



ERJU SYSTEM PILLAR

50 System Architecture Description CCS System



System Architecture Description CCS System

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1 Preamble


1.1 Purpose

This document describes the System Architecture as required per  SPPRAMSS-349 - [EN 50126-1:2017] phase 5 (architecture and apportionment of system requirements) for the CCS-System. It contains a general description of the system architecture to justify the architectural decisions. The goal is to convey a clear and overall understanding of the considered principles which led to the chosen architecture and to describe how the system architecture provides a solution to the system requirements.


1.2 Intended audience


Domain experts involved in the tendering, development, verification, validation or assessment of the system under consideration (e.g. System Engineers, RAMSS Engineers, Developer, Tester, Assessors, etc).

Note:



This documentation is not intended for a general audience. For a comprehensive understanding of Traffic CS, please refer to the Traffic CS System Concept  SPP-19049 - Traffic CS System Concept V1.0].



1.3 Document context

As shown in  SPP-18424, the System Architecture Description of the CCS-System is based on the following inputs:

-  SPP-18056 - TCS_System Definition CCS System_V0.3]:
This document describes the capabilities to be provided by the CCS-System.



Note:



The traceability between the artefacts of the  SPP-18056 - System Definition CCS-System R1] and the System Architecture Description of the CCS-System is shown in  SPP-19705 - TCS_System Architecture Description CCS System: Traceability Report_V0.3].

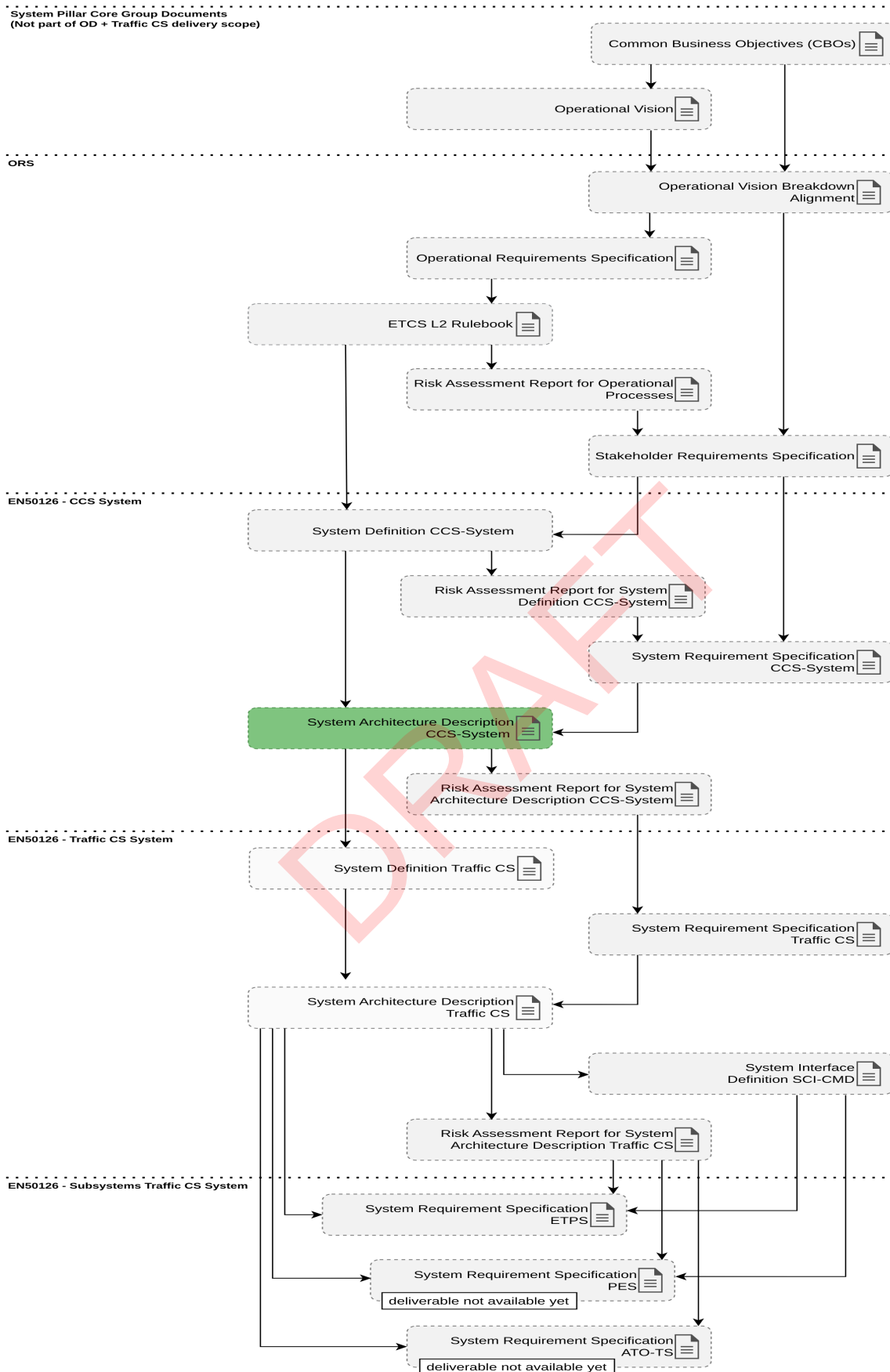
-  SPP-18063 - TCS_System Requirement Specification CCS System_V0.4]:
This document contains the system requirements defined for the CCS-System. Due to the MBSE approach used within System Pillar, the system requirements contain mainly non-functional requirements. Functional requirements are covered by the capabilities defined in  SPP-18056 - TCS_System Definition CCS System_V0.3]:

The System Architecture Description of the CCS-System contains the allocation of the capabilities and requirements defined by the input documents to the different System Level 4 systems. Therefore, the System Architecture Description of the CCS-System is an input document for:

- the subsequent Risk and Hazard Analysis
- the System Definitions of the identified System Level 4 systems
- the System Requirement Specifications of the identified System Level 4 systems

The  SPP-18355 - EET_Systems Engineering Management Plan_V4.0 ] explains in more detail the dependencies between the different documents.

 SPP-18424 below shows the System Architecture Description of the CCS-System in the context of the overall document list (see also  SPP-19283 - Release Note ESR1.0]).



ID	SPP-18424
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1.4 Glossary

1.4.1 Terms and definitions

Term	Definition
Single European Railway Area	Defining the fundamental design principles and process for adopting a functional architecture for rail as a system, with a focus on CCS, CMS and TMS supporting the implementation of the SERA (Single European Railway Area)

1.4.2 Abbreviations

Abbreviation	Definition
SERA	Single European Railway Area



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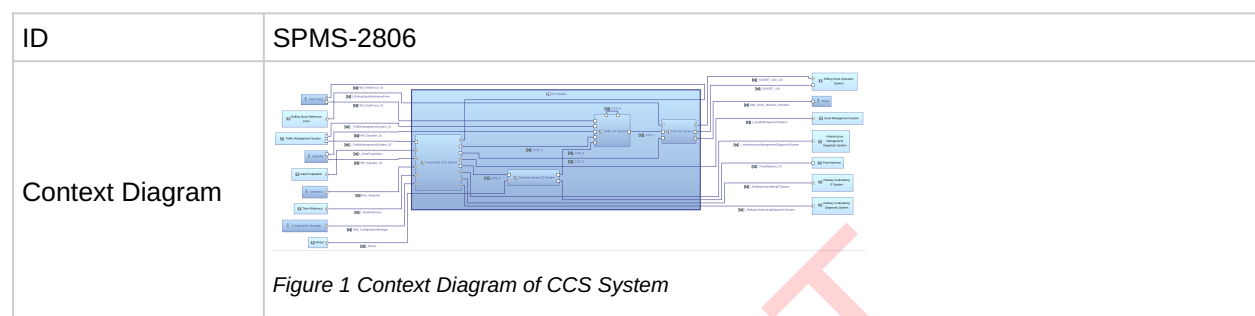
2 Overview

2.1 Overall architecture description

This chapter shows the decomposition of the CCS-System into its subsystems and the involved interfaces.

CCS System

The  SPMS-2806 - CCS System is a vital framework in railway operations, ensuring the safe and efficient movement of trains. By utilising precise signalling and train protection mechanisms, it helps to prevent collisions and mitigate other operational risks. The  SPMS-2806 - CCS System enables seamless and secure train operations across diverse railway networks, prioritising safety and reliability.




2.2 Architecture decisions

Will be provided in a future release and contain:

- architectural principles
- design decisions made

which led to the choice of the system architecture.

2.3 Functional distribution

 SPMS-3826 shows the function allocation to the different subsystems of the CCS-System.

[LAB] CCS System [Function allocation]

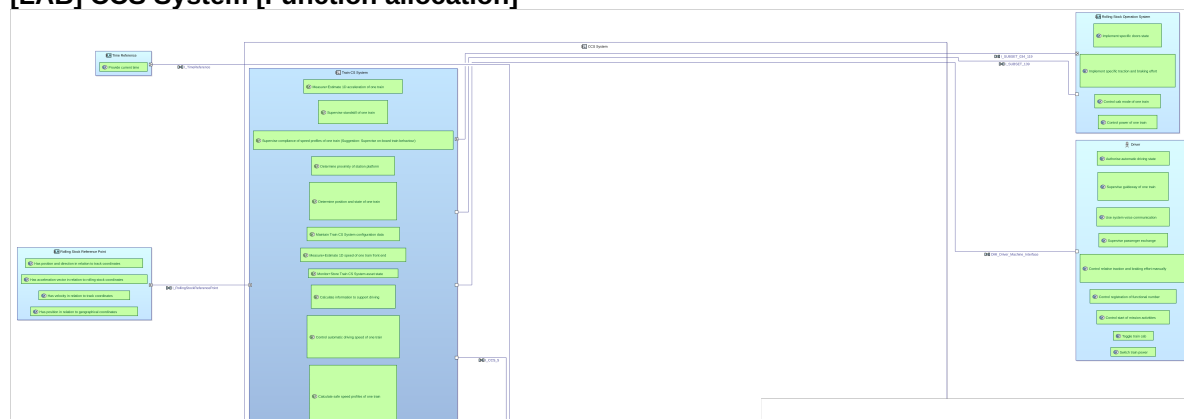


Figure 2 Diagram [LAB] CCS System [Function allocation]

ID	SPMS-3826
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2.4 Geographical distribution

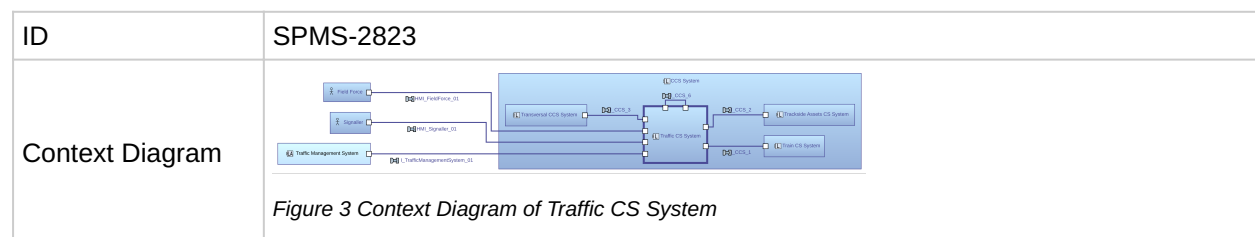
Not applicable. Will be defined for each subsystem in other documentation.

3 Subsystems

3.1 Traffic CS System

Traffic CS System

Is responsible to execute the operational plan while controlling and reporting infrastructure usages. The execution of a plan means controls infrastructure users and infrastructure states in a compatible and safe way to fulfil the plan at the right point in time. For unsafe events (wrong-side failures or events e.g input or process failures) it reacts directly with safe reactions.



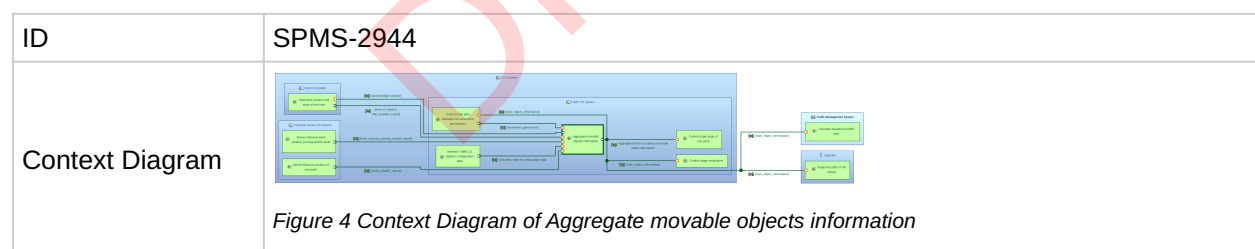
3.1.1 Functions





















3.1.1-1 - Aggregate movable objects information























This function is allocated to SPMS-2823 - Traffic CS System.

This function aggregates and stores information (e.g. position) submitted by different actors (e.g., Trackside Asset CS, Train CS) and outputs of other functions into an operational state representation of movable objects.


Movable objects are defined as trains and wagons that either submit localisation and/or additional data (such as speed and status) or are localised by alternative technologies such as TTD systems. The scope is extended to include track workers (actor Field Force) that have an own localisation device. Further extension of the scope can be done in the following analysis steps.



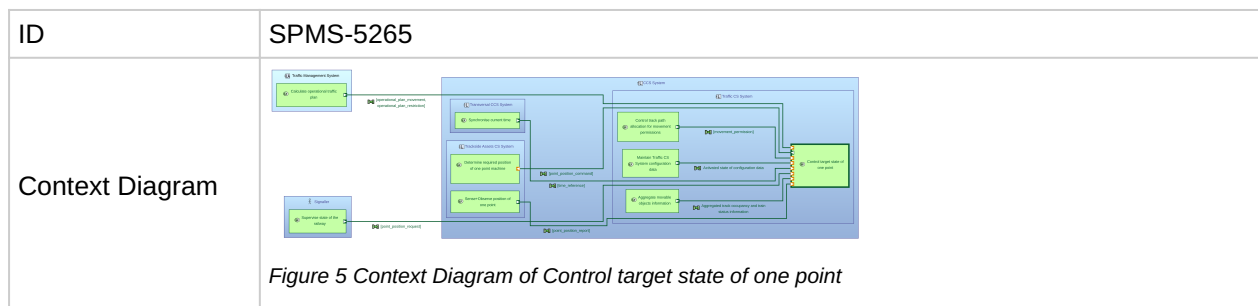
Input exchanges	Input exchanges	Source function	Function allocated to	
	 SPMS-3039 - Allocated track path <ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-2874 - Control track path allocation for movement permissions	 SPMS-2823 - Traffic CS Sy	
	 SPMS-3212 - Determined train position and state <ul style="list-style-type: none">  SPMS-7042 - end_of_mission  SPMS-6664 - train_position_report 	 SPMS-2878 - Determine position and state of one train	 SPMS-2807 - Train CS Sys	
	<p>No exchange items allocated on</p>  SPMS-3130 - Activated state of configuration data.	 SPMS-2840 - Maintain Traffic CS System configuration data	 SPMS-2823 - Traffic CS Sy	
	 SPMS-5268 - Observed point position <ul style="list-style-type: none">  SPMS-3283 - point_position_report 	 SPMS-2914 - Sense+Observe position of one point	 SPMS-2818 - Trackside As	
	 SPMS-4648 - Observed track vacancy proving section state <ul style="list-style-type: none">  SPMS-6569 - track_vacancy_proving_section_report 	 SPMS-2919 - Sense+Observe track vacancy proving section state	 SPMS-2818 - Trackside As	
































Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-3021 - Aggregated track occupancy and train status information <ul style="list-style-type: none">  SPMS-5562 - train_object_information 	 SPMS-2874 - Control track path allocation for movement permissions	 SPMS-2823 - Traffic CS System
	 SPMS-3028 - Aggregated track occupancy and train status information <ul style="list-style-type: none">  SPMS-5562 - train_object_information 	 SPMS-2929 - Control usage restrictions	 SPMS-2823 - Traffic CS System
	 SPMS-3050 - Aggregated track occupancy and train status information <ul style="list-style-type: none">  SPMS-5562 - train_object_information 	 SPMS-2843 - Calculate operational traffic plan	 SPMS-2813 - Traffic Management System
	 SPMS-4666 - Aggregated track occupancy and train status information <ul style="list-style-type: none">  SPMS-5562 - train_object_information 	 SPMS-2853 - Supervise state of the railway	 SPMS-2827 - Signaller
	<p>No exchange items allocated on  SPMS-5274 - Aggregated track occupancy and train status information.</p> <p>No exchange items allocated on  SPMS-7765 - Acknowledged position.</p>	 SPMS-5265 - Control target state of one point  SPMS-2878 - Determine position and state of one train	 SPMS-2823 - Traffic CS System  SPMS-2807 - Train CS System

3.1.1-2 - Control target state of one point

This function is allocated to  SPMS-2823 - Traffic CS System.

This function determines the target position of one point for the planned movement of the train on the intended path. Furthermore, this function receives the requested point position from the Signaller and controls the point position according to this when the respective point is not allocated to an intended path. The time it takes to set the point, and other constraints like electrical load shall be taken into account.



Input exchanges	Input exchanges	Source function	Function allocated to	
	 SPMS-4546 - Required operational traffic plan <ul style="list-style-type: none">  SPMS-2370 - operational_plan_movement  SPMS-5548 - operational_plan_restriction 	 SPMS-2843 - Calculate operational traffic plan	 SPMS-2813 - Traffic Manager	
	 SPMS-3228 - Observed point position <ul style="list-style-type: none">  SPMS-3283 - point_position_report 	 SPMS-2914 - Sense+Observe position of one point	 SPMS-2818 - Trackside Assets	
	No exchange items allocated on  SPMS-5274 - Aggregated track occupancy and train status information.	 SPMS-2944 - Aggregate movable objects information	 SPMS-2823 - Traffic CS System	
	 SPMS-5275 - Requested point position <ul style="list-style-type: none">  SPMS-2386 - point_position_request 	 SPMS-2853 - Supervise state of the railway	 SPMS-2827 - Signaller	
	 SPMS-5276 - Provided current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-2922 - Synchronise current time	 SPMS-2819 - Transversal CC	
	No exchange items allocated on  SPMS-5277 - Activated state of configuration data.	 SPMS-2840 - Maintain Traffic CS System configuration data	 SPMS-2823 - Traffic CS System	
	 SPMS-5278 - Allocated track path <ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-2874 - Control track path allocation for movement permissions	 SPMS-2823 - Traffic CS System	
Output exchanges	Output exchanges	Target function	Function allocated to	
	 SPMS-3227 - Required point position <ul style="list-style-type: none">  SPMS-3286 - point_position_command 	 SPMS-2851 - Determine required position of one point machine	 SPMS-2818 - Trackside Assets CS System	

3.1.1-3 - Control track path allocation for movement permissions

This function is allocated to  SPMS-2823 - Traffic CS System.

This function performs a safe allocation of a track path for a planned train movement, i.e.

- determines track paths that need to be allocated for train movement
- checks that the track path for a planned train movement is clear

- checks whether there are no conflicting track paths already allocated to other train movements nor restrictions already defined
- supervises and verifies that the switchable trackside assets for train movement are in the required position
- locks required switchable trackside assets
- generates the authorisation and if relevant the track conditions for movement for one train inside the allocated track path and reports it to the train.
- checks if the first position reported by a train fits to the expected position from the operational plan. It means for example that before executing the operational plan this cross check is performed and that in case of deviations the operational plan is not executed. Based on this Traffic CS information, Traffic Management System would then have to update the operational plan accordingly so that it fits again and can be executed.

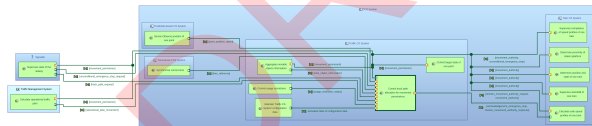
Note: The function also involves flank protection supervision that can be either ensured by trackside assets being part of the requested track path or by logic (if railway vehicle movements close to the train can be excluded).





































This function also performs the safe allocation of a track path as a reaction to a failure (the requested track path is transmitted by the function "Determine reaction to failure").







The function also releases track parts that are no longer used for train movement after checking the corresponding rules, e.g.,

- releases allocated portion of track path which is overpassed and therefore no more occupied by the train
- ensures that allocated portion of track in front of the train will not be released if it is still to be used by the train
- releases allocated portion of track in front of the train if it is ensured to not be used anymore (e.g. overlap release at the end of the journey)

Note: We currently do not have a data model defined and therefore there might be room for interpretation if flank protection is contained in the requested track path. The current assumption is that the function checks that all rules are fulfilled to either reserve or release a track path.

ID	SPMS-2874
Context Diagram	 <p>Figure 6 Context Diagram of Control track path allocation for movement permissions</p>

Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-3220 - Observed point position <ul style="list-style-type: none">  SPMS-3283 - point_position_report 	 SPMS-2914 - Sense+Observe position of one point	 SPMS-2818 - Trackside Ass
	 SPMS-3021 - Aggregated track occupancy and train status information <ul style="list-style-type: none">  SPMS-5562 - train_object_information 	 SPMS-2944 - Aggregate movable objects information	 SPMS-2823 - Traffic CS Sys
	<p>No exchange items allocated on</p>  SPMS-3131 - Activated state of configuration data.	 SPMS-2840 - Maintain Traffic CS System configuration data	 SPMS-2823 - Traffic CS Sys
	 SPMS-3000 - Usage restriction state <ul style="list-style-type: none">  SPMS-2398 - usage_restriction_status 	 SPMS-2929 - Control usage restrictions	 SPMS-2823 - Traffic CS Sys
	 SPMS-5424 - Respond and request for movement authority data <ul style="list-style-type: none">  SPMS-7235 - acknowledgement_emergency_stop  SPMS-7242 - shorten_movement_authority_response 	 SPMS-2872 - Calculate safe speed profiles of one train	 SPMS-2807 - Train CS Syst
	 SPMS-3079 - Required operational traffic plan <ul style="list-style-type: none">  SPMS-2370 - operational_plan_movement 	 SPMS-2843 - Calculate operational traffic plan	 SPMS-2813 - Traffic Manag
	 SPMS-3123 - Requested track path <ul style="list-style-type: none">  SPMS-2418 - track_path_request 	 SPMS-2853 - Supervise state of the railway	 SPMS-2827 - Signaller
	 SPMS-3042 - Provided current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-2922 - Synchronise current time	 SPMS-2819 - Transversal C
	 SPMS-7719 - Request emergency stop <ul style="list-style-type: none">  SPMS-7137 - unconditional_emergency_stop_request 	 SPMS-2853 - Supervise state of the railway	 SPMS-2827 - Signaller

Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-3039 - Allocated track path <ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-2944 - Aggregate movable objects information	 SPMS-2823 - Traffic CS System
	 SPMS-3044 - Allocated track path <ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-2853 - Supervise state of the railway	 SPMS-2827 - Signaller
	 SPMS-3052 - Allocated track path <ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-2843 - Calculate operational traffic plan	 SPMS-2813 - Traffic Manager
	 SPMS-5278 - Allocated track path <ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-5265 - Control target state of one point	 SPMS-2823 - Traffic CS System
	 SPMS-3065 - Allocated track path <ul style="list-style-type: none">  SPMS-5446 - shorten_movement_authority_request  SPMS-5835 - movement_authority 	 SPMS-2872 - Calculate safe speed profiles of one train	 SPMS-2807 - Train CS System
	 SPMS-3232 - Allocated track path <ul style="list-style-type: none">  SPMS-5835 - movement_authority 	 SPMS-2878 - Determine position and state of one train	 SPMS-2807 - Train CS System
	 SPMS-6982 - Allocated track path <ul style="list-style-type: none">  SPMS-5835 - movement_authority 	 SPMS-6971 - Determine proximity of station platform	 SPMS-2807 - Train CS System
	 SPMS-7661 - Allocated track path <ul style="list-style-type: none">  SPMS-5835 - movement_authority  SPMS-7234 - unconditional_emergency_stop 	 SPMS-2921 - Supervise compliance of speed profiles of one train	 SPMS-2807 - Train CS System
	 SPMS-2991 - Allocated track path <ul style="list-style-type: none">  SPMS-5835 - movement_authority 	 SPMS-2897 - Supervise standstill of one train	 SPMS-2807 - Train CS System

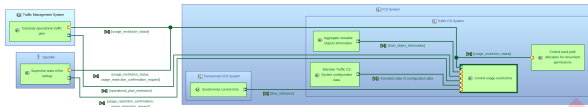
3.1.1-4 - Control usage restrictions

This function is allocated to  SPMS-2823 - Traffic CS System.

This function:

- Creates a planned usage restriction area according to the operational plan restriction and stores it until the time for the activation has been reached.

- Creates an unplanned usage restriction area on a Signaller request.
- checks if all conditions for the activation/deactivation of usage restrictions are fulfilled taking into account feedback from Signaller as well as already active usage restriction areas and the current operational state i.e. states of trackside assets and trains currently using the infrastructure (e.g. track occupancies, train-specific authorisations, allocated track paths)).
- If necessary request trackside asset states or derive additional usage restrictions associated to specific usage restrictions.
- informs the respective functions about the activation or deactivation of a relevant usage restrictions (e.g. "request target state of one trackside asset" about a blocked trackside asset).
- provides information about the execution state of usage restrictions
- stores the activated usage restrictions




























ID	SPMS-2929		
Context Diagram	<div></div> <p>Figure 7 Context Diagram of Control usage restrictions</p>		
Input exchanges	Input exchanges	Source function	Function allocated to
	No exchange items allocated on SPMS-3135 - Activated state of configuration data.	SPMS-2840 - Maintain Traffic CS System configuration data	SPMS-2823 - Traffic CS System
	SPMS-2988 - Required operational traffic plan <ul style="list-style-type: none">SPMS-5548 - operational_plan_restriction	SPMS-2843 - Calculate operational traffic plan	SPMS-2813 - Traffic Management System
	SPMS-3028 - Aggregated track occupancy and train status information <ul style="list-style-type: none">SPMS-5562 - train_object_information	SPMS-2944 - Aggregate movable objects information	SPMS-2823 - Traffic CS System
	SPMS-3078 - Provided usage restriction state <ul style="list-style-type: none">SPMS-4826 - usage_restriction_confirmationSPMS-2407 - usage_restriction_request	SPMS-2853 - Supervise state of the railway	SPMS-2827 - Signaller
	SPMS-3045 - Provided current time <ul style="list-style-type: none">SPMS-2412 - time_reference	SPMS-2922 - Synchronise current time	SPMS-2819 - Transversal CCS System

Output exchanges	Output exchanges	Target function	Function allocated to
	SPMS-3000 - Usage restriction state <ul style="list-style-type: none"> SPMS-2398 - usage_restriction_status	SPMS-2874	SPMS-2823 - Traffic CS System
	SPMS-3173 - Usage restriction state <ul style="list-style-type: none"> SPMS-2398 - usage_restriction_status	SPMS-2843	SPMS-2813 - Traffic CS System
	SPMS-3174 - Usage restriction state <ul style="list-style-type: none"> SPMS-2398 - usage_restriction_status SPMS-4827 - usage_restriction_confirmation_request	SPMS-2853	SPMS-2827 - Traffic CS System

3.1.1-5 - Generate train-specific timetable information

This function is allocated to SPMS-2823 - Traffic CS System.
This function generates a non-safety time-table from the operational plan movement. This time-table is only operational plan and time dependant.

ID	SPMS-5332
Context Diagram	<p>Figure 8 Context Diagram of Generate train-specific timetable information</p>

Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-5333 - Required operational traffic plan <ul style="list-style-type: none">  SPMS-2370 - operational_plan_movement 	 SPMS-2843 - Calculate operational traffic plan	 SPMS-2813 - Traffic Management System
	 SPMS-5334 - Provided current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-2922 - Synchronise current time	 SPMS-2819 - Transversal CCS System
	No exchange items allocated on  SPMS-5335 - Activated state of configuration data.	 SPMS-2840 - Maintain Traffic CS System configuration data	 SPMS-2823 - Traffic CS System
Output exchanges	No exchange items allocated on  SPMS-5515 - Determined train position and state.	 SPMS-2878 - Determine position and state of one train	 SPMS-2807 - Train CS System
	Output exchanges	Target function	Function allocated to
	 SPMS-3182 - Generated train-specific timetable and infrastructure information <ul style="list-style-type: none">  SPMS-5666 - train_specific_timetable_information 	 SPMS-2862 - SPMS-2807 of Train CS System	 SPMS-2807 - Train CS System
	 SPMS-4549 - Generated train-specific timetable information <ul style="list-style-type: none">  SPMS-5666 - train_specific_timetable_information 	 SPMS-2928 - SPMS-2807 of Train CS System	 SPMS-2807 - Train CS System
	 SPMS-3067 - Generated train-specific timetable information <ul style="list-style-type: none">  SPMS-5666 - train_specific_timetable_information  SPMS-7718 - train_specific_infrastructure_information 	 SPMS-2870 - SPMS-2807 of Train CS System	 SPMS-2807 - Train CS System

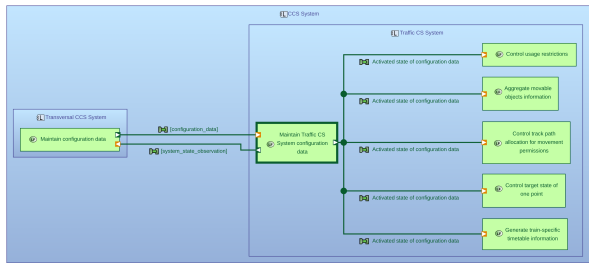























3.1.1-6 - Maintain Traffic CS System configuration data

This function is allocated to  SPMS-2823 - Traffic CS System.

This functions preloads, and activates preloaded system configuration version. For configuration changes that have an implication on the operation or safety, this function also stops the operation of the system for system configuration purposes before the activation, and restarts the operation of the system for system configuration purposes after the activation of the new system configuration. Finally, this function distributes the new active system configuration data.

This function stores, updates and delivers static trackside attribute data. The data is synchronised downstream from the Transversal CCS data storage and no changes are provided upstream from this

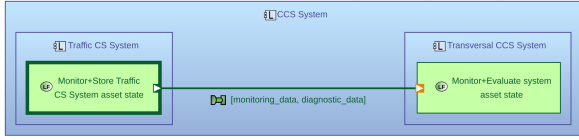





function. As the function does not manipulate the data in any way, the input is the same as the output.

ID	SPMS-2840		
Context Diagram	 <p>Figure 9 Context Diagram of Maintain Traffic CS System configuration data</p>		
Input exchanges	Input exchanges  SPMS-2993 - Actual state of configuration data <ul style="list-style-type: none">  SPMS-6465 - configuration_data 	Source function  SPMS-2834 - Maintain configuration data	Function allocated to  SPMS-2819 - Transversal CCS System
Output exchanges	Output exchanges  SPMS-3211 - Activated state of configuration data <ul style="list-style-type: none">  SPMS-3251 - system_state_observation 	Target function  SPMS-2834 - Maintain configuration data	Function allocated to  SPMS-2819 - Transversal CCS System
Output exchanges	No exchange items allocated on  SPMS-3130 - Activated state of configuration data.	 SPMS-2944 - Aggregate movable objects information	 SPMS-2823 - Traffic CS System
	No exchange items allocated on  SPMS-3131 - Activated state of configuration data.	 SPMS-2874 - Control track path allocation for movement permissions	 SPMS-2823 - Traffic CS System
	No exchange items allocated on  SPMS-3135 - Activated state of configuration data.	 SPMS-2929 - Control usage restrictions	 SPMS-2823 - Traffic CS System
	No exchange items allocated on  SPMS-5277 - Activated state of configuration data.	 SPMS-5265 - Control target state of one point	 SPMS-2823 - Traffic CS System
	No exchange items allocated on  SPMS-5335 - Activated state of configuration data.	 SPMS-5332 - Generate train-specific timetable information	 SPMS-2823 - Traffic CS System

3.1.1-7 - Monitor+Store Traffic CS System asset state

This function is allocated to  SPMS-2823 - Traffic CS System.

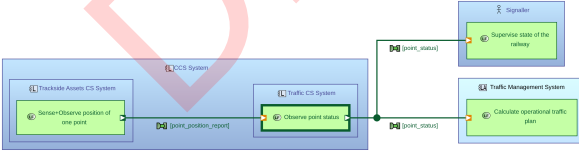




This function monitors and stores the state of  SPMS-2823 - Traffic CS System, in order to provide asset conditions continuously.









ID	SPMS-2895		
Context Diagram	 <p>Figure 10 Context Diagram of Monitor+Store Traffic CS System asset state</p>		
Input exchanges	No inputs defined for this function.		
Output exchanges	Output exchanges  SPMS-3062 - Monitoring and diagnostic data <ul style="list-style-type: none">  SPMS-6988 - monitoring_data  SPMS-6989 - diagnostic_data 	Target function  SPMS-4502 - Monitor+Evaluate system asset state	Function allocated to  SPMS-2819 - Transversal CCS System

3.1.1-8 - Observe point status

This function is allocated to  SPMS-2823 - Traffic CS System.

This function observes the overall state of one point including its availability and its position compared to the required point position.

ID	SPMS-2886		
Context Diagram	 <p>Figure 11 Context Diagram of Observe point status</p>		
Input exchanges	Input exchanges  SPMS-3209 - Observed point position <ul style="list-style-type: none">  SPMS-3283 - point_position_report 	Source function  SPMS-2914 - Sense+Observe position of one point	Function allocated to  SPMS-2818 - Trackside Assets CS System

Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-3189 - Observed point status <ul style="list-style-type: none">  SPMS-5288 - point_status 	 SPMS-2853 - Supervise state of the railway	 SPMS-2827 - Signaller
Output exchanges	 SPMS-5339 - Observed point status <ul style="list-style-type: none">  SPMS-5288 - point_status 	 SPMS-2843 - Calculate operational traffic plan	 SPMS-2813 - Traffic Management System

3.1.2 States

Will be provided in a future release.

3.1.3 Non-functional requirements

Will be provided in a future release.

