/YM.
Result/Requirement	The track allocation plan for the A/D-yard is updated to account for the new arrival time (and communicated to TMS).
Final State	The track allocation plan for the hand-over yard has been updated (replanned) to account for the new arrival time. The track allocation changes have been communicated to planners of adjacent operations (the multi-modal terminal, the marshalling yard, TMS). All actors have adapted their planning with respect to the A/D-yard to account for the new arrival time. The track allocation plan matches with the actors' intended work activities.
Sequence	1. An arrival time is changed in TMS, and the arrival time change is propagated to YCS (via WP 11). 2. YCS automatically extends the track reservation to make it feasible with regards to the new arrival time. This may result in conflicts. 3. LM identifies any track allocation conflict or other problems that require the plan to be adjusted. 4. LM changes track allocation to remove conflict/problem. Conflicts are resolved one at a time (with decision support). 5. If a departure time needs to be changed, the LM changes this in the TMS and the change is propagated to YCS (via WP 11). 6. LM loops 3. - 5. until they are satisfied. 7. TeM/YM identifies a track allocation requirement conflict, incorrect track allocation requirement or unmet track allocation need. 8. TeM/YM updates the track allocation requirement to account for need or resolve conflict/inaccuracy. 9. TeM/YM loops 5. and 6. until they are satisfied. 10. LM inspects track allocation plan and, if necessary, go back to step 2.

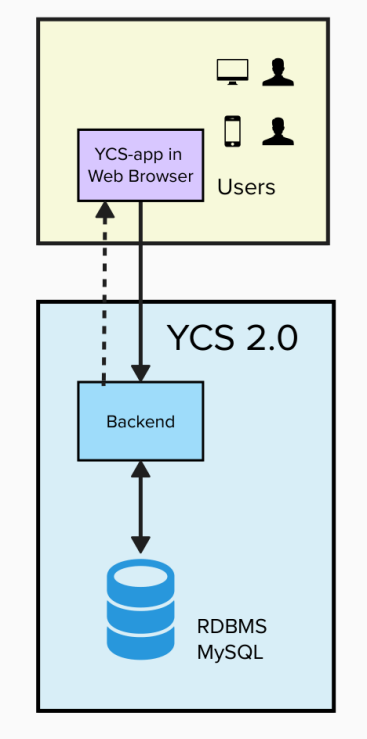
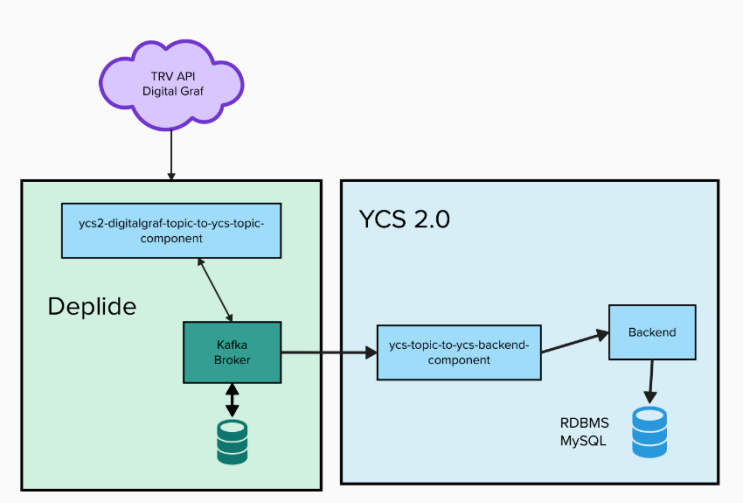
Diagram(s)	 New Arrival time from Trafikverket's TMS Digital Graf is propagated through Deplide to Backend and the train arrival time is updated in the database.  User using YCS in the Browser fetches the new arrival time for the train. Users reacts to the new information and user input is fetched by Backend and stored in the database.
Expected Implementation Date	2026-06
Involved components (System)	YCS - Yard coordination system (developed in WP 4/5) Digital Graph – TMS system. Deplide – Data sharing prototype. Kafka – open-source distributed event streaming platform

	Kubernetes – open source platform for managing containerised workloads and services Docker – used to run YCS in Kubernetes Web-browser – used to access YCS. Keycloak – used for user access management. MySQL – program used to maintain a relational database Node.js – web-server
Responsible partner/person	Kristian Persson, Trafikverket Sara Gestrelius, RISE
Notes	The actors may need to, e.g., call each other and discuss to find a solution they all find satisfactory. The updated ready-to-depart times may be later than the current planned departure time. However, the departure times are not changed in YCS but rather in the TMS system.

7.4.3. YCS – Wagons for outbound train not ready for departure on time

Name	YCS – Wagons for outbound train not ready for departure on time
ID	FP1-DEMO-5.4-UC-3
Partner	TRV A.E. RISE
Demonstration associated	Demo 5.4
Description	Replanning triggered by information from terminal about cars not being ready for departure on time.
Related to task/subtask(s)	Task 4.5, Task 5.1, 5.2, 5.2.4 and 5.3
Related UC ID(s) in WP3	UC-FP1-WP3-12
Impact on other task(s)	WP 11/12, Task 11.3.8, Task 12.2.8.
Technical Enabler(s)	TE 6 "Integration of TMS with yard /station planning"
Interactions SP/FP	FP 5 (data integration via FP 5 WP 32),
Actor(s)	TMS Operator for the hand-over yard, also called Line Manager – LM, active Yard Manager – YM, active Terminal Manager -TeM, active Train driver, passive TMS Operators for adjacent lines, passive RU, passive
Trigger	Cars from Terminal for an outbound train are delayed.
Pre-Condition(s)	A track allocation plan exists.
Input	New track allocation requirements from Terminal. Secondary track allocation changes made by the LM.

	Tertiary track allocation requirement changes made by the TeM/YM.
Result/Requirement	The track allocation plan for the A/D-yard is updated to account for the late cars (and communicated to TMS).
Final State	The track allocation plan for the hand-over yard has been updated (replanned), based on updated information from planners of adjacent operations (the Terminal). The track allocation changes have been communicated to planners of adjacent operations (the multi-modal terminal, the marshalling yard, TMS). The track allocation plan matches with the actors' intended work activities.
Sequence	1. TeM detects that the cars for an outbound train will not be ready for departure at the planned time. 2. TeM change track allocation requirement for A/D-yard in YCS. 3. LM identifies track allocation conflict or other problem that requires the plan to be adjusted. 4. LM changes track allocation to remove conflict/problem. Conflicts are resolved one at a time (with decision support). 5. If a departure time needs to be changed, the LM changes this in the TMS and the change is propagated to YCS (via WP 11). 6. LM loops 3. - 5. until they are satisfied. 7. TeM/YM identifies a track allocation requirement conflict, incorrect track allocation requirement or unmet track allocation need. 8. TeM/YM updates the track allocation requirement to account for need or resolve conflict/inaccuracy. 9. TeM/YM loops 6. and 7. until they are satisfied. 10. LM inspects track allocation plan and, if necessary, go back to step 3.

