




ERJU SYSTEM PILLAR

51 Risk assessment report for the System Architecture Traffic CS



Risk assessment report for the System Architecture Traffic CS

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Abstract	The purpose of this document is to provide the results of the risk assessment of the CCS-System Architecture (according to CENELEC Phase 3
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1 Preamble

1.1 Purpose

The purpose of this document is to provide the results of the risk assessment of the CCS-System Architecture (according to CENELEC Phase 3, see [SPT2TRAFFIC-13107 - ERJU PRAMS Plan]).

For a wider view on risk assessment covering safety culture as well as the variety of possible risk assessment methods, please take a look at the Safety Guideline provided by the PRAMS team [SPT2TRAFFIC-4141 - ERJU Safety Guideline].

While the risk assessment has to be done in the context of Performance, RAM, Safety and Security, the first version of this document focusses on Safety and RAM topics.

1.2 Intended Audience

This document is intended for all stakeholders involved in the development, implementation, and operation of CCS systems (e.g. Business stakeholders, End users, Development and engineering teams, Assessors, etc).

1.3 Document Context

As shown in the illustration below (SPP-31650 - Dependencies between Configuration Items), the Risk assessment report for the System Architecture Description of Traffic CS is based on the following inputs:

- [SPP-18075 - TCS_System Architecture Description Traffic CS_V0.4]:
This document allocates the functions and requirements identified for the Traffic CS system (System Level 4 system) to the different System Level 5 systems of Traffic CS. The SPMS-5062 - European Trackside Protection System is one of these System Level 5 systems.

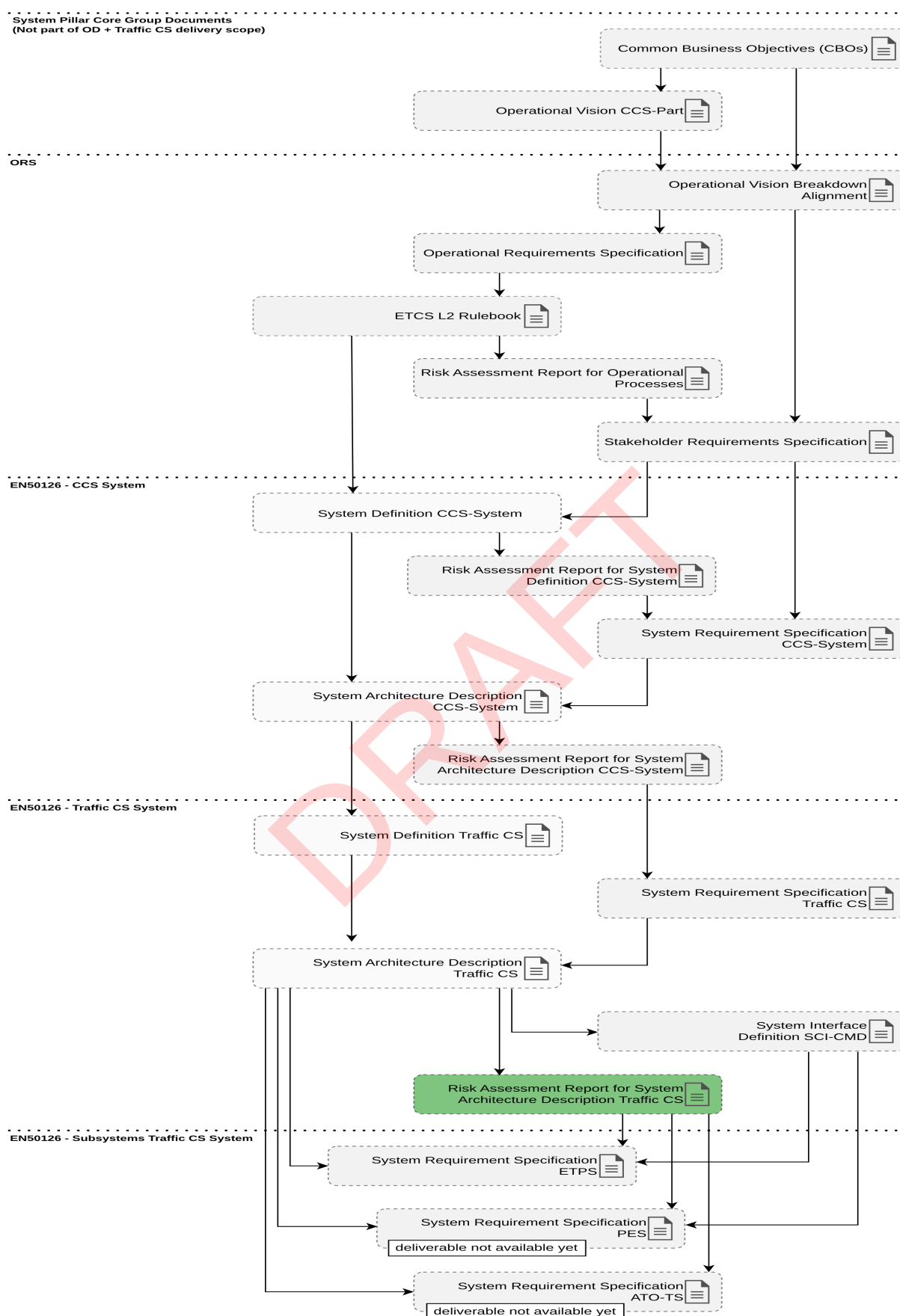
Note: the System Architecture Description of Traffic CS contains changes in Release 1 that were not analysed yet. They will be assessed in a later point in time. In the scope of the analysis, the versions of the scenarios of the Architecture Description of Traffic CS that were analysed are referenced.