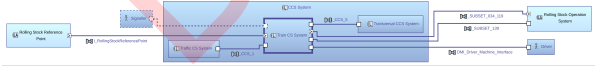
3.1.4 Installation spaces

Will be provided in a future release.

3.2 Train CS System

Train CS System

Is responsible, but not exclusively for all relevant functions related to train protection and automatic driving from the point of view of one train.













































































ID	SPMS-2807
Context Diagram	 <p>Figure 12 Context Diagram of Train CS System</p>

3.2.1 Functions

3.2.1-1 - Calculate information to support driving

This function is allocated to  SPMS-2807 - Train CS System.

This function provides supporting information for the driver in helping driving the train and opening the doors : remaining departure time, approaching a stopping point, stopping accuracy.

ID	SPMS-2862														
Context Diagram	<div></div> <p>Figure 13 Context Diagram of Calculate information to support driving</p>														
Input exchanges	<table><tr><th>Input exchanges</th><th>Source function</th><th>Function allocated to</th></tr><tr><td><div> SPMS-3182 - Generated train-specific timetable and infrastructure information<ul style="list-style-type: none"> SPMS-5666 - train_specific_timetable_information</div></td><td><div> SPMS-5332 - </div></td><td><div> SPMS-2822 - Traffic Control System</div></td></tr><tr><td><div> SPMS-6525 - Observed state of doors<ul style="list-style-type: none"> SPMS-2405 - door_state</div></td><td><div> SPMS-4559 - </div></td><td><div> SPMS-2822 - Rolling Stock Control</div></td></tr><tr><td><div> SPMS-6993 - Determined train position and state<ul style="list-style-type: none"> SPMS-5667 - train_front_end_position_estimation</div></td><td><div> SPMS-2878 - </div></td><td><div> SPMS-2822 - Train Control System</div></td></tr></table>	Input exchanges	Source function	Function allocated to	<div> SPMS-3182 - Generated train-specific timetable and infrastructure information<ul style="list-style-type: none"> SPMS-5666 - train_specific_timetable_information</div>	<div> SPMS-5332 - </div>	<div> SPMS-2822 - Traffic Control System</div>	<div> SPMS-6525 - Observed state of doors<ul style="list-style-type: none"> SPMS-2405 - door_state</div>	<div> SPMS-4559 - </div>	<div> SPMS-2822 - Rolling Stock Control</div>	<div> SPMS-6993 - Determined train position and state<ul style="list-style-type: none"> SPMS-5667 - train_front_end_position_estimation</div>	<div> SPMS-2878 - </div>	<div> SPMS-2822 - Train Control System</div>		
Input exchanges	Source function	Function allocated to													
<div> SPMS-3182 - Generated train-specific timetable and infrastructure information<ul style="list-style-type: none"> SPMS-5666 - train_specific_timetable_information</div>	<div> SPMS-5332 - </div>	<div> SPMS-2822 - Traffic Control System</div>													
<div> SPMS-6525 - Observed state of doors<ul style="list-style-type: none"> SPMS-2405 - door_state</div>	<div> SPMS-4559 - </div>	<div> SPMS-2822 - Rolling Stock Control</div>													
<div> SPMS-6993 - Determined train position and state<ul style="list-style-type: none"> SPMS-5667 - train_front_end_position_estimation</div>	<div> SPMS-2878 - </div>	<div> SPMS-2822 - Train Control System</div>													
Output exchanges	<table><tr><th>Output exchanges</th><th>Target function</th><th>Function allocated to</th></tr><tr><td><div> SPMS-3186 - Indicated supporting information<ul style="list-style-type: none"> SPMS-2409 - stopping_point_information SPMS-2408 - driving_information</div></td><td><div> SPMS-2836 - Control relative traction and braking effort manually</div></td><td><div> SPMS-2822 - Driver</div></td></tr><tr><td><div> SPMS-3187 - Indicated supporting information<ul style="list-style-type: none"> SPMS-2409 - stopping_point_information SPMS-2408 - driving_information</div></td><td><div> SPMS-2933 - Supervise guideway of one train</div></td><td><div> SPMS-2822 - Driver</div></td></tr><tr><td><div> SPMS-4561 - Indicated supporting information<ul style="list-style-type: none"> SPMS-2409 - stopping_point_information</div></td><td><div> SPMS-4560 - Supervise passenger exchange</div></td><td><div> SPMS-2822 - Driver</div></td></tr></table>	Output exchanges	Target function	Function allocated to	<div> SPMS-3186 - Indicated supporting information<ul style="list-style-type: none"> SPMS-2409 - stopping_point_information SPMS-2408 - driving_information</div>	<div> SPMS-2836 - Control relative traction and braking effort manually</div>	<div> SPMS-2822 - Driver</div>	<div> SPMS-3187 - Indicated supporting information<ul style="list-style-type: none"> SPMS-2409 - stopping_point_information SPMS-2408 - driving_information</div>	<div> SPMS-2933 - Supervise guideway of one train</div>	<div> SPMS-2822 - Driver</div>	<div> SPMS-4561 - Indicated supporting information<ul style="list-style-type: none"> SPMS-2409 - stopping_point_information</div>	<div> SPMS-4560 - Supervise passenger exchange</div>	<div> SPMS-2822 - Driver</div>		
Output exchanges	Target function	Function allocated to													
<div> SPMS-3186 - Indicated supporting information<ul style="list-style-type: none"> SPMS-2409 - stopping_point_information SPMS-2408 - driving_information</div>	<div> SPMS-2836 - Control relative traction and braking effort manually</div>	<div> SPMS-2822 - Driver</div>													
<div> SPMS-3187 - Indicated supporting information<ul style="list-style-type: none"> SPMS-2409 - stopping_point_information SPMS-2408 - driving_information</div>	<div> SPMS-2933 - Supervise guideway of one train</div>	<div> SPMS-2822 - Driver</div>													
<div> SPMS-4561 - Indicated supporting information<ul style="list-style-type: none"> SPMS-2409 - stopping_point_information</div>	<div> SPMS-4560 - Supervise passenger exchange</div>	<div> SPMS-2822 - Driver</div>													

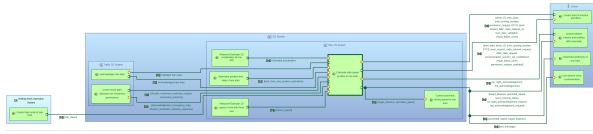
3.2.1-2 - Calculate safe speed profiles of one train

This function is allocated to  SPMS-2807 - Train CS System.









































This function calculates the safe driving limits for the train based on the input of train data and trackside conditions. It outputs the safety relevant speed profiles, and the speed/distance information to the Driver in











































order to allow him to drive the train and safely supervise the speed limits and distance targets. In more detail, this means that this function uses a braking model to calculate train-specific deceleration curves which are provided in the train-specific authorisation, so that a train can stop before reaching a danger point.

Additionally this function can accept or reject the request for a cooperative shortening of a movement authority.

ID	SPMS-2872
Context Diagram	 <p>The context diagram shows the 'Calculate safe speed profiles of one train' function (SPMS-2872) as a central blue box. It has several interfaces: 'Train' (green box) on the left, 'Movement Authority' (green box) on the right, 'Braking Model' (green box) on the right, 'Speed Limit' (green box) on the right, and 'Distance Target' (green box) on the right. Arrows indicate data flow between these interfaces and the central function.</p> <p><i>Figure 14 Context Diagram of Calculate safe speed profiles of one train</i></p>

DRAFT

Input exchanges	Input exchanges	Source function	Function allocated to	
	 SPMS-3065 - Allocated track path <ul style="list-style-type: none">  SPMS-5446 - shorten_movement_authority_request  SPMS-5835 - movement_authority 	 SPMS-2874 - Control track path allocation for movement permissions	 SPMS-2823 - Traffic CS Sys	
	 SPMS-3153 - Determined train position and state <ul style="list-style-type: none">  SPMS-5667 - train_front_end_position_estimation 	 SPMS-2878 - Determine position and state of one train	 SPMS-2807 - Train CS Sys	
	<p>No exchange items allocated on</p>  SPMS-3148 - Estimated acceleration.	 SPMS-2880 - Measure+Estimate 1D acceleration of one train	 SPMS-2807 - Train CS Sys	
	 SPMS-3165 - Estimated speed <ul style="list-style-type: none">  SPMS-2400 - current_speed 	 SPMS-2892 - Measure+Estimate 1D speed of one train front end	 SPMS-2807 - Train CS Sys	
	 SPMS-6236 - Activated cab status <ul style="list-style-type: none">  SPMS-2385 - cab_status 	 SPMS-2936 - Control cab mode of one train	 SPMS-2820 - Rolling Stock	
	 SPMS-3239 - Provided driver information <ul style="list-style-type: none">  SPMS-2406 - driver_ID  SPMS-2371 - train_data  SPMS-2414 - train_running_number  SPMS-6691 - permission_request  SPMS-7169 - ETCS_level  SPMS-7171 - contact_RBC  SPMS-7174 - radio_network_id  SPMS-7111 - train_data_validation  SPMS-7216 - virtual_balise_cover 	 SPMS-2852 - Control start of mission activities	 SPMS-2822 - Driver	
	 SPMS-6981 - Acknowledged permission <ul style="list-style-type: none">  SPMS-6602 - on_sight_acknowledgement  SPMS-7109 - trip_acknowledgement 	 SPMS-2836 - Control relative traction and braking effort manually	 SPMS-2822 - Driver	
	<p>No exchange items allocated on</p>  SPMS-7121 - Acknowledged train data.	 SPMS-7115 - Acknowledge train data	 SPMS-2823 - Traffic CS Sys	

Output exchanges	Output exchanges	Target function	Function allocated to	
	 SPMS-3190 - Calculated supervision limits <ul style="list-style-type: none">  SPMS-2373 - permitted_speed  SPMS-2375 - target_distance 	 SPMS-2933 - Supervise guideway of one train	 SPMS-2822 - Driver	
	 SPMS-3072 - Calculated supervision limits <ul style="list-style-type: none">  SPMS-2375 - target_distance  SPMS-2373 - permitted_speed 	 SPMS-2870 - Control automatic driving speed of one train	 SPMS-2807 - Train CS Sys	
	 SPMS-3191 - Calculated supervision limits <ul style="list-style-type: none">  SPMS-2375 - target_distance  SPMS-2373 - permitted_speed  SPMS-5939 - level_crossing_status  SPMS-6693 - on_sight_acknowledgement_request  SPMS-7110 - trip_acknowledgement_request 	 SPMS-2836 - Control relative traction and braking effort manually	 SPMS-2822 - Driver	
	 SPMS-6992 - Calculated supervision limits <ul style="list-style-type: none">  SPMS-6928 - text_message 	 SPMS-6952 - Use system voice communication	 SPMS-2822 - Driver	
	 SPMS-5424 - Respond and request for movement authority data <ul style="list-style-type: none">  SPMS-7235 - acknowledgement_emergency_stop  SPMS-7242 - shorten_movement_authority_response 	 SPMS-2874 - Control track path allocation for movement permissions	 SPMS-2823 - Traffic CS Sy	
	 SPMS-3188 - Indicated start of mission data <ul style="list-style-type: none">  SPMS-2371 - train_data  SPMS-2406 - driver_ID  SPMS-2414 - train_running_number  SPMS-7168 - ETCS_level_request  SPMS-7170 - radio_network_request  SPMS-7175 - RBC_data_request  SPMS-7176 - communication_session_not_established  SPMS-7216 - virtual_balise_cover  SPMS-7237 - permission_request_available 	 SPMS-2852 - Control start of mission activites	 SPMS-2822 - Driver	
	No exchange items allocated on  SPMS-7120 - Validated train data.	 SPMS-7115 - Acknowledge train data	 SPMS-2823 - Traffic CS Sy	

3.2.1-3 - Control automatic driving speed of one train

This function is allocated to  SPMS-2807 - Train CS System.

This function manages the automatic driving mode of one train by determining the driving speed and controlling the required traction and brake effort. It is designed to operate at Grades of Automation (GoA) higher than GoA 1, ensuring efficient train operations. The function transitions through the following states (See Subset-125 chapter 9):

Available: Available to be used but is not actively controlling the train.

Ready for engagement: All conditions are fulfilled

Engaged: The driver engaged the automatic driving and the function actively controlling the train's speed and the required traction and braking forces.





























Disengaging: The system is in the process of transferring control back to the driver.











When the driver engages this function to initiate automatic driving, the system autonomously manages the train's speed and traction/brake efforts, optimizing for efficiency under the specified automation grade.

This function need to follow a train-specific timetable constrained by:

- secure path/danger point
- overspeed limits (static and dynamics)
- driving style settings
- train-specific overspeed limits
- train-specific braking models
- jerk limits constraints for passenger comfort or specific freight constraints

[illegible]

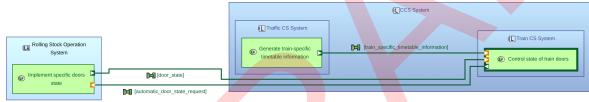












Input exchanges	Input exchanges	Source function	Function allocated to	
	 SPMS-3067 - Generated train-specific timetable information <ul style="list-style-type: none">  SPMS-5666 - train_specific_timetable_information  SPMS-7718 - train_specific_infrastructure_information 	 SPMS-5332 - Generate train-specific timetable information	 SPMS-2823 - Traffic CS Sys	
	 SPMS-3072 - Calculated supervision limits <ul style="list-style-type: none">  SPMS-2375 - target_distance  SPMS-2373 - permitted_speed 	 SPMS-2872 - Calculate safe speed profiles of one train	 SPMS-2807 - Train CS Sys	
	 SPMS-3169 - Estimated speed <ul style="list-style-type: none">  SPMS-2400 - current_speed 	 SPMS-2892 - Measure+Estimate 1D speed of one train front end	 SPMS-2807 - Train CS Sys	
	 SPMS-3154 - Determined train position and state <ul style="list-style-type: none">  SPMS-5667 - train_front_end_position_estimation 	 SPMS-2878 - Determine position and state of one train	 SPMS-2807 - Train CS Sys	
	 SPMS-3051 - Applied level of traction and brake effort <ul style="list-style-type: none">  SPMS-2394 - traction_applied  SPMS-2395 - traction_brake_set_value  SPMS-5482 - brake_applied 	 SPMS-2837 - Implement specific traction and braking effort	 SPMS-2820 - Rolling Stock	
	 SPMS-3055 - Authorised automatic driving state <ul style="list-style-type: none">  SPMS-3868 - automatic_driving_state_authorisation 	 SPMS-2907 - Authorise automatic driving state	 SPMS-2822 - Driver	

Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-3014 - Required relative traction and brake effort <ul style="list-style-type: none">  SPMS-2393 - relative_traction_brake_request  SPMS-2396 - traction_request  SPMS-5481 - brake_request 	 SPMS-2837 - Implement specific traction and braking effort	 SPMS-2820 - Rolling Stock Operation System
	 SPMS-3185 - Indicated automatic driving state <ul style="list-style-type: none">  SPMS-3869 - automatic_driving_state_indication 	 SPMS-2907 - Authorise automatic driving state	 SPMS-2822 - Driver

3.2.1-4 - Control state of train doors

This function is allocated to  SPMS-2807 - Train CS System.

This function sends requests to the rolling stock to control the state of doors based on the required plan, which provides the required side to open (left, right, both) as well as the door opening mode (automatic - manual is covered by the function Calculate Information to support Driving) and which doors to open (depending on the platform length and train position).

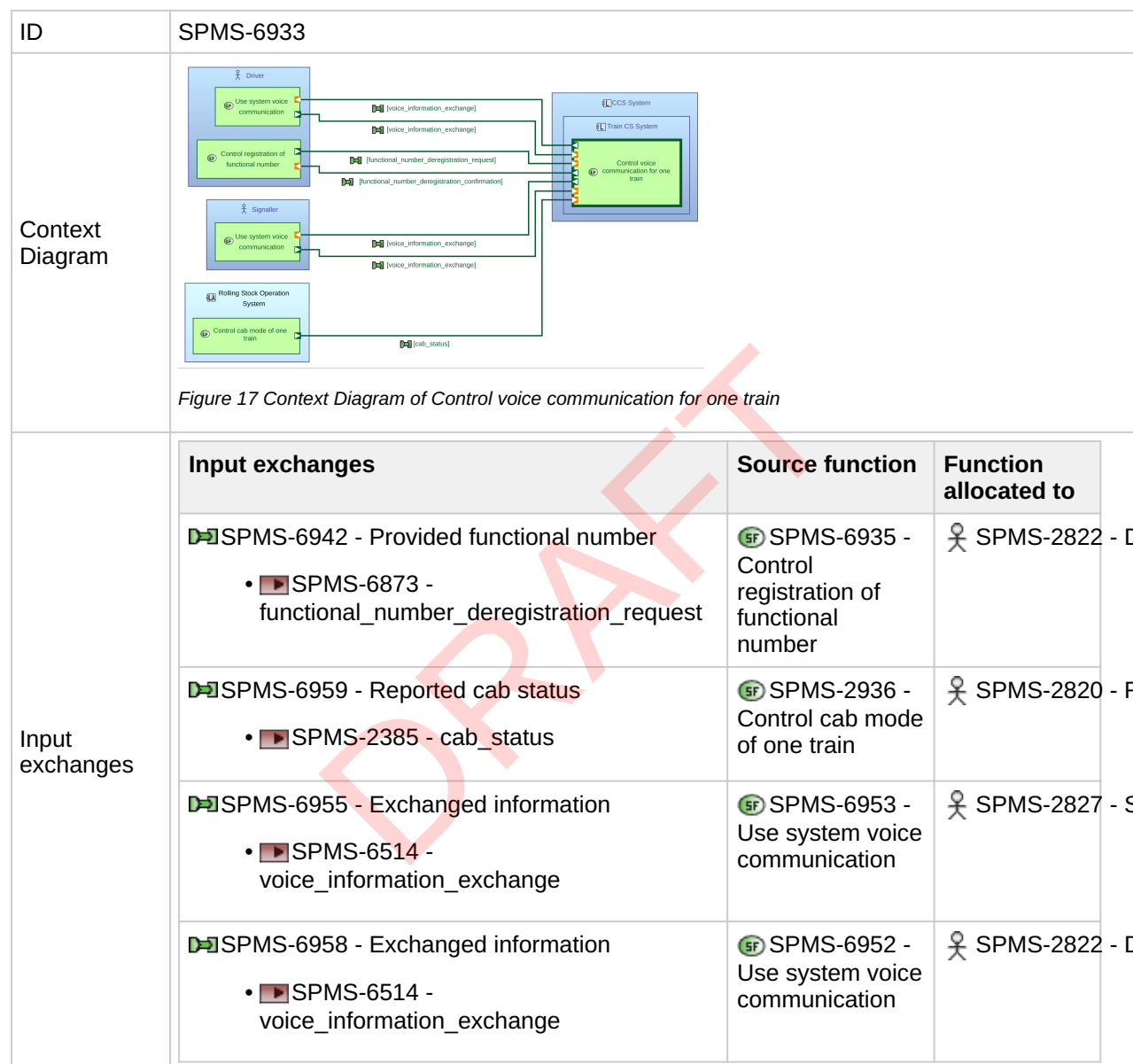
ID	SPMS-2928		
Context Diagram	 <p>Figure 16 Context Diagram of Control state of train doors</p>		
Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-4549 - Generated train-specific timetable information <ul style="list-style-type: none">  SPMS-5666 - train_specific_timetable_information 	 SPMS-5332 - Generate train-specific timetable information	 SPMS-2823 - Traffic CS System
	 SPMS-4562 - Observed state of doors <ul style="list-style-type: none">  SPMS-2405 - door_state 	 SPMS-4559 - Implement specific doors state	 SPMS-2820 - Rolling Stock Operation System
Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-4564 - Requested state of doors <ul style="list-style-type: none">  SPMS-2397 - automatic_door_state_request 	 SPMS-4559 - Implement specific doors state	 SPMS-2820 - Rolling Stock Operation System













3.2.1-5 - Control voice communication for one train

This function is allocated to  SPMS-2807 - Train CS System.

This function covers all the voice communication applications needs in according to specifications referred in TSI CCS 4.2.4.2.

One part of the functionality is the registration and de-registration of the functional number. By this, it enables the activation and deactivation of the voice communication channel between driver and signaller.



	Output exchanges	Target function	Function allocated to	
Output exchanges	 SPMS-6956 - Exchanged information <ul style="list-style-type: none">  SPMS-6514 - voice_information_exchange 	 SPMS-6953 - Use system voice communication	 SPMS-2827 - Signaller	
	 SPMS-6957 - Exchanged information <ul style="list-style-type: none">  SPMS-6514 - voice_information_exchange 	 SPMS-6952 - Use system voice communication	 SPMS-2822 - Driver	
	 SPMS-6975 - Indicated functional number <ul style="list-style-type: none">  SPMS-6966 - functional_number_deregistration_confirmation 	 SPMS-6935 - Control registration of functional number	 SPMS-2822 - Driver	

3.2.1-6 - Determine position and state of one train

This function is allocated to  SPMS-2807 - Train CS System.

This function reports, observes and monitors the following parameters of one train:

- front and rear end
- speed
- direction
- train mode (= power off, = standby, ...)
- Confirmation of successful joining operation
- Confirmation of successful splitting operation

[illegible]

Input exchanges	Input exchanges	Source function	Function allocated to
	No exchange items allocated on SPMS-7765 - Acknowledged position.	SPMS-2944 - Aggregate movable objects information	SPMS-2823 - Traffic CS Sys
	SPMS-3171 - Estimated speed • SPMS-2400 - current_speed	SPMS-2892 - Measure+Estimate 1D speed of one train front end	SPMS-2807 - Train CS Syst
	SPMS-3004 - Actual present geographical coordinate • SPMS-6520 - actual_geographical_coordinate	SPMS-2945 - Has position in relation to geographical coordinates	SPMS-2809 - Rolling Stock
	SPMS-3007 - Actual present position and direction in track coordinates • SPMS-6521 - actual_position_and_direction	SPMS-2949 - Has position and direction in relation to track coordinates	SPMS-2809 - Rolling Stock
	SPMS-3232 - Allocated track path • SPMS-5835 - movement_authority	SPMS-2874 - Control track path allocation for movement permissions	SPMS-2823 - Traffic CS Sys
	SPMS-7766 - Provided driver information • SPMS-2371 - train_data • SPMS-2414 - train_running_number • SPMS-7169 - ETCS_level • SPMS-7111 - train_data_validation	SPMS-2852 - Control start of mission activities	SPMS-2822 - Driver

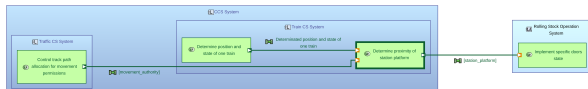
Output exchanges	Output exchanges	Target function	Function allocated to
	No exchange items allocated on SPMS-6977 - Determinated position and state of one train.	SPMS-6971 - SPMS-2807 - Traffic CS System	SPMS-2807 - Train CS System
	SPMS-3153 - Determined train position and state <ul style="list-style-type: none"> SPMS-5667 - train_front_end_position_estimation 	SPMS-2872 - SPMS-2807 - Train CS System	SPMS-2807 - Train CS System
	SPMS-3154 - Determined train position and state <ul style="list-style-type: none"> SPMS-5667 - train_front_end_position_estimation 	SPMS-2870 - SPMS-2807 - Train CS System	SPMS-2807 - Train CS System
	No exchange items allocated on SPMS-5515 - Determined train position and state.	SPMS-5332 - SPMS-2823 - Traffic CS System	SPMS-2823 - Traffic CS System
	SPMS-3212 - Determined train position and state <ul style="list-style-type: none"> SPMS-7042 - end_of_mission SPMS-6664 - train_position_report 	SPMS-2944 - SPMS-2807 - Train CS System	SPMS-2807 - Train CS System
	SPMS-6993 - Determined train position and state <ul style="list-style-type: none"> SPMS-5667 - train_front_end_position_estimation 	SPMS-2862 - SPMS-2807 - Train CS System	SPMS-2807 - Train CS System

3.2.1-7 - Determine proximity of station platform

This function is allocated to SPMS-2807 - Train CS System.

This function generates the station platform information when the train is approaching the platform station and train is about to stop. This function acts as trigger to start the unlocking process of the train doors.

Note: This function is also used to communicate track conditions to the on-board CCS (such as SS026 track conditions optional packets)

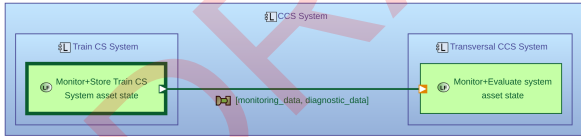
ID	SPMS-6971
Context Diagram	 <p>The diagram shows the 'Determine proximity of station platform' function within the 'Train CS System' boundary. It receives an 'Inherent_activity' input from the 'Traffic CS System' and sends a 'Station_product' output to the 'Traffic CS System'. The function itself is composed of several sub-processes: 'Determine position and state of one train', 'Determine position and state of one train', 'Determine position and state of one train', and 'Determine position and state of one train'.</p>
Figure 19 Context Diagram of Determine proximity of station platform	

Input exchanges	Input exchanges	Source function	Function allocated to
	No exchange items allocated on SPMS-6977 - Determinated position and state of one train.	SPMS-2878 - Determine position and state of one train	SPMS-2807 - Train CS System
	SPMS-6982 - Allocated track path <ul style="list-style-type: none"> SPMS-5835 - movement_authority 	SPMS-2874 - Control track path allocation for movement permissions	SPMS-2823 - Traffic CS System
Output exchanges	Output exchanges	Target function	Function allocated to
	SPMS-6973 - Determinated distance to the next station platform and properties <ul style="list-style-type: none"> SPMS-6990 - station_platform 	SPMS-4559 - Implement specific doors state	SPMS-2820 - Rolling Stock Operation System

3.2.1-8 - Monitor+Store Train CS System asset state

This function is allocated to SPMS-2807 - Train CS System.

This function monitors and stores the state of Train CS System, in order to provide asset conditions continuously.

ID	SPMS-6884		
Context Diagram	 <p>Figure 20 Context Diagram of Monitor+Store Train CS System asset state</p>		
Input exchanges	No inputs defined for this function.		
Output exchanges	Output exchanges	Target function	Function allocated to
	SPMS-6909 - Monitoring and diagnostic data <ul style="list-style-type: none"> SPMS-6988 - monitoring_data SPMS-6989 - diagnostic_data 	SPMS-4502 - Monitor+Evaluate system asset state	SPMS-2819 - Transversal CCS System

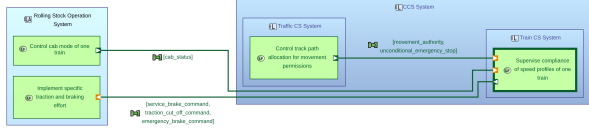
3.2.1-9 - Supervise compliance of speed profiles of one train

This function is allocated to SPMS-2807 - Train CS System.

This function ensure safe speed of one train by supervising the compliance of the train speed with the speed profiles of that train. If the speed-profile is about to be violated or is actually violated, an emergency brake reaction is required or full service brake or traction cut off. This function triggers emergency reaction

as response to an emergency command.

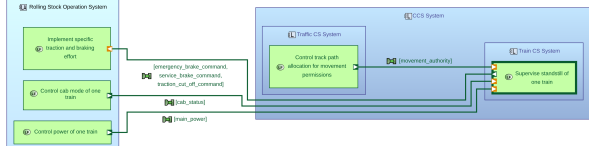
This function needs the cab status in order to determine the supervision mode in Train CS.



















ID	SPMS-2921		
Context Diagram	 <p>Figure 21 Context Diagram of Supervise compliance of speed profiles of one train</p>		
Input exchanges	Input exchanges <ul style="list-style-type: none"> SPMS-7661 - Allocated track path <ul style="list-style-type: none"> SPMS-5835 - movement_authority SPMS-7234 - unconditional_emergency_stop SPMS-2995 - Reported cab status <ul style="list-style-type: none"> SPMS-2385 - cab_status 	Source function <ul style="list-style-type: none"> SPMS-2874 - Control track path allocation for movement permissions SPMS-2936 - Control cab mode of one train 	Function allocated to <ul style="list-style-type: none"> SPMS-2823 - Traffic CS System SPMS-2820 - Rolling Stock Operation System
Output exchanges	Output exchanges <ul style="list-style-type: none"> SPMS-3020 - Required state of full service brake or traction cut off or emergency brake <ul style="list-style-type: none"> SPMS-2380 - service_brake_command SPMS-2382 - traction_cut_off_command SPMS-2378 - emergency_brake_command 	Target function <ul style="list-style-type: none"> SPMS-2837 - Implement specific traction and braking effort 	Function allocated to <ul style="list-style-type: none"> SPMS-2820 - Rolling Stock Operation System

3.2.1-10 - Supervise standstill of one train

This function is allocated to SPMS-2807 - Train CS System.

This function supervises the train movement in case of standstill. For example it can react with emergency brake command in case of violation of the roll-away distance threshold.

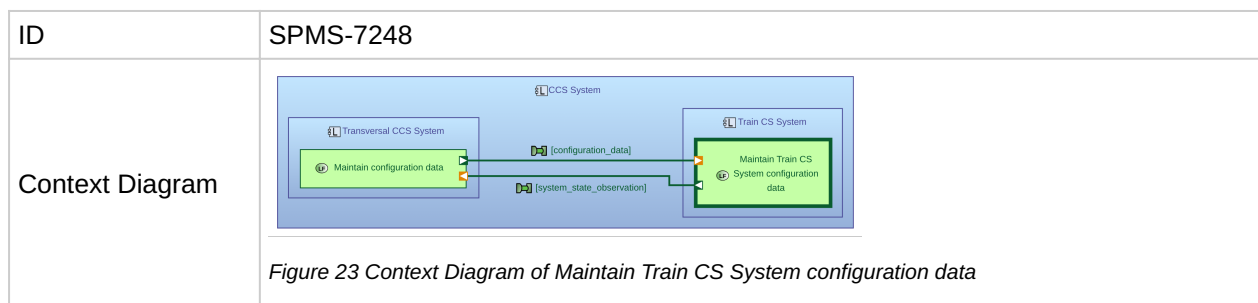
ID	SPMS-2897		
Context Diagram	 <p>Figure 22 Context Diagram of Supervise standstill of one train</p>		









Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-2991 - Allocated track path <ul style="list-style-type: none">  SPMS-5835 - movement_authority 	 SPMS-2874 - Control track path allocation for movement permissions	 SPMS-2823 - Traffic CS System
	 SPMS-6974 - Main power status <ul style="list-style-type: none">  SPMS-6872 - main_power 	 SPMS-6932 - Control power of one train	 SPMS-2820 - Rolling Stock Operation System
	 SPMS-6983 - Reported cab status <ul style="list-style-type: none">  SPMS-2385 - cab_status 	 SPMS-2936 - Control cab mode of one train	 SPMS-2820 - Rolling Stock Operation System
Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-3022 - Required state of parking brake or emergency brake <ul style="list-style-type: none">  SPMS-2378 - emergency_brake_command  SPMS-2380 - service_brake_command  SPMS-2382 - traction_cut_off_command 	 SPMS-2837 - Implement specific traction and braking effort	 SPMS-2820 - Rolling Stock Operation System

3.2.1-11 - Maintain Train CS System configuration data

This function is allocated to  SPMS-2807 - Train CS System.

This functions preloads, and activates preloaded system configuration version. For configuration changes that have an implication on the operation or safety, this function also stops the operation of the system for system configuration purposes before the activation, and restarts the operation of the system for system configuration purposes after the activation of the new system configuration. Finally, this function distributes the new active system configuration data.

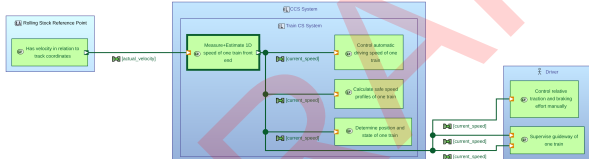






























Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-7250 - Configuration data <ul style="list-style-type: none">  SPMS-6465 - configuration_data 	 SPMS-2834 - Maintain configuration data	 SPMS-2819 - Transversal CCS System
Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-7251 - Activated state of configuration data <ul style="list-style-type: none">  SPMS-3251 - system_state_observation 	 SPMS-2834 - Maintain configuration data	 SPMS-2819 - Transversal CCS System

3.2.1-12 - Measure+Estimate 1D speed of one train front end

This function is allocated to  SPMS-2807 - Train CS System.

This function calculates the speed of the trains front end in relation to infrastructure. Additionally, this function uses the 3D kinematic information for more reliability.

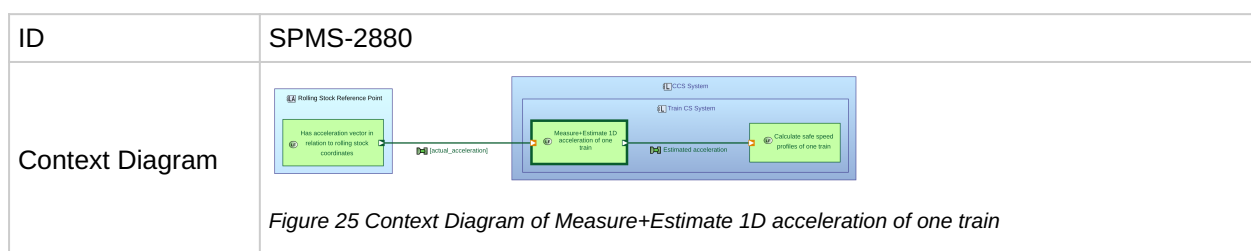
ID	SPMS-2892		
Context Diagram	 <p>Figure 24 Context Diagram of Measure+Estimate 1D speed of one train front end</p>		
Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-3013 - Actual velocity <ul style="list-style-type: none">  SPMS-6522 - actual_velocity 	 SPMS-2951 - Has velocity in relation to track coordinates	 SPMS-2809 - Rolling Stock Reference Point








Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-3165 - Estimated speed <ul style="list-style-type: none"> •  SPMS-2400 - current_speed 	 SPMS-2872 - Calculate safe speed profiles of one train	 SPMS-2807 - Train CS System
	 SPMS-3169 - Estimated speed <ul style="list-style-type: none"> •  SPMS-2400 - current_speed 	 SPMS-2870 - Control automatic driving speed of one train	 SPMS-2807 - Train CS System
	 SPMS-3171 - Estimated speed <ul style="list-style-type: none"> •  SPMS-2400 - current_speed 	 SPMS-2878 - Determine position and state of one train	 SPMS-2807 - Train CS System
	 SPMS-4510 - Estimated speed <ul style="list-style-type: none"> •  SPMS-2400 - current_speed 	 SPMS-2836 - Control relative traction and braking effort manually	 SPMS-2822 - Driver
	 SPMS-5338 - Estimated speed <ul style="list-style-type: none"> •  SPMS-2400 - current_speed 	 SPMS-2933 - Supervise guideway of one train	 SPMS-2822 - Driver
	 SPMS-6994 - Estimated speed <ul style="list-style-type: none"> •  SPMS-2400 - current_speed 	 SPMS-2933 - Supervise guideway of one train	 SPMS-2822 - Driver

3.2.1-13 - Measure+Estimate 1D acceleration of one train

This function is allocated to  SPMS-2807 - Train CS System.