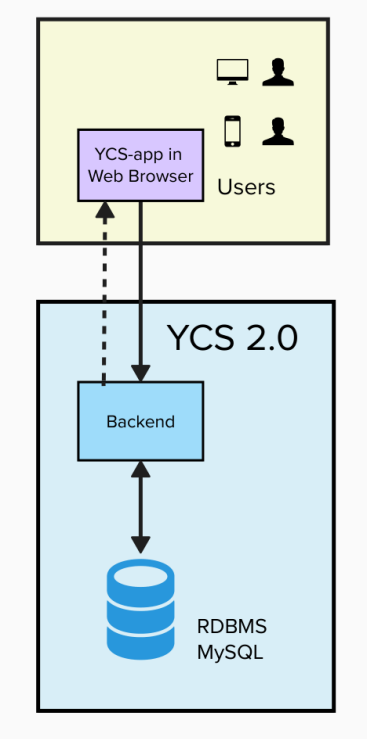
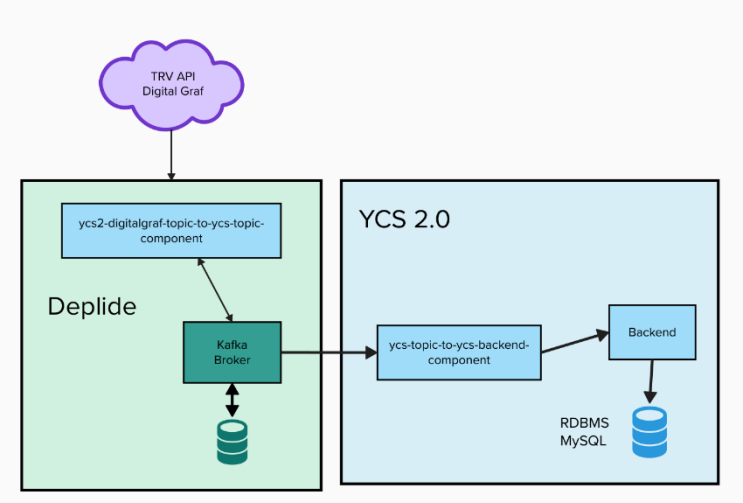
Diagram(s)	 TeM updates information in YCS in the Browser. The new information is fetched by Backend and information is updated in the database. The new information is pushed to other users of YCS.  TMS operator changes the arrival/departure time of a train in conflict in Trafikverket's TMS Digital Graf. The new time is propagated to Deplide and to Backend and the database is updated.
Expected Implementation Date	2026-06
Involved components (System)	YCS - Yard coordination system (developed in WP 4/5) Digital Graph – TMS system. Deplide – Data sharing prototype. Kafka – open-source distributed event streaming

	platform Kubernetes – open source platform for managing containerised workloads and services Docker – used to run YCS in Kubernetes Web-browser – used to access YCS. Keycloak – used for user access management. MySQL – program used to maintain a relational database Node.js – web-server
Responsible partner/person	Kristian Persson, Trafikverket Sara Gestrelius, RISE
Notes	Use case can also be initiated by changes connected to marshalling yard. The actors may need to, e.g., call each other and discuss to find a solution they all find satisfactory. The updated ready-to-depart times may be later than the current planned departure time. However, the departure times are not changed in YCS but rather in the TMS system.

7.4.4. YCS – New shunting need from YM

Name	YCS – New shunting need from YM.
ID	FP1-DEMO-5.4-UC-4
Partner	TRV A.E. RISE
Demonstration associated	Demo 5.4
Description	Replanning triggered by new information from Yard Manager regarding shunting operations that requires track capacity on A/D-yard.
Related to task/subtask(s)	Task 4.5, Task 5.1, 5.2, 5.2.4 and 5.3
Related UC ID(s) in WP3	UC-FP1-WP3-13
Impact on other task(s)	WP 11/12, Task 11.3.8, Task 12.2.8.
Technical Enabler(s)	TE6 “Integration of TMS with yard /station planning”
Interactions SP/FP	FP5 (data integration via FP 5 WP 32),
Actor(s)	TMS Operator for the hand-over yard, also called Line Manager – LM, active Yard Manager – YM, active Terminal Manager -TeM, active Train driver, passive TMS Operators for adjacent lines, passive RU, passive
Trigger	YM need track access at A/D-yard to perform marshalling operations.
Pre-Condition(s)	A track allocation plan exists.

Input	New track allocation requirements from YM. Secondary track allocation changes made by the LM. Tertiary track allocation requirement changes made by the TM/YM.
Result/Requirement	The track allocation plan for the A/D-yard is updated with the new shunting (and track allocations and ready-to-depart times communicated to TMS).
Final State	The track allocation plan for the hand-over yard has been updated (replanned), based on updated information from planners of adjacent operations. The track allocation changes have been communicated to planners of adjacent operations (the multi-modal terminal, the marshalling yard, TMS). The track allocation plan matches with the actors' intended work activities.
Sequence	1. YM detects need to use A/D-yard for shunting activities. 2. YM post a track allocation requirement for shunting in YCS. 3. LM updates track allocation plan and may identify track allocation conflicts or other problems. 4. LM changes track allocation to remove conflict/problem. Conflicts are resolved one at a time (with decision support). 5. If a departure time needs to be changed, the LM changes this in the TMS and the change is propagated to YCS (via WP 11). 6. LM loops 3. - 5. until they are satisfied. 7. TeM/YM identifies potential secondary track allocation requirement conflict, incorrect track allocation requirement or unmet track allocation need because of the changed track allocation plan. 8. TeM/YM updates the track allocation requirement to account for need or resolve conflict/inaccuracy. 9. TeM/YM loops 6. and 7. until they are satisfied.

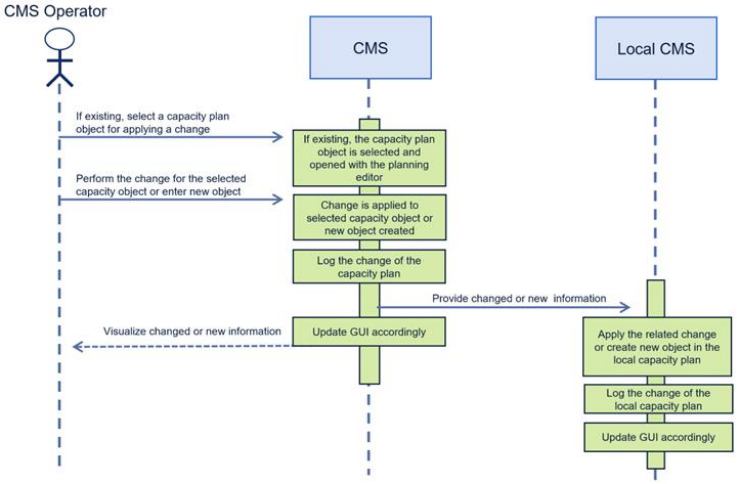
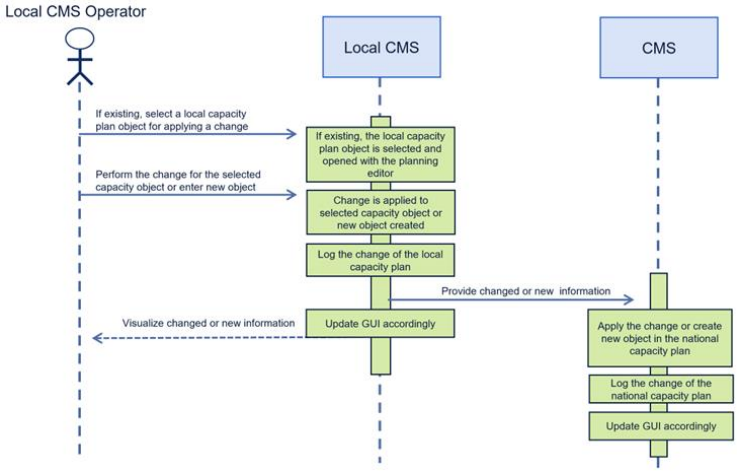
Diagram(s)	 YM updates information in YCS in the Browser. The new information is fetched by Backend and information is updated in the database. The new information is pushed to other users of YCS.  TMS operator changes the arrival/departure time of a train in conflict in Trafikverket's TMS Digital Graf. The new time is propagated to Deplide and to Backend and the database is updated.
Expected Implementation Date	2026-06
Involved components (System)	YCS - Yard coordination system (developed in WP 4/5) Digital Graph – TMS system. Deplide – Data sharing prototype. Kafka – open-source distributed event streaming

	platform Kubernetes – open source platform for managing containerised workloads and services Docker – used to run YCS in Kubernetes Web-browser – used to access YCS. Keycloak – used for user access management. MySQL – program used to maintain a relational database Node.js – web-server
Responsible partner/person	Kristian Persson, Trafikverket Sara Gestrelius, RISE
Notes	Use case can also be triggered by new shunting need from TeM. The actors may need to, e.g., call each other and discuss to find a solution they all find satisfactory. The updated ready-to-depart times may be later than the current planned departure time. However, the departure times are not changed in YCS but rather in the TMS system.