- [SPT2TRAFFIC-13108 - ERJU Hazard Database - Main Document]:
This document details the European Railway Harmonized Hazards Database to be used for risk assessment by ERJU SP Domains in accordance with ERJU PRAMS Plan and guidelines.

The Risk Assessment report for the System Architecture Description of Traffic CS itself is an input document for the [SPP-19938 - TCS_System Requirement Specification ETPS_V0.4], [SPP-20332 - System Requirement Specification PES] and [SPP-20333 - System Requirement Specification ATP-TS].

Further details regarding document independencies are described in [SPP-18362 - Requirements Management Plan v2.0]. The positioning of the ETCS L2 Rulebook within the document framework is shown in SPP-31533 - Dependencies between Configuration Items.

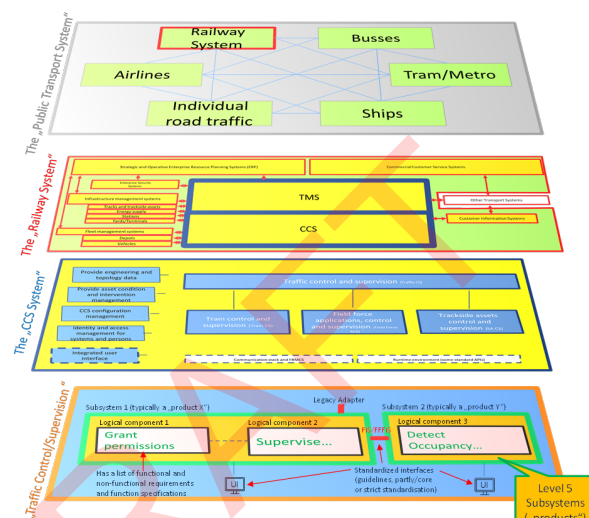
The risk traceability report showing all logical functions and their related risks that need to be allocated to the corresponding exchanges and functions on System Level 5 (physical architecture) is made available in [SPP-31663 - TCS_System Architecture Description Traffic CS - Annex B Traceability Report Risk_V0.1]. A summary of the most important results of the risk assessment of the System Architecture of Traffic CS is made available in: [SPP-31656 - Risk assessment report for the System Architecture Traffic CS - Annex A Traceability Report_V0.1].



[SPP-31650]

1.4 Glossary

1.4.1 Terms

Term	Definition
System Levels of the System Pillar	<p>The system of systems approach is used inside the System Pillar to recursively refine the structure of the architecture down to the level of subsystems.</p> <p>The following figure shows the decomposition of a system of systems on one consistent example spanning 5 layers of refinement. Level 5 is the actual subsystem layer and is visually integrated into the bottom layer in the following figure to be able to show the relationship to logical components.</p>  <p>Figure 1: System Level 1-5 combined view</p>

1.4.2 Abbreviations

Abbreviation	Definition
CCS	Control-Command and Signalling
FMEA	Failure Mode and Effects Analysis

2 Scope

For performing a qualitative risk analysis, the FMEA method is used, whereby FMEA stands for Failure mode and effects analysis. How to perform an FMEA is described in [SPT2TRAFFIC-13109 - ERJU Risk Assessment Process & Template]. The FMEA is conducted with the help of the Nextedy RiskSheet tool in Polaron.







































FMEA represents an inductive/bottom-up risk analysis, starting with possible failure modes of a function and analysing their effects on the function itself, on the system under consideration as well as on the railway system in total. The goal of the FMEA of the CCS system definition is to:







- Identify safety-relevant functions and interfaces,
- Identify potential new hazards,
- connect failure modes to hazards and accidents of Europe's Rail Hazard Database

The scope of analysis are the exchanges between the Traffic CS subsystems.