This function estimates the acceleration in the movement direction of one train.



Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-2989 - Actual acceleration <ul style="list-style-type: none">  SPMS-6519 - actual_acceleration 	 SPMS-2937 - Has acceleration vector in relation to rolling stock coordinates	 SPMS-2809 - Rolling Stock Reference Point
Output exchanges	Output exchanges	Target function	Function allocated to
	No exchange items allocated on  SPMS-3148 - Estimated acceleration.	 SPMS-2872 - Calculate safe speed profiles of one train	 SPMS-2807 - Train CS System

3.2.2 States

Will be provided in a future release.

3.2.3 Non-functional requirements

Will be provided in a future release.

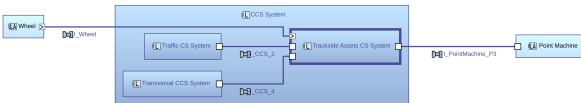
3.2.4 Installation spaces

Will be provided in a future release.

3.3 Trackside Assets CS System


Trackside Assets CS System

Is responsible for controlling and observing the trackside objects like points, track vacancy detection, level crossings and others.

ID	SPMS-2818
Context Diagram	 <p>Figure 26 Context Diagram of Trackside Assets CS System</p>

3.3.1 Functions

3.3.1-1 - Determine required position of one point machine

This function is allocated to  SPMS-2818 - Trackside Assets CS System.

This function determines the required Point Machine position based on the required Point position compared to the estimated Point Machine position.

ID	SPMS-2851
----	-----------

Context Diagram
















Figure 27 Context Diagram of Determine required position of one point machine


Input exchanges


Input exchanges	Source function	Function allocated to
<div>  SPMS-3227 - Required point position <ul style="list-style-type: none">  SPMS-3286 - point_position_command </div>	<div>  SPMS-5265 - Control target state of one point </div>	<div>  SPMS-2823 - Traffic CS System </div>
<div>  SPMS-5816 - Observed point position <ul style="list-style-type: none">  SPMS-3283 - point_position_report </div>	<div>  SPMS-2914 - Sense+Observe position of one point </div>	<div>  SPMS-2818 - Trackside Assets CS System </div>

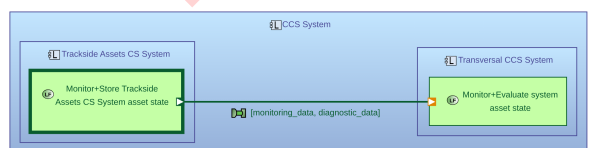
Output exchanges






Output exchanges	Target function	Function allocated to
<div>  SPMS-3008 - Required point machine position <ul style="list-style-type: none">  SPMS-2377 - point_machine_movement_requirement </div>	<div>  SPMS-2932 - Sense+Observe position of one point machine </div>	<div>  SPMS-2818 - Trackside Assets CS System </div>

3.3.1-2 - Monitor+Store Trackside Assets CS System asset state


This function is allocated to  SPMS-2818 - Trackside Assets CS System.

This function monitors and stores the state of  SPMS-2818 - Trackside Assets CS System, in order to provide asset conditions continuously.

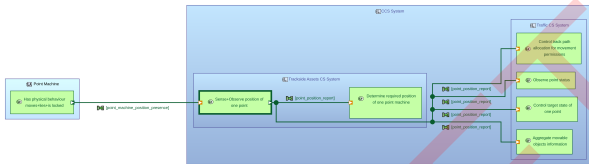




ID	SPMS-6533
Context Diagram	 <p>Figure 28 Context Diagram of Monitor+Store Trackside Assets CS System asset state</p>
Input exchanges	No inputs defined for this function.





















	Output exchanges	Target function	Function allocated to
Output exchanges	 SPMS-6561 - Monitoring and diagnostic data <ul style="list-style-type: none">  SPMS-6988 - monitoring_data  SPMS-6989 - diagnostic_data 	 SPMS-4502 - Monitor+Evaluate system asset state	 SPMS-2819 - Transversal CCS System

3.3.1-3 - Sense+Observe position of one point


This function is allocated to  SPMS-2818 - Trackside Assets CS System.

This function estimates the position state of one Point based on the sensed and estimated position of each Point Machine.

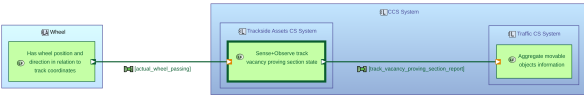




ID	SPMS-2914		
Context Diagram	 <p>Figure 29 Context Diagram of Sense+Observe position of one point</p>		
Input exchanges	Input exchanges  SPMS-5815 - Actual physical point machine position <ul style="list-style-type: none">  SPMS-2381 - point_machine_position_presence 	Source function  SPMS-2942 - Has physical behaviour moves+lies+is locked	Function allocated to  SPMS-2812 - Point Machine





Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-3209 - Observed point position <ul style="list-style-type: none">  SPMS-3283 - point_position_report 	 SPMS-2886 - Observe point status	 SPMS-2823 - Traffic CS System
	 SPMS-5816 - Observed point position <ul style="list-style-type: none">  SPMS-3283 - point_position_report 	 SPMS-2851 - Determine required position of one point machine	 SPMS-2818 - Trackside Assets CS System
	 SPMS-3228 - Observed point position <ul style="list-style-type: none">  SPMS-3283 - point_position_report 	 SPMS-5265 - Control target state of one point	 SPMS-2823 - Traffic CS System
	 SPMS-3220 - Observed point position <ul style="list-style-type: none">  SPMS-3283 - point_position_report 	 SPMS-2874 - Control track path allocation for movement permissions	 SPMS-2823 - Traffic CS System
	 SPMS-5268 - Observed point position <ul style="list-style-type: none">  SPMS-3283 - point_position_report 	 SPMS-2944 - Aggregate movable objects information	 SPMS-2823 - Traffic CS System

3.3.1-4 - Sense+Observe track vacancy proving section state


This function is allocated to  SPMS-2818 - Trackside Assets CS System.

This function senses the passing of one wheel by infrastructure reference location in order to observe the occupation of one track vacancy proving section.

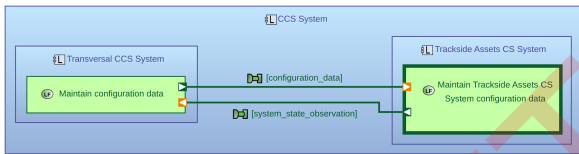








ID	SPMS-2919		
Context Diagram	 <p>Figure 30 Context Diagram of Sense+Observe track vacancy proving section state</p>		
Input exchanges	Input exchanges  SPMS-3015 - Actual wheel passing <ul style="list-style-type: none">  SPMS-6523 - actual_wheel_passing 	Source function  SPMS-2833 - Has wheel position and direction in relation to track coordinates	Function allocated to  SPMS-2829 - Wheel

Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-4648 - Observed track vacancy proving section state <ul style="list-style-type: none">  SPMS-6569 - track_vacancy_proving_section_report 	 SPMS-2944 - Page 2 of 2	 SPMS-2823 - Traffic CS Sys

3.3.1-5 - Maintain Trackside Assets CS System configuration data

This function is allocated to  SPMS-2818 - Trackside Assets CS System.

This function refers to the continuous process of managing, updating, and maintaining (including functionalities like preloading and activation) the configuration data of Trackside Assets CS.

ID	SPMS-6534		
Context Diagram	 <p>Figure 31 Context Diagram of Maintain Trackside Assets CS System configuration data</p>		
Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-6562 - Actual state of configuration data <ul style="list-style-type: none">  SPMS-6465 - configuration_data 	 SPMS-2834 - Maintain configuration data	 SPMS-2819 - Transversal CCS System
Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-6609 - Activated state of configuration data <ul style="list-style-type: none">  SPMS-3251 - system_state_observation 	 SPMS-2834 - Maintain configuration data	 SPMS-2819 - Transversal CCS System

3.3.2 States

Will be provided in a future release.

3.3.3 Non-functional requirements

Will be provided in a future release.

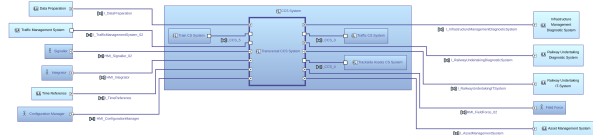
3.3.4 Installation spaces

Will be provided in a future release.

3.4 Transversal CCS System


Transversal CCS System

Is responsible for configuration data and diagnosis.

<p>ID</p>	<p>SPMS-2819</p>
<p>Context Diagram</p>	 <p>The diagram illustrates the context of the Transversal CCS System. It features a central 'Transversal CCS System' block. To its left, several external systems provide inputs: 'File Processor', 'Task Management System', 'Control', 'Manager', 'Task Scheduler', and 'Configuration Manager'. To its right, the system interacts with 'Integration Manager Support System', 'Policy Library Support System', 'Policy Library of System', 'Policy Library of System', 'Policy Library of System', and 'Policy Library of System'. Each interaction is labeled with a specific data flow or control signal.</p> <p><i>Figure 32 Context Diagram of Transversal CCS System</i></p>

3.4.1 Functions

3.4.1-1 - Maintain configuration data





































This function is allocated to  SPMS-2819 - Transversal CCS System.

























This function refers to the continuous process of managing, updating, and maintaining (including functionalities like preloading and activation) the configuration data of a system.

Furthermore this functions distributes new configuration data and its system version for all systems in TMS and CCS.


This functions also request to preload or request to activate a specific system configuration and system version. This function enables safe configuration state (e.g. stop system operation) for activation of system configuration and requests to restart the operation of the subsystem after successful new system configuration activation.

[illegible]

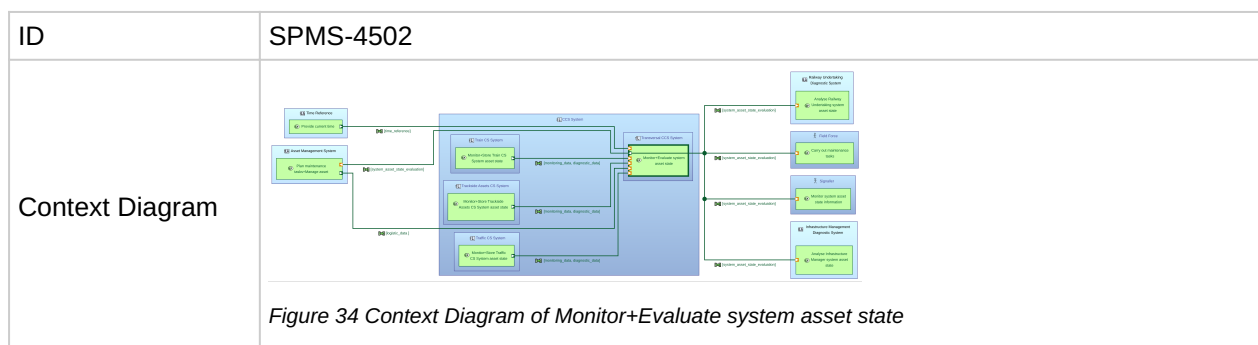
Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-3211 - Activated state of configuration data <ul style="list-style-type: none">  SPMS-3251 - system_state_observation 	 SPMS-2840 - Maintain Traffic CS System configuration data	 SPMS-2823 - Traffic CS Sys
	 SPMS-5412 - Provided current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-6269 - Provide current time	 SPMS-6268 - Time Referenc
	 SPMS-5413 - Required state of configuration data <ul style="list-style-type: none">  SPMS-6467 - configuration_data_state_request 	 SPMS-5400 - Prepare+Supervise distribution of the configuration data	 SPMS-5389 - Configuration
	 SPMS-5411 - Planned activation time <ul style="list-style-type: none">  SPMS-6468 - configuration_data_activation_plan 	 SPMS-5399 - Provide planned activation time	 SPMS-2813 - Traffic Manag
	 SPMS-6609 - Activated state of configuration data <ul style="list-style-type: none">  SPMS-3251 - system_state_observation 	 SPMS-6534 - Maintain Trackside Assets CS System configuration data	 SPMS-2818 - Trackside Ass
	 SPMS-6906 - Configuration data <ul style="list-style-type: none">  SPMS-6465 - configuration_data 	 SPMS-6883 - Check+Sign configuration data	 SPMS-6882 - Integrator
	 SPMS-6907 - Configuration data <ul style="list-style-type: none">  SPMS-6465 - configuration_data 	 SPMS-5395 - Provide+sign configuration data	 SPMS-5390 - Data Preparat
	 SPMS-6905 - Configuration data <ul style="list-style-type: none">  SPMS-6465 - configuration_data 	 SPMS-6885 - Provide configuration data	 SPMS-6882 - Integrator
	 SPMS-6910 - Planned activation time <ul style="list-style-type: none">  SPMS-6468 - configuration_data_activation_plan 	 SPMS-6886 - Provide planned activation time for vehicle	 SPMS-5392 - Railway Unde
	 SPMS-7251 - Activated state of configuration data <ul style="list-style-type: none">  SPMS-3251 - system_state_observation 	 SPMS-7248 - Maintain Train CS System configuration data	 SPMS-2807 - Train CS Syst
























Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-2993 - Actual state of configuration data <ul style="list-style-type: none">  SPMS-6465 - configuration_data 	 SPMS-2840 - Maintain Traffic CS System configuration data	 SPMS-2823 - Traffic CS System
	 SPMS-6562 - Actual state of configuration data <ul style="list-style-type: none">  SPMS-6465 - configuration_data 	 SPMS-6534 - Maintain Trackside Assets CS System configuration data	 SPMS-2818 - Trackside Assets CS System
	 SPMS-6900 - Actual state of configuration data <ul style="list-style-type: none">  SPMS-6466 - configuration_data_state 	 SPMS-2843 - Calculate operational traffic plan	 SPMS-2813 - Traffic Management System
	 SPMS-6901 - Actual state of configuration data <ul style="list-style-type: none">  SPMS-6466 - configuration_data_state 	 SPMS-5400 - Prepare+Supervise distribution of the configuration data	 SPMS-5389 - Configuration Manager
	 SPMS-6902 - Actual state of configuration data <ul style="list-style-type: none">  SPMS-6466 - configuration_data_state 	 SPMS-2853 - Supervise state of the railway	 SPMS-2827 - Signaller
	 SPMS-7250 - Configuration data <ul style="list-style-type: none">  SPMS-6465 - configuration_data 	 SPMS-7248 - Maintain Train CS System configuration data	 SPMS-2807 - Train CS System





















3.4.1-2 - Monitor+Evaluate system asset state

This function is allocated to  SPMS-2819 - Transversal CCS System.


This function monitors the CCS System assets, evaluates and displays the actual state of these assets based on the aggregated data for maintenance.



Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-4506 - Provided current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-6269 - Provide current time	 SPMS-6268 - Time Reference
	 SPMS-3062 - Monitoring and diagnostic data <ul style="list-style-type: none">  SPMS-6988 - monitoring_data  SPMS-6989 - diagnostic_data 	 SPMS-2895 - Monitor+Store Traffic CS System asset state	 SPMS-2823 - Traffic CS System
	 SPMS-6555 - Logistic data <ul style="list-style-type: none">  SPMS-6464 - logistic_data 	 SPMS-4503 - Plan maintenance tasks+Manage asset	 SPMS-6528 - Asset Management System
	 SPMS-6561 - Monitoring and diagnostic data <ul style="list-style-type: none">  SPMS-6988 - monitoring_data  SPMS-6989 - diagnostic_data 	 SPMS-6533 - Monitor+Store Trackside Assets CS System asset state	 SPMS-2818 - Trackside Assets CS System
	 SPMS-6909 - Monitoring and diagnostic data <ul style="list-style-type: none">  SPMS-6988 - monitoring_data  SPMS-6989 - diagnostic_data 	 SPMS-6884 - Monitor+Store Train CS System asset state	 SPMS-2807 - Train CS System
<p>The following ports are not connected to any exchange:</p> <ul style="list-style-type: none"> FIP 3 			

Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-4507 - Evaluated system asset state <ul style="list-style-type: none">  SPMS-6233 - system_asset_state_evaluation 	 SPMS-4503 - Plan maintenance tasks+Manage asset	 SPMS-6528 - Asset Management System
	 SPMS-6556 - Evaluated system asset state <ul style="list-style-type: none">  SPMS-6233 - system_asset_state_evaluation 	 SPMS-6532 - Monitor system asset state information	 SPMS-2827 - Signaller
	 SPMS-6558 - Evaluated system asset state <ul style="list-style-type: none">  SPMS-6233 - system_asset_state_evaluation 	 SPMS-6529 - Analyse Infrastructure Manager system asset state	 SPMS-6526 - Infrastructure Management Diagnostic System
	 SPMS-6559 - Evaluated system asset state <ul style="list-style-type: none">  SPMS-6233 - system_asset_state_evaluation 	 SPMS-6530 - Analyse Railway Undertaking system asset state	 SPMS-6527 - Railway Undertaking Diagnostic System
	 SPMS-6560 - Evaluated system asset state <ul style="list-style-type: none">  SPMS-6233 - system_asset_state_evaluation 	 SPMS-7319 - Carry out maintenance tasks	 SPMS-2808 - Field Force

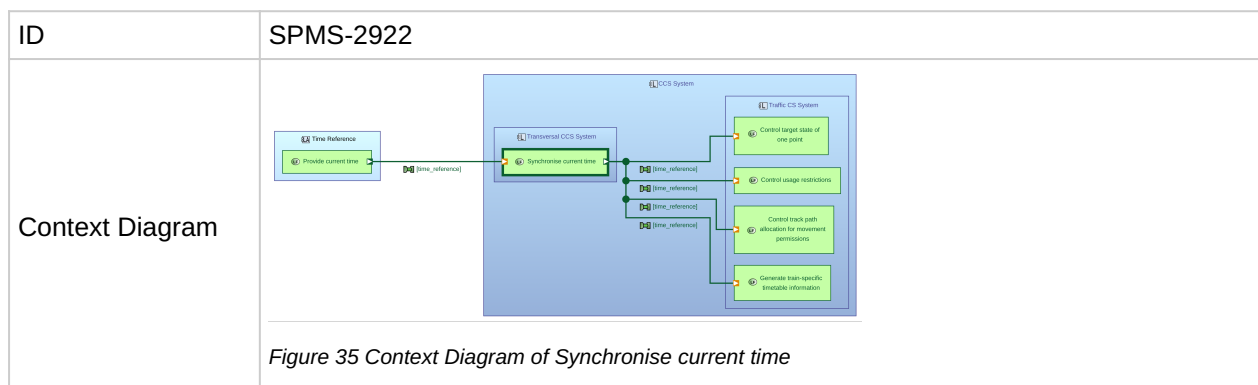
3.4.1-3 - Synchronise current time





















This function is allocated to  SPMS-2819 - Transversal CCS System.

This function synchronise the current time as a single point.

For the avoidance of doubt, this function has the behaviour of a clock.

Allocation still to be clarified if the time get distributed over transversal or all systems get the time provided by the external time reference.



Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-6271 - Provide current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-6269 - Provide current time	 SPMS-6268 - Time Reference
Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-3045 - Provided current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-2929 - Control usage restrictions	 SPMS-2823 - Traffic CS System
	 SPMS-3042 - Provided current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-2874 - Control track path allocation for movement permissions	 SPMS-2823 - Traffic CS System
	 SPMS-5276 - Provided current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-5265 - Control target state of one point	 SPMS-2823 - Traffic CS System
	 SPMS-5334 - Provided current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-5332 - Generate train-specific timetable information	 SPMS-2823 - Traffic CS System

3.4.2 States

Will be provided in a future release.

3.4.3 Non-functional requirements

Will be provided in a future release.

3.4.4 Installation spaces

Will be provided in a future release.

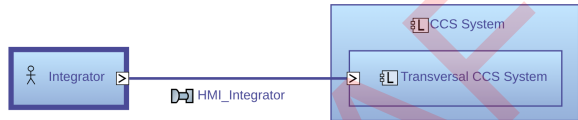
4 System interfaces

4.1 External interfaces

This section describes the external system and human actors interacting with the CCS-System and the interfaces of the CCS-System to these external systems and the human actors.


4.1-2 - Integrator

is responsible for the overall CCS Configuration of a specific instance Deployment of the CCS System including: Integration Testing, Verification, Validation, Approval (including assessment according to TSI CCS (if relevant) and CENELEC standards (if relevant)), Homologation (authorisation for vehicle or trackside instances).

ID	SPMS-6882		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> • SPMS-6912 - HMI_Integrator 	outgoing to	<ul style="list-style-type: none"> • SPMS-2819 - Transversal CCS System
Context Diagram	 <p>Figure 36 Context Diagram of Integrator</p>		




4.1-3 - Asset Management System

Is responsible to track the condition, lifecycle, and maintenance activities of railway assets, supporting informed decisions and optimised maintenance planning based on diagnostic and monitoring data.

ID	SPMS-6528		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> • SPMS-6564 - I_AssetManagementSystem 	incoming from	<ul style="list-style-type: none"> • SPMS-2819 - Transversal CCS System
Context Diagram	 <p>Figure 37 Context Diagram of Asset Management System</p>		




4.1-4 - Railway Undertaking Diagnostic System

Is responsible for analysing and interpreting the collected diagnostic and monitoring data from the railway undertaking assets. It focuses on advanced processing of the data.

ID	SPMS-6527		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> •  SPMS-6566 - I_RailwayUndertakingDiagnosticSystem 	incoming from	<ul style="list-style-type: none"> •  SPMS-2819 - Transversal CCS System
Context Diagram	 <p>Figure 38 Context Diagram of Railway Undertaking Diagnostic System</p>		




4.1-5 - Infrastructure Management Diagnostic System

Is responsible for analysing and interpreting the collected diagnostic and monitoring data from the infrastructure management assets. It focuses on advanced processing of the data.

ID	SPMS-6526		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> •  SPMS-6565 - I_InfrastructureManagementDiagnosticSystem 	incoming from	<ul style="list-style-type: none"> •  SPMS-2819 - Transversal CCS System
Context Diagram	 <p>Figure 39 Context Diagram of Infrastructure Management Diagnostic System</p>		

4.1-6 - Time Reference




Represents an integral entity designed to supply precise time information. Serve as a reliable source for current time data across multiple regions and time zones. Maintain synchronisation with official global time standards, ensuring accurate and consistent time delivery.

ID	SPMS-6268		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> •  SPMS-6270 - I_TimeReference 	outgoing to	<ul style="list-style-type: none"> •  SPMS-2819 - Transversal CCS System
Context Diagram	 <p>Figure 40 Context Diagram of Time Reference</p>		

4.1-7 - Railway Undertaking IT-System

is responsible to provide information about railway undertaking planning times of vehicle configuration

updates.

ID	SPMS-5392		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> •  SPMS-5405 - I_RailwayUndertakingITSystem 	outgoing to	<ul style="list-style-type: none"> •  SPMS-2819 - Transversal CCS System
Context Diagram	 <p>Figure 41 Context Diagram of Railway Undertaking IT-System</p>		

4.1-8 - Data Preparation




Is responsible to prepare and validate configuration data required by the CCS system.

This system encompasses the contributions of three types of stakeholders:

Infrastructure Manager: Provides infrastructure related configuration data, such as track topology.

Railway Undertaking: Provides Vehicle related configuration data, such as static train/vehicle characteristics used for the parametrisation of the CCS on-board.


Supplier: Delivers application specific configuration data, such as hardware configurations or software parameters for onboard or wayside components.

ID	SPMS-5390		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> •  SPMS-5404 - I_DataPreparation 	outgoing to	<ul style="list-style-type: none"> •  SPMS-2819 - Transversal CCS System
Context Diagram	 <p>Figure 42 Context Diagram of Data Preparation</p>		

4.1-9 - Configuration Manager

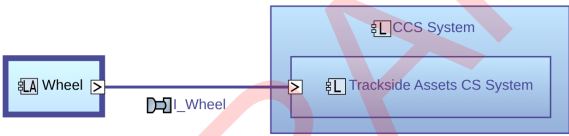
is responsible to manage and supervise distribution of configuration data published by Integrators for CCS system. This role is also responsible for producing the distribution-job defining the target and when to preload and activate Configuration data. In this context it is usually an Infrastructure Manager or Train Operator/Owner.

ID	SPMS-5389
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Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> SPMS-5402 - HMI_ConfigurationManager 	outgoing to	<ul style="list-style-type: none"> SPMS-2819 - Transversal CCS System
Context Diagram	 <p>Figure 43 Context Diagram of Configuration Manager</p>		

4.1-10 - Wheel

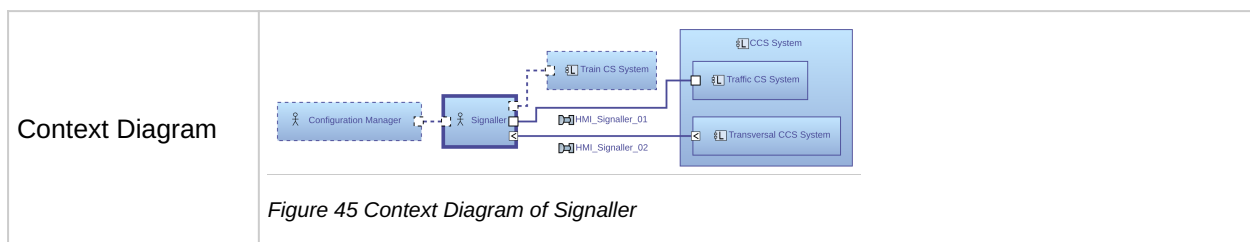
Represents the physical wheel of one rolling stock. Is used as a special kind of rolling stock reference point.

ID	SPMS-2829		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> SPMS-2968 - I_Wheel 	outgoing to	<ul style="list-style-type: none"> SPMS-2818 - Trackside Assets CS System
Context Diagram	 <p>Figure 44 Context Diagram of Wheel</p>		

4.1-11 - Signaller

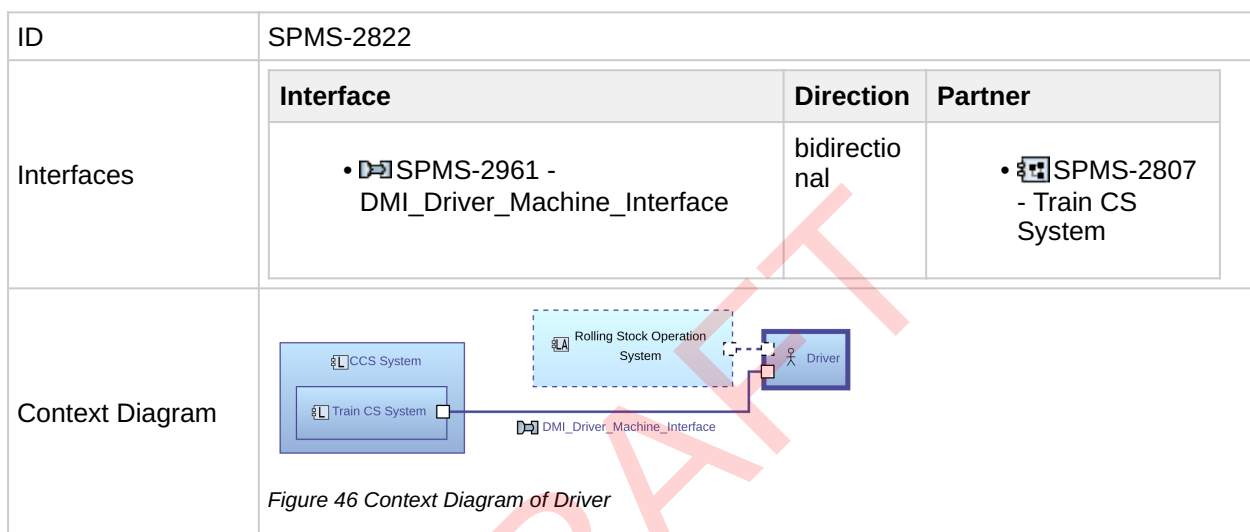
Staff in charge of authorising trains/shunting movements and of issuing instructions to train drivers to ensure safe train operation.

ID	SPMS-2827		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> SPMS-2963 - HMI_Signaller_01 	bidirectional	<ul style="list-style-type: none"> SPMS-2823 - Traffic CS System
	<ul style="list-style-type: none"> SPMS-6580 - HMI_Signaller_02 	incoming from	<ul style="list-style-type: none"> SPMS-2819 - Transversal CCS System





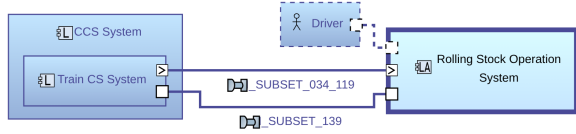
4.1-12 - Driver

A person capable and authorised to drive trains, including locomotives, shunting locomotives, work trains, maintenance railway vehicles or trains for the carriage of passengers or goods by rail in autonomous, responsible and safe manner. (Reference: Article 3 of Directive 2007/59/EC)



4.1-13 - Rolling Stock Operation System


The Rolling Stock Operation System represents a collection of functionalities of on-board systems which are external to the  SPMS-2098 - CCS System. This actor includes the Train Control Management System and other control systems e.g. door control, traction control or braking control and can be specific to the class from the supplier of the rolling stock; but it interacts with the  SPMS-2098 - CCS System over a standardised interface.

ID	SPMS-2820		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> • SPMS-4493 - I_SUBSET_139 	bidirectional	<ul style="list-style-type: none"> • SPMS-2807 - Train CS System
	<ul style="list-style-type: none"> • SPMS-2971 - I_SUBSET_034_119 	incoming from	<ul style="list-style-type: none"> • SPMS-2807 - Train CS System
Context Diagram	 <p>The diagram shows the Rolling Stock Operation System (RSOS) as a central component. It is connected to the CCS System (Control-Centered System) and the Train CS System (Train Control System) via the I_SUBSET_034_119 interface. The RSOS is also connected to the Driver via the I_SUBSET_139 interface.</p> <p>Figure 47 Context Diagram of Rolling Stock Operation System</p>		

4.1-14 - Traffic Management System

Traffic Management System covers the management and the planning level.



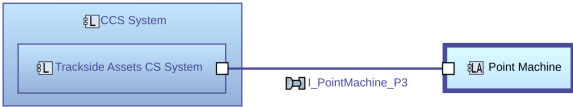
Traffic Management is responsible for all planning activities including producing an operational plan, based upon the operational state and operational events. A conflict free operational plan would be sent to Traffic Control and Supervision usually at the beginning of a service day. Change of planning can be done for the next minutes up to the next year. A plan includes regular or incidence-related commands for infrastructure users (e.g. trains, construction sites), including measures to correct deviations or to stabilize the traffic flow in short term.

ID	SPMS-2813		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> • SPMS-2958 - I_TrafficManagementSystem_01 	bidirectional	<ul style="list-style-type: none"> • SPMS-2823 - Traffic CS System
	<ul style="list-style-type: none"> • SPMS-6690 - I_TrafficManagementSystem_02 	bidirectional	<ul style="list-style-type: none"> • SPMS-2819 - Transversal CCS System
Context Diagram	 <p>The diagram shows the Traffic Management System (TMS) as a central component. It is connected to the CCS System (Control-Centered System) and the Transversal CCS System via the I_TrafficManagementSystem_02 interface. The TMS is also connected to the Traffic CS System via the I_TrafficManagementSystem_01 interface.</p> <p>Figure 48 Context Diagram of Traffic Management System</p>		

4.1-15 - Point Machine




The Point machine is an apparatus for moving and detecting point blades from a source of power, usually electric. It may also include a system to mechanically lock the point in a physical end position. The point machine safety relevant signalling component, ensuring safe passage of railway vehicles over moveable

elements at points, crossings and derailleurs.

ID	SPMS-2812		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> •  SPMS-2967 - I_PointMachine_P3 	bidirectional	<ul style="list-style-type: none"> •  SPMS-2818 - Trackside Assets CS System
Context Diagram	 <p>Figure 49 Context Diagram of Point Machine</p>		





4.1-16 - Rolling Stock Reference Point

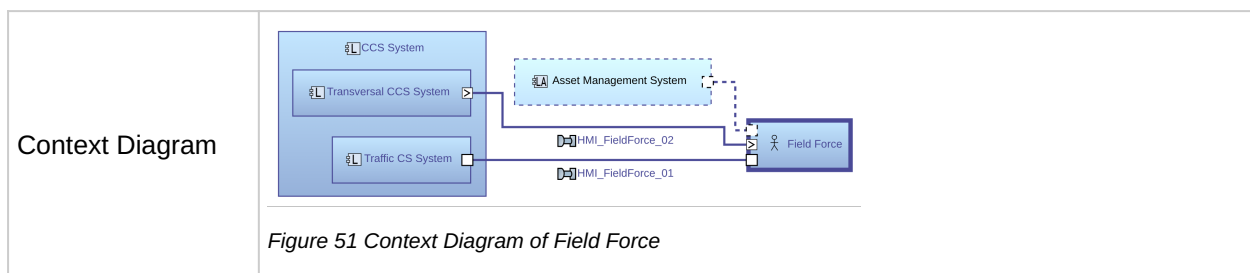
Represents any point on the structure of one rolling stock including undercarriage, wheels etc. that can be used to determine this reference point's relative motion to the track. The reference point has a 3 axis coordinate system, that is aligned with the coordinate system of the body it is notionally attached to.