7.4.5. Data exchange between CMS and local CMS

Name	Data exchange between national capacity management/planning system (national CMS) and local, yard-based capacity management/planning system (local CMS)
ID	FP1-DEMO-5.7-UC-1
Partner	HACON
Demonstration associated	Demo 5.7
Description	The national CMS planning application demonstrates the exchange of data with local (yard) based CMS showing new planning process capabilities. The following sub-Use Cases are covered: 1. New or changed plan in national CMS sent to yard based local CMS a) train path b) TCR; 2. New or changed local plan of yard based local CMS sent to national CMS, a) train consist b) later arrival in departure track c) earlier arrival in departure track d) track assignment change e) changed or new track reservation f) changed or new shunting activities with impact on lines;
Related to task/subtask(s)	Tasks 4.5, 5.2, 5.2.4
Related UC ID(s) in WP3	UC-FP1-WP3-6
Impact on other task(s)	
Technical Enabler(s)	TE 6 “Integration of TMS with yard /station planning”

Interactions SP/FP	SP/RNE: Timetable Re-Design (TTR): TCR, ad-hoc paths, R-CDM, FP 5
Actor(s)	National CMS / CMS operator Yard based local CMS / CMS operator
Trigger	1. National plan in the CMS is changed impacting the planning area of the local CMS. 2. Local plan in local CMS is changed impacting the line-based operations planned by the CMS.
Pre-Condition(s)	• Capacity plans of CMS and local CMS are synchronised for the overlapping area. • Established interface connection between CMS and local CMS.
Input	1. Suitable train path or TCR identified to apply the change. 2. Suitable information available to apply required changes for train consist, late arrival in departure track, earlier arrival in departure track, track assignment change, changed or new track reservation, changed or new shunting activities with impact on lines.
Result/Requirement	The relevant information to be shared between CMS and local CMS is exchanged for optimum integrated planning capability.
Final State	The relevant changes are in consistent between CMS and local CMS
Sequence	1. National plan in the CMS is changed local CMS area. 1.1 The CMS Operator performs the creation of a new or the change of an existing planned train path / TCR impacting the area of the local CMS. 1.2 The CMS sends the change to the local CMS. 1.3 The local CMS receives capacity plan change, applies related change to the local capacity plan and indicates it in the GUI of the local CMS. 2. Local plan in the local CMS is changed impacting a line planned by the CMS. 2.1 The local CMS Operator performs a change of train consist, late arrival in departure track, earlier arrival in departure track, track assignment change, changed or new track reservation, or changes or create new shunting activities with impact on lines planned by the CMS. 2.2 The local CMS sends the change to the CMS. 2.3 The CMS receives the change and indicates it in the GUI of the CMS.

Diagram(s)	1. National plan in the CMS is changed local CMS area  2. Local plan in the local CMS is changed impacting a line planned by the CMS 
Expected Implementation Date	2025-11-30
Involved components (System)	• CMS software • Local CMS software • CMS hardware • Local CMS hardware
Responsible partner/person	HACON/Rolf Gooßmann
Notes	

8. Specification of Requirements

Chapter 0 describes the requirements for all demonstrations in WP 4. The chapter is divided per task (tasks 4.2, 4.3, 4.4 and 4.5). The requirements present a more detailed picture of the demonstrations than the high-level requirements presented in Chapter 6 which were defined as part of the activities of WP 3. The level of detail should be high enough to be evaluated at the end of WP 5 if each demonstration has fulfilled its respective requirements or not.

Only relevant demonstration requirements connected to the high-level requirements are presented here. Each demonstration may need more functions than those presented in this report to make the demonstration work but these are generally on a low innovation level and only required to enable the demonstration in general to work. The requirements presented here are related to the innovative part of the demonstration and connected to the high-level requirement. Requirements that could be beneficial for the task subject but are not described in the high-level requirements are not presented here and will consequently not be focus for implementation nor for demonstration.

The requirements are generally functional requirements, describing what the program/function/code shall do, but it can also be non-functional requirements, for example for response times. Below the templates of functional and non-functional requirements are included.

Functional Requirements template:

Requirement ID	***WP4_Demoxx_FRQ_yyy***
Demonstration	*Identification of the demonstration(s) in which its coverage will be shown*
Requirement	*A descriptive name or title to the requirement so that it is easily identifiable.*
Type	*Functional (static)*
Priority	*Shall: Indicates a strong obligation or a requirement that must be compulsorily fulfilled.* *Should: Indicates a recommendation or requirement that is considered important, but not necessarily mandatory.* *May: Indicates an option or permission. This word suggests that an action or condition is permitted, but not required.*
Main goal	*Concise description of the fundamental purpose of the requirement.*
Assumptions	*Any assumptions or conditions assumed in relation to the requirement. These assumptions may include important information that is not specifically stated in the requirement but is considered essential to compliance with the requirement.* *(Examples: Valid input data, resource availability, compliance with standards or regulations, integration an interaction with existing systems, user interaction…)*

Specifications	*Detailed description of the requirement providing a clear explanation of what the system must do or the actions that must be supported.*
Additional information and background	*Any additional information or comments that are relevant to the requirement. This includes clarifications or additional context as e.g., link to High-Level Requirements of the respective Technical Enabler.*
Open topics	*Any information describing known gaps or assumed future activities in conjunction with the requirement.*

Non-Functional Requirements template:

Requirement ID	***WP4_Demoxx_NFRQ_yyy***
Demonstration	*Identification of the demonstration(s) in which its coverage will be shown*
Requirement	*A descriptive name or title to the requirement so that it is easily identifiable.*
Type	*Non-Functional (static)*
Priority	*Shall: Indicates a strong obligation or a requirement that must be compulsorily fulfilled.* *Should: Indicates a recommendation or requirement that is considered important, but not necessarily mandatory.* *May: Indicates an option or permission. This word suggests that an action or condition is permitted, but not required. (This type of priority is generally not specified)*
Main goal	*Concise description of the fundamental purpose of the requirement.*
Assumptions	*Any assumptions or conditions assumed in relation to the requirement. These assumptions may include important information that is not specifically stated in the requirement but is considered essential to compliance with the requirement.* *(Examples: Valid input data, resource availability, compliance with standards or regulations, integration an interaction with existing systems, user interaction…)*
Specifications	*Detailed description of the requirement providing a clear explanation of what features or constraints the system must be met such as e.g., performance, security, scalability…*
Additional information and background	*Any additional information or comments that are relevant to the requirement. This includes clarifications or additional context as e.g., link to High-Level Requirements of the respective Technical Enabler.*
Open topics	*Any information describing known gaps or assumed future activities in conjunction with the requirement.*

8.1. Requirements for interaction with external national or central planning applications

In section 8.1 the requirements for the demonstrations related to integration between planning applications, i.e. task 4.2 in the Grant agreement, are presented.