Please note: Following the initial hazard identification and assignment of safety requirements, quantitative risk assessment will be performed using Fault Tree Analysis when the system architecture is defined during the design and development phases, in accordance with CENELEC standards.

The base for the risk analysis are the following scenarios:

System capability	Scenarios	Revision
  SPMS-5970 - Grant movement permission	  SPMS-5014 - Grant movement permission   SPMS-4868 - Grant movement permission	625262
  SPMS-2443 - Localise train on railway infrastructure	  SPMS-4329 - Localise train on railway infrastructure   SPMS-4438 - Localise train on railway infrastructure (Control loop)	541808
  SPMS-2440 - Perform train movement	  SPMS-4333 - Perform train movement (Full supervision)   SPMS-4447 - Perform train movement (Full supervision control loop)	541808
  SPMS-5996 - Release movement permission	  SPMS-5893 - Release movement permission   SPMS-5886 - Release movement permission	625262
  SPMS-5144 - Set point position	  SPMS-5015 - Set point position (Left to right, Operational plan)   SPMS-5796 - Set point position (Left to right, Signaller)   SPMS-4869 - Set point position	665406
  SPMS-5172 - Shorten movement permission	  SPMS-5177 - Shorten movement permission (Operational plan change, accepted)   SPMS-5221 - Shorten movement permission	670576

System capability	Scenarios	Revision
	(Operational plan change, rejected)   SPMS-5222 - Shorten movement permission (Signaller request, accepted)   SPMS-5223 - Shorten movement permission (Signaller request, rejected)   SPMS-5474 - Shorten movement permission (Cooperative shortening of movement permission)	

Please refer to the scenarios listed above in order to understand the context in which the functions are analysed (e.g. which exchange items of the analysis are in scope, the target function, pre- and postconditions).

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3 Risk analysis

3.1 Risk tracing report

The Risk Traceability Report is showing all logical functions and their related risks that need to be allocated to the corresponding exchanges and functions on System Level 5 (physical architecture). The Risk Traceability Report is made available in [SPP-31663 - TCS_System Architecture Description Traffic CS - Annex B Traceability Report Risk_V0.1](#).

3.2 Risk assessment report

This Risk Assessment Report is the overview of the most important results of the Risk Analysis performed for the System Architecture of Traffic CS. The Risk assessment report is made available in [SPP-31656 - Risk assessment report for the System Architecture Traffic CS - Annex A Traceability Report_V0.1](#).

3.3 Detailed Failure Modes and Effect Analysis

The following chapters list the detailed results of the risk analysis of the CCS system specified in the scope of the capabilities listed in [SPRM-2429 - Missing cross-reference](#) and presented in the linked reports above.

3.3.1 Plan Execution System functions

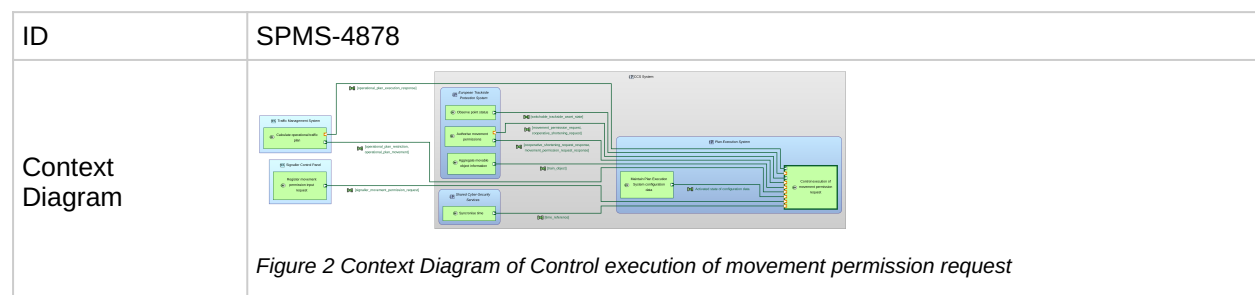
3.3.1.1 Control execution of movement permission request






























3.3.1.1.1 Functional description










Control execution of movement permission request

This function is allocated to [SPMS-5060 - Plan Execution System](#).