ID	SPMS-2809		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> •  SPMS-2970 - I_RollingStockReferencePoint 	outgoing to	<ul style="list-style-type: none"> •  SPMS-2807 - Train CS System
Context Diagram	 <p>Figure 50 Context Diagram of Rolling Stock Reference Point</p>		

4.1-17 - Field Force

The field force is the single point of contact when maintenance activity or construction work is carried out in the field, e.g. this actor is responsible for the safety of the staff in the field.

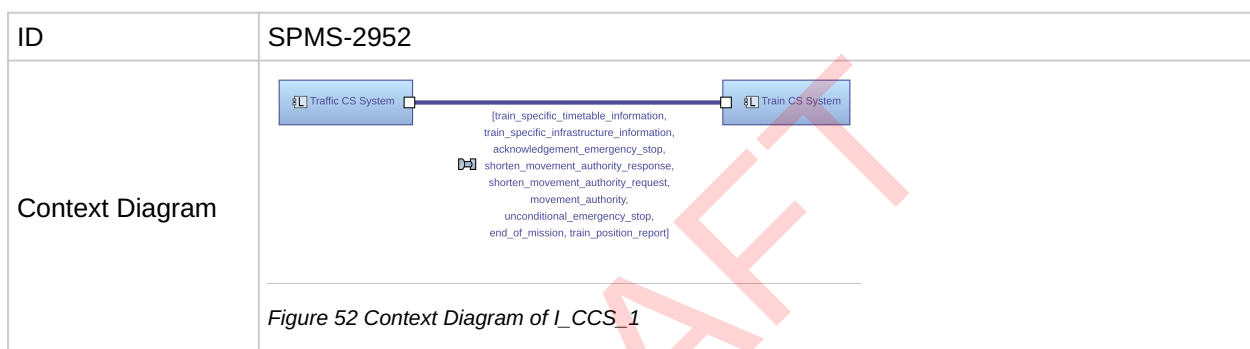
ID	SPMS-2808		
Interfaces	Interface	Direction	Partner
	<ul style="list-style-type: none"> •  SPMS-4484 - HMI_FieldForce_01 	bidirectional	<ul style="list-style-type: none"> •  SPMS-2823 - Traffic CS System
	<ul style="list-style-type: none"> •  SPMS-7320 - HMI_FieldForce_02 	incoming from	<ul style="list-style-type: none"> •  SPMS-2819 - Transversal CCS System



4.2 Internal interfaces

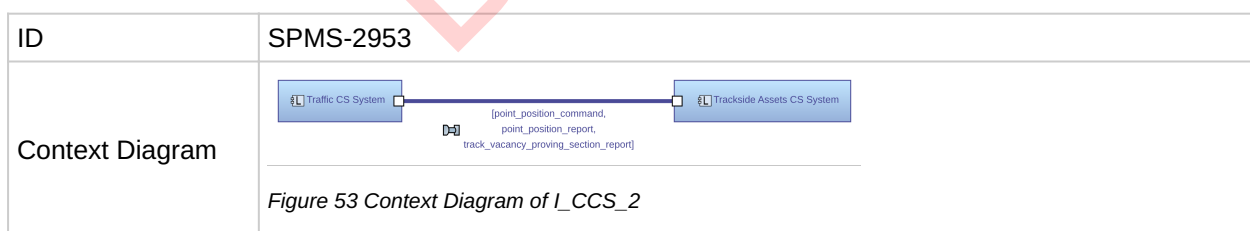
4.2-1 - I_CCS_1

The interface SPMS-2952 - I_CCS_1 connects SPMS-2823 - Traffic CS System with SPMS-2807 - Train CS System.



4.2-2 - I_CCS_2

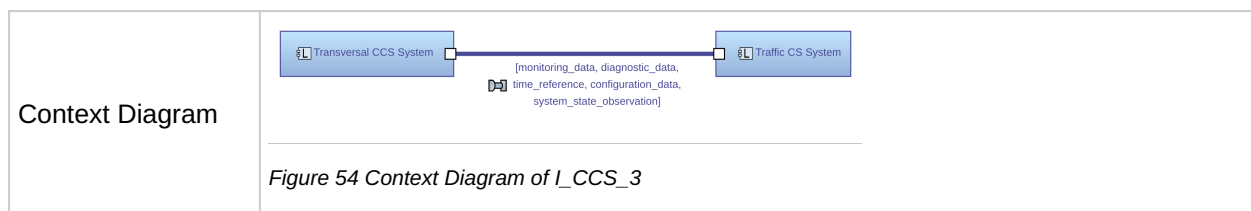
The interface SPMS-2953 - I_CCS_2 connects SPMS-2823 - Traffic CS System with SPMS-2818 - Trackside Assets CS System.



4.2-3 - I_CCS_3

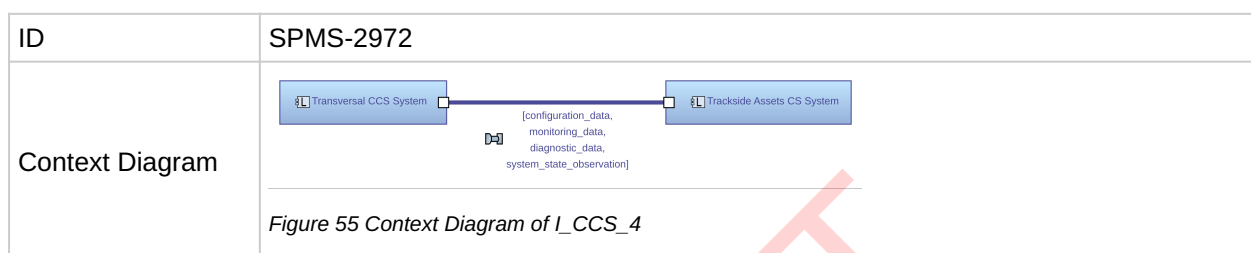
The interface SPMS-2973 - I_CCS_3 connects SPMS-2819 - Transversal CCS System with SPMS-2823 - Traffic CS System.

ID	SPMS-2973
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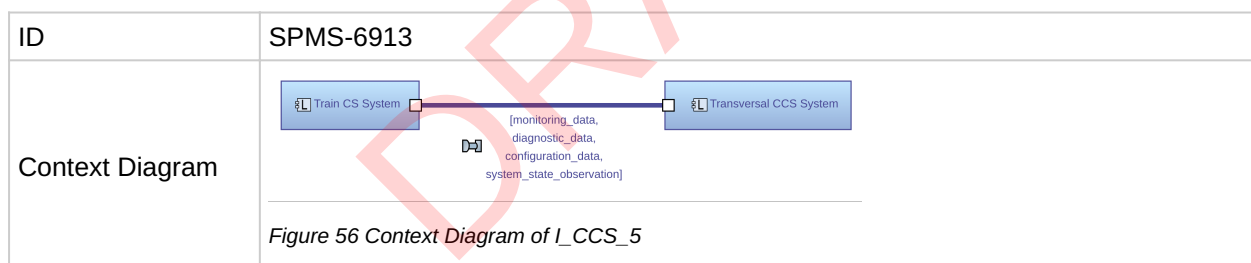
4.2-4 - I_CCS_4

The interface SPMS-2972 - I_CCS_4 connects SPMS-2819 - Transversal CCS System with SPMS-2818 - Trackside Assets CS System.



4.2-5 - I_CCS_5

The interface SPMS-6913 - I_CCS_5 connects SPMS-2807 - Train CS System with SPMS-2819 - Transversal CCS System.



5 System behaviour








The system behaviour is represented via system capabilities. These capabilities are further described by scenarios and functional chains in the following sub chapters.

5.1 Perform operational plan movement

5.1-1 - Perform operational plan movement

The Traffic Management System needs the system to execute an Operational plan movement. An Operational plan movement consist of at least one movement event and operates at least one train. Furthermore, an operational plan movement can contain movement restrictions.

ID	SPMS-3314
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Involved entities	<ul style="list-style-type: none"> •  SPMS-2807 - Train CS System •  SPMS-2813 - Traffic Management System •  SPMS-2818 - Trackside Assets CS System •  SPMS-2819 - Transversal CCS System •  SPMS-2822 - Driver •  SPMS-2823 - Traffic CS System •  SPMS-2827 - Signaller
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5.1-2 - Perform operational plan movement

This functional chain describes the sequence of processes of one operational plan which could happen during the movement or standstill of the train.

The figure below provides an overview of *Perform operational plan movement*.

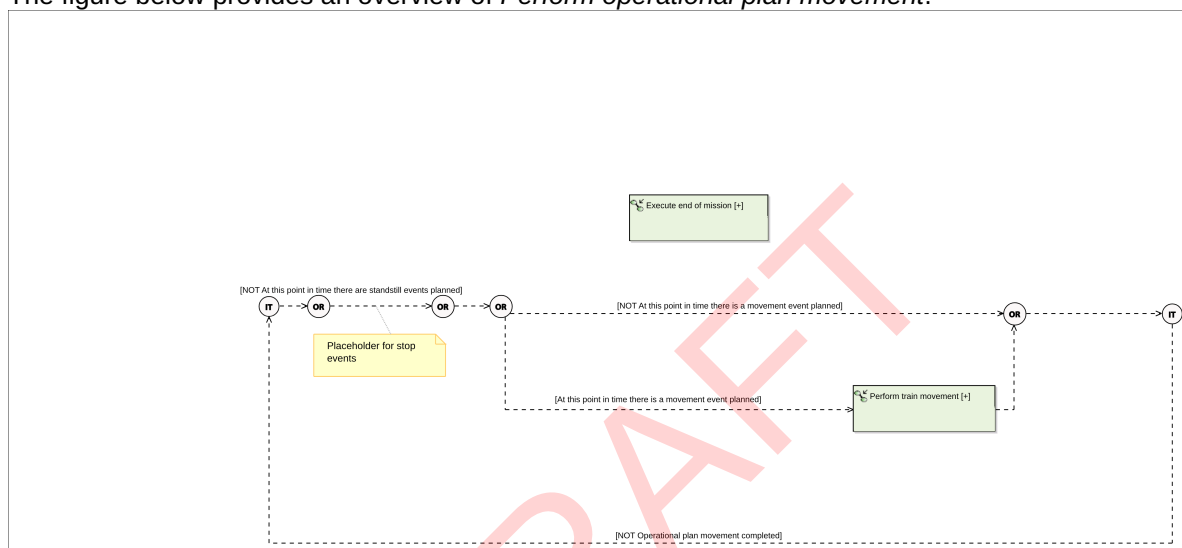


Figure 57 Diagram [LFCD] Perform operational plan movement [Functional chain description]

ID	SPMS-4553
Pre Condition	Operational plan movement available and ready for execution.
Post Condition	Operational plan movement completed or aborted.

5.1-3 - Perform operational plan movement

This exchange scenario describes the sequence of scenarios of one operational plan which could happen during the movement or standstill of the train.

The figure below provides an overview of *Perform operational plan movement*.

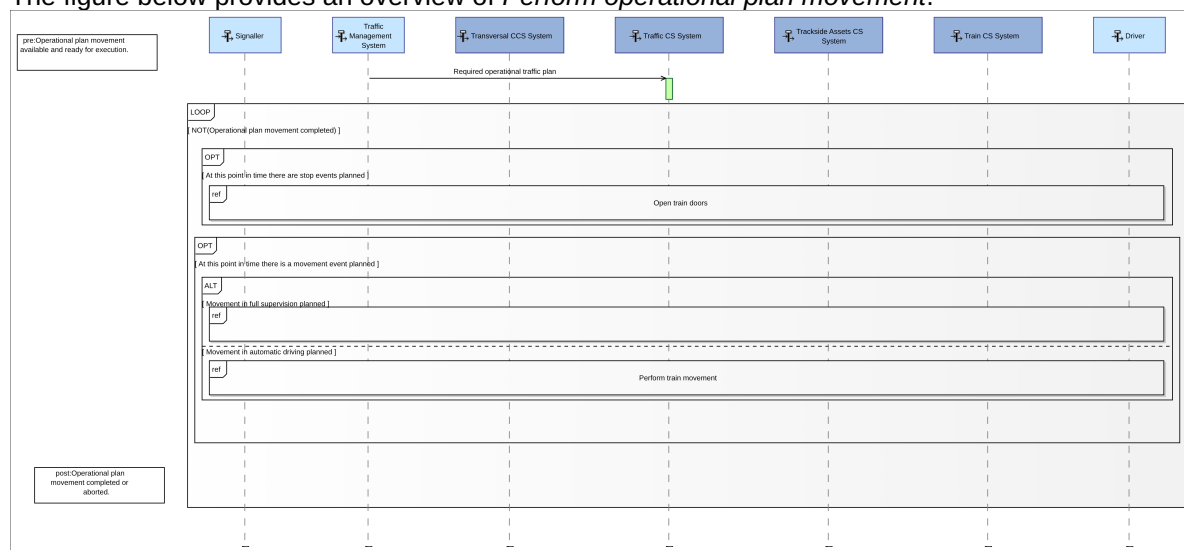


Figure 58 Diagram [LES] Perform operational plan movement [Exchange scenario]

ID	SPMS-5708
Pre Condition	Operational plan movement available and ready for execution.
Post Condition	Operational plan movement completed or aborted.

5.2 Perform train movement

5.2-1 - Perform train movement

The Traffic Management System need the system to perform a movement of the train from one location to another with the involvement of the Signaller and Driver to enable the operation on the train.

ID	SPMS-3316
Involved entities	<ul style="list-style-type: none"> SPMS-2807 - Train CS System SPMS-2813 - Traffic Management System SPMS-2818 - Trackside Assets CS System SPMS-2819 - Transversal CCS System SPMS-2820 - Rolling Stock Operation System SPMS-2822 - Driver SPMS-2823 - Traffic CS System SPMS-2827 - Signaller

5.2-2 - Perform train movement

This functional chain outlines the sequence of processes that facilitate train movement. These processes may occur during the operation of a train in full supervision or automatic driving mode.

The figure below provides an overview of *Perform train movement*.

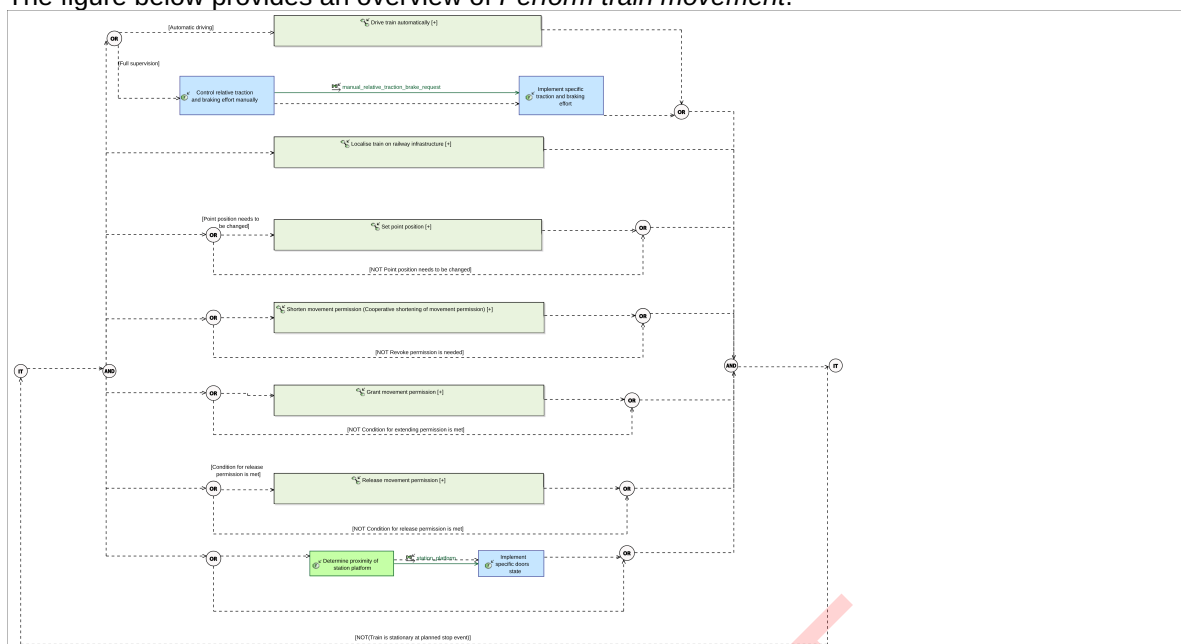


Figure 59 Diagram [LFCD] Perform train movement [Functional chain description]

ID	SPMS-4473
Pre Condition	Distance and speed permission is indicated to the Driver AND Movement permission is indicated to the Signaller AND Distance and speed restriction is provided to the Traffic Management System AND Planned movement event is ready for execution AND Train is stationary and localised.
Post Condition	Movement is completed AND Train is stationary at planned stop event AND train doors are unlocked

5.2-3 - Perform train movement

This exchange scenario describes the sequence of scenarios that support train movement. These scenarios may occur during the operation of a train in full supervision or automatic driving mode, with the movement requested by the Traffic Management System in accordance with the operational plan.

The figure below provides an overview of *Perform train movement*.

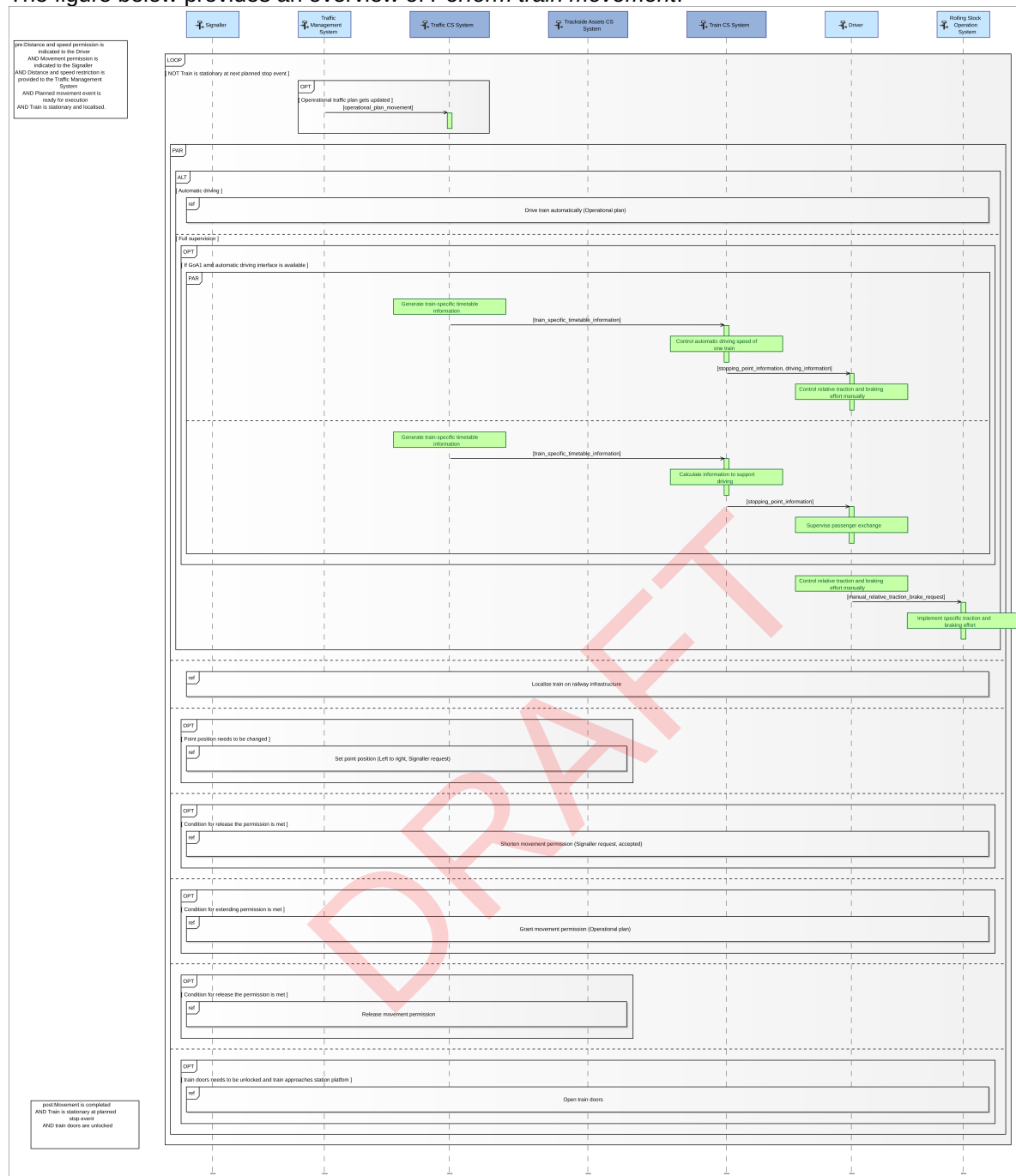


Figure 60 Diagram [LES] Perform train movement [Exchange scenario]

ID	SPMS-5643
Pre Condition	Distance and speed permission is indicated to the Driver AND Movement permission is indicated to the Signaller AND Distance and speed restriction is provided to the Traffic Management System AND Planned movement event is ready for execution AND Train is stationary and localised.
Post Condition	Movement is completed AND Train is stationary at planned stop event AND train doors are unlocked

5.3 Grant movement permission

5.3-1 - Grant movement permission

The CCS system needs to grant movement permissions that ensure safe train operations, taking into account all relevant safety constraints. These constraints include infrastructure characteristics, train parameters, track layout, current occupation of track sections by other movements, and any applicable usage restrictions.

ID	SPMS-3305
Involved entities	<ul style="list-style-type: none"> SPMS-2807 - Train CS System SPMS-2813 - Traffic Management System SPMS-2822 - Driver SPMS-2823 - Traffic CS System SPMS-2827 - Signaller

5.3-2 - Grant movement permission

This functional chain describes the sequence of functions related to each other to grant a movement permission requested by the SPMS-2813 - Traffic Management System according to the operational plan or by the SPMS-2827 - Signaller.

The figure below provides an overview of *Grant movement permission*.

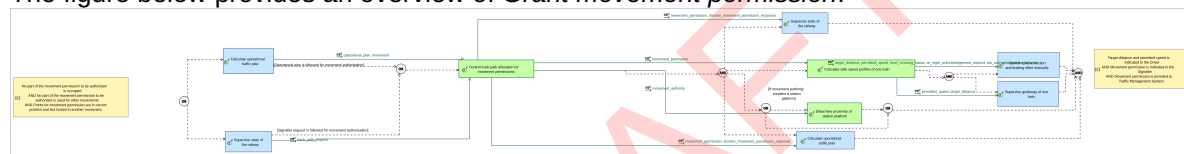


Figure 61 Diagram [LFCD] Grant movement permission [Functional chain description]

ID	SPMS-4462
Pre Condition	<p>No part of the movement permission to be authorised is occupied AND No part of the movement permission to be authorised is used for other movements AND Points for movement permission are in correct position and Not locked in another movement.</p>
Post Condition	<p>Target distance and permitted speed is indicated to the Driver AND Movement permission is indicated to the Signaller AND Movement permission is provided to Traffic Management System.</p>

5.3.1 Grant movement permission (Operational plan)

5.3.1-1 - Grant movement permission (Operational plan)

This scenario describes the sequence of functions related to each other to grant a movement permission requested by the SPMS-2813 - Traffic Management System according to the operational plan.

The figure below provides an overview of *Grant movement permission (Operational plan)*.

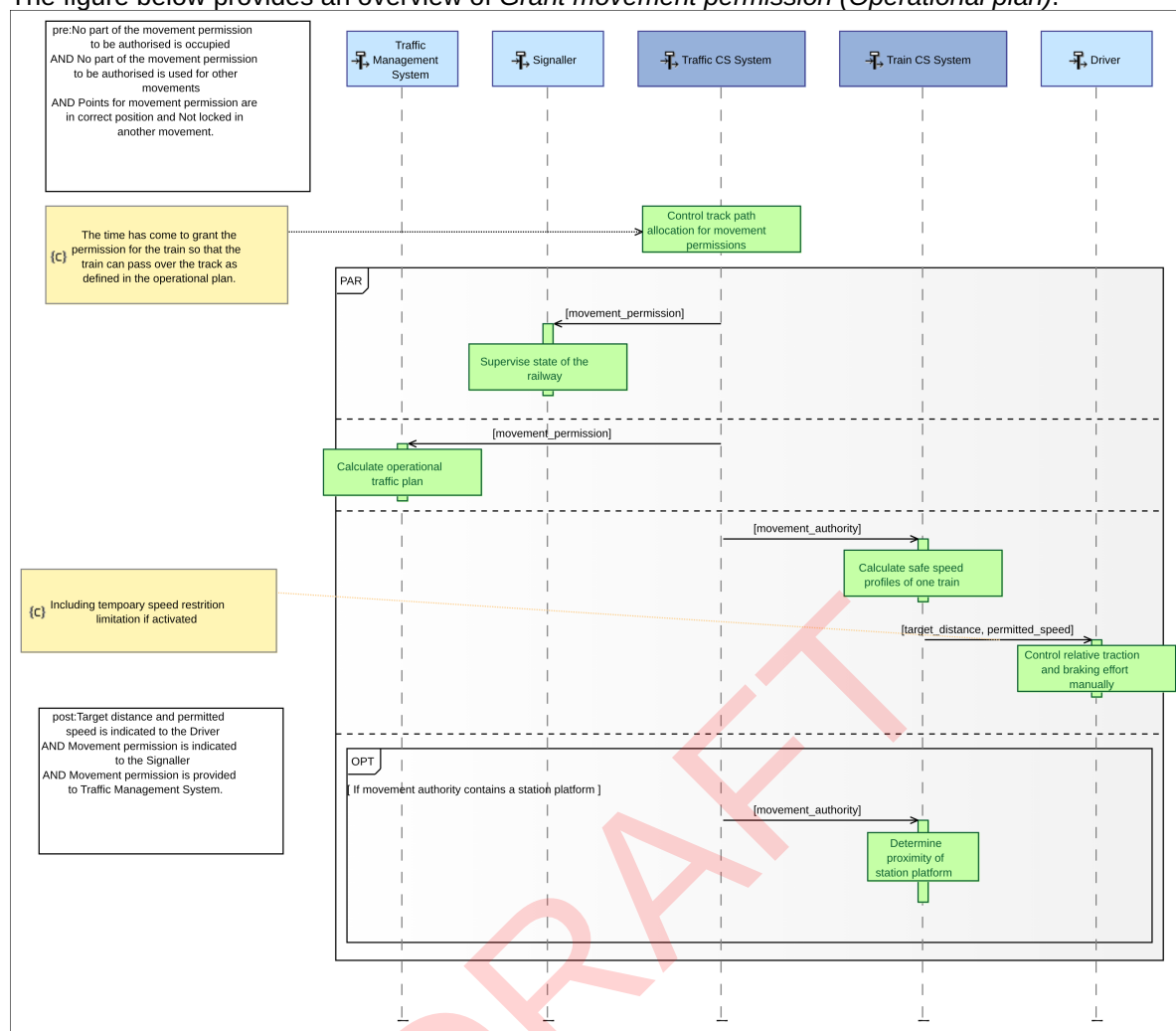


Figure 62 Diagram [LES] Grant movement permission (Operational plan) [Exchange scenario]

ID	SPMS-5368
Pre Condition	<p>No part of the movement permission to be authorised is occupied</p> <p>AND No part of the movement permission to be authorised is used for other movements</p> <p>AND Points for movement permission are in correct position and Not locked in another movement.</p>
Post Condition	<p>Target distance and permitted speed is indicated to the Driver</p> <p>AND Movement permission is indicated to the Signaller</p> <p>AND Movement permission is provided to Traffic Management System.</p>

[LAB] Grant and release movement permission (Operational plan) [Control loop]

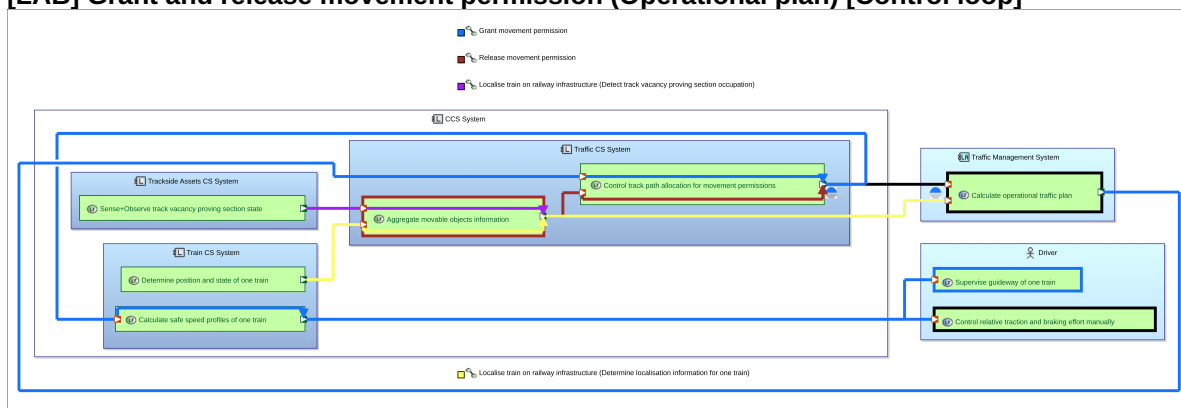


Figure 63 Diagram [LAB] Grant and release movement permission (Operational plan) [Control loop]

ID	SPMS-5803
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5.3.2 Grant movement permission (Signaller request)

5.3.2-1 - Grant movement permission (Signaller request)

This scenario describes the sequence of functions related to each other to grant a movement permission requested by the SPMS-2827 - Signaller.

The figure below provides an overview of *Grant movement permission (Signaller request)*.

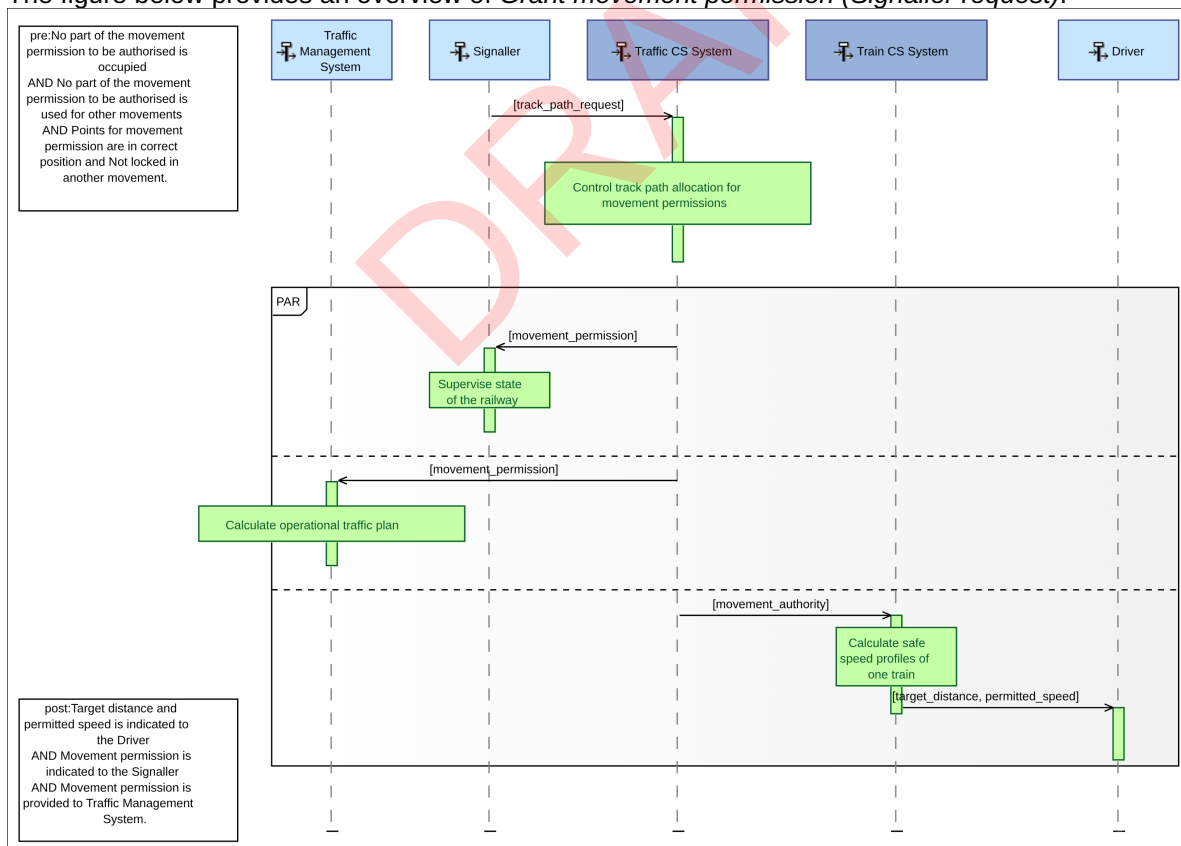


Figure 64 Diagram [LES] Grant movement permission (Signaller request) [Exchange scenario]

ID	SPMS-5810
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Pre Condition	No part of the movement permission to be authorised is occupied AND No part of the movement permission to be authorised is used for other movements AND Points for movement permission are in correct position and Not locked in another movement.
Post Condition	Target distance and permitted speed is indicated to the Driver AND Movement permission is indicated to the Signaller AND Movement permission is provided to Traffic Management System.