Requirement ID	**WP4_Demo5.1_FRQ_01**
Demonstration	Demonstration 5.1
Requirement	Integration of the CMS national systems with PCS for the booking of capacity
Type	Functional
Priority	Shall
Main goal	Exchange of relevant information from the CMS system with the PCS with the objective to improve the capacity booking and harmonisation.
Assumptions	PCS and CMS must have a common protocol interface specification.
Specification	To allocate a new path CMS and PCS shall exchange data using a bidirectional connection.
Additional information and background	PCS is an international system for the path request and allocation to be used by Path Applicants, IMs, Allocation Bodies and RFCs. It supports international path coordination by ensuring that path requests and offers are harmonised by all involved parties. Linked to TE 1, High-Level Requirement 1a and Use Case FP1-DEMO-5.1-UC-1.
Open topics	Common Protocol Interface

Requirement ID	**WP4_Demo5.1_FRQ_02**
Demonstration	Demonstration 5.1 and 5.2
Requirement	CMS shall show graphical timetable
Type	Functional
Priority	Shall
Main goal	The CMS shall be able to show the timetable graphically.
Assumptions	Timetable and infrastructure data is available in the CMS.
Specification	The CMS shall show the graphical timetable as a time-distance graph.
Additional information and background	Linked to TE 1, High-Level Requirement 1b and Use Cases FP1-DEMO-5.1-UC-1, FP1-DEMO-5.2-UC-1, FP1-DEMO-5.2-UC-2 and FP1-DEMO-5.2-UC-3.
Open topics	None

Requirement ID	**WP4_Demo5.1_FRQ_02**
Demonstration	Demonstration 5.1 and 5.2
Requirement	CMS shall show graphical timetable

Type	Functional
Priority	Shall
Main goal	The CMS shall be able to show the timetable graphically.
Assumptions	Timetable and infrastructure data is available in the CMS.
Specification	The CMS shall show the graphical timetable as a time-distance graph.
Additional information and background	Linked to TE 1, High-Level Requirement 1b and Use Cases FP1-DEMO-5.1-UC-1, FP1-DEMO-5.2-UC-1, FP1-DEMO-5.2-UC-2 and FP1-DEMO-5.2-UC-3.
Open topics	None

Requirement ID	**WP4_Demo5.1_FRQ_03**
Demonstration	Demonstration 5.1
Requirement	Managing PCS train path requests
Type	Functional
Priority	Shall
Main goal	The CMS should be able to receive from the PCS train path requests and generate an updated timetable when the planner has made a feasible change
Assumptions	It is assumed that the requests are either to insert or adjust an existing train. Requests should specify the desired time window for at least one station, mandatory stops (including minimum dwell times), and train type and its characteristics.
Specification	The CMS shall manage a train path request and update the timetable to produce a new one when the train path request is managed.
Additional information and background	Linked to TE 1, High-Level Requirements 1b, 1e, 1f and Use Cases FP1-DEMO-5.1-UC-1.
Open topics	Common Protocol Interface

Requirement ID	**WP4_Demo5.1_FRQ_04**
Demonstration	Demonstration 5.1 and 5.2
Requirement	The CMS shall detect and solve conflicts.
Type	Functional
Priority	Shall (Demonstration 5.1), Should (Demonstration 5.2)
Main goal	The CMS should verify that the received train paths are feasible and solve conflicts to produce a new timetable.
Assumptions	Automatically generated train paths are macroscopically feasible. The train path is macroscopically feasible if running times, dwell times, and headway times between trains are sufficiently large. The planner is responsible for the final track allocation. Running times for selected train types shall be given. Dwell times are

	chosen by the by planner, and headway times specified by the infrastructure manager A conflict detection and resolution module shall be accessible.
Specification	The CMS shall (demo 5.1) / should (demo 5.2): • Verify that running times, dwell times, and headways between trains comply with requirements. • Detect conflicts and show them to the user. • Produce conflict-free train paths or accept solutions made by the user.
Additional information and background	Linked to TE 1, High-Level Requirements 1b, 1d and Use Cases FP1-DEMO-5.1-UC-1, FP1-DEMO-5.2-UC-1, FP1-DEMO-5.2-UC-2 and FP1-DEMO-5.2-UC-3. Connected to WP17/WP18.
Open topics	None

Requirement ID	**WP4_Demo5.2_FRQ_01**
Demonstration	Demonstration 5.2
Requirement	Visualising CMS track allocation plan
Type	Functional
Priority	Should
Main goal	The CMS should visualise the track allocation plan at stations.
Assumptions	Timetable and infrastructure data is available in the CMS.
Specification	The CMS should show track allocation at stations.
Additional information and background	Linked to TE 1, High-Level Requirement 1b and Use Cases FP1-DEMO-5.2-UC-1, FP1-DEMO-5.2-UC-2 and FP1-DEMO-5.2-UC-3. This is important for the microscopic planning and allows the planner to perform feasible track allocation at stations. For the user, the CMS shows the track allocation for one station at the time.
Open topics	None

Requirement ID	**WP4_Demo5.2_FRQ_02**
Demonstration	Demonstration 5.2
Requirement	Visualising residual capacity
Type	Functional
Priority	Shall
Main goal	The CMS shall visualise available capacity for given requests.
Assumptions	The CMS receives train path request (train path insertion or train path rescheduling). The given train path request is assumed to specify a time window for the train path on at least one station. Given the specified time window and existing trains, the CMS visualise the feasible area where the train path can be scheduled.
Specification	The CMS shall highlight the area in the graphical timetable where the train path can be scheduled.

Additional information and background	Linked to TE 1, High-Level Requirement 1b and Use Cases FP1-DEMO-5.2-UC-1, FP1-DEMO-5.2-UC-2 and FP1-DEMO-5.2-UC-3
Open topics	None

Requirement ID	**WP4_Demo5.2_FRQ_03**
Demonstration	Demonstration 5.2
Requirement	Managing train path requests
Type	Functional
Priority	Shall
Main goal	The CMS shall be able to receive train path requests and generate an updated timetable when the planner has made a feasible change.
Assumptions	It is assumed that the requests are either to insert or adjust an existing train. Requests shall specify the desired time window for at least one station, mandatory stops (including minimum dwell times), and train type.
Specification	The CMS shall import a train path. The import function requests the planner to manually enter necessary data and loads the request whenever a train path request is saved on a local directory. The system saves a new version of the timetable when the planner has handled the train path request.
Additional information and background	Linked to TE 1, High-Level Requirement 1b and Use Cases FP1-DEMO-5.2-UC-1, FP1-DEMO-5.2-UC-2 and FP1-DEMO-5.2-UC-3
Open topics	None

Requirement ID	**WP4_Demo5.2_FRQ_04**
Demonstration	Demonstration 5.2
Requirement	Automatic train path generation on macroscopic level
Type	Functional
Priority	Shall
Main goal	The CMS shall automatically generate at least one train path (if the request is feasible) within the identified residual capacity.
Assumptions	
Specification	The CMS shall: • Generate at least one train path proposal for each train path request (if the request is feasible). • Allow the planner to select objective for the train path search.
Additional information and background	Linked to TE 1, High-Level Requirement 1b and Use Cases FP1-DEMO-5.2-UC-1, FP1-DEMO-5.2-UC-2 and FP1-DEMO-5.2-UC-3. The train path search is based on macroscopic timetable data. The planner is responsible for deciding the final track allocation for the train.
Open topics	None