This functions derives a time-based request for a movement permission according to the operational traffic plan (this can include a request to shorten an existing movement permission). Thereby, it takes into account the position and status of the points (and the level crossings) for the planned movement. This function is also able to reply to the submitter (TMS or Signaller) requesting a (shortened) movement permission by using i.a operating state information.










Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-6410 - Observed point status <ul style="list-style-type: none">  SPMS-7747 - switchable_trackside_asset_state 	 SPMS-4888	 SPMS-5062
	 SPMS-6438 - Synchronised current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-4897	 SPMS-6696
	 SPMS-6327 - Aggregated track occupancy and train status information <ul style="list-style-type: none">  SPMS-5119 - train_object 	 SPMS-4871	 SPMS-3662
	No exchange items allocated on  SPMS-6362 - Activated state of configuration data.	 SPMS-4922	 SPMS-5061
	 SPMS-6413 - Register input <ul style="list-style-type: none">  SPMS-6238 - signaller_movement_permission_request 	 SPMS-5190	 SPMS-6864
	 SPMS-6351 - Calculated operational traffic plan <ul style="list-style-type: none">  SPMS-7756 - operational_plan_restriction  SPMS-7753 - operational_plan_movement 	 SPMS-4875	 SPMS-5110
	 SPMS-6441 - Authorised movement permission <ul style="list-style-type: none">  SPMS-7787 - cooperative_shortening_request_response  SPMS-7783 - movement_permission_request_response 	 SPMS-4883	 SPMS-5062

Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-6421 - Requested movement permission <ul style="list-style-type: none">  SPMS-4928 - movement_permission_request  SPMS-7786 - cooperative_shortening_request 	 SPMS-4883 - Control execution of movement permission request	 SPMS-5062 - European Trackside Protection System
	 SPMS-6442 - Responded operational traffic plan <ul style="list-style-type: none">  SPMS-5136 - operational_plan_execution_response 	 SPMS-4875 - Control execution of operational traffic plan	 SPMS-5114 - Traffic Management System












3.3.1.1.2 Failure Modes and Effects Analysis

Early movement permission request to ETPS

ID	SPRM-1394
Failure Mode (Keyword)	Commission
Failure Description	PES sends movement permission request too early to ETPS.
Effect on Linked Functions Systems	<p>Requested movement permission is received (by ETPS) too early.</p> <p>ETPS receives the early Movement permission request, therefore Movement permission request could be authorised earlier in the ETPS and sent to Onboard. Resources of ETPS are used earlier than necessary.</p> <p>OR</p> <p>Movement permission request could be rejected .</p> <p>In any case, ETPS always considers the safety issues, either if Movement permission is issued earlier or rejected, it has no safety consequences but business consequences.</p>
Effect on Railway System	No safety issues.
Risk Comment	ETPS rejects any request that could lead to a hazardous situation. Movement permissions that may cause a safety issue are not authorized by ETPS.
Linked Work Items	<p>relates to :  SPMS-4878 - Control execution of movement permission request</p> <p>relates to :  SPMS-6421 - Requested movement permission</p> <p>relates to :  SPMS-4868 - Grant movement permission</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>causes :  SPRM-517 - No accident</p> <p>relates to :  SPMS-5014 - Grant movement permission</p> <p>has parent :  SPRM-2144 - Detailed Failure Modes and Effect Analysis</p>








Early shortening request to ETPS

ID	SPRM-2231
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

Failure Mode (Keyword)	Commission
Failure Description	PES sends a cooperative shortening request too early to ETPS
Effect on Linked Functions Systems	ETPS receives the shortening request before the train has cleared the section to be released. This may lead to premature evaluation of the request. ETPS could either authorize the shortening too early, causing early release of trackside assets, or reject the request. In both cases, ETPS applies its safety logic to ensure no unsafe condition is introduced. The PES may need to reissue the request, and TMS may receive movement permission updates earlier than expected, potentially misaligning with the operational plan.
Effect on Railway System	No safety issues. Possible early release of resources (not needed by operational plan) or rejection requiring reprocessing.
Risk Comment	ETPS rejects any request that could lead to a hazardous situation. Shortening of Movement permissions that may cause a safety issue are not authorized by ETPS.
Linked Work Items	<p>relates to :  SPMS-4878 - Control execution of movement permission request</p> <p>relates to :  SPMS-6421 - Requested movement permission</p> <p>relates to :  SPMS-4441 - Shorten movement permission</p> <p>relates to :  SPMS-5177 - Shorten movement permission (Operational plan change, accepted)</p> <p>relates to :  SPMS-5221 - Shorten movement permission (Operational plan change, rejected)</p> <p>relates to :  SPMS-5222 - Shorten movement permission (Signaller request, accepted)</p> <p>relates to :  SPMS-5223 - Shorten movement permission (Signaller request, rejected)</p> <p>relates to :  SPMS-5474 - Shorten movement permission (Cooperative shortening of movement permission)</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>causes :  SPRM-517 - No accident</p> <p>has parent :  SPRM-2144 - Detailed Failure Modes and Effect Analysis</p>