[LAB] Grant and release movement permission (Signaller) [Control loop]

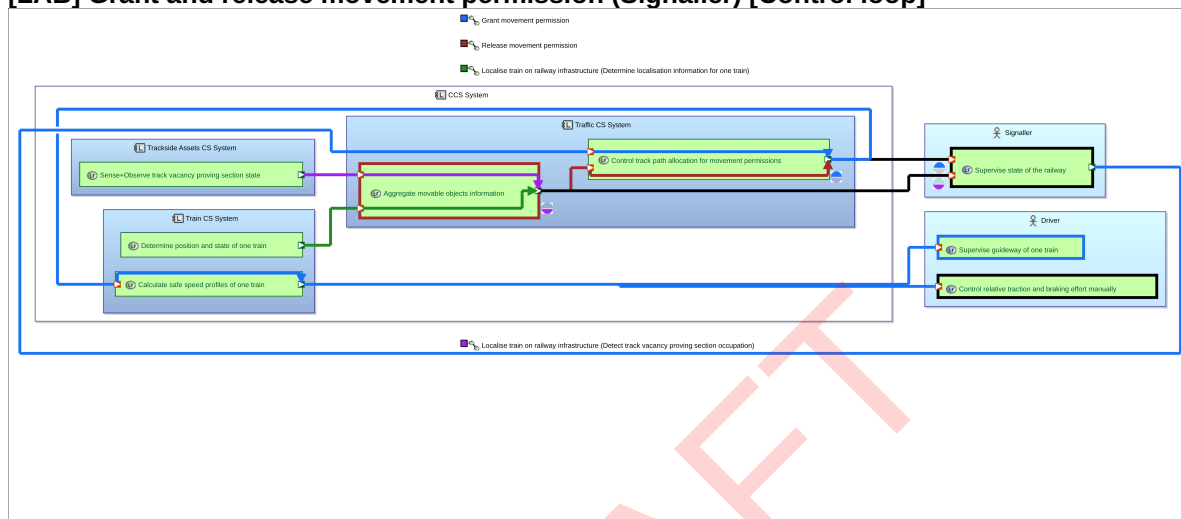


Figure 65 Diagram [LAB] Grant and release movement permission (Signaller) [Control loop]

ID	SPMS-5870
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5.4 Release movement permission

5.4-1 - Release movement permission

The Traffic Management System or the Signaller need the system to release a part of the movement permission that is no longer occupied in order to use it for other movements, ensuring that all permissions are managed with full consideration of safety constraints. Safe movement authorizations and driving limitations are constrained by infrastructure characteristics, train characteristics, and the track layout. The system must ensure that the release of movement permissions does not conflict with the operational plan.

ID	SPMS-5345
Involved entities	<ul style="list-style-type: none"> SPMS-2807 - Train CS System SPMS-2818 - Trackside Assets CS System

5.4-2 - Release movement permission

This scenario describes the sequence of functions related to each other to release a movement permission according to the operational plan and the train position (train has passed part of the movement permission).

The figure below provides an overview of *Release movement permission*.

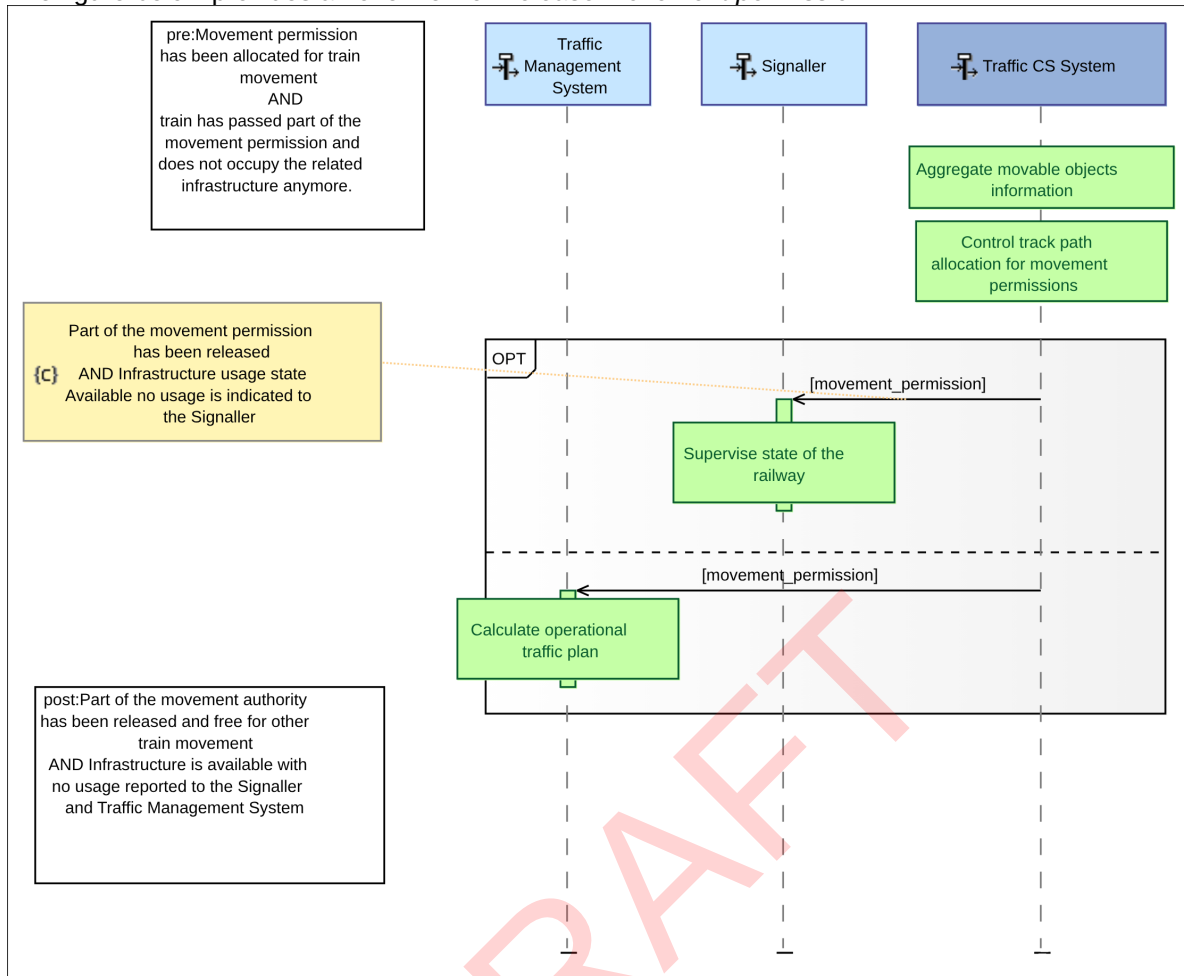


Figure 66 Diagram [LES] Release movement permission [Exchange scenario]

ID	SPMS-5369
Pre Condition	Movement permission has been allocated for train movement AND train has passed part of the movement permission and does not occupy the related infrastructure anymore.
Post Condition	Part of the movement authority has been released and free for other train movement AND Infrastructure is available with no usage reported to the Signaller and Traffic Management System

5.4-3 - Release movement permission

This functional chain describes the sequence of functions related to each other to release a movement permission according to the operational plan and the train position (train has passed part of the movement permission).

The figure below provides an overview of *Release movement permission*.

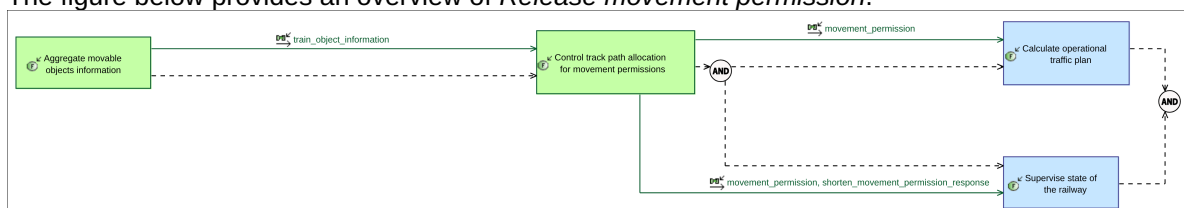


Figure 67 Diagram [LFCD] Release movement permission [Functional chain description]

ID	SPMS-5364
Pre Condition	Movement permission has been allocated for train movement AND train has passed part of the movement permission and does not occupy the related infrastructure anymore.
Post Condition	Part of the movement authority has been released and free for other train movement AND Infrastructure is available with no usage reported to the Signaller and Traffic Management System

Note:

Control loops for "Release movement permission" are shown in:

- 5.3.1-2 - [LAB] Grant and release movement permission (Operational plan) [Control loop]
- 5.3.2-2 - [LAB] Grant and release movement permission (Signaller) [Control loop]

5.5 Shorten movement permission

5.5-1 - Shorten movement permission

The Traffic Management System or the Signaller need the system to shorten a movement permission which has already been authorised.

Note: in the scope it is foreseen that a movement permission is only shortened by the system if it does not lead to an immediate impact such that the train needs to brake.

ID	SPMS-5041
Involved entities	<ul style="list-style-type: none"> • SPMS-2807 - Train CS System • SPMS-2813 - Traffic Management System • SPMS-2822 - Driver • SPMS-2823 - Traffic CS System • SPMS-2827 - Signaller

5.5-2 - Shorten movement permission (Cooperative shortening of movement permission)

This functional chain describes the sequence of functions related to each other in case an active movement permission needs to be shortened. Such request can be triggered by the Traffic Management System or by the Signaller.

The figure below provides an overview of *Shorten movement permission (Cooperative shortening of movement permission)*.

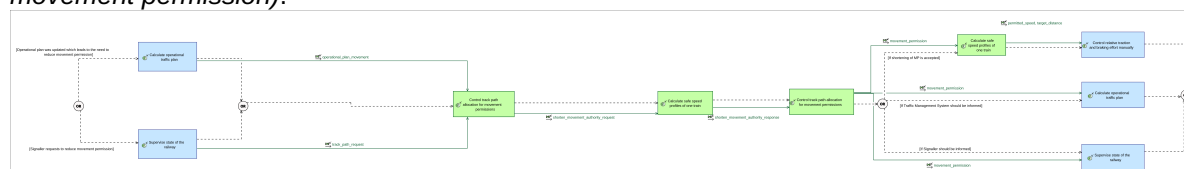


Figure 68 Diagram [LFCD] Shorten movement permission (Cooperative shortening of movement permission) [Functional chain description]

ID	SPMS-5426
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5.5.1 Shorten movement permission (Operational plan change)

5.5.1-1 - Shorten movement permission (Operational plan change, accepted)

This exchange scenario describes the exchange of information on the interfaces of the Traffic CS System when a shortening request for an active movement permission is triggered by the Traffic Management System and will be accepted by the Traffic CS System.

The figure below provides an overview of *Shorten movement permission (Operational plan change, accepted)*.

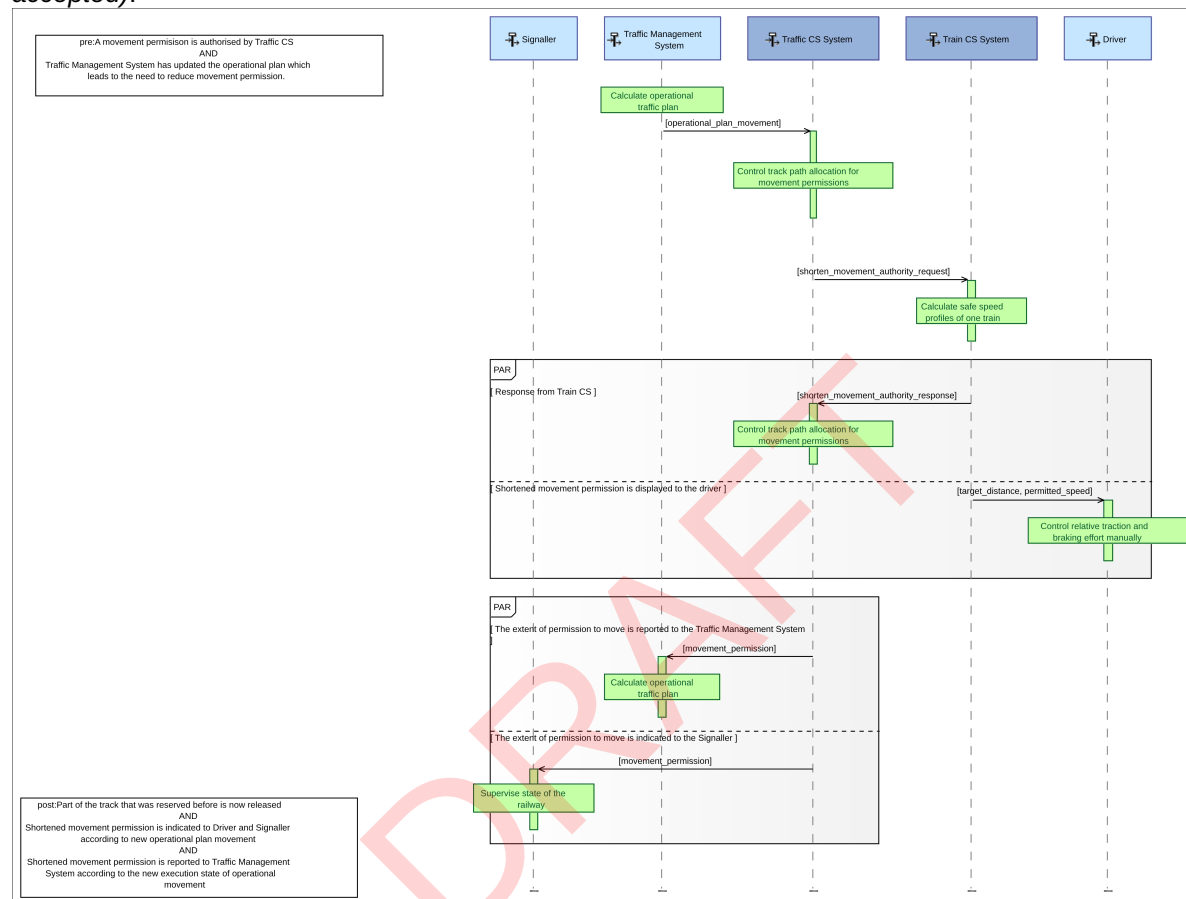


Figure 69 Diagram [LES] Shorten movement permission (Operational plan change, accepted) [Logical exchange scenario]

ID	SPMS-5047
Pre Condition	A movement permission is authorised by Traffic CS AND Traffic Management System has updated the operational plan which leads to the need to reduce movement permission.
Post Condition	Part of the track that was reserved before is now released AND Shortened movement permission is indicated to Driver and Signaller according to new operational plan movement AND Shortened movement permission is reported to Traffic Management System according to the new execution state of operational movement

5.5.1-2 - Shorten movement permission (Operational plan change, rejected)

This exchange scenario describes the exchange of information on the interfaces of the Traffic CS System when a shortening request for an active movement permission is triggered by the Traffic Management System and will be rejected by the Traffic CS System.

The figure below provides an overview of *Shorten movement permission (Operational plan change, rejected)*.

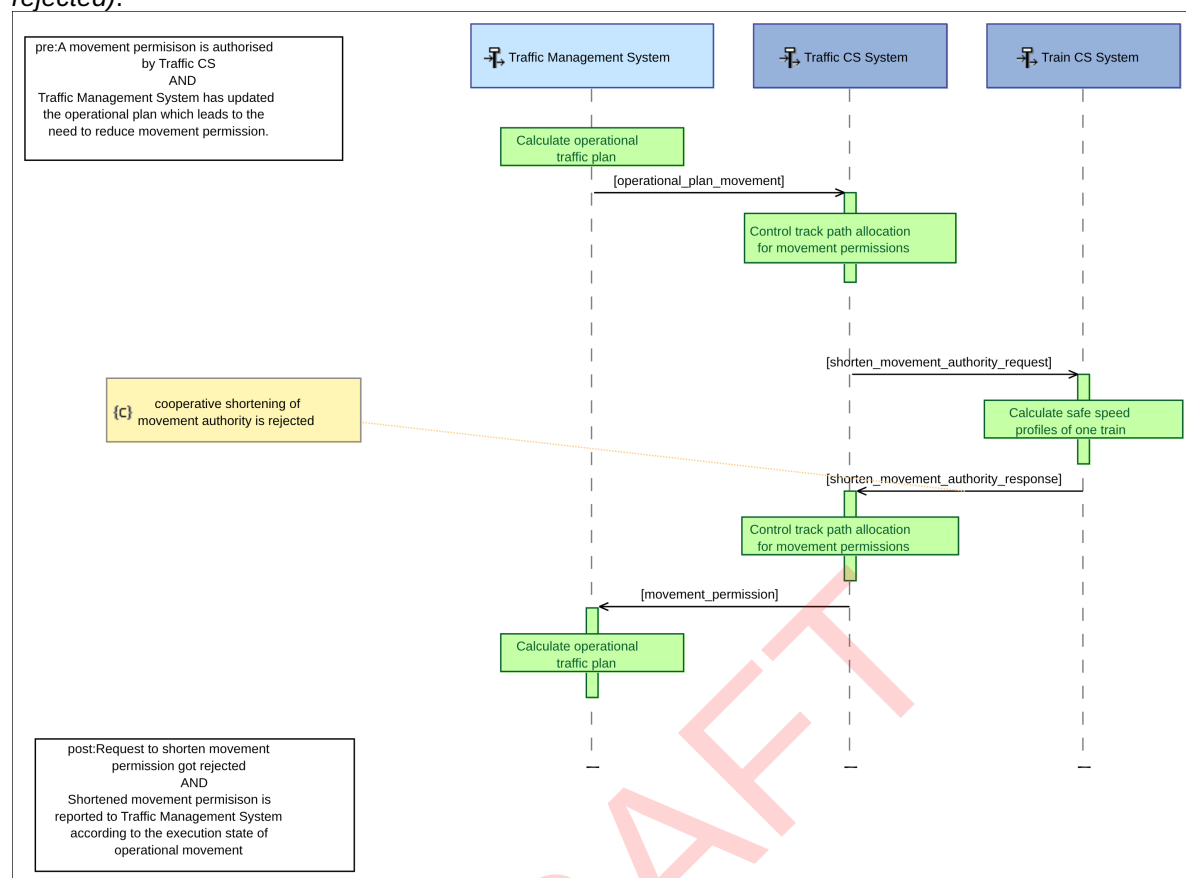


Figure 70 Diagram [LES] Shorten movement permission (Operational plan change, rejected) [Exchange scenario]

ID	SPMS-5131
Pre Condition	A movement permission is authorised by Traffic CS AND Traffic Management System has updated the operational plan which leads to the need to reduce movement permission.
Post Condition	Request to shorten movement permission got rejected AND Shortened movement permission is reported to Traffic Management System according to the execution state of operational movement

[LAB] Shorten movement permission (Operational plan) [Control loop]

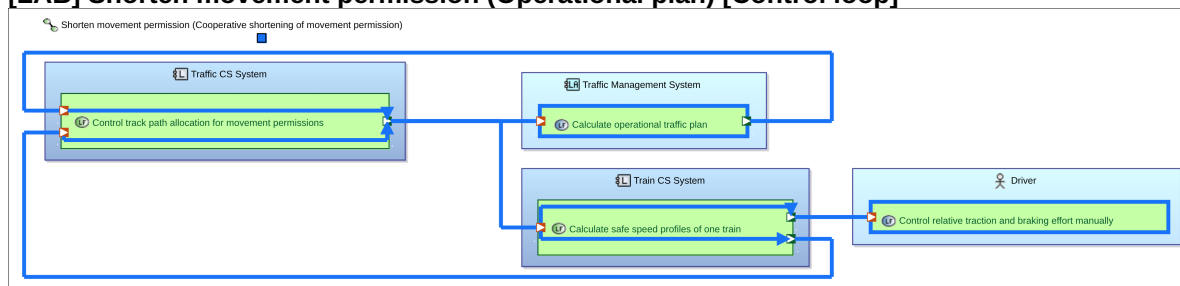


Figure 71 Diagram [LAB] Shorten movement permission (Operational plan) [Control loop]

ID	SPMS-5692
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5.5.2 Shorten movement permission (Signaller request)

5.5.2-1 - Shorten movement permission (Signaller request, accepted)

This exchange scenario describes the exchange of information on the interfaces of the Traffic CS System when a shortening request for an active movement permission is triggered by the Signaller and will be accepted by the Traffic CS System.

The figure below provides an overview of *Shorten movement permission (Signaller request, accepted)*.

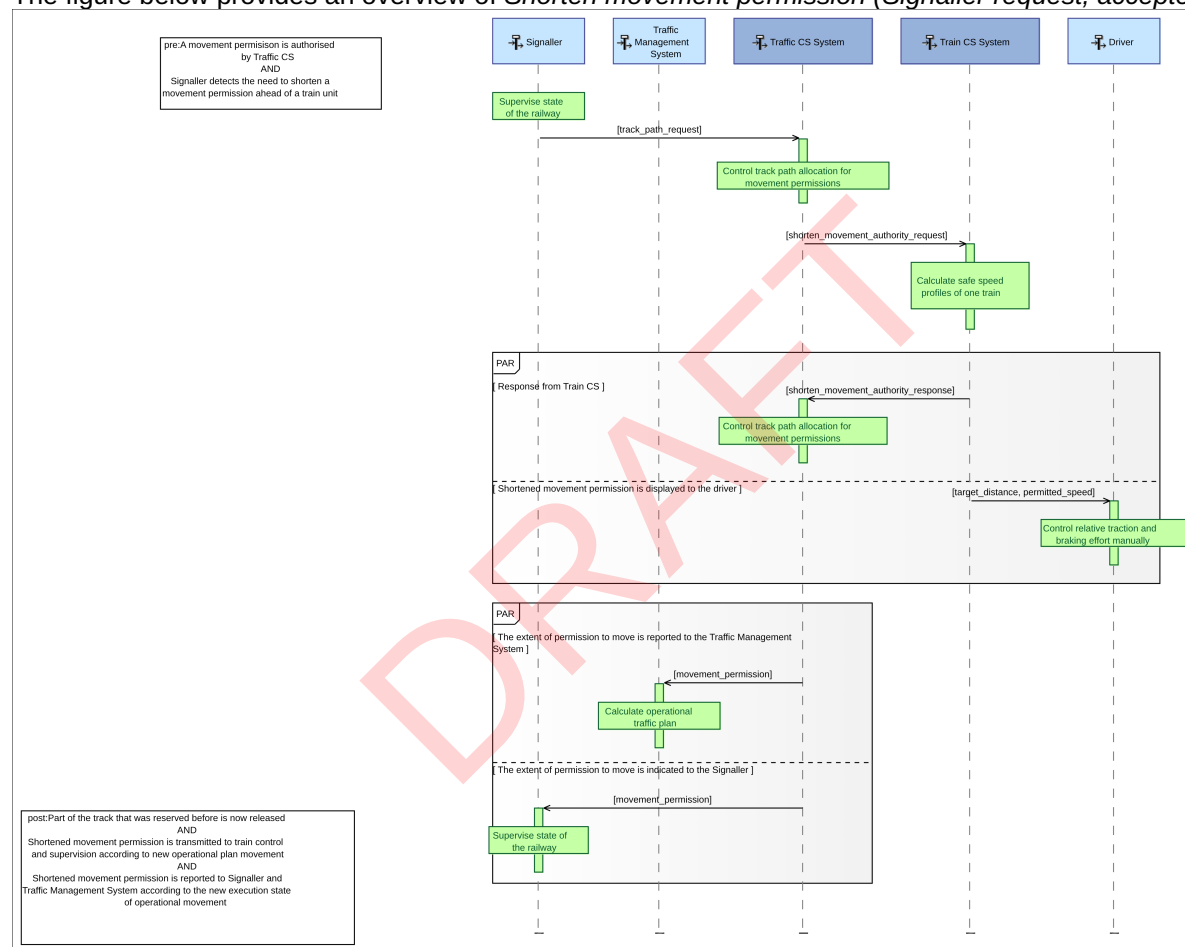


Figure 72 Diagram [LES] Shorten movement permission (Signaller request, accepted) [Logical exchange scenario]

ID	SPMS-5170
Pre Condition	<p>A movement permission is authorised by Traffic CS</p> <p>AND</p> <p>Signaller detects the need to shorten a movement permission ahead of a train unit</p>

Post Condition	Part of the track that was reserved before is now released AND Shortened movement permission is transmitted to train control and supervision according to new operational plan movement AND Shortened movement permission is reported to Signaller and Traffic Management System according to the new execution state of operational movement
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5.5.2-2 - Shorten movement permission (Signaller request, rejected)

This exchange scenario describes the exchange of information on the interfaces of the Traffic CS System when a shortening request for an active movement permission is triggered by the Signaller and will be rejected by the Traffic CS System.

The figure below provides an overview of *Shorten movement permission (Signaller request, rejected)*.

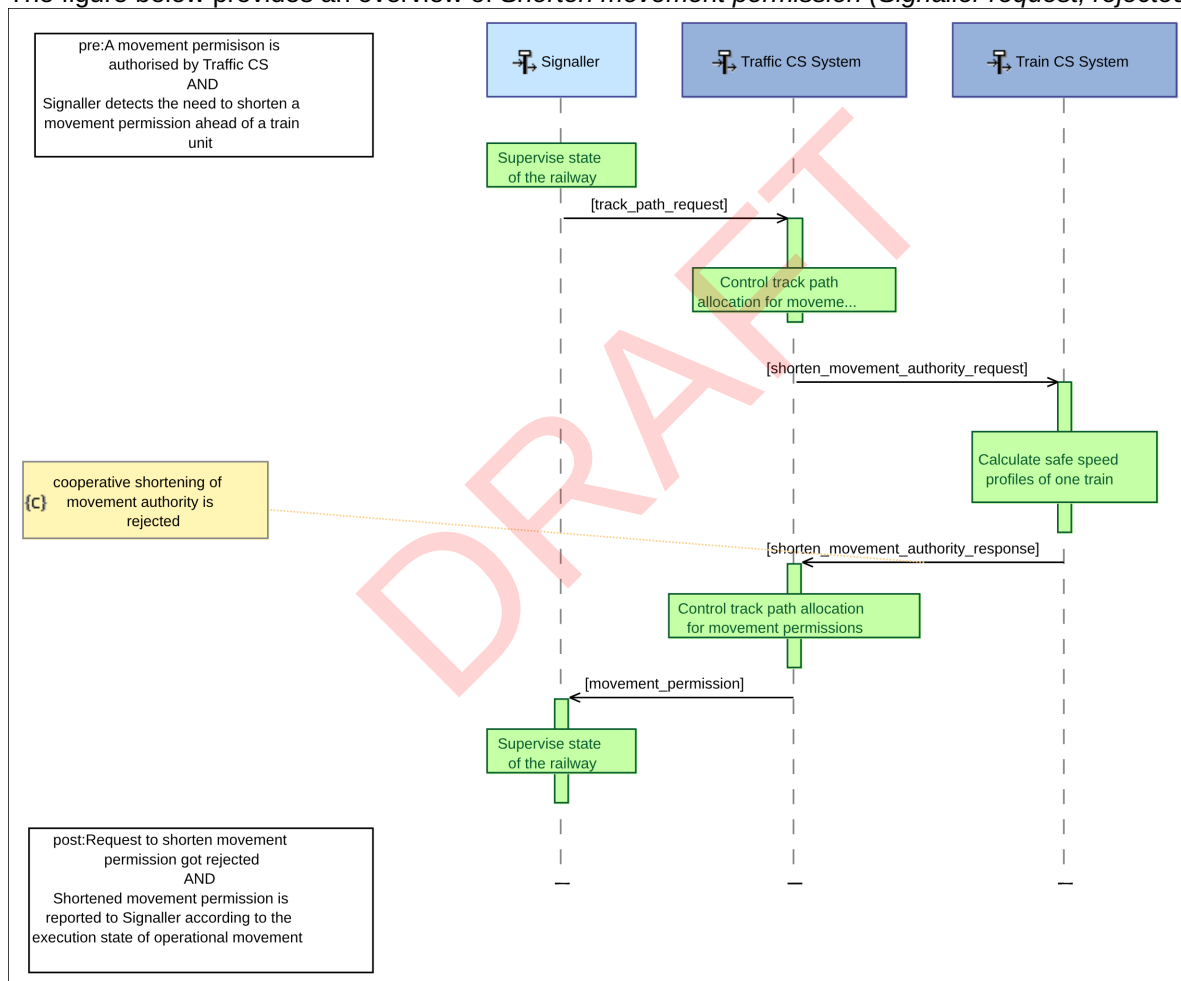


Figure 73 Diagram [LES] Shorten movement permission (Signaller request, rejected) [Logical exchange scenario]

ID	SPMS-5171
Pre Condition	A movement permission is authorised by Traffic CS AND Signaller detects the need to shorten a movement permission ahead of a train unit

Post Condition	Request to shorten movement permission got rejected AND Shortened movement permission is reported to Signaller according to the execution state of operational movement
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[LAB] Shorten movement permission (Signaller) [Control loop]

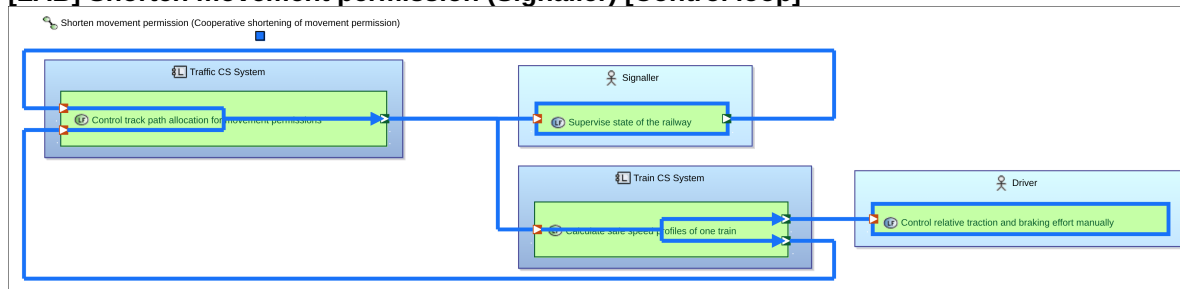





Figure 74 Diagram [LAB] Shorten movement permission (Signaller) [Control loop]

ID	SPMS-5730
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5.6 Execute End of Mission

5.6-1 - Execute end of mission

The Driver, Signaller and Traffic Management System needs the CCS reference system to execute the end of mission. This capability includes the deregistration of functional number, the cab closure as well as powering off the rolling stock.

ID	SPMS-3313
Involved entities	<ul style="list-style-type: none"> •  SPMS-2820 - Rolling Stock Operation System •  SPMS-2822 - Driver •  SPMS-2827 - Signaller

5.6-2 - Execute end of mission

This functional chain describes the sequence of functions related to each other in case an End of Mission (i.e. cab closure and possibly power off) is executed by the driver.

The figure below provides an overview of *Execute end of mission*.

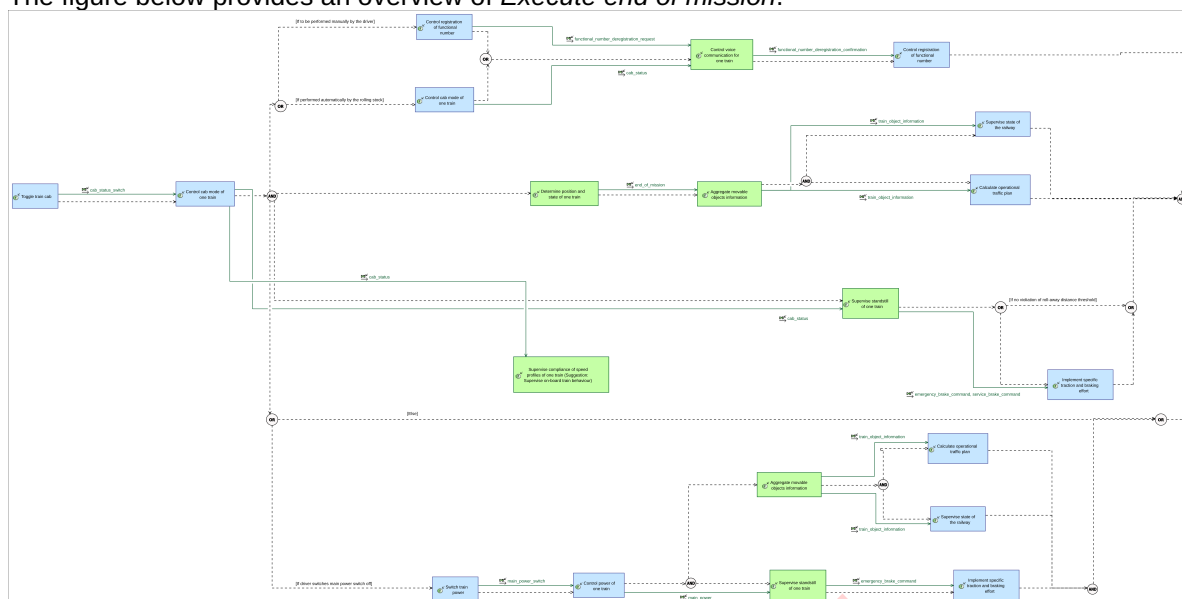


Figure 75 Diagram [LFCD] Execute end of mission [Functional chain description]

ID	SPMS-5703
Pre Condition	Desk is open AND Train is at standstill AND functional number is registered in voice communication mobile
Post Condition	Desk is closed AND functional number is de-registered from voice communication mobile AND/OR Train is powered off

5.6-3 - Execute end of mission

This exchange scenario describes the exchange of information on the interfaces of the CCS System when an End of Mission (i.e. cab closure and possibly power off) is executed by the driver.

The figure below provides an overview of *Execute end of mission*.