Requirement ID	WP4_Demo5.2_FRQ_05
Demonstration	Demonstration 5.2
Requirement	Integrated cross-border timetabling
Type	Functional
Priority	Shall
Main goal	The CMS shall enable integrated cross-border timetabling.
Assumptions	It is assumed that timetable and infrastructure data exist for both countries.
Specification	The CMS shall: • Visualise the graphical timetable for two countries in a single time-distance graph. • Generate cross-border train paths in a single integrated search. • Allow the user to define different construction rules for different parts of the network.
Additional information and background	Linked to TE 1, High-Level Requirement 1b and Use Cases FP1-DEMO-5.2-UC-1, FP1-DEMO-5.2-UC-2 and FP1-DEMO-5.2-UC-3.
Open topics	None

Requirement ID	WP4_Demo5.3_FRQ_01
Demonstration	Demonstration 5.3
Requirement	Receipt of path requests for international trains via the path coordination system PCS (RNE).
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to participate in the PCS based European coordination process of train paths for international trains.
Assumptions	PCS system and related Common Interface available.
Specification	The CMS shall receive a path request for the national capacity planning in relation to a suggested international train via the path coordination system PCS (RNE).
Additional information and background	PCS is an international system for the path request and allocation to be used by Path Applicants, IMs, Allocation Bodies and RFCs. It supports international path coordination by ensuring that path requests and offers are harmonised by all involved parties. The PCS Interface includes an Integration Platform based on PCS web services and an Internet connector of the Common Interface (CI) for exchange of the PCS TAF/TAP TSI messages of the interface. Linked to TE 1, High-Level Requirements 1a, 1b, 1c and Use Cases FP1-DEMO-5.3-UC-1 , FP1-DEMO-5.3-UC-4 .
Open topics	None

Requirement ID	WP4_Demo5.3_FRQ_02
Demonstration	Demonstration 5.3
Requirement	Submission of path offers for international trains via the path coordination system PCS (RNE) using the Common Interface.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to participate in the PCS based European coordination process of train paths for international trains using the Common Interface.
Assumptions	PCS system and related Common Interface available.
Specification	The CMS shall send a path offer from the national capacity planning in relation to a suggested international train via the path coordination system PCS (RNE).
Additional information and background	PCS is an international system for the path request and allocation to be used by Path Applicants, IMs, Allocation Bodies and RFCs. It supports international path coordination by ensuring that path requests and offers are harmonised by all involved parties. The PCS Interface includes an Integration Platform based on PCS web services and an Internet connector of the Common Interface (CI) for exchange of the PCS TAF/TAP TSI messages of the interface. Linked to TE 1, High-Level Requirements 1a, 1b and Use Cases UC- FP1-DEMO-5.3-UC-2, FP1-DEMO-5.3-UC-3, FP1-DEMO-5.3-UC-5, FP1-DEMO-5.3-UC-6.
Open topics	None

Requirement ID	WP4_Demo5.3_FRQ_03
Demonstration	Demonstration 5.3
Requirement	Import of TCR received from a maintenance planning system.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to make use of up-to-date TCR.
Assumptions	Maintenance planning system available and capable to provide new or updated TCR via an interface shared with the CMS.
Specification	The CMS shall receive new or updated TCR from a connected maintenance planning system via an interface and use them for the capacity planning.
Additional information and background	Linked to TE 1, High-Level Requirements 1f, 1g and Use Case FP1-DEMO-5.3-UC-7.
Open topics	None

Requirement ID	WP4_Demo5.3_FRQ_04
Demonstration	Demonstration 5.3
Requirement	Visibility of foreign line section behind the border location and related

	capacity objects.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to allow for an extended network view including line sections behind the border up to the next major node on the foreign network. This is required for a pre-alignment of required capacity plan changes between the two national CMSs involved.
Assumptions	Related topology information of the foreign network sections available.
Specification	The CMS shall make use of an extended national topology model including line sections behind the border up to the next major node on the foreign network.
Additional information and background	Linked to TE 1, High-Level Requirements 1e, 1f, 1g and Use Case FP1-DEMO-5.3-UC-7.
Open topics	None

Requirement ID	**WP4_Demo5.3_FRQ_05**
Demonstration	Demonstration 5.3
Requirement	Set-up and sharing change scenarios (‘sandboxes’) in the national capacity plan with the neighboring IM/CMS.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to participate in joint pre-alignment of cross-border capacity plan changes with the neighboring IM/CMS.
Assumptions	Visibility of foreign line section behind the border location and related capacity objects, i.e., WP4_Demo5.3_FRQ_004 fulfilled.
Specification	The CMS shall create a change scenario of the national capacity plan on the line section towards the border location/handling point including a TCR and impacted train paths and to share it with the neighboring IM/CMS.
Additional information and background	Linked to TE 1, High-Level Requirements 1e, 1f, 1g and Use Case FP1-DEMO-5.3-UC-7.
Open topics	None

Requirement ID	**WP4_Demo5.3_FRQ_06**
Demonstration	Demonstration 5.3
Requirement	Access rights in conjunction with capacity plan change scenarios (‘sandboxes’) shared with the neighboring IM/CMS for alignment on cross-border line sections.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to participate in joint pre-alignment of cross-border

	capacity plan changes with the neighboring IM/CMS.
Assumptions	Visibility of foreign line section behind the border location and related capacity objects, i.e., WP4_Demo5.3_FRQ_004 fulfilled.
Specification	The CMS shall respect defined access rights in conjunction with change scenarios ('sandboxes') of the capacity plan shared with the neighboring IM/CMS.
Additional information and background	Linked to TE 1, High-Level Requirements 1e, 1f, 1g and Use Case FP1-DEMO-5.3-UC-7.
Open topics	None

Requirement ID	**WP4_Demo5.3_FRQ_07**
Demonstration	Demonstration 5.3
Requirement	Status transition of change scenarios ('sandboxes') shared with the neighboring IM/CMS for alignment on cross-border line sections.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to participate in joint pre-alignment of cross-border capacity plan changes with the neighboring IM/CMS.
Assumptions	Visibility of foreign line section behind the border location and related capacity objects, i.e., WP4_Demo5.3_FRQ_004 fulfilled.
Specification	The CMS shall provide the capability for a status transition of change scenarios ('sandboxes') of the capacity plan shared with the neighboring IM/CMS. The status values need to at least comprise 'New', 'In Progress', 'Confirmed'.
Additional information and background	Linked to TE 1, High-Level Requirements 1e, 1f, 1g and Use Case FP1-DEMO-5.3-UC-7.
Open topics	None

8.2. Requirements for improved capacity allocation and new processes (Demos in Task 4.3)

In section 8.2 the requirements for the demonstrations related to capacity allocation and planning processes, e.g. TTR, are presented. This reflects Task 4.3 in the Grant agreement.

Requirement ID	**WP4_Demo5.5_FRQ_01**
Demonstration	Demonstration 5.5
Requirement	Create, display, change and delete a train path envelope (Slot).
Type	Functional
Priority	Shall

Main goal	Ability of a CMS to manage TTR capacity model objects.
Assumptions	Train path envelope data structure designed by WP 4 sufficient, see Open topics below.
Specification	The CMS shall allow the CMS Operator to create, change and delete a train path envelope (Slot) in the CMS.
Additional information and background	Linked to TE 1, High-Level Requirements 1c, 1e, and TE 2, High-Level Requirements 2a, 2b, 2c and Use Case FP1-DEMO-5.5-UC-1.
Open topics	Train path envelope data structure for TTR not harmonised yet. Expected to be available from SP/RNE in SP Task 3 until end of October 2025.