Late movement permission request to ETPS

ID	SPRM-1395
Failure Mode (Keyword)	Omission
Failure Description	PES sends movement permission request too late or not at all to ETPS.
Effect on Linked Functions Systems	<p>Requested movement permission is received (by ETPS) too late.</p> <p>The movement request could be authorised too late OR movement permission request could be rejected.</p>
Effect on Railway System	<p>No safety issues.</p> <p>Disturbed operation possible due to the train stopping because it doesn't have a movement authority.</p>








Risk Comment	ETPS rejects any request that could lead to a hazardous situation. Movement permissions that may cause a safety issue are not authorized by ETPS.
Linked Work Items	<p>relates to :  SPMS-4878 - Control execution of movement permission request</p> <p>relates to :  SPMS-6421 - Requested movement permisison</p> <p>relates to :  SPMS-4868 - Grant movement permission</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>causes :  SPRM-517 - No accident</p> <p>relates to :  SPMS-5014 - Grant movement permission</p> <p>has parent :  SPRM-2144 - Detailed Failure Modes and Effect Analysis</p>

Late shortening request to ETPS

ID	SPRM-2233
Failure Mode (Keyword)	Omission
Failure Description	PES sends the cooperative shortening request too late or not at all to ETPS
Effect on Linked Functions Systems	ETPS does not receive the request in time to process the shortening. As a result, the Movement Permission remains unchanged, and track sections that could be released stay reserved. PES may fail to update the operational plan accordingly, and TMS continues to consider the full extent of the original Movement Permission. ETPS maintains outdated information in its Operating State, which may delay infrastructure reallocation.
Effect on Railway System	No safety issues. Reduced infrastructure availability and delayed resource release.
Risk Comment	ETPS rejects any request that could lead to a hazardous situation. Shortening of Movement permissions that may cause a safety issue are not authorized by ETPS.
Linked Work Items	<p>relates to :  SPMS-4878 - Control execution of movement permission request</p> <p>relates to :  SPMS-6421 - Requested movement permisison</p> <p>relates to :  SPMS-4441 - Shorten movement permission</p> <p>relates to :  SPMS-5177 - Shorten movement permission (Operational plan change, accepted)</p> <p>relates to :  SPMS-5221 - Shorten movement permission (Operational plan change, rejected)</p> <p>relates to :  SPMS-5222 - Shorten movement permission (Signaller request, accepted)</p> <p>relates to :  SPMS-5474 - Shorten movement permission (Cooperative shortening of movement permission)</p> <p>assesses :  SPRM-517 - No accident</p> <p>causes :  SPRM-517 - No accident</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>has parent :  SPRM-2144 - Detailed Failure Modes and Effect Analysis</p>












Incorrect movement permission request to ETPS

ID	SPRM-1396
Failure Mode (Keyword)	Incorrect

Failure Description	PES sends incorrect movement permission request to ETPS.
Effect on Linked Functions Systems	Wrong movement permisison is requested to ETPS. Wrong movement authority could be authorised by the ETPS. OR Wrong movement authority could be rejected by ETPS. In any case, ETPS always considers the safety issues, either if Movement permission is issued or rejected, it has no safety consequences but business consequences.
Effect on Railway System	No safety issues.
Risk Comment	ETPS rejects any request that could lead to a hazardous situation. Movement permissions that may cause a safety issue are not authorized by ETPS.
Linked Work Items	relates to :  SPMS-4878 - Control execution of movement permission request relates to :  SPMS-6421 - Requested movement permisison relates to :  SPMS-4868 - Grant movement permission assesses :  SPRM-516 - No safety hazard causes :  SPRM-517 - No accident relates to :  SPMS-5014 - Grant movement permission has parent :  SPRM-2144 - Detailed Failure Modes and Effect Analysis