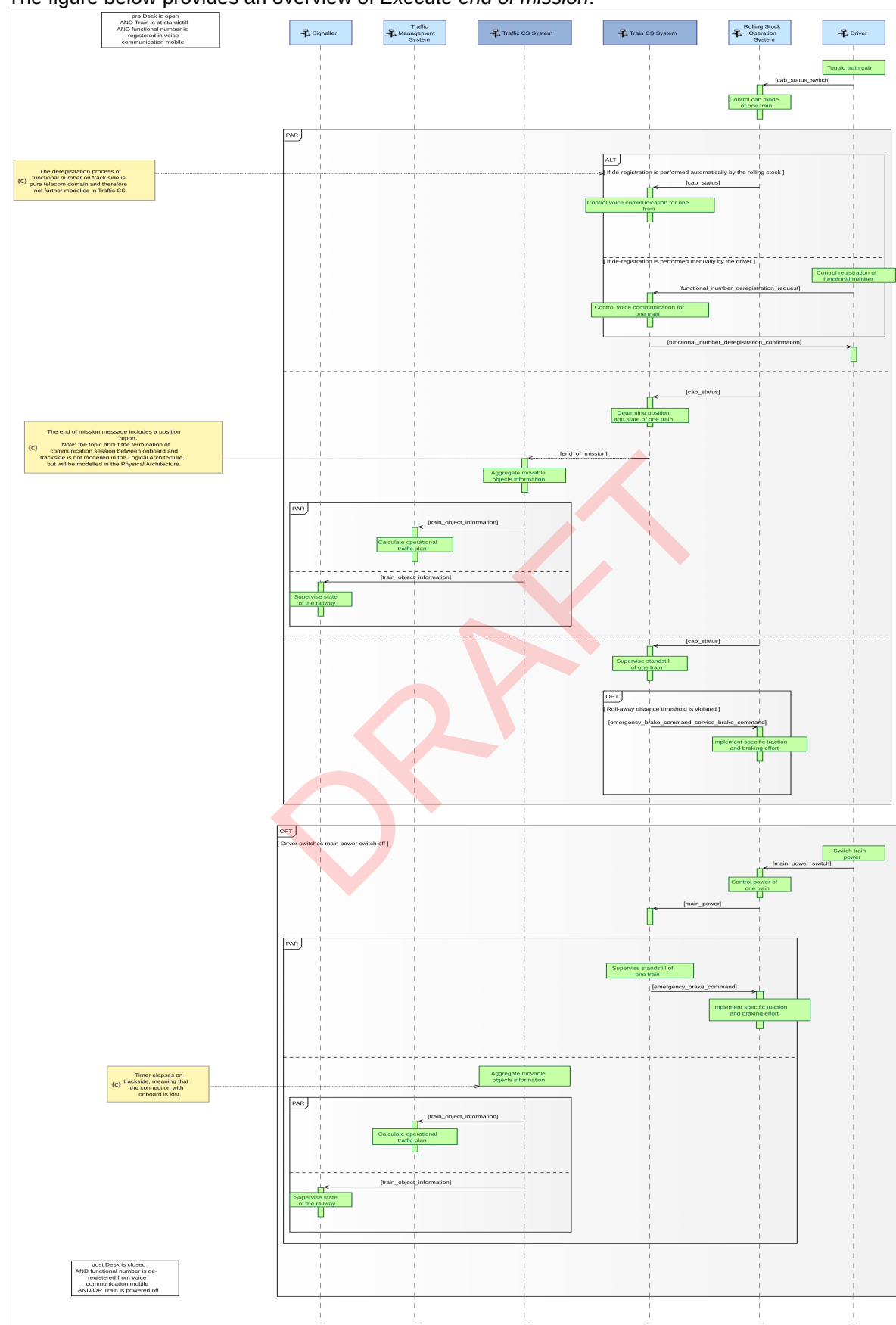


Figure 76 Diagram [LES] Execute end of mission

ID	SPMS-6938
Pre Condition	Desk is open AND Train is at standstill AND functional number is registered in voice communication mobile
Post Condition	Desk is closed AND functional number is de-registered from voice communication mobile AND/OR Train is powered off

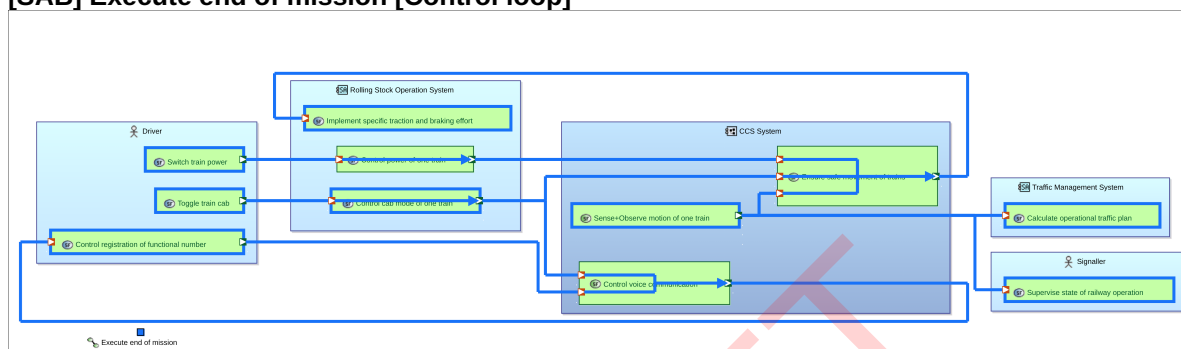








[SAB] Execute end of mission [Control loop]

Figure 77 Diagram [SAB] Execute end of mission [Control loop]

ID	SPMS-6815
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5.7 Localise train on railway infrastructure**5.7-1 - Localise train on railway infrastructure**

The Signaller and Traffic Management System needs the system to localise the train on the railway infrastructure, to ensure accurate positioning. The Signaller needs the system to observe all track occupancies within the corresponding occupancy extent to ensure safe train operation. The Driver needs the system to observe the current speed to avoid overspeed and maintain alignment with the timetable. The Traffic Management System needs the system to observe the motion of the train to provide accurate plans.

ID	SPMS-3309
Involved entities	<ul style="list-style-type: none"> •  SPMS-2807 - Train CS System •  SPMS-2809 - Rolling Stock Reference Point •  SPMS-2813 - Traffic Management System •  SPMS-2818 - Trackside Assets CS System •  SPMS-2820 - Rolling Stock Operation System •  SPMS-2822 - Driver •  SPMS-2827 - Signaller •  SPMS-2829 - Wheel

5.7-2 - Localise train on railway infrastructure

This functional chain includes the functional chain to detect the occupation of a track vacancy proving section as well as the functional chain to determine localisation information of one rolling stock in order to combine all functionality to localise a train on the railway infrastructure.

The figure below provides an overview of *Localise train on railway infrastructure*.

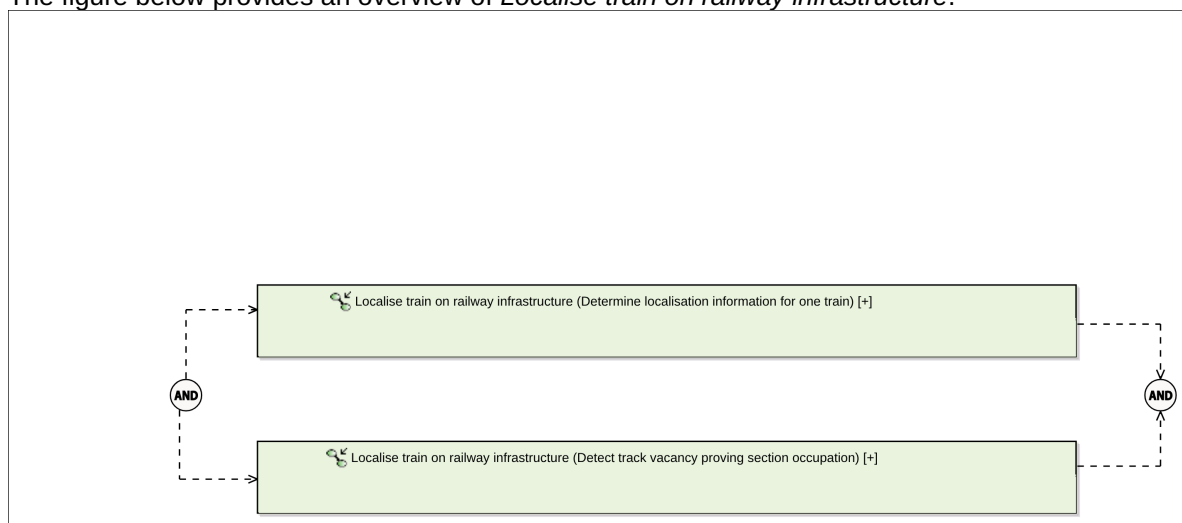


Figure 78 Diagram [LFCD] Localise train on railway infrastructure [Functional chain description]

ID	SPMS-4467
Pre Condition	<p>Last passed reference and physical orientation is known at the beginning of the movement.</p> <p>AND The train localisation data have changed while performing movement</p> <p>AND Train integrity and safe confirmed train length is assured.</p>
Post Condition	<p>The updated train localisation data have been indicated to Signaller</p> <p>AND The current speed has been indicated to the Driver</p> <p>AND The updated train localisation data have been sent to Traffic Management System.</p>

5.7-3 - Localise train on railway infrastructure

The Signaller needs the system to observe all track occupancies in the corresponding occupancy extent in a proper representation in order to perform safe train operation.

The Driver needs the system to observe the current speed in order to avoid overspeed and maintaining (or be in line with) the time table.

The Traffic Management System needs the system to observe the motion of one train in order to provide accurate plans.

The figure below provides an overview of *Localise train on railway infrastructure*.

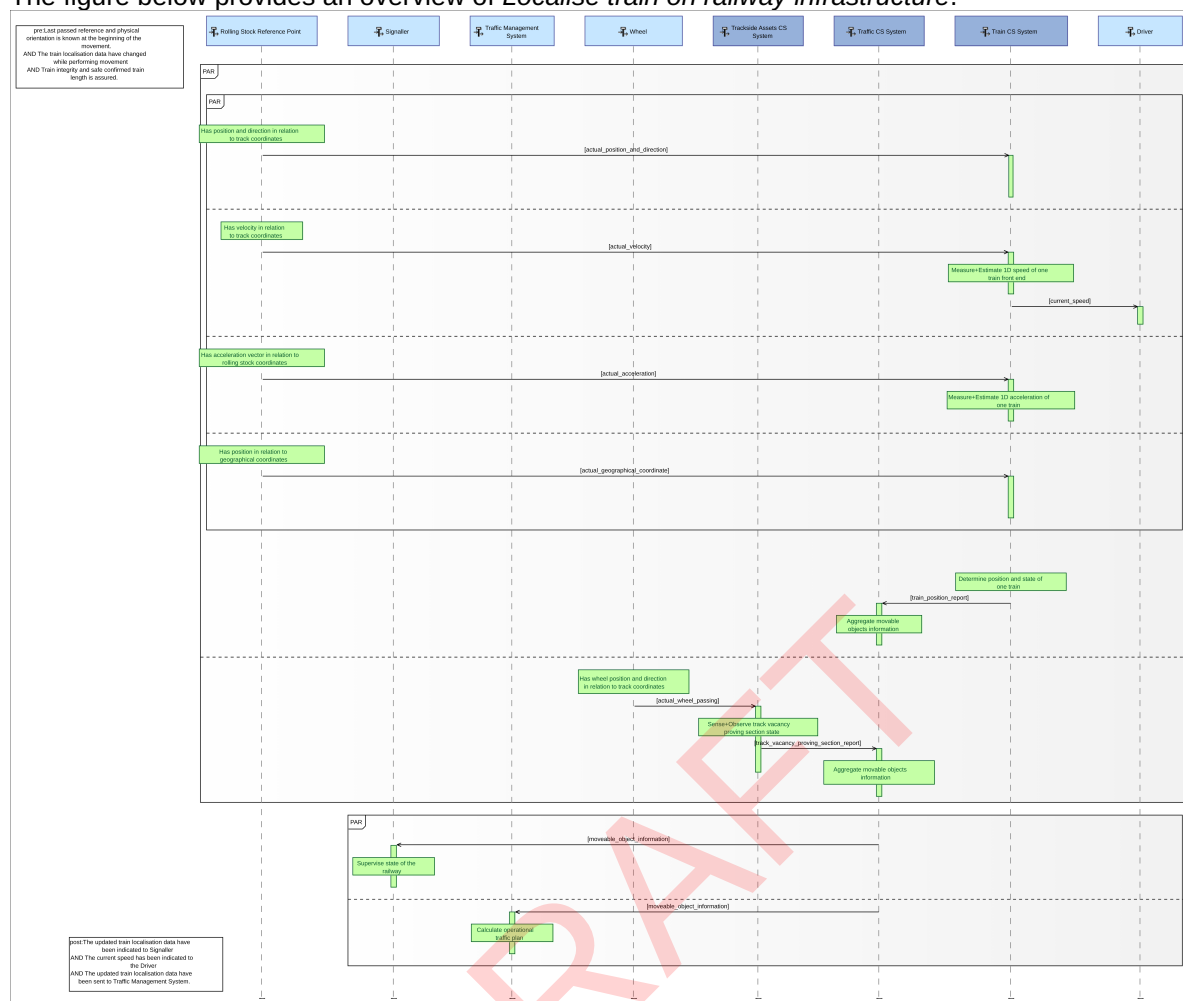


Figure 79 Diagram [LES] Localise train on railway infrastructure [Logical exchange scenario]

ID	SPMS-4364
Pre Condition	<p>Last passed reference and physical orientation is known at the beginning of the movement.</p> <p>AND The train localisation data have changed while performing movement</p> <p>AND Train integrity and safe confirmed train length is assured.</p>
Post Condition	<p>The updated train localisation data have been indicated to Signaller</p> <p>AND The current speed has been indicated to the Driver</p> <p>AND The updated train localisation data have been sent to Traffic Management System.</p>

[LAB] Localise train on railway infrastructure [Control loop]

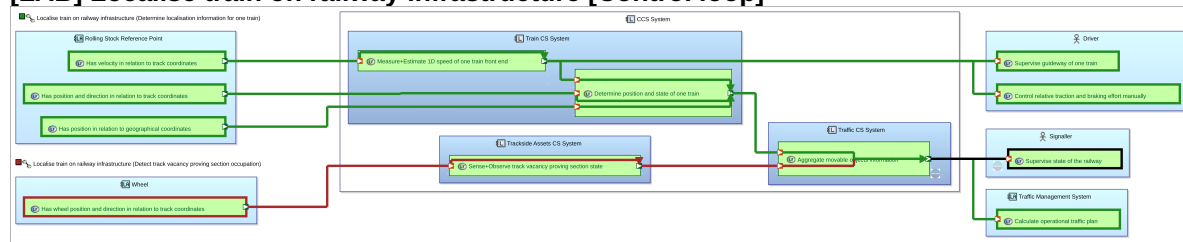


Figure 80 Diagram [LAB] Localise train on railway infrastructure [Control loop]

ID	SPMS-5809
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5.7.1 Localise train on railway infrastructure (Detect track vacancy proving section occupation)

5.7.1-1 - Localise train on railway infrastructure (Detect track vacancy proving section occupation)

This functional chain describes the sequence of functions related to each other in case of a wheel passing an infrastructure reference point to derive from that the occupation of a track vacancy proving section. The figure below provides an overview of *Localise train on railway infrastructure (Detect track vacancy proving section occupation)*.

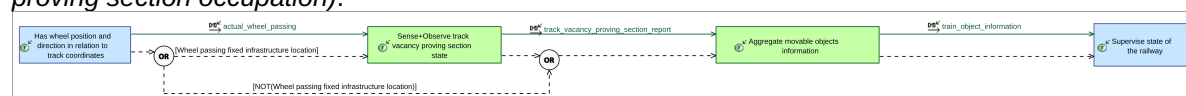


Figure 81 Diagram [LFCD] Detect track vacancy proving section occupation [Functional chain description]

ID	SPMS-4465
Post Condition	The updated train localisation data have been indicated to Signaller AND The updated train localisation data have been sent to Traffic Management System.

5.7.2 Localise train on railway infrastructure (Determine localisation information for one train)

5.7.2-1 - Localise train on railway infrastructure (Determine localisation information for one train)

This functional chain describes the sequence of functions related to each other to determine localisation information (e.g. velocity, position in geographical coordinates) of a rolling stock. The figure below provides an overview of *Localise train on railway infrastructure (Determine localisation information for one train)*.

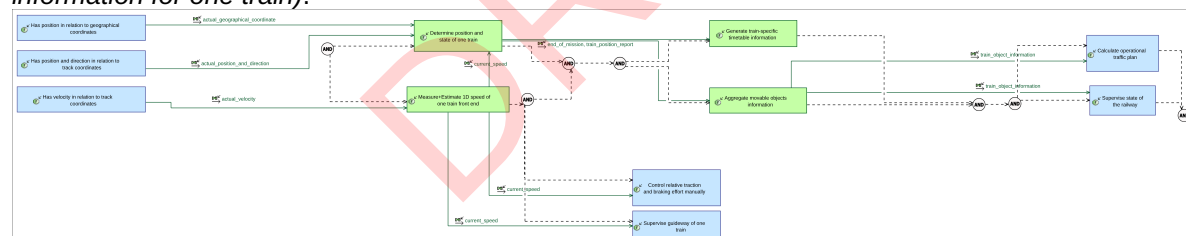







Figure 82 Diagram [LFCD] Determine localisation information for one rolling stock [Functional chain description]

ID	SPMS-4474
Post Condition	The updated train localisation data have been indicated to Signaller AND The current speed has been indicated to the Driver AND The updated train localisation data have been sent to Traffic Management System.

5.8 Set point position

5.8-1 - Set point position

The Traffic Management System or the Signaller need the system to set a point to the required position (e.g. to perform a train movement).

ID	SPMS-3312
Involved entities	<ul style="list-style-type: none"> •  SPMS-2812 - Point Machine •  SPMS-2813 - Traffic Management System •  SPMS-2818 - Trackside Assets CS System •  SPMS-2823 - Traffic CS System •  SPMS-2827 - Signaller

5.8-2 - Set point position



This functional chain describes the sequence of functions related to each other in case of a point position request by the  SPMS-2813 - Traffic Management System or the  SPMS-2827 - Signaller. The figure below provides an overview of *Set point position*.




Figure 83 Diagram [LFCD] Set point position [Functional chain description]

ID	SPMS-4476
Pre Condition	The estimated position of the point is not in the required end position
Post Condition	<p>The estimated position of the point is in the required end position</p> <p>AND</p> <p>the point status is indicated to the Signaller</p> <p>AND</p> <p>the point status is indicated to the Traffic Management System.</p>

5.8.1 Set point position (Left to right, Operational plan)

5.8.1-1 - Set point position (Left to right, Operational plan)

This scenario describes the sequence of functions related to each other in case of a operational plan movement requiring "right end position" point position request by the  SPMS-2813 - Traffic Management System.

The figure below provides an overview of *Set point position (Left to right, Operational plan)*.

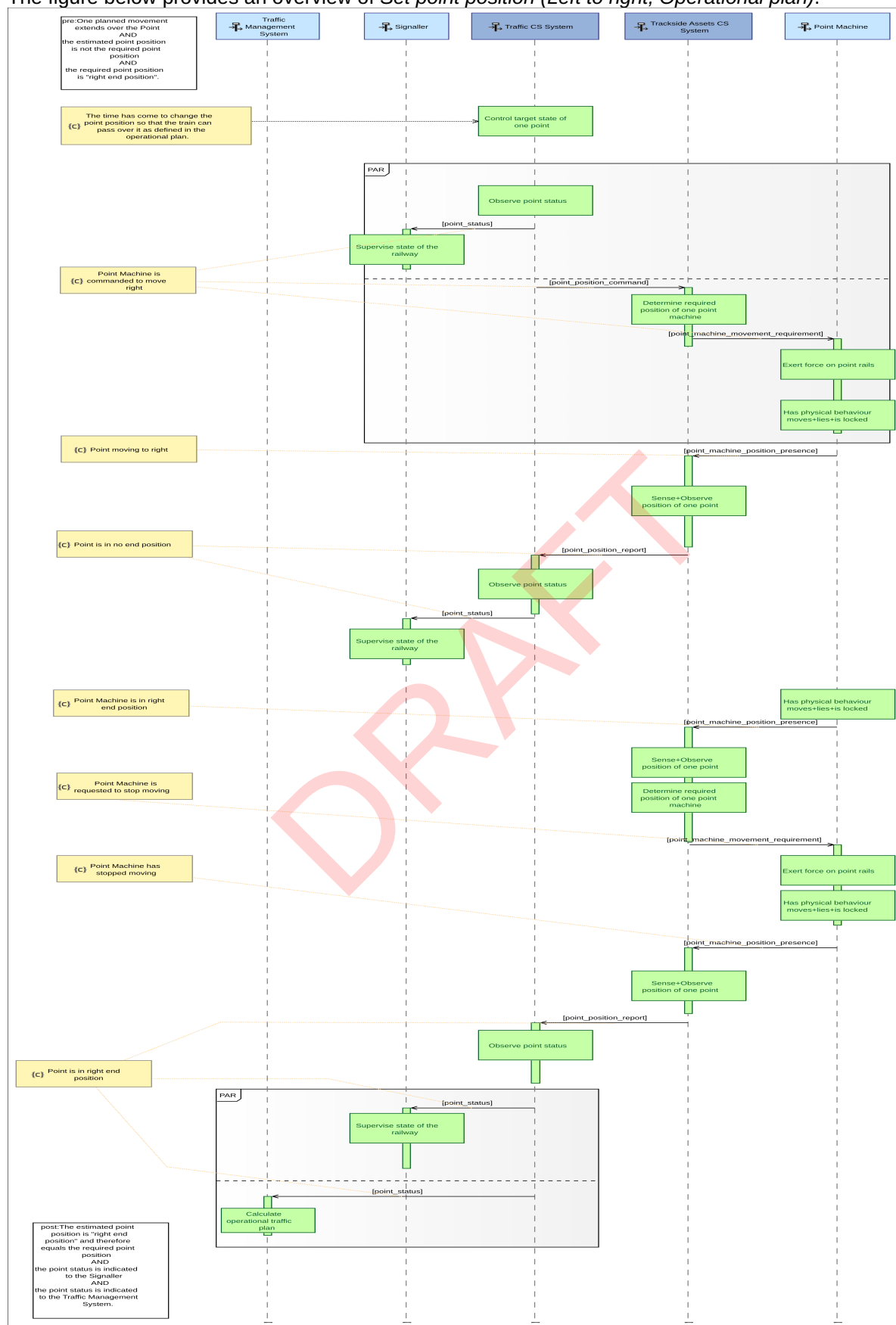


Figure 84 Diagram [LES] Set point position (Left to right, Operational plan) [Logical exchange scenario]

ID	SPMS-4382
Pre Condition	One planned movement extends over the Point AND the estimated point position is not the required point position AND the required point position is "right end position".
Post Condition	The estimated point position is "right end position" and therefore equals the required point position AND the point status is indicated to the Signaller AND the point status is indicated to the Traffic Management System.

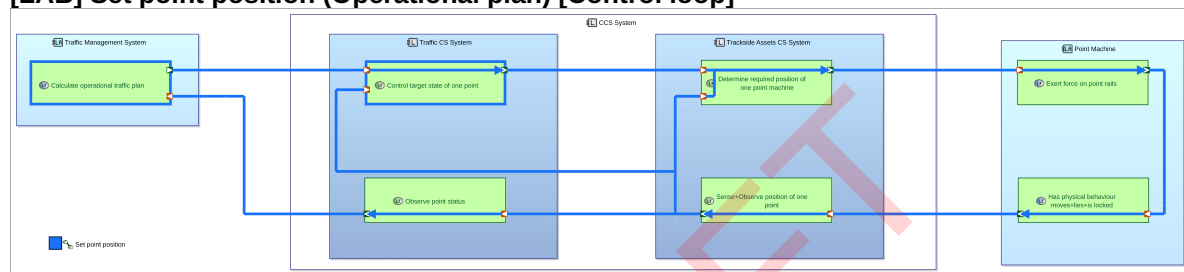

[LAB] Set point position (Operational plan) [Control loop]

Figure 85 Diagram [LAB] Set point position (Operational plan) [Control loop]

ID	SPMS-5826
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5.8.2 Set point position (Left to right, Signaller request)**5.8.2-1 - Set point position (Left to right, Signaller request)**

This scenario describes the sequence of functions related to each other in case of a right end position point position request by the  SPMS-2827 - Signaller.

The figure below provides an overview of *Set point position (Left to right, Signaller request)*.

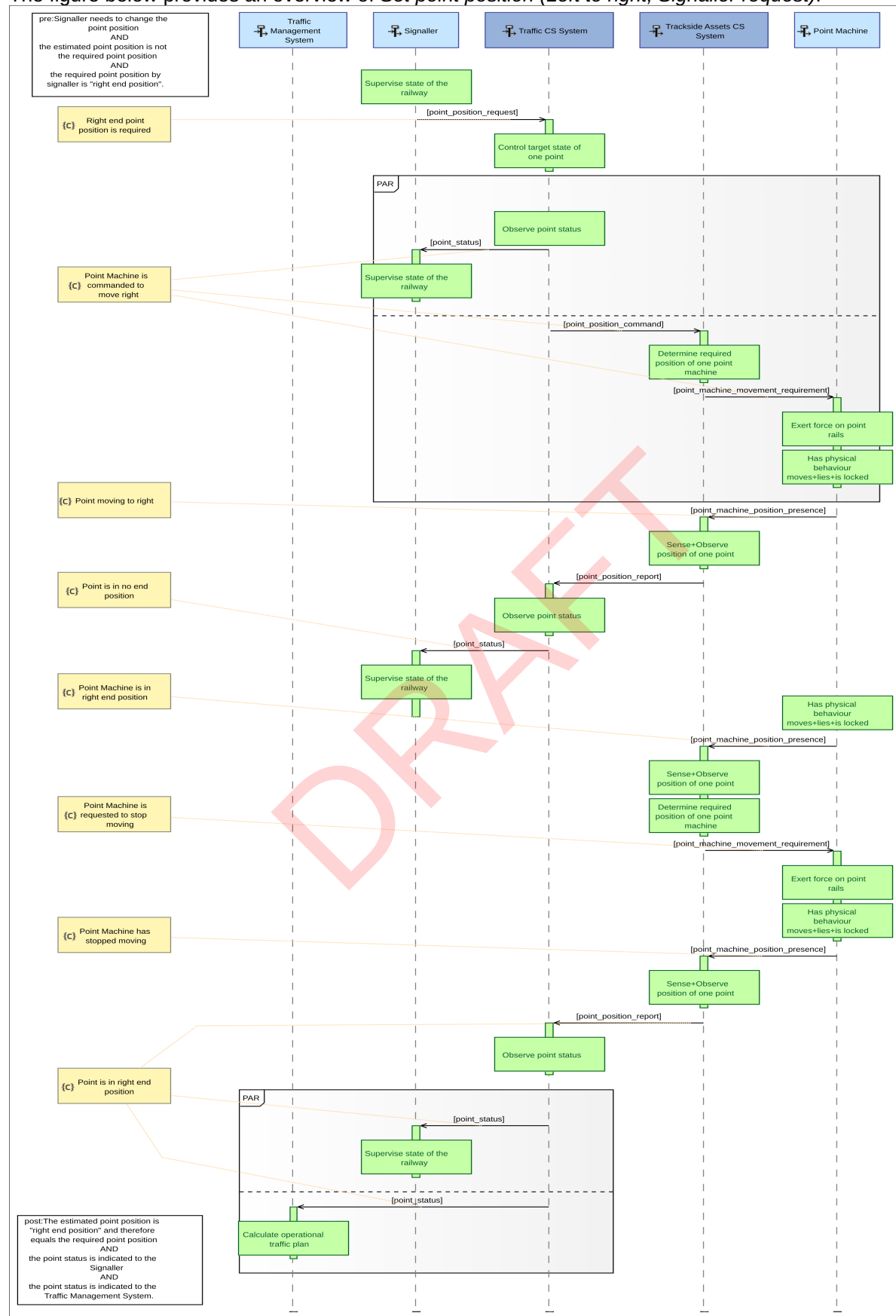


Figure 86 Diagram [LES] Set point position (Left to right, Signaller request) [Logical exchange scenario]

ID	SPMS-4692
Pre Condition	Signaller needs to change the point position AND the estimated point position is not the required point position AND the required point position by signaller is "right end position".
Post Condition	The estimated point position is "right end position" and therefore equals the required point position AND the point status is indicated to the Signaller AND the point status is indicated to the Traffic Management System.

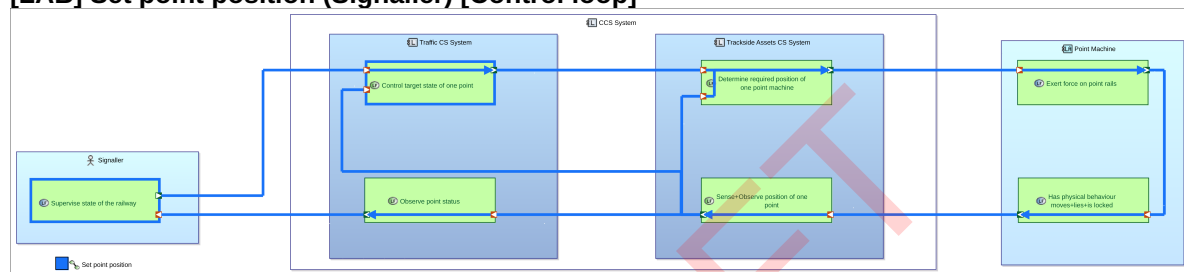
[LAB] Set point position (Signaller) [Control loop]

Figure 87 Diagram [LAB] Set point position (Signaller) [Control loop]





ID	SPMS-5434
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5.9 Activate usage restriction**5.9-1 - Activate usage restriction**



The Traffic Management System needs the system to consider and activate planned usage restrictions (e.g. temporary unavailability of some areas, Temporary Speed Restrictions, points locked in only one position) included in the Operational Plan in order to reserve track path and perform supervised train movement.

The Signaller needs the system to consider and activate unplanned usage restrictions (e.g. temporary unavailability of some areas, Temporary Speed Restrictions, points locked in only one position) not included in the Operational Plan in order to reserve track path and perform supervised train movement.

Note: The usage restriction does not apply to trains that have already been granted a Movement Authority overlapping the planned or unplanned restriction area.

ID	SPMS-3318
Involved entities	<ul style="list-style-type: none"> •  SPMS-2813 - Traffic Management System •  SPMS-2818 - Trackside Assets CS System •  SPMS-2823 - Traffic CS System •  SPMS-2827 - Signaller

5.9-2 - Activate usage restriction

This functional chain describes the sequence of functions related to each other in case of an activation request by the  SPMS-2813 - Traffic Management System for a planned usage restriction or by the  SPMS-2827 - Signaller for an unplanned usage restriction.

The figure below provides an overview of *Activate usage restriction*.

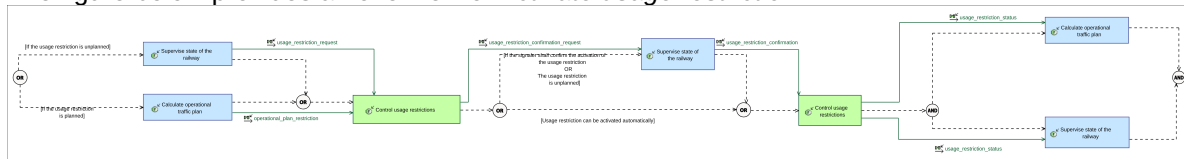


Figure 88 Diagram [LFCD] Activate usage restriction [Functional chain description]

ID	SPMS-4469
Pre Condition	Planned usage restriction is available in CCS system, provided ba operational plan.
Post Condition	The usage restriction is activated AND Signaller and Traffic Management System are informed about the activation status.

[LAB] Activate usage restriction [Control loop]

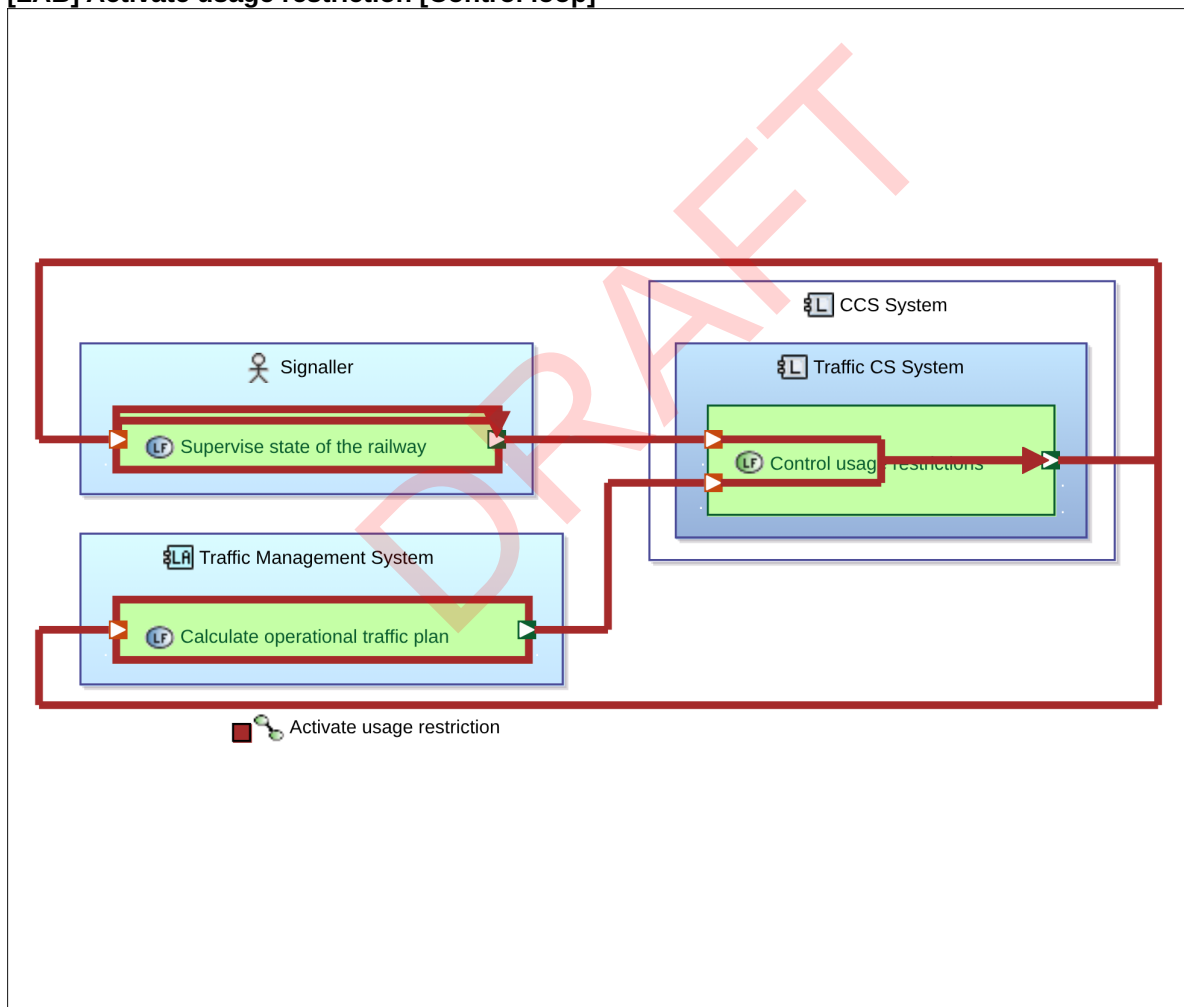



Figure 89 Diagram [LAB] Activate usage restriction [Control loop]

ID	SPMS-7815
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5.9.1 Activate usage restriction (Planned usage restriction)

5.9.1-1 - Activate usage restriction (Planned usage restriction)

This scenario describes the sequence of functions related to each other in case of an activation request by the  SPMS-2813 - Traffic Management System for a planned usage restriction.