Requirement ID	**WP4_Demo5.5_FRQ_02**
Demonstration	Demonstration 5.5
Requirement	Create, display, change and delete a TCR.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to manage TTR capacity model objects.
Assumptions	TCR format from current draft of Telematics TSI sufficient to be used. See also Open topics below.
Specification	The CMS shall allow the CMS Operator to create, change and delete a TCR in the CMS.
Additional information and background	Linked to TE 1, High-Level Requirements 1c, 1e, and TE 2, High-Level Requirements 2a, 2b, 2c and Use Case FP1-DEMO-5.5-UC-1.
Open topics	TCR data structure for TTR not harmonised yet. Expected to be available from SP/RNE in SP Task 3 until end of October 2025.

Requirement ID	**WP4_Demo5.5_FRQ_03**
Demonstration	Demonstration 5.5
Requirement	Create, display, change and delete a Capacity Band.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to manage TTR capacity model objects.
Assumptions	Capacity Band data structure designed by WP4 sufficient, see Open topics below.
Specification	The CMS shall allow the CMS Operator to create, change and delete a Capacity Band in the CMS.
Additional information and background	Linked to TE 1, High-Level Requirements 1c, 1e, and TE 2, High-Level Requirements 2a, 2b, 2c and Use Case FP1-DEMO-5.5-UC-2.
Open topics	Capacity Band data structure for TTR not harmonised yet. Expected to be

	available from SP/RNE in SP Task 3 until end of October 2025.

Requirement ID	**WP4_Demo5.5_FRQ_04**
Demonstration	Demonstration 5.5
Requirement	Manage Slots as part of a Capacity Band.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to manage TTR capacity model objects.
Assumptions	Capacity Band data structure designed by WP4 sufficient, see Open topics below.
Specification	The CMS shall allow the CMS Operator to create, change and delete Slots being assigned to a Capacity Band in the CMS.
Additional information and background	Linked to TE 1, High-Level Requirements 1c, 1e, and TE 2, High-Level Requirements 2a, 2b, 2c and Use Case FP1-DEMO-5.5-UC-2.
Open topics	Capacity Band data structure for TTR not harmonised yet. Expected to be available from SP/RNE in SP Task 3 until end of October 2025.

Requirement ID	**WP4_Demo5.5_FRQ_05**
Demonstration	Demonstration 5.5
Requirement	Multi-annual capacity model objects.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to comply with TTR process (Rolling Planning).
Assumptions	None
Specification	The CMS shall allow to manage validity periods of multiple consecutive years being assigned to Capacity Bands, Slots, train paths and TCR.
Additional information and background	Linked to TE 1, High-Level Requirements 1c, 1e, and TE 2, High-Level Requirements 2a, 2b, 2c and Use Case FP1-DEMO-5.5-UC-3.
Open topics	None

Requirement ID	**WP4_Demo5.5_FRQ_06**
Demonstration	Demonstration 5.5
Requirement	Multi-annual capacity requests.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to comply with TTR process (Rolling Planning).
Assumptions	None
Specification	The CMS shall allow to accept and manage multi-annual capacity requests submitted by RU timetable planners which may include different capacity

	model object types (Capacity Bands, Slots and train paths).
Additional information and background	Linked to TE 1, High-Level Requirements 1c, 1e, and TE 2, High-Level Requirements 2a, 2b, 2c and Use Case FP1-DEMO-5.5-UC-3.
Open topics	None

Requirement ID	**WP4_Demo5.5_FRQ_07**
Demonstration	Demonstration 5.5
Requirement	Upload of Capacity Model data to ECMT (RNE).
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to comply with TTR process (Rolling Planning).
Assumptions	TTR messages are sufficient to be used as far as described in requirements WP4_Demo5.5_FRQ_01 to _04 above. Due to non-readiness of ECMT to receive the uploaded data, a simulation of the transfer is sufficient for demonstration.
Specification	The CMS shall allow the CMS Operator to initiate a transfer of Capacity Bands including Slots, train paths and TCRs to the ECMT tool (RNE) based on filter settings being available to restrict the data to be transferred.
Additional information and background	Linked to TE 1, High-Level Requirements 1c, 1e, and TE 2, High-Level Requirements 2a, 2b, 2c and Use Case FP1-DEMO-5.5-UC-4.
Open topics	The TTR messages definition is expected to be available from SP/RNE in SP Task 3 until end of October 2025. ECMT (RNE) not available yet.

Requirement ID	**WP4_Demo5.5_FRQ_08**
Demonstration	Demonstration 5.5
Requirement	Management of planned changes of the infrastructure.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to comply with TTR process.
Assumptions	None
Specification	The CMS shall allow the CMS Operator to create and change two different infrastructure data baseline versions featuring different, consecutive validity periods.
Additional information and background	Linked to TE 1, High-Level Requirements 1c, 1e, and TE 2, High-Level Requirements 2a, 2b, 2c and Use Case FP1-DEMO-5.5-UC-5.
Open topics	None

Requirement ID	**WP4_Demo5.5_FRQ_09**

Demonstration	Demonstration 5.5
Requirement	Evolving infrastructure linked to the Capacity Model.
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to comply with TTR process.
Assumptions	None
Specification	The CMS shall allow the CMS Operator to assign different infrastructure data baseline versions with consecutive validity periods to the multi-annual capacity plan which involves Capacity Bands and included Slots, train paths and TCR.
Additional information and background	Linked to TE 1, High-Level Requirements 1c, 1e, and TE 2, High-Level Requirements 2a, 2b, 2c and Use Case FP1-DEMO-5.5-UC-5.
Open topics	None

Requirement ID	**WP4_Demo5.5_FRQ_10**
Demonstration	Demonstration 5.5
Requirement	CMS report on TTR planning status
Type	Functional
Priority	Shall
Main goal	Ability of a CMS to check and approve the TTR planning status before uploading Capacity Model data to the ECMT (RNE).
Assumptions	None
Specification	The CMS shall allow the CMS Operator to generate a report showing the current status of annual (ATT) and rolling planning (RP) volumes on particular line sections for a standard day.
Additional information and background	Linked to TE 1, High-Level Requirements 1c, 1e, and TE 2, High-Level Requirements 2a, 2b, 2c and Use Case FP1-DEMO-5.5-UC-6.
Open topics	None

8.3. Requirements for integration of traffic management system with network capacity planning (Demos in Task 4.4)

In section 8.3 the requirements for the demonstrations related to integration between capacity managements system and traffic management system, i.e. task 4.4 in the Grant agreement, are presented.

Requirement ID	**WP4_Demo5.6_FRQ_01**
Demonstration	Demonstration 5.6
Requirement	CMS Capacity Plan sent to TMS
Type	Functional

Priority	Shall
Main goal	Ability of a national CMS to exchange data with the TMS.
Assumptions	None
Specification	The CMS shall allow to send a new or changed capacity plan in the national CMS to the TMS including train paths and TCR.
Additional information and background	Linked to TE 2, High-Level Requirement 2d, and TE 6, High-Level Requirements 6e, 6f and Use Case FP1-DEMO-5.6-UC-1.
Open topics	None

Requirement ID	**WP4_Demo5.6_FRQ_02**
Demonstration	Demonstration 5.6
Requirement	New or changed local plan of yard-based CMS sent to TMS
Type	Functional
Priority	Shall
Main goal	Ability of a local, yard-based CMS to exchange data with the TMS.
Assumptions	None
Specification	A local, yard-based CMS shall allow to send a new or changed local yard capacity plan to the TMS including train consist information, later / earlier arrivals in departure track, track assignment changes, changed or new track reservations, changed or new shunting activities with impact on lines.
Additional information and background	Linked to TE 2, High-Level Requirement 2d, and TE 6, High-Level Requirements 6e, 6f and Use Case FP1-DEMO-5.6-UC-2.
Open topics	None