Incorrect shortening request to ETPS









ID	SPRM-2232
Failure Mode (Keyword)	Incorrect
Failure Description	PES sends an incorrect cooperative shortening request to ETPS
Effect on Linked Functions Systems	ETPS rejects any request that could lead to a hazardous situation. Shortening of Movement permissions that may cause a safety issue are not authorized by ETPS.
Effect on Railway System	No safety issues. Potential misalignment between infrastructure state and operational plan.
Risk Comment	ETPS shall reject any cooperative shortening request that could compromise safety. All requests must be evaluated against the current Operating State and Train Object. Movement permissions shall only be shortened if the train position, track occupancy, and flank protection conditions are verified to be safe. ETPS ensures that no shortening is authorized if it may lead to a hazardous situation

Linked Work Items	<p>relates to :  SPMS-4878 - Control execution of movement permission request</p> <p>relates to :  SPMS-6421 - Requested movement permisison</p> <p>relates to :  SPMS-4441 - Shorten movement permission</p> <p>relates to :  SPMS-5177 - Shorten movement permission (Operational plan change, accepted)</p> <p>relates to :  SPMS-5221 - Shorten movement permission (Operational plan change, rejected)</p> <p>relates to :  SPMS-5222 - Shorten movement permission (Signaller request, accepted)</p> <p>relates to :  SPMS-5474 - Shorten movement permission (Cooperative shortening of movement permission)</p> <p>assesses :  SPRM-517 - No accident</p> <p>causes :  SPRM-517 - No accident</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>has parent :  SPRM-2144 - Detailed Failure Modes and Effect Analysis</p>
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3.3.1.1.3 Constraints











Requested track path is free of occupancies

The requested track path doesn't include occupancies by other trains or vehicles. Only the occupancy of the train for with the track path is requested is allowed.

ID	SPRM-1443
Linked Work Items	<p>mitigates :  SPRM-1050 - Incorrect requested track path from Signaller</p> <p>mitigates :  SPRM-1048 - Incorrect required operational traffic plan from TMS</p> <p>mitigates :  SPRM-1392 - Late required operational traffic plan from TMS (2)</p> <p>mitigates :  SPRM-1391 - Late requested track path from Signaller (2)</p> <p>constrains :  SPMS-2137 - Ensure safe movement of trains</p> <p>constrains :  SPMS-2874 - Control track path allocation for movement permissions</p> <p>constrains :  SPMS-4878 - Control execution of movement permission request</p> <p>_ is derived by :  SPRM-1561 - Movement permission is free of occupancies</p>

Train adheres to infrastructure restrictions


The train is able to run on the infrastructure (e.g. loading gauge, train category) and does not violate the loading gauge, weight limits etc. which could cause a collision or derailment.

ID	SPRM-1442
Linked Work Items	<p>mitigates :  SPRM-1050 - Incorrect requested track path from Signaller</p> <p>mitigates :  SPRM-1048 - Incorrect required operational traffic plan from TMS</p> <p>mitigates :  SPRM-1392 - Late required operational traffic plan from TMS (2)</p> <p>constrains :  SPMS-2137 - Ensure safe movement of trains</p> <p>constrains :  SPMS-2874 - Control track path allocation for movement permissions</p> <p>constrains :  SPMS-4878 - Control execution of movement permission request</p> <p>_ is derived by :  SPRM-1563 - Authorised speed is less or equal to the maximum allowed track speed</p> <p>_ is derived by :  SPT2TRAFFIC-12351 - Respond to accepted Movement Permission Request via SCI_CMD</p> <p>_ is derived by :  SPT2TRAFFIC-12359 - Send Movement Authority via I_SUBSET_026</p> <p>_ is derived by :  SPT2TRAFFIC-16387 - Respond to rejected Movement Permission Request via SCI_CMD</p>

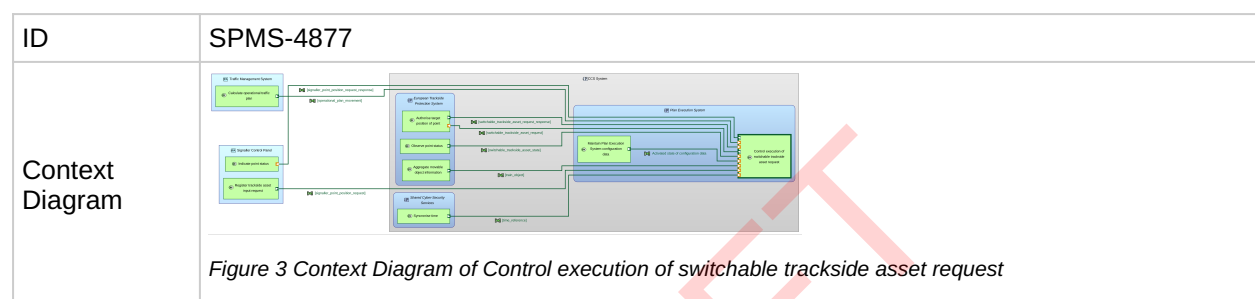
3.3.1.2 Control execution of switchable trackside asset request




