The figure below provides an overview of *Activate usage restriction (Planned usage restriction)*.

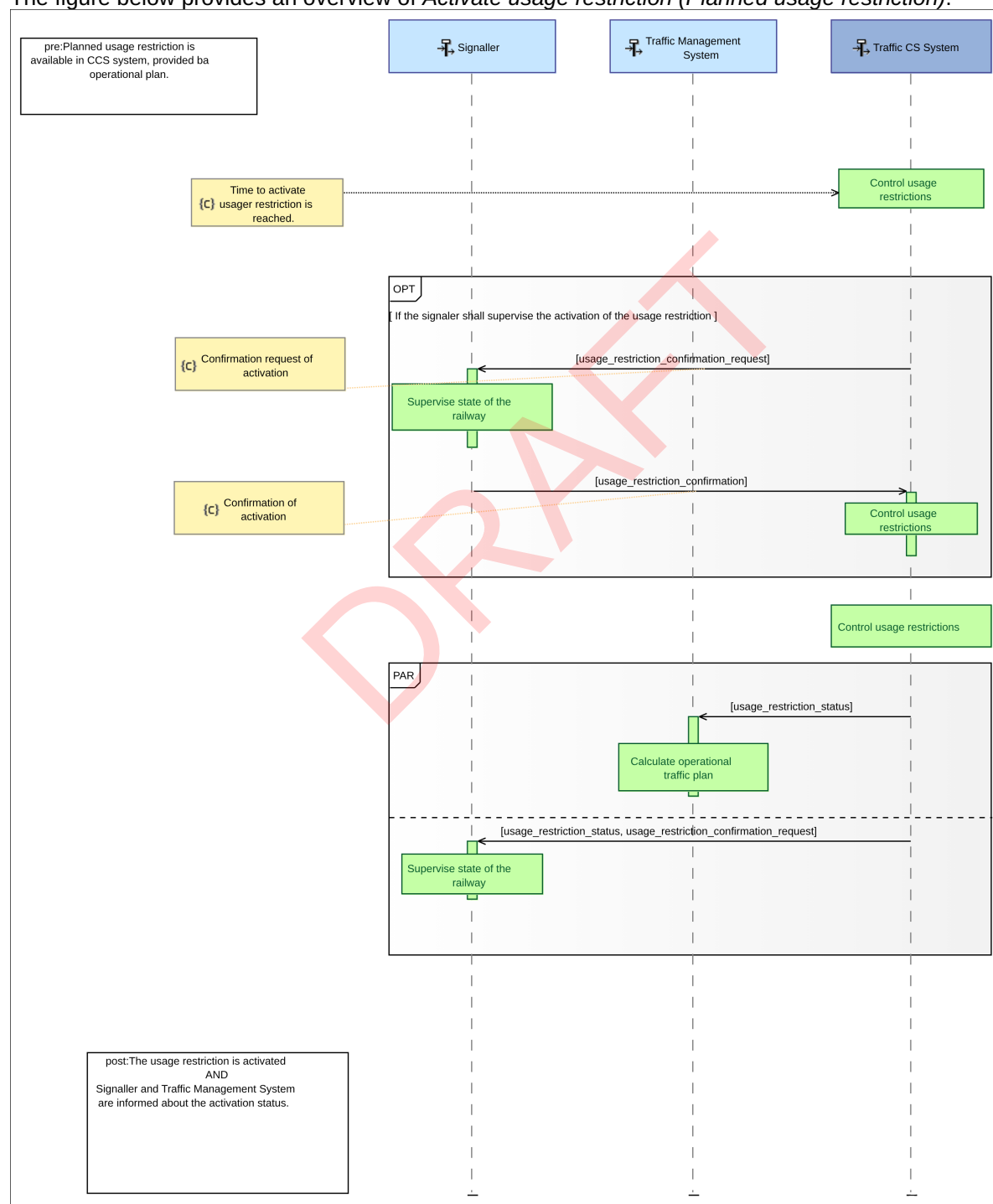



Figure 90 Diagram [LES] Activate planned usage restriction (Planned usage restriction) [Logical exchange scenario]

ID	SPMS-4355
Pre Condition	Planned usage restriction is available in CCS system, provided ba operational plan.
Post Condition	The usage restriction is activated AND Signaller and Traffic Management System are informed about the activation status.

5.9.2 Activate usage restriction (Unplanned Temporary Speed Restriction)

5.9.2-1 - Activate usage restriction (Unplanned TSR)

This scenario describes the sequence of functions related to each other in case of an activation request by the  SPMS-2090 - Signaller for an unplanned temporary speed restriction.

The figure below provides an overview of *Activate usage restriction (Unplanned TSR)*.

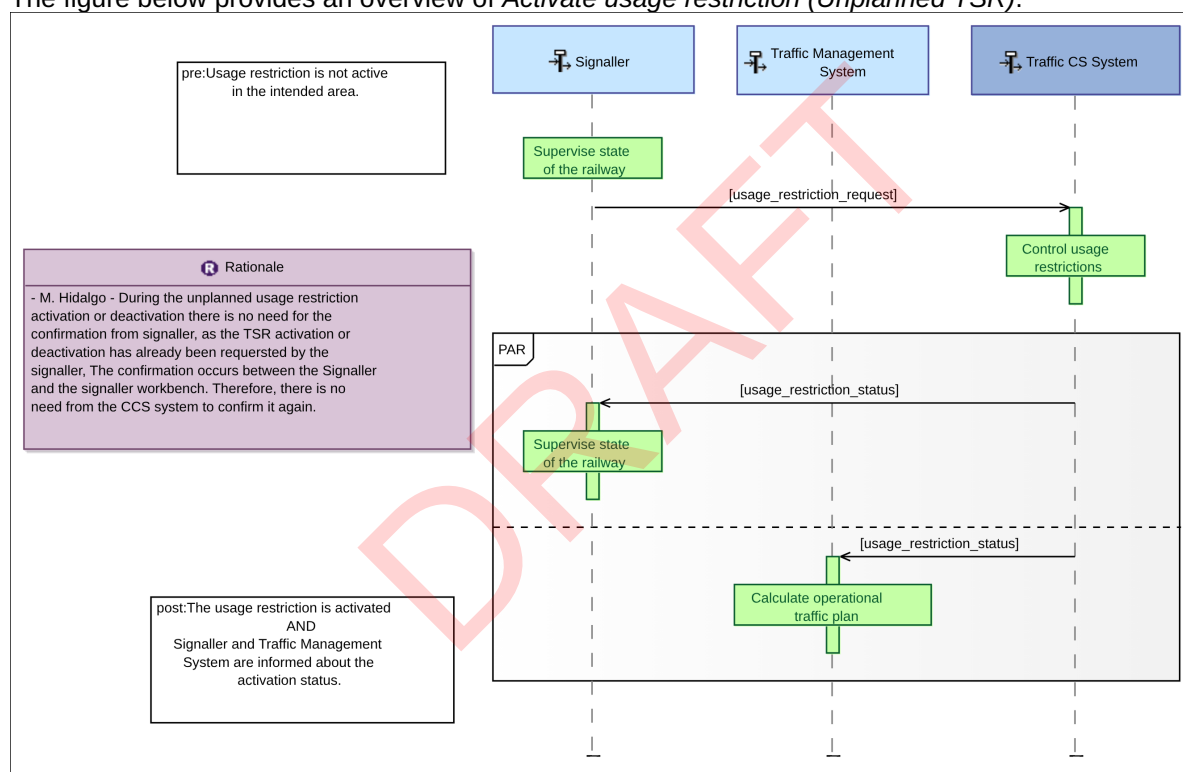


Figure 91 Diagram [LES] Activate usage restriction (Unplanned TSR)

ID	SPMS-7246
Pre Condition	Usage restriction is not active in the intended area.
Post Condition	The usage restriction is activated AND Signaller and Traffic Management System are informed about the activation status.

5.10 Deactivate usage restriction

5.10-1 - Deactivate usage restriction

The Traffic Management System needs the system to deactivate planned usage restrictions (e.g. temporary unavailability of some areas, Temporary Speed Restrictions, points locked in only one position) included in the Operational Plan.

The Signaller needs the system to consider and deactivate unplanned usage restrictions (e.g. temporary unavailability of some areas, Temporary Speed Restrictions, points locked in only one position) not included in the Operational Plan.

Note: Activation and deactivation need both to be implemented safely by the system. At this stage, the potential different criticalities of activation or deactivation appears not to be relevant, as the activation as well as the deactivation of usage restrictions will be checked by the respective functions of the model implementing safety logic.

ID	SPMS-4518
Involved entities	<ul style="list-style-type: none"> SPMS-2813 - Traffic Management System SPMS-2818 - Trackside Assets CS System SPMS-2823 - Traffic CS System SPMS-2827 - Signaller

5.10-2 - Deactivate usage restriction

This functional chain describes the sequence of functions related to each other in case of a deactivation request by the SPMS-2813 - Traffic Management System for a planned usage restriction or by the SPMS-2827 - Signaller for an unplanned usage restriction.

The figure below provides an overview of *Deactivate usage restriction*.

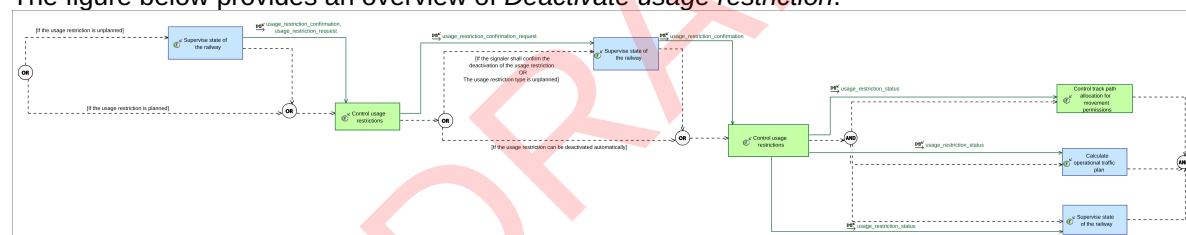


Figure 92 Diagram [LFCD] Deactivate usage restriction [Functional chain description]

ID	SPMS-4470
Post Condition	<p>The usage restriction is activated AND Signaller and Traffic Management System are informed about the activation status.</p>

[LAB] Deactivate usage restriction [Control loop]

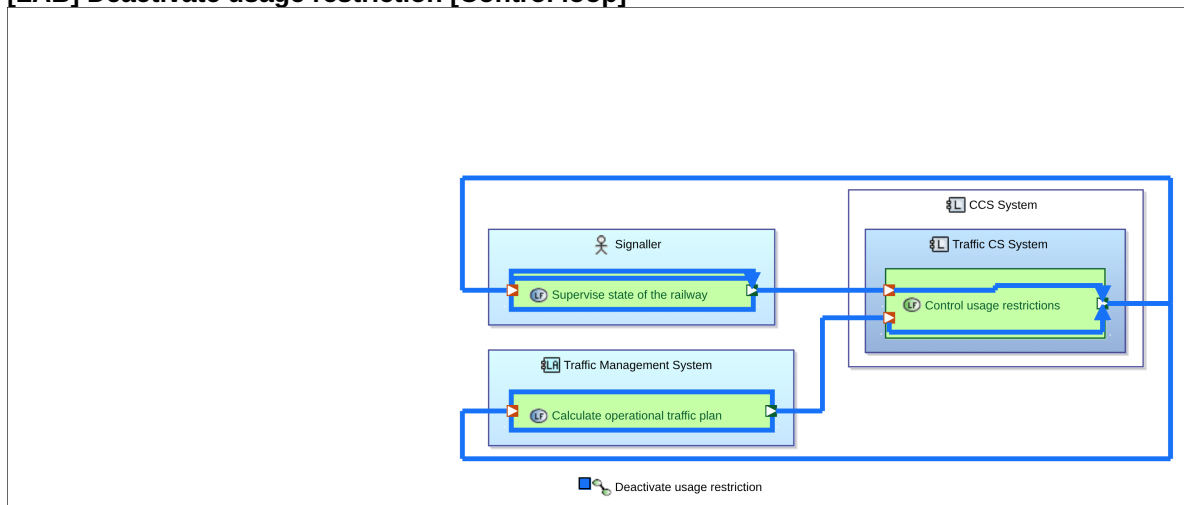



Figure 93 Diagram [LAB] Deactivate usage restriction [Control loop]

ID	SPMS-5801
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5.10.1 Deactivate usage restriction (Planned)

5.10.1-1 - Deactivate usage restriction (Planned usage restriction)

This scenario describes the sequence of functions related to each other in case of a deactivation request by the  SPMS-2813 - Traffic Management System for a planned usage restriction.

The figure below provides an overview of *Deactivate usage restriction (Planned usage restriction)*.

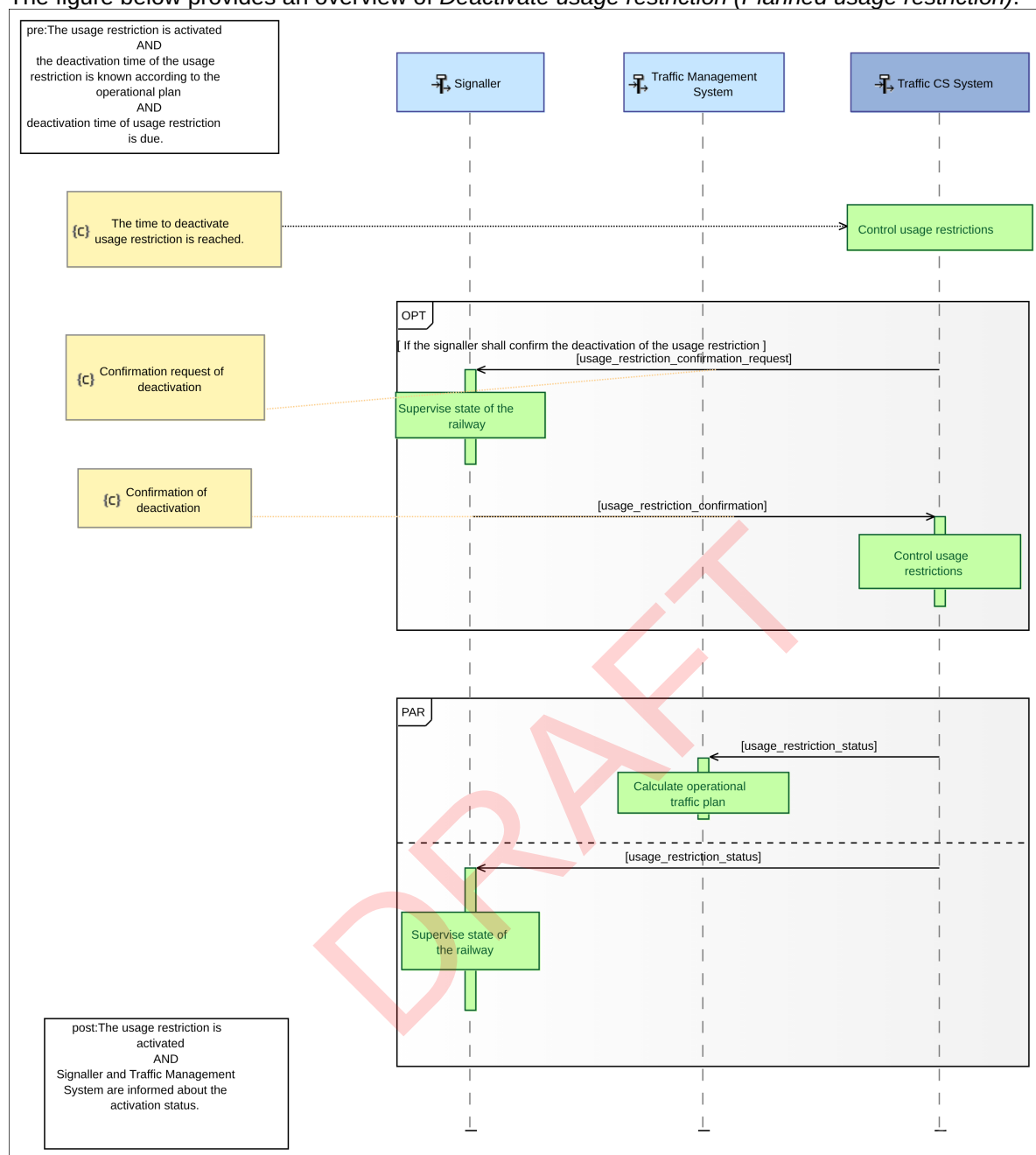



Figure 94 Diagram [LES] Deactivate usage restriction (Planned usage restriction) [Logical exchange scenario]

ID	SPMS-4363
Pre Condition	The usage restriction is activated AND the deactivation time of the usage restriction is known according to the operational plan AND deactivation time of usage restriction is due.
Post Condition	The usage restriction is activated AND Signaller and Traffic Management System are informed about the activation status.

5.10.2 Deactivate usage restriction (Unplanned temporary speed restriction)

5.10.2-1 - Deactivate usage restriction (Unplanned TSR)

This scenario describes the sequence of functions related to each other in case of a deactivation request by the  SPMS-2090 - Signaller for an unplanned temporary speed restriction.

The figure below provides an overview of *Deactivate usage restriction (Unplanned TSR)*.

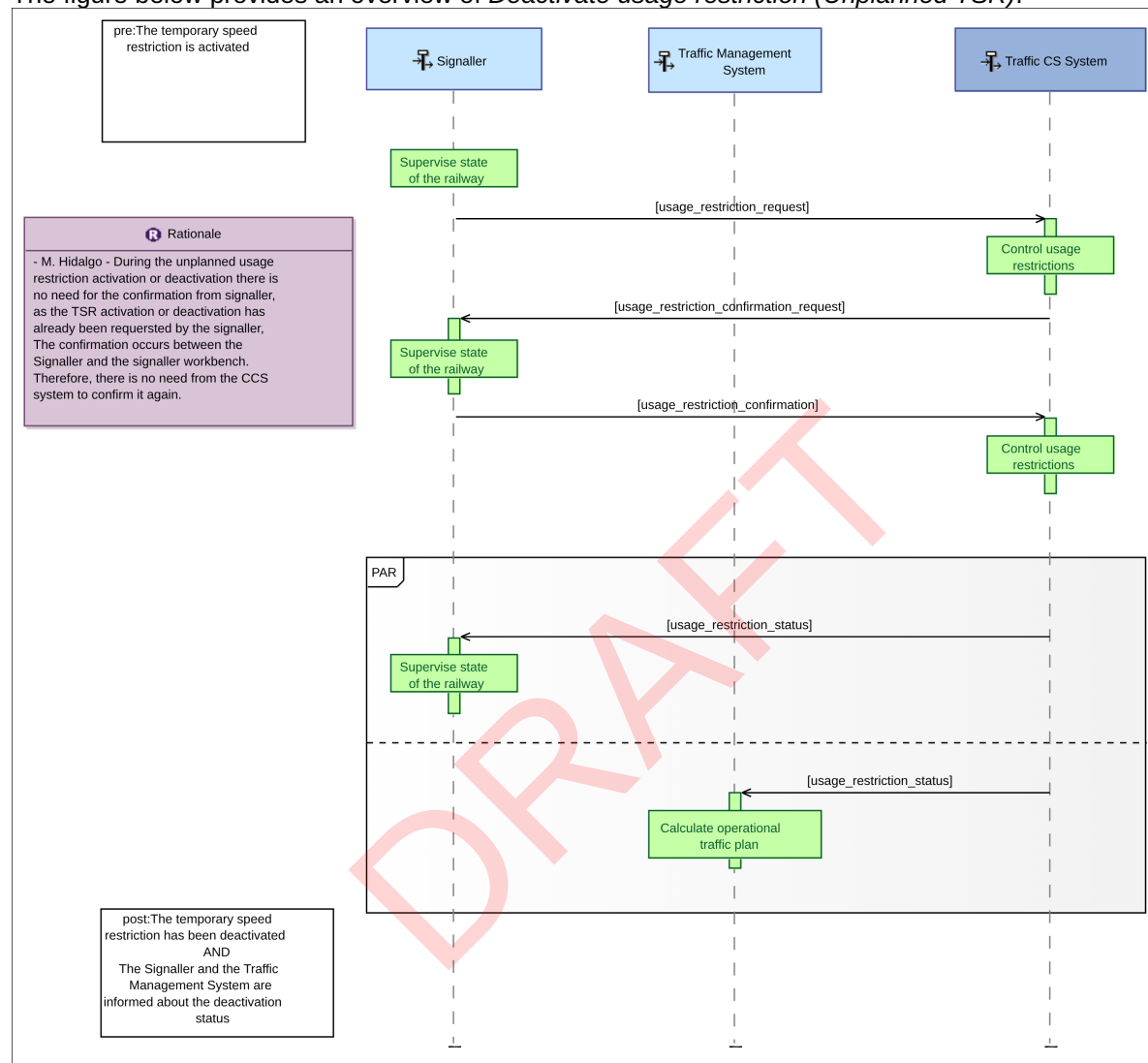









Figure 95 Diagram [LES] Deactivate usage restriction (Unplanned TSR)

ID	SPMS-7249
Pre Condition	The temporary speed restriction is activated
Post Condition	The temporary speed restriction has been deactivated AND The Signaller and the Traffic Management System are informed about the deactivation status

5.11 Drive train automatically

5.11-1 - Drive train automatically

The Railway Undertaking represented as Driver needs the system to drive the train automatically between two operational timing points according to the operational plan movement. This is done by controlling the relative traction and brake effort and providing it directly to the Rolling Stock Operation System, leading to the actuation of the required traction and brake effort by the train. The involvement of the Traffic Management System ensures coordination and alignment with the operational plan.

ID	SPMS-5346
Involved entities	<ul style="list-style-type: none"> •  SPMS-2807 - Train CS System •  SPMS-2809 - Rolling Stock Reference Point •  SPMS-2813 - Traffic Management System •  SPMS-2820 - Rolling Stock Operation System •  SPMS-2822 - Driver •  SPMS-2823 - Traffic CS System •  SPMS-2829 - Wheel

5.11-2 - Drive train automatically

This functional chain describes the sequence of functions related to each other to drive a train automatically according to the operational plan.

The figure below provides an overview of *Drive train automatically*.



Figure 96 Diagram [LFCD] Drive train automatically [Functional chain description]

ID	SPMS-5365
Pre Condition	Distance and speed permission is indicated to the Driver AND Planned movement event is ready for execution
Post Condition	[Movement event completed OR Movement permission not yet extended]

5.11-3 - Drive train automatically (Operational plan)

This scenario describes the sequence of functions related to each other to drive a train automatically according to the operational plan.

The figure below provides an overview of *Drive train automatically (Operational plan)*.

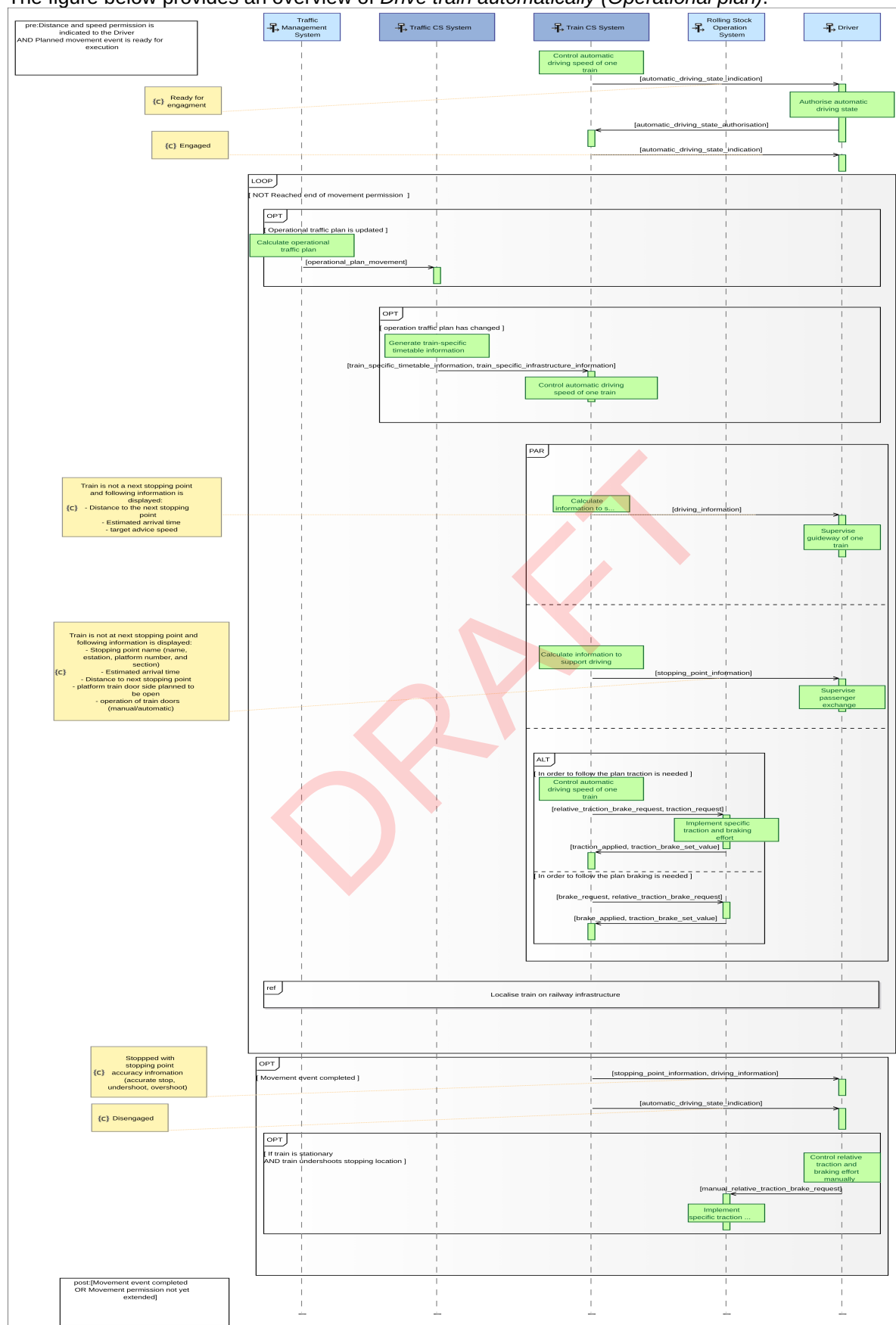


Figure 97 Diagram [LES] Drive train automatically (Operational plan) [Logical exchange scenario]

ID	SPMS-5370
Pre Condition	Distance and speed permission is indicated to the Driver AND Planned movement event is ready for execution
Post Condition	[Movement event completed OR Movement permission not yet extended]

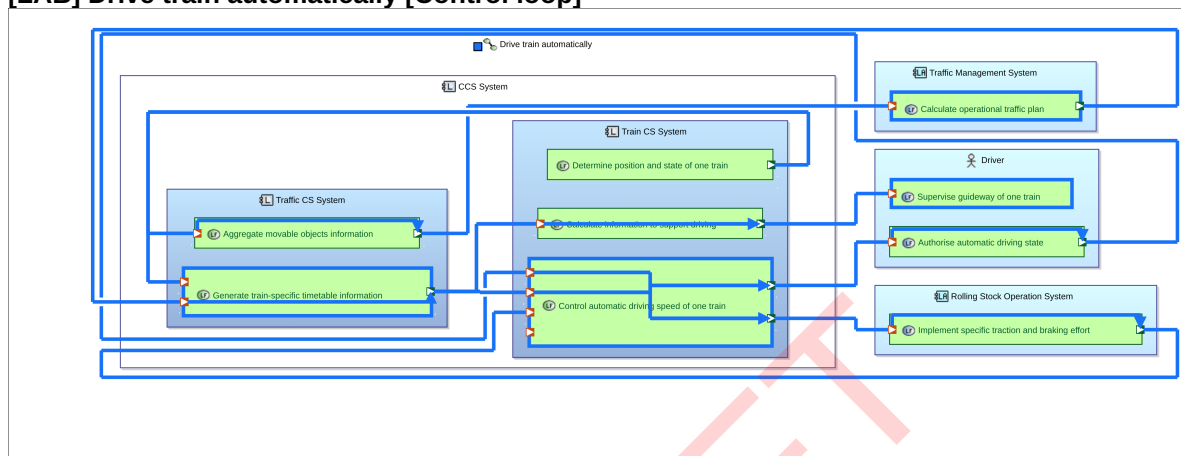
[LAB] Drive train automatically [Control loop]

Figure 98 Diagram [LAB] Drive train automatically [Control loop]

ID	SPMS-5804
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5.12 Open train doors**5.12-1 - Open train doors**

The Traffic Management System needs the Traffic CS and Train CS to perform a passenger exchange according to the operational plan by controlling the train doors so that the passengers can board and alight to the respective platform.

ID	SPMS-6888
Involved entities	<ul style="list-style-type: none"> SPMS-2807 - Train CS System SPMS-2813 - Traffic Management System SPMS-2820 - Rolling Stock Operation System SPMS-2822 - Driver SPMS-2823 - Traffic CS System

5.12-2 - Open train doors

The Traffic Management System needs the Traffic CS and Train CS to perform a passenger exchange according to the operational plan by controlling the train doors so that the passengers can board and alight to the respective platform.

The figure below provides an overview of *Open train doors*.

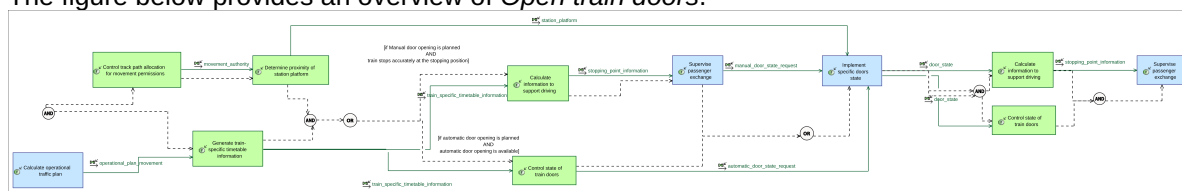


Figure 99 Diagram [LFCD] Open train doors [Functional chain description]

ID	SPMS-6911
Pre Condition	<p>Train is localised and in standstill AND train doors are closed and unlocked AND train doors side (right/left/both) to be open are known AND train doors opening operation (manual/automatic) is known AND train occupies area within the currently defined stopping position AND train is compatible with platform height.</p>
Post Condition	<p>The train doors state is open AND train is in standstill AND train driver is informed train doors are open AND train driver is informed remaining dwell time.</p>

5.12-3 - Open train doors

The Traffic Management System needs the Traffic CS and Train CS to perform a passenger exchange according to the operational plan by controlling the train doors so that the passengers can board and alight to the respective platform.

The figure below provides an overview of *Open train doors*.