Requirement ID	**WP4_Demo5.6_FRQ_03**
Demonstration	Demonstration 5.6
Requirement	New or changed operational TCR in TMS sent to national CMS.
Type	Functional
Priority	Shall
Main goal	Ability of the CMS to exchange data with the TMS.
Assumptions	None
Specification	The CMS shall allow to receive new or changed operational TCRs from the TMS.
Additional information and background	Linked to TE 2, High-Level Requirement 2d, and TE 6, High-Level Requirements 6e, 6f and Use Case FP1-DEMO-5.6-UC-3.
Open topics	None

Requirement ID	**WP4_Demo5.6_FRQ_04**

Demonstration	Demonstration 5.6
Requirement	New or changed operational TCR in TMS sent to local, yard-based CMS.
Type	Functional
Priority	Shall
Main goal	Ability of a local, yard-based CMS to exchange data with the TMS.
Assumptions	None
Specification	A local, yard-based CMS shall allow to receive new or changed operational TCR from the TMS.
Additional information and background	Linked to TE 2, High-Level Requirement 2d, and TE 6, High-Level Requirements 6e, 6f and Use Case FP1-DEMO-5.6-UC-3.
Open topics	None

Requirement ID	**WP4_Demo5.6_FRQ_05**
Demonstration	Demonstration 5.6
Requirement	Train position feed-back from TMS sent to national CMS.
Type	Functional
Priority	Shall
Main goal	Ability of the CMS to exchange data with the TMS.
Assumptions	None
Specification	The CMS shall allow to receive up-to-date train position feed-back from the TMS for deviation detection (track/time).
Additional information and background	Linked to TE 2, High-Level Requirement 2d, and TE 6, High-Level Requirements 6e, 6f and Use Case FP1-DEMO-5.6-UC-4.
Open topics	None

8.4. Requirements for integration of network capacity planning with yard and station capacity planning (Demos in Task 4.5)

In section 8.4 the requirements for the demonstrations related to yard/station capacity planning and its interaction with line planning, i.e. task 4.2 in the Grant agreement, are presented.

Requirement ID	**WP4_Demo5.4_FRQ_01**
Demonstration	Demonstration 5.4
Requirement	Log in functionality and permission management for different roles
Type	Functional
Priority	Shall
Main goal	Ensure that different actors can log in to YCS and see information relevant for them, and also ensure that actors can only change/add data that their role is entitled to change/add.
Assumptions	Users working as LM, YM and TM will use the system. They need to

	perform different actions in the system and are responsible for different data. The system should support the users in their respective work but also stop users from changing data that they do not have permission to change. For example, the YM should not be able to remove a track need entered by the TM.
Specification	The system shall: • Allow users to be connected to one role. • Have a log in page where users can log in. • Show different views depending on the role of the user. • Only allow users to add/change data that they have permission to add/change.
Additional information and background	Linked to TE 6, High-Level Requirements 6a, 6i, 6k and Use Case FP1-DEMO-5.4-UC-1, although data entry permission is also used in FP1-DEMO-5.4-UC-2, FP1-DEMO-5.4-UC-3, FP1-DEMO-5.4-UC-4. A lower priority role is the "look-only"-role, which is a role that allows the user to see the plan but not change any data. This role would e.g. be used by staff working on the tracks. The rules for which role that is allowed to change which data follow the following pattern: • The LM is allowed to add/change track allocation data, including track closures. • The TM is allowed to add/change TM track need data, as well as shunting data connected to the TM. • The YM is allowed to add/change YM track need data, as well as shunting data connected to the YM.
Open topics	Some discussions on which data that different roles should be allowed to change, and also work with deciding which data that should be updated automatically now that the system is using live data.

Requirement ID	**WP4_Demo5.4_FRQ_02**
Demonstration	Demonstration 5.4
Requirement	Visualise the YCS track allocation plan
Type	Functional
Priority	Shall
Main goal	The track allocation plan and planned activities shall be visualised for all users.
Assumptions	A set of activities and process steps that are considered important has been decided.
Specification	The system shall: • Show the track allocation plan. • Show activities that are planned. • Allow users to enter/change data by clicking on the relevant objects.

Additional information and background	Linked to TE 6, High-Level Requirements 6a, 6i, 6j, 6k and Use Cases FP1-DEMO-5.4-UC-1, FP1-DEMO-5.4-UC-2, FP1-DEMO-5.4-UC-3 and FP1-DEMO-5.4-UC-4.
Open topics	Overlapping planning objects may cause usability issues.

Requirement ID	**WP4_Demo5.4_FRQ_03**
Demonstration	Demonstration 5.4
Requirement	YCS should interface with TMS
Type	Functional
Priority	Shall
Main goal	When arrival and departure times are updated in the TMS, the times should automatically be updated in YCS.
Assumptions	The TMS is the master system for planned arrival and departure times. When the planned times are changed in the TMS, the TMS sends a message about this. The YCS should capture these messages and update the arrival and departure times in the track allocation plan accordingly. A further assumption is that the YCS does not need to clean the data from the TMS, i.e. the arrival/departure times will be updated whenever they are changed in the TMS.
Specification	The system shall: • Listen to updated arrival and departure times from the TMS. • Record the updated times.
Additional information and background	Linked to TE 6, High-Level Requirement 6c and Use Cases FP1-DEMO-5.4-UC-1, FP1-DEMO-5.4-UC-2. The YCS is assumed to be the master system for track assignments, therefore updated track assignments in the TMS will not be propagated to YCS.
Open topics	None

Requirement ID	**WP4_Demo5.4_FRQ_04**
Demonstration	Demonstration 5.4
Requirement	Automatic updating of the track allocation plan based on updated arrival/departure times from the TMS
Type	Functional
Priority	Shall
Main goal	When YCS receives a message from the TMS that an arrival/departure time is updated the new time is shown in the UI and certain plan updates are automatically performed.
Assumptions	The TMS sends a message when a planned arrival/departure time is updated. A set of rules for how the plan should be updated in case of changed arrival/departure times exists.

Specification	The system shall: • Show the latest updated arrival/departure time from the TMS. • Adapt the track allocation plan according to the provided rules. • Show any new conflicts that occur as a result of the updated arrival/departure time.
Additional information and background	Linked to TE 6, High-Level Requirements 6c, 6j and Use Cases UC- FP1-DEMO-5.4-UC-1, FP1-DEMO-5.4-UC-2. Note that only the track allocation plan is updated automatically, the track needs will not be automatically updated as this may break the internal planning at the YM/TM, e.g. staff work plan. In general, the automatic updating never make the track allocations more restrictive but move the allocation to cover the new arrival or departure time. For example, in case of an early arrival, the end of the track allocation interval will not be changed, but the start will be moved to the new arrival time.
Open topics	None

Requirement ID	**WP4_Demo5.4_FRQ_05**
Demonstration	Demonstration 5.4
Requirement	Data entry for different roles
Type	Functional
Priority	Shall
Main goal	Users can enter planning data relevant for their roles.
Assumptions	There is a set of rules specifying which data each user should enter.
Specification	The system shall: • Allow users to add/change data that they are responsible for. • Show when data is missing. • Disallow impossible data entries.
Additional information and background	Linked to TE 6, High-Level Requirements 6a, 6i, 6j and Use Cases FP1-DEMO-5.4-UC-1, FP1-DEMO-5.4-UC-2, FP1-DEMO-5.4-UC-3, FP1-DEMO-5.4-UC-4 The rules for which role that may change which data is given in FRQ_1. Impossible data entries are e.g. intervals with an end time before the start time.
Open topics	None

Requirement ID	**WP4_Demo5.4_FRQ_06**
Demonstration	Demonstration 5.4
Requirement	YCS can detect conflicts and visualise them.
Type	Functional
Priority	Shall
Main goal	The YCS should detect when data points conflict with one another and show this to the user.