3.3.1.2.1 Functional description

Control execution of switchable trackside asset request

This function is allocated to  SPMS-5060 - Plan Execution System.

This function determines the optimal time to request a turnout of a point. It takes into account various input parameters, including the planned track path, the current position, the status and technical turnaround time of the point, the current position of the train and the usage restriction areas with restriction types, its expected speed profile and current movement authority as well as the estimated reaction time of the train driver.











Input exchanges	Input exchanges	Source function	Function allocated to
	 SPMS-6430 - Response to point position request <ul style="list-style-type: none">  SPMS-5191 - switchable_trackside_asset_request_response 	 SPMS-4903	 SPMS-5062
	 SPMS-6436 - Synchronised current time <ul style="list-style-type: none">  SPMS-2412 - time_reference 	 SPMS-4897	 SPMS-6606
	 SPMS-6328 - Aggregated track occupancy and train status information <ul style="list-style-type: none">  SPMS-5119 - train_object 	 SPMS-4871	 SPMS-3062
	 SPMS-6409 - Observed point status <ul style="list-style-type: none">  SPMS-7747 - switchable_trackside_asset_state 	 SPMS-4888	 SPMS-5062
	No exchange items allocated on  SPMS-6361 - Activated state of configuration data.	 SPMS-4922	 SPMS-5062
	 SPMS-6414 - Registered input <ul style="list-style-type: none">  SPMS-4926 - signaller_point_position_request 	 SPMS-4911	 SPMS-6094
	 SPMS-6347 - Calculated operational traffic plan <ul style="list-style-type: none">  SPMS-2370 - operational_plan_movement 	 SPMS-4875	 SPMS-5119
Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-6422 - Requested point position <ul style="list-style-type: none">  SPMS-7746 - switchable_trackside_asset_request 	 SPMS-4903	 SPMS-5062
	 SPMS-7828 - Registered input response <ul style="list-style-type: none">  SPMS-7824 - signaller_point_position_request_response 	 SPMS-4913	 SPMS-6094









3.3.1.2.2 Failure Modes and Effects Analysis

Early requested point position to ETPS

ID	SPRM-1683
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Failure Mode (Keyword)	Commission
Failure Description	PES sends request for movement of point earlier to ETPS.
Effect on Linked Functions Systems	ETPS is checking if all the conditions to command the point machines are met (e.g. point not occupied or reserved for other operational movements).
Effect on Railway System	Potentially disturbed operation.
Risk Comment	PRAM consideration: ETPS shall send the reason for rejecting the requested point position to PES.
Linked Work Items	<p>relates to :  SPMS-4877 - Control execution of switchable trackside asset request</p> <p>relates to :  SPMS-6422 - Requested point position</p> <p>relates to :  SPMS-4869 - Set point position</p> <p>relates to :  SPMS-5015 - Set point position (Left to right, Operational plan)</p> <p>relates to :  SPMS-5796 - Set point position (Left to right, Signaller, accepted)</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>causes :  SPRM-517 - No accident</p> <p>has parent :  SPRM-2164 - Detailed Failure Modes and Effect Analysis</p>

Incorrect requested point position to ETPS

ID	SPRM-1684
Failure Mode (Keyword)	Incorrect
Failure Description	PES sends incorrect request for movement of point to ETPS.
Effect on Linked Functions Systems	ETPS is checking if all the conditions to command the point machines are met (e.g. point not occupied or reserved for other operational movements).
Effect on Railway System	Potentially disturbed operation.
Risk Comment	PRAM consideration: ETPS shall send the reason for rejecting the requested point position to PES.
Linked Work Items	<p>relates to :  SPMS-4877 - Control execution of switchable trackside asset request</p> <p>relates to :  SPMS-6422 - Requested point position</p> <p>relates to :  SPMS-4869 - Set point position</p> <p>relates to :  SPMS-5015 - Set point position (Left to right, Operational plan)</p> <p>relates to :  SPMS-5796 - Set point position (Left to right, Signaller, accepted)</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>causes :  SPRM-517 - No accident</p> <p>has parent :  SPRM-2164 - Detailed Failure Modes and Effect Analysis</p>