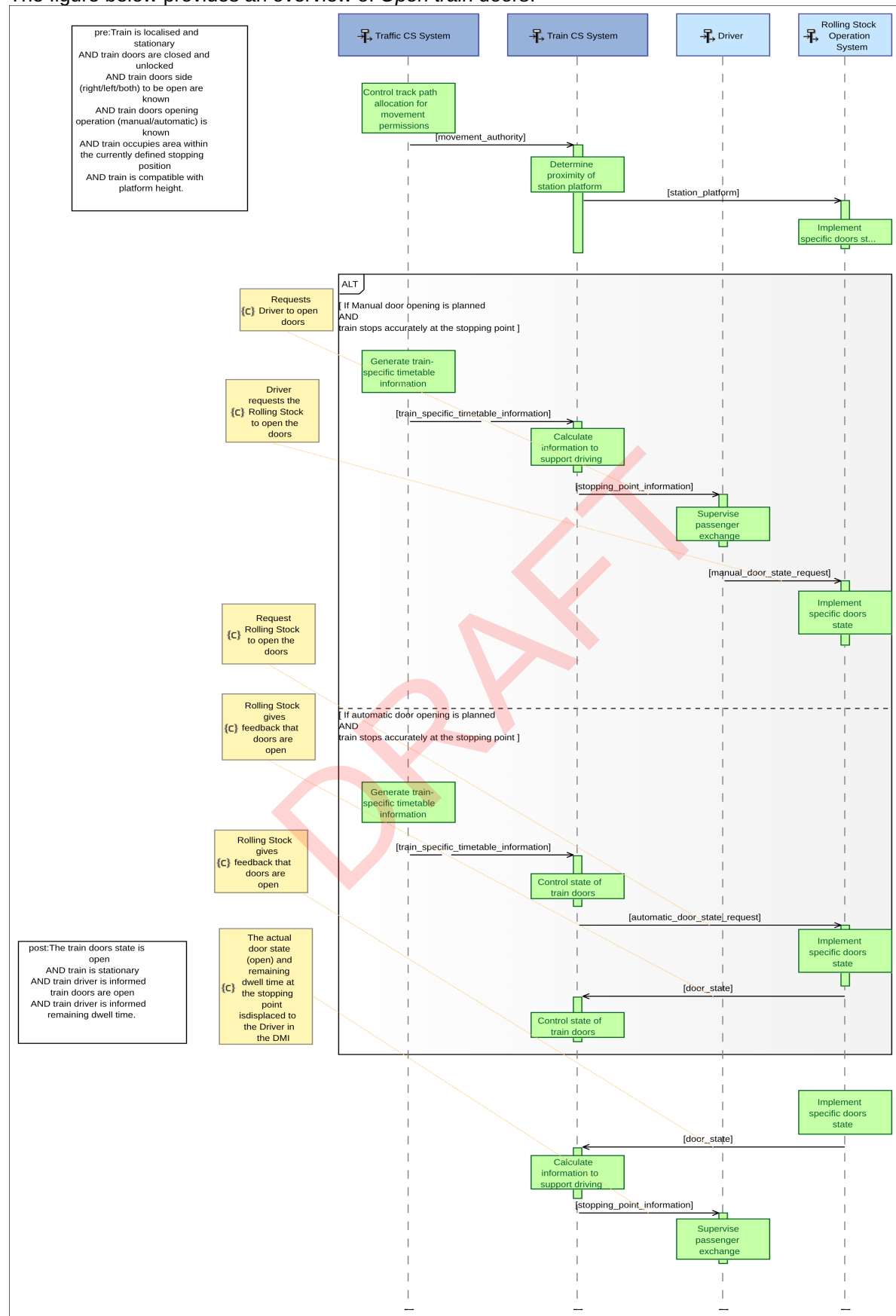


Figure 100 Diagram [LES] Open train doors [Exchange scenario]

ID	SPMS-6899
Pre Condition	<p>Train is localised and in standstill AND train doors are closed and unlocked AND train doors side (right/left/both) to be open are known AND train doors opening operation (manual/automatic) is known AND train occupies area within the currently defined stopping position AND train is compatible with platform height.</p>
Post Condition	<p>The train doors state is open AND train is in standstill AND train driver is informed train doors are open AND train driver is informed remaining dwell time.</p>

[LAB] Open train doors [Control loop]

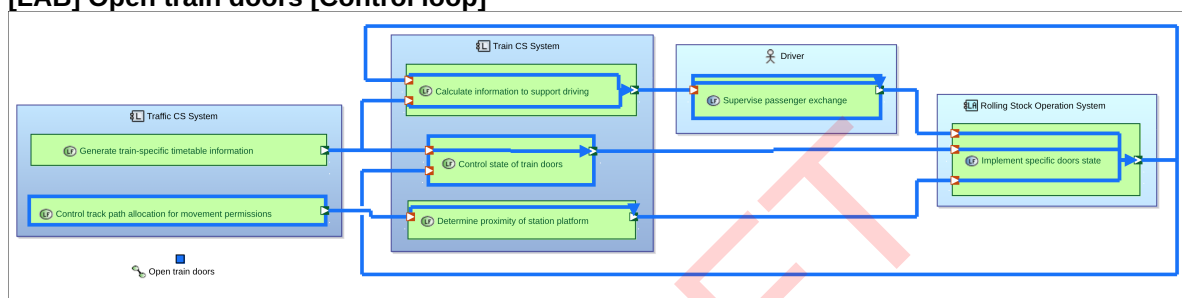


Figure 101 Diagram [LAB] Open train doors [Control loop]





ID	SPMS-6923
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5.13 Close train doors

5.13-1 - Close train doors

The Traffic Management System needs the CCS System to perform a passenger exchange according to the operational plan by closing the train doors so that the passenger exchange ends.

Note: Platform staff and Train Manager are out of the scope of this System Capability, since they don't have a direct interaction with CCS System

ID	SPMS-3304
Involved entities	<ul style="list-style-type: none"> •  SPMS-2807 - Train CS System •  SPMS-2820 - Rolling Stock Operation System •  SPMS-2822 - Driver •  SPMS-2823 - Traffic CS System

5.13-2 - Close train doors

This functional chain describes the sequence of functions to close the train doors. The figure below provides an overview of Close train doors.

The figure below provides an overview of *Close train doors*.

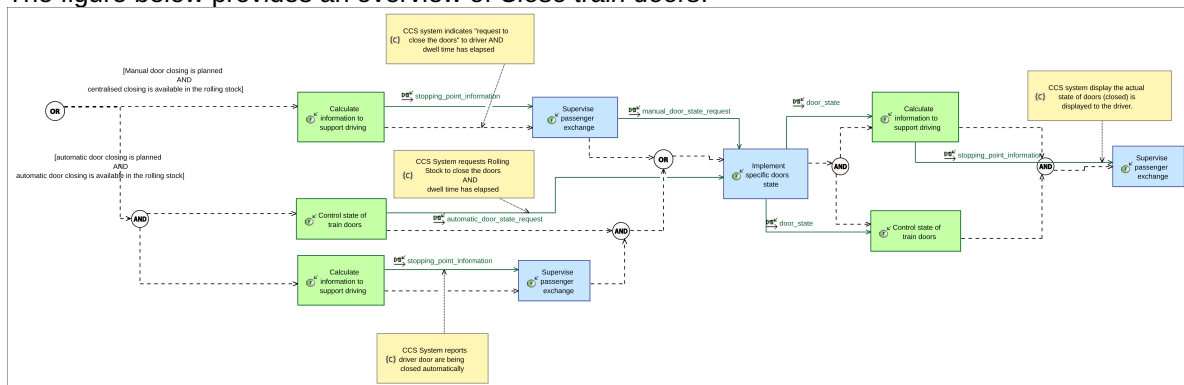


Figure 102 Diagram [LFCD] Close train doors

ID	SPMS-4471
Pre Condition	<p>The train doors state is open AND train is in standstill AND Operational plan is known AND passenger exchange is completed.</p>
Post Condition	<p>Train is localised and in standstill AND train doors are closed and locked AND train driver knows the train door state is closed and locked.</p>

5.13-3 - Close train doors

This sequence scenario describes the sequence of functions to close the train doors. There are two alternatives - the driver closing them manually or the CCS system closing the train doors automatically. Note: The type of door closing operation is defined in the Operational Plan and it sent to Traffic and Train CS during the SysC Perform Train Movement

The figure below provides an overview of *Close train doors*.

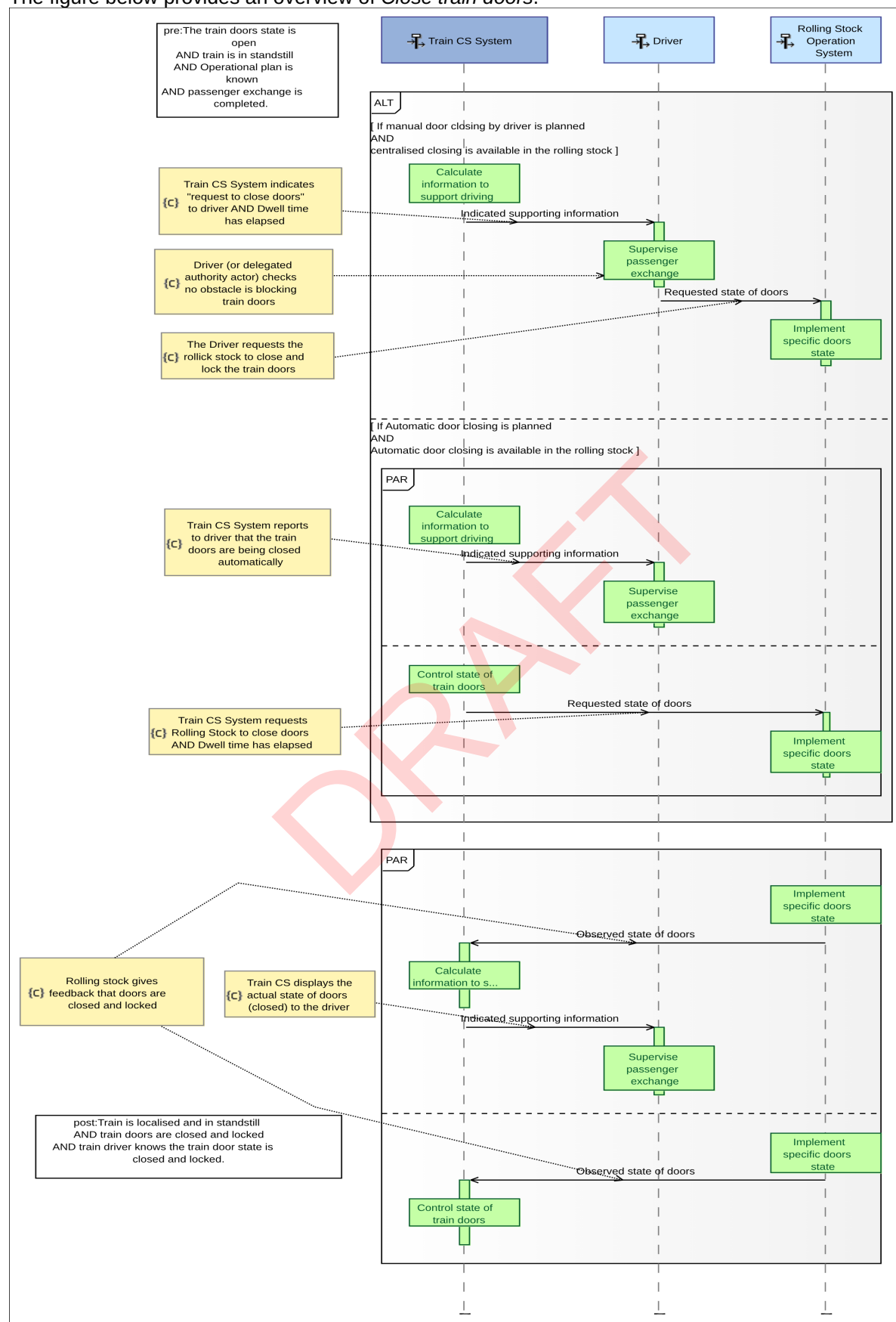


Figure 103 Diagram [LES] Close train doors

ID	SPMS-4381
Pre Condition	The train doors state is open AND train is in standstill AND Operational plan is known AND passenger exchange is completed.
Post Condition	Train is localised and in standstill AND train doors are closed and locked AND train driver knows the train door state is closed and locked.

[LAB] Close Train Doors [Control Loop]

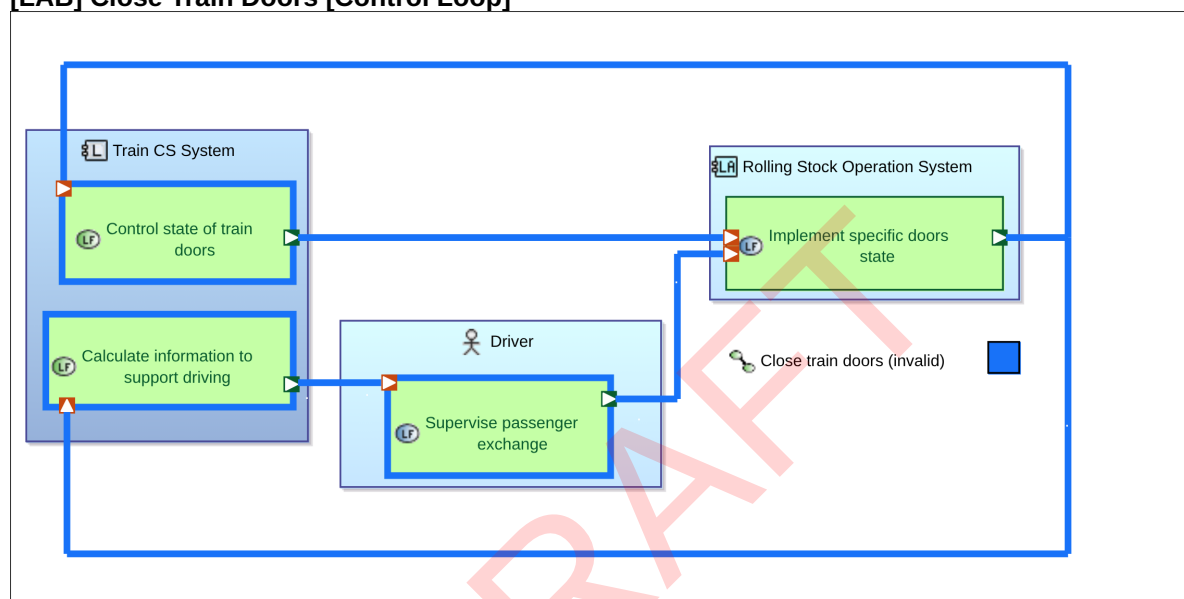


Figure 104 Diagram [LAB] Close Train Doors [Control Loop]

ID	SPMS-7906
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5.14 Activate configuration data

5.14-1 - Activate configuration data

This capability enables the import and update SPT2TS-127779 - Configuration Data, including steps such as preloading, deactivation, and activation within the CCS system. In addition, it provides a mechanism to distribute new configuration data across different system levels in a consistent and controlled manner. This capability is extended by Activate usage restriction and Deactivate usage restriction capabilities when handling configuration updates related to infrastructure side.

ID	SPMS-5363
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Involved entities	<ul style="list-style-type: none"> SPMS-2807 - Train CS System SPMS-2813 - Traffic Management System SPMS-2818 - Trackside Assets CS System SPMS-2819 - Transversal CCS System SPMS-2823 - Traffic CS System SPMS-5389 - Configuration Manager SPMS-5390 - Data Preparation SPMS-5392 - Railway Undertaking IT-System SPMS-6882 - Integrator
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5.14-2 - Activate configuration data (Vehicle Data)

This scenario describes the sequence of functions related to each other to activate a new set of configuration data (vehicle data) within the CCS System.

The figure below provides an overview of *Activate configuration data (Vehicle Data)*.

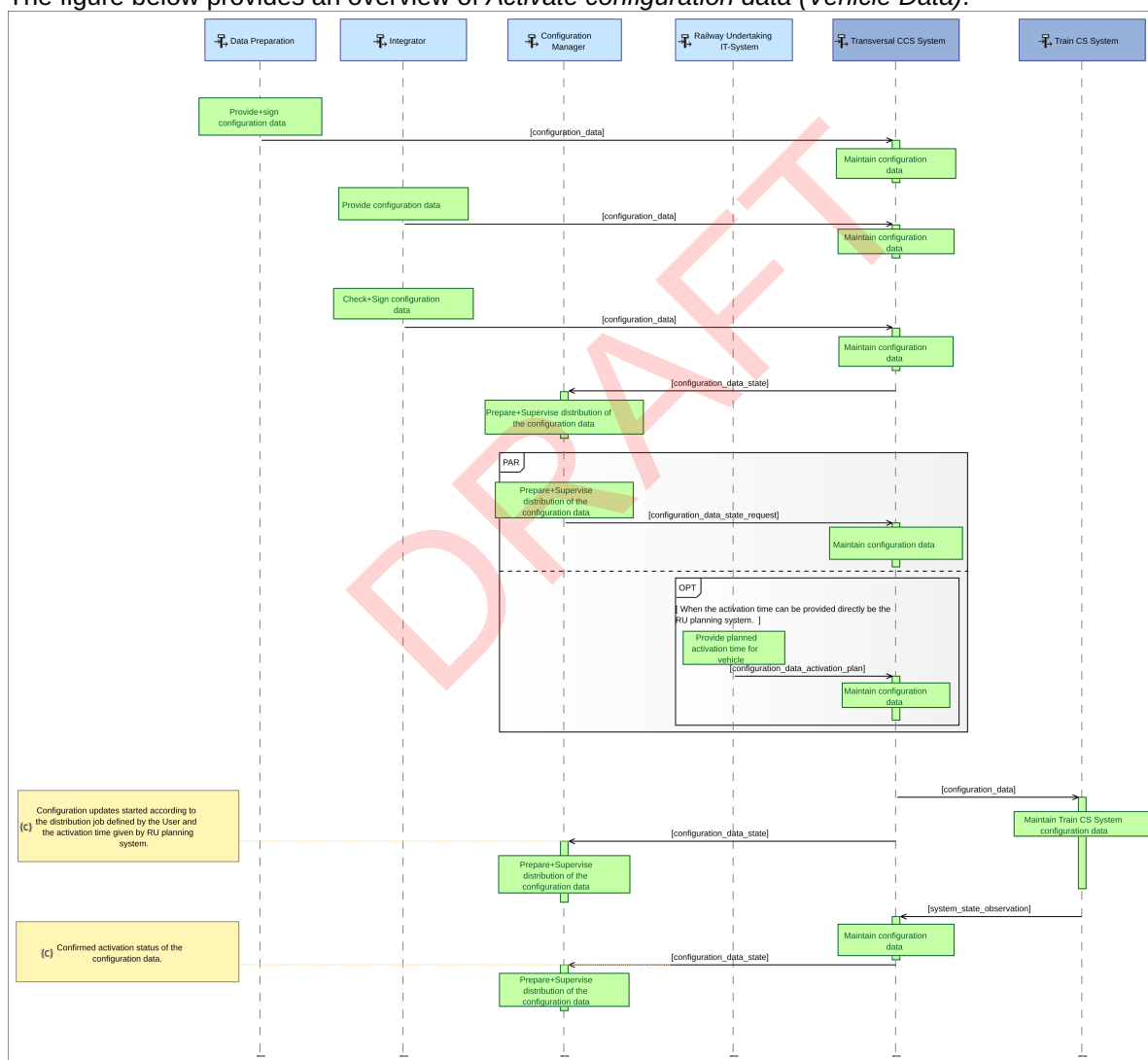


Figure 105 Diagram [LES] Activate configuration data (Vehicle Data)

ID	SPMS-7210
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5.14-3 - Activate configuration data (Main)

This scenario describes the sequence of functions related to each other to activate a new set of

configuration data (infrastructure data) within the CCS System.
The figure below provides an overview of *Activate configuration data (Main)*.

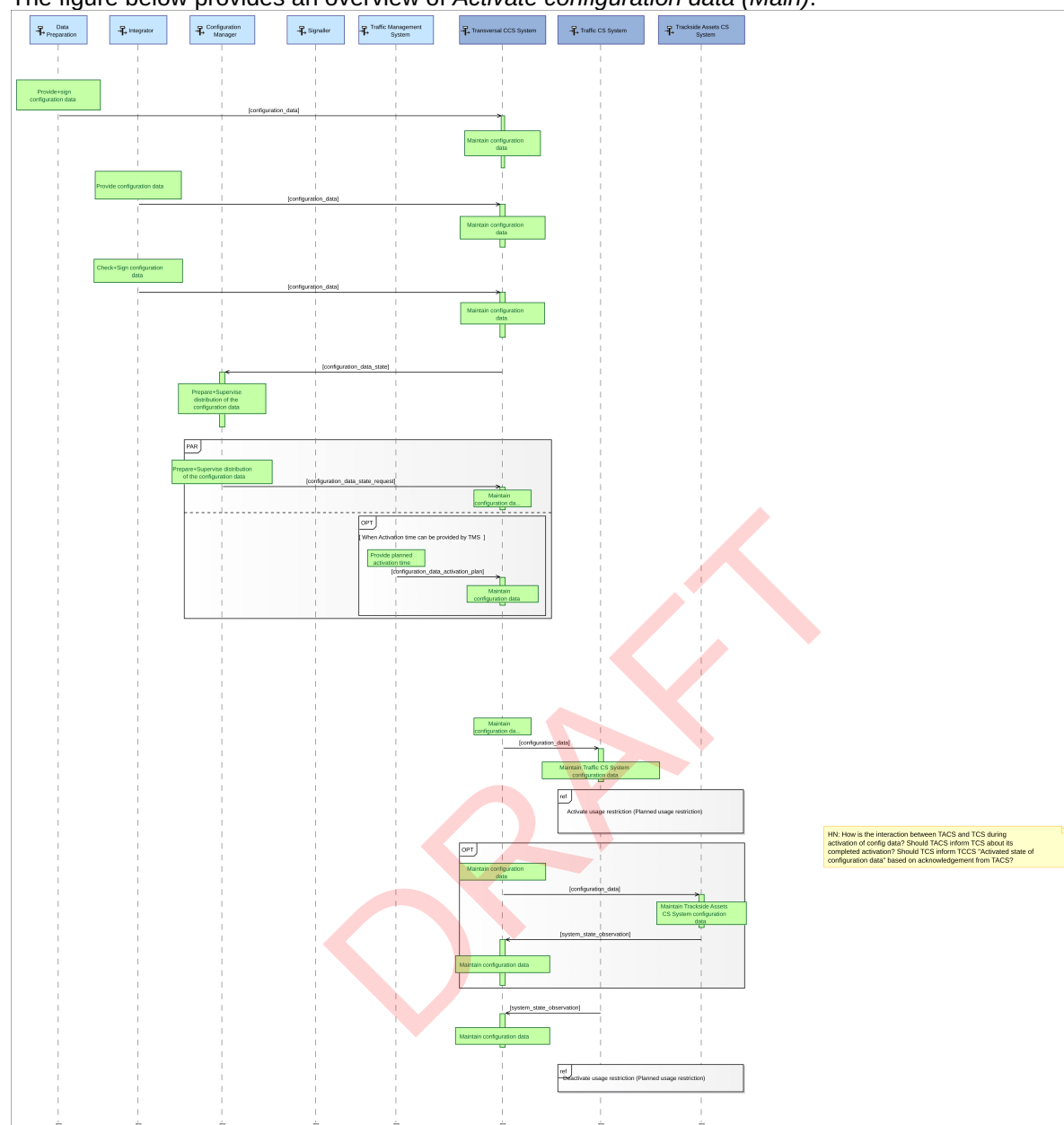


Figure 106 Diagram [LES] Activate configuration data (Infrastructure Data)

ID	SPMS-6991
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5.15 Perform system asset diagnosis

5.15-1 - Perform system asset diagnosis

This capability enables the continuous monitoring and health assessment of assets within the CCS system. It involves supervision of asset conditions and performance to detect degradation, faults, or anomalies. The system evaluates diagnostic and monitoring data to determine asset health status and provides insights to relevant stakeholders.

ID	SPMS-6535
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Involved entities	<ul style="list-style-type: none"> SPMS-2807 - Train CS System SPMS-2808 - Field Force SPMS-2818 - Trackside Assets CS System SPMS-2819 - Transversal CCS System SPMS-2823 - Traffic CS System SPMS-2827 - Signaller SPMS-6526 - Infrastructure Management Diagnostic System SPMS-6527 - Railway Undertaking Diagnostic System SPMS-6528 - Asset Management System
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5.15-2 - Perform system asset diagnosis

This functional chain describes the sequence of functions related to each other to monitor and evaluate malfunctions of a SPMS-2098 - CCS System asset.

The figure below provides an overview of *Perform system asset diagnosis*.

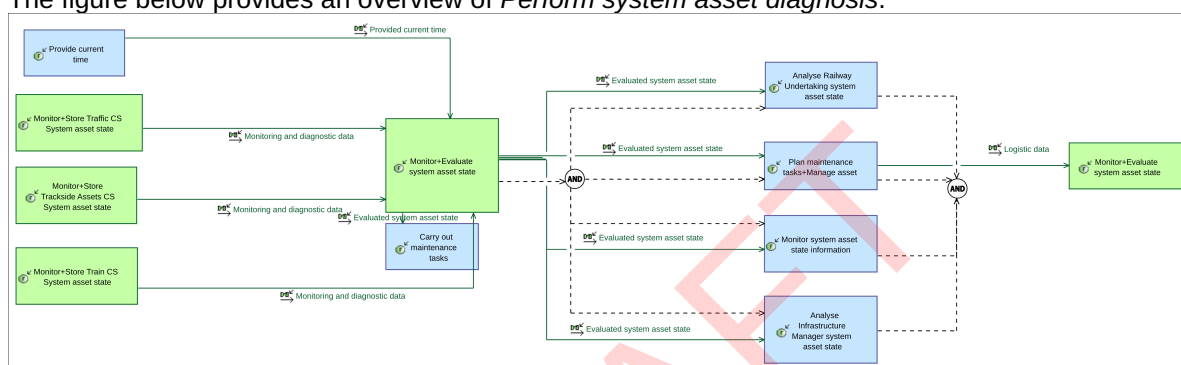


Figure 107 Diagram [LFCD] Perform system asset diagnosis [Functional chain description]

ID	SPMS-6563
Pre Condition	The CCS System internally provides diagnostic and monitoring data.
Post Condition	The evaluated CCS System asset state is indicated to the stakeholders.

5.15-3 - Perform system asset diagnosis (logistic data)

This scenario describes the sequence of functions related to the asset management system, enabling monitoring and evaluation of the CCS system asset's condition.

The figure below provides an overview of *Perform system asset diagnosis (logistic data)*.

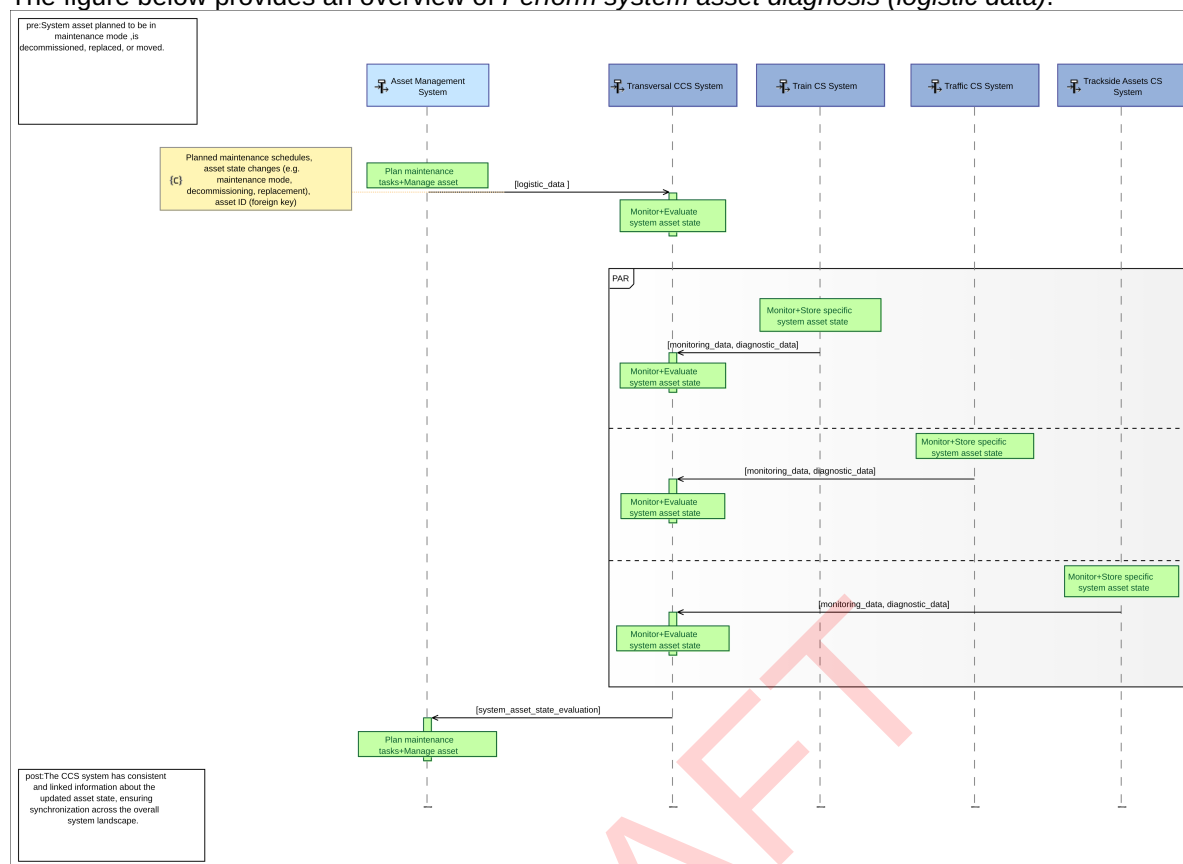


Figure 108 Diagram [LES] Perform system asset diagnosis (logistic data)

ID	SPMS-6979
Pre Condition	System asset planned to be in maintenance mode, is decommissioned, replaced, or moved.
Post Condition	The CCS system has consistent and linked information about the updated asset state, ensuring synchronization across the overall system landscape.

5.15-4 - Perform system asset diagnosis

This scenario describes the sequence of functions related to each other to monitor and evaluate state of a CCS System asset.

The figure below provides an overview of *Perform system asset diagnosis*.

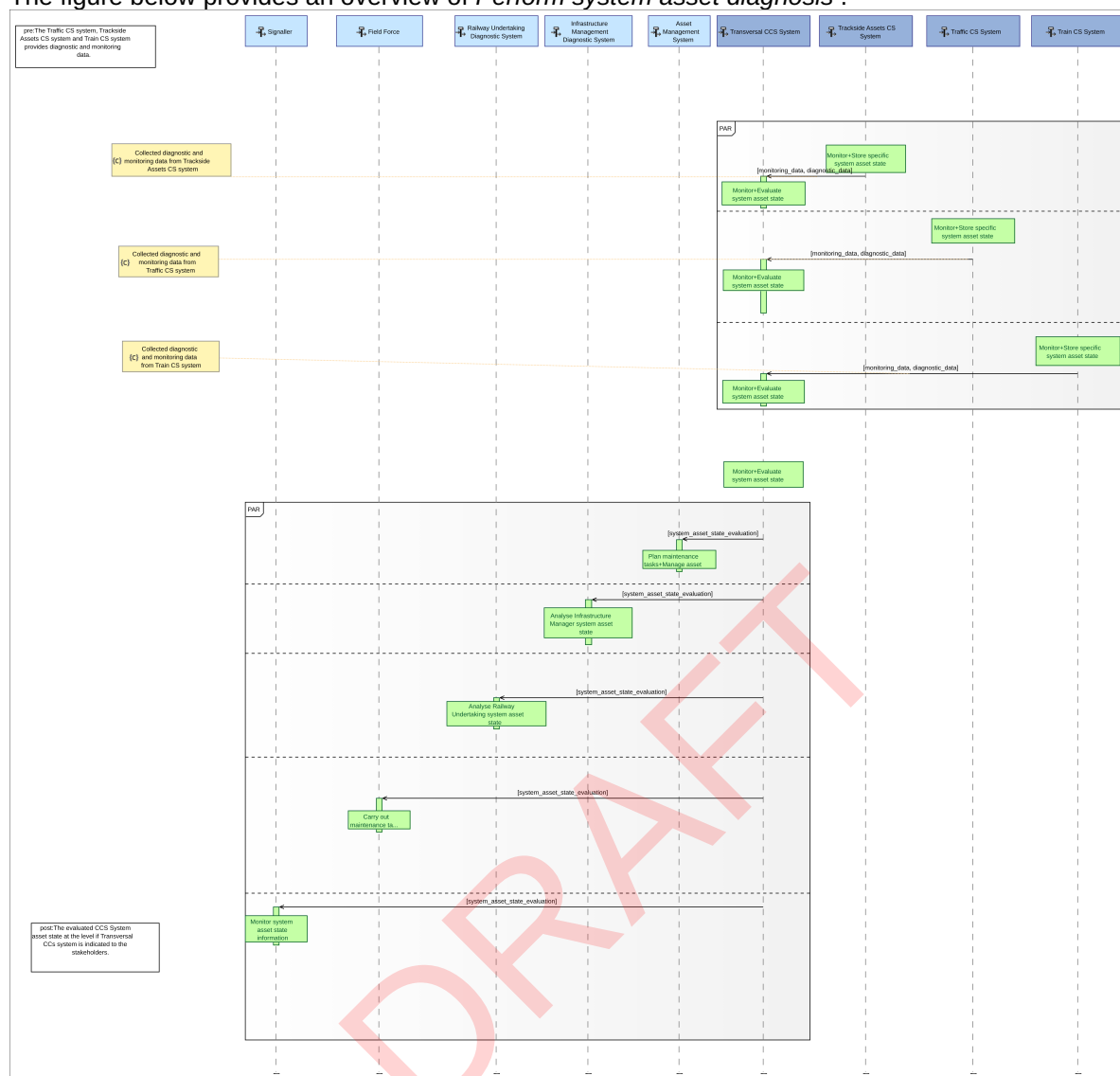


Figure 109 Diagram [LES] Perform system asset diagnosis [Logical exchange scenario]

ID	SPMS-6663
Pre Condition	The Traffic CS system, Trackside Assets CS system and Train CS system provides diagnostic and monitoring data.
Post Condition	The evaluated CCS System asset state at the level of Transversal CCS system is indicated to the stakeholders.

6 Non-Functional System Requirements Breakdown

Will be provided in a future release.

DRAFT

7 System data

7.1 Exchange items

Will be provided in a future release.






7.2 Data classes

Will be provided in a future release.

DRAFT

8 Appendix

8.1 References

Id	Description	Reference
[ SPP-19705 - TCS_System Architecture Description CCS System: Traceability Report_V0.3]	Traceability Report: System Definition - System Architecture Description CCS System.	Link
[ SPP-18056 - TCS_System Definition CCS System_V0.3]	System Definition of the CCS-System according to .	Link
[ SPP-18063 - TCS_System Requirement Specification CCS System_V0.4]	System Requirement Specification of the CCS System according to.	Link
[ SPP-19049 - Traffic CS System Concept V1.0]	Traffic CS prepared this document to summarise the most important system requirements for Traffic CS and the solution concept how it is foreseen to fulfil these requirements. Furthermore, assumptions and expectations to external systems outside of Traffic CS are stated and roadmap is presented.	Link
[EN 50126-1:2017">  SPPRAMSS-349 - EN 50126-1:2017]	Railway Applications – The Specification and Demonstration of Reliability, Availability, Maintainability	-

Id	Description	Reference
	and Safety (RAMS) - Part 1: Generic RAMS Process	

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