Assumptions	There is a set of rules specifying when data points are in conflict.
Specification	The system shall: • Detect when data points conflict with one another. • Visualise the conflicts. • Provide a text explanation for each conflict. • Remove the conflict from the UI when it has been resolved.
Additional information and background	Linked to TE 6, High-Level Requirement 6j and Use Cases FP1-DEMO-5.4-UC-1, FP1-DEMO-5.4-UC-2, FP1-DEMO-5.4-UC-3, FP1-DEMO-5.4-UC-4. A data point may be involved in more than one conflict at any given time. Conflicts are e.g. two track allocation interval that overlap, or when a track need interval is outside its respective track allocation interval.
Open topics	Overlapping conflicts may cause usability problems.

Requirement ID	**WP4_Demo5.4_FRQ_07**
Demonstration	Demonstration 5.4
Requirement	Conflict resolution suggestions
Type	Functional
Priority	Shall
Main goal	The YCS should suggest a way that a conflict could be resolved.
Assumptions	There is a set of rules that specify which conflict resolution actions YCS should suggest for the user.
Specification	The system shall: • Generate suggested conflict resolution actions. • Enable the user to select or choose a conflict resolution action.
Additional information and background	Linked to TE 6, High-Level Requirement 6j and Use Cases FP1-DEMO-5.4-UC-1, FP1-DEMO-5.4-UC-2, FP1-DEMO-5.4-UC-3, FP1-DEMO-5.4-UC-4. The first instance of solution suggestions will be quite simple strategies, and will, to some extent, mainly automate simple tasks and thereby reduce the mental workload of the users. However, in the future more advanced strategies and more global optimisation may be considered. Note that there is no guarantee that YCS can resolve a conflict as there may not be enough track capacity. This is particularly true in this first instance when more simple conflict resolution strategies are used to suggest a solution.
Open topics	The more advanced strategies and global optimization methods mentioned above, including their usability.

Requirement ID	**WP4_Demo5.4_NFRQ_01**
Demonstration	Demonstration 5.4
Requirement	Response time
Type	Non functional
Priority	Shall

Main goal	The YCS shall show updated information to all relevant users within seconds after receiving it.
Assumptions	Updated data are received either from user input or from the TMS.
Specification	The system shall show the updated data within seconds to all relevant users.
Additional information and background	Linked to TE 6, High-Level Requirements 6a, 6c, 6i, 6j, 6k and Use Cases FP1-DEMO-5.4-UC-1, FP1-DEMO-5.4-UC-2, FP1-DEMO-5.4-UC-3, FP1-DEMO-5.4-UC-4. To make the system useful for planning during operations, the data handling must be fairly fast. This non-functional requirement excludes the generation of conflict resolution suggestions generated by advanced strategies and global optimisation as this is a task where the user can accept a longer waiting time.
Open topics	None

Requirement ID	**WP4_Demo5.7_FRQ_01**
Demonstration	Demonstration 5.7
Requirement	CMS sends new or changed capacity plan to local, yard-based CMS.
Type	Functional
Priority	Shall
Main goal	Ability of the CMS to exchange data with the local, yard-based CMS.
Assumptions	None
Specification	The CMS shall send a new or changed capacity plan to the local, yard-based CMS including train paths and TCRs.
Additional information and background	Linked to TE 6, High-Level Requirement 6b, 6c, 6d, 6f, 6g, 6h, 6j and Use Case FP1-DEMO-5.7-UC-1.
Open topics	None

Requirement ID	**WP4_Demo5.7_FRQ_002**
Demonstration	Demonstration 5.7
Requirement	Local, yard-based CMS receives new or changed capacity plan from the CMS.
Type	Functional
Priority	Shall
Main goal	Ability of the CMS to exchange data with the local, yard-based CMS.
Assumptions	None
Specification	The local, yard-based CMS shall receive a new or changed capacity plan from the CMS including train paths and TCRs.
Additional information and background	Linked to TE 6, High-Level Requirement 6b, 6c, 6d, 6f, 6g, 6h, 6j and Use Case FP1-DEMO-5.7-UC-1.

Open topics	None

Requirement ID	**WP4_Demo5.7_FRQ_03**
Demonstration	Demonstration 5.7
Requirement	Local, yard-based CMS sends new or changed local plan to the CMS.
Type	Functional
Priority	Shall
Main goal	Ability of the CMS to exchange data with the local, yard-based CMS.
Assumptions	None
Specification	The local, yard-based CMS shall send a new or changed local plan of to the CMS including train consists, later arrivals/departures in departure tracks, track assignment changes, changed or new track reservations, changed or new shunting activities with impact on lines.
Additional information and background	Linked to TE 6, High-Level Requirement 6b, 6c, 6d, 6f, 6g, 6h, 6j and Use Case FP1-DEMO-5.7-UC-1.
Open topics	None

Requirement ID	**WP4_Demo5.7_FRQ_004**
Demonstration	Demonstration 5.7
Requirement	CMS receives new or changed local plan from the local, yard-based CMS.
Type	Functional
Priority	Shall
Main goal	Ability of the CMS to exchange data with the local, yard-based CMS.
Assumptions	None
Specification	The CMS shall receive a new or changed local plan from the local, yard-based CMS including train consists, later arrivals/departures in departure tracks, track assignment changes, changed or new track reservations, changed or new shunting activities with impact on lines.
Additional information and background	Linked to TE 6, High-Level Requirement 6b, 6c, 6d, 6f, 6g, 6h, 6j and Use Case FP1-DEMO-5.7-UC-1.
Open topics	None

9. Conclusions

The present report constitutes the deliverable D4.1 *Integration of planning systems* of the WP 4 *Development - Integration of planning systems and processes including cross-border planning* in the EU-Rail Project MOTIONAL.

The objective of this report is to provide a comprehensive and aligned set of detailed Use Cases and related functional and non-functional requirements for demonstrations related to the technical capabilities that are to be developed and demonstrated under WP 4 and WP 5. These capabilities are addressing the Technical Enablers TE 1 “European cross-border scheduling with international train path planning”, TE 2 “Improved capacity allocation using rolling planning and TTR” as well as TE 6 “Integration of TMS with a) yard capacity planning and b) station capacity planning”.

The specification of the in total 26 detailed Use Cases and 43 requirements delivered in this report was based on the related state-of-the-art analysis in WP4 and inputs provided by inter alia, WP 3, the System Pillar and RNE as well as the Flagship projects IAM4RAIL (MAWP Destination 3) and TRANS4M-R (MAWP Destination 5). The creation of this report followed a classical requirement engineering approach featuring repeated sequences of iterative “information gathering” and writing stages being separated by review phases.

The present specifications are used by the involved project partners as an applicable base for the implementation of demonstrations 1 to 7 of the WS 1.1 within the FA 1 (MAWP Destination 1). However, the project partners are aware of potential needs to improve or enhance the Use Cases and requirements as a consequence of feedback sessions maintained throughout the WP5 especially in conjunction with specific network characteristics or planning situations faced when extending tests and network data scope within the different demonstration environments during the activities performed in the WP5. The finalised Use Cases and requirements considering the feedback, lessons learnt, and other insights are planned to be incorporated into the future deliverable D5.1 of WP 5.

10. References

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