Late requested point position to ETPS

ID	SPRM-1685
Failure Mode (Keyword)	Omission

Failure Description	PES sends request for movement of point too late or not at all to ETPS.
Effect on Linked Functions Systems	ETPS is checking if all the conditions to command the point machines are met (e.g. point not occupied or reserved for other operational movements).
Effect on Railway System	Potentially disturbed operation.
Risk Comment	PRAM consideration: ETPS shall send the reason for rejecting the requested point position to PES.
Linked Work Items	<p>relates to :  SPMS-4877 - Control execution of switchable trackside asset request</p> <p>relates to :  SPMS-6422 - Requested point position</p> <p>relates to :  SPMS-4869 - Set point position</p> <p>relates to :  SPMS-5015 - Set point position (Left to right, Operational plan)</p> <p>relates to :  SPMS-5796 - Set point position (Left to right, Signaller, accepted)</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>causes :  SPRM-517 - No accident</p> <p>has parent :  SPRM-2164 - Detailed Failure Modes and Effect Analysis</p>

3.3.1.2.3 Constraints


No constraints allocated to this function.

3.3.2 European Trackside Protection System functions

3.3.2.1 Aggregate movable object information

3.3.2.1.1 Functional description

Aggregate movable object information

This function is allocated to  SPMS-5062 - European Trackside Protection System.

This function aggregates and stores information (e.g. position) submitted by different actors (e.g., Trackside Asset CS, Train CS) and output of other functions into an operational state representation of movable objects. The function includes occupancies NOT allocated to a train object as well. Movable objects are defined as trains and wagons that either submit localisation and/or additional data (such as speed and status) or that are localised by alternative technologies such as TTD systems.

ID	SPMS-4871
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Linked Work Items	<p>C2P-outgoing :  SPMS-6328 - Aggregated track occupancy and train status information</p> <p>C2P-outgoing :  SPMS-6329 - Aggregated track occupancy and train status information</p> <p>C2P-incoming :  SPMS-6364 - Activated state of configuration data</p> <p>C2P-outgoing :  SPMS-6330 - Aggregated track occupancy and train status information</p> <p>C2P-outgoing :  SPMS-6332 - Aggregated track occupancy and train status information</p> <p>C2P-outgoing :  SPMS-6326 - Aggregated track occupancy and train status information</p> <p>C2P-outgoing :  SPMS-6334 - Aggregated track occupancy and train status information</p> <p>C2P-outgoing :  SPMS-6327 - Aggregated track occupancy and train status information</p> <p>C2P-incoming :  SPMS-6398 - Observed track vacancy proving section state</p> <p>C2P-incoming :  SPMS-6412 - Observed state and position of one train</p> <p>references in description :  SPMS-5062 - European Trackside Protection System</p> <p>C2P-realized :  SPMS-2944 - Aggregate movable objects information</p> <p>C2P-outgoing :  SPMS-7215 - Aggregated track occupancy and train status information</p> <p>C2P-incoming :  SPMS-7953 - Authorised movement permission</p> <p>C2P-incoming :  SPMS-7969 - Provided communication session message</p> <p>_C2P-involved_functions :  SPMS-4868 - Grant movement permission</p> <p>_C2P-involved_functions :  SPMS-5014 - Grant movement permission</p> <p>_C2P-allocated to :  SPMS-5062 - European Trackside Protection System</p> <p>_C2P-involved_functions :  SPMS-5144 - Set point position</p> <p>_C2P-involved_functions :  SPMS-5172 - Shorten movement permission</p> <p>_C2P-involved_functions :  SPMS-5474 - Shorten movement permission (Cooperative shortening of movement permission)</p> <p>_C2P-involved_functions :  SPMS-5886 - Release movement permission</p> <p>_C2P-involved_functions :  SPMS-5893 - Release movement permission</p> <p>_C2P-involved_functions :  SPMS-5970 - Grant movement permission</p> <p>_C2P-involved_functions :  SPMS-6054 - Deactivate level crossing</p> <p>_C2P-involved_functions :  SPMS-6095 - Localise train on railway infrastructure</p> <p>_C2P-involved_functions :  SPMS-6098 - Localise train on railway infrastructure (Detect track vacancy proving section occupation)</p> <p>_C2P-involved_functions :  SPMS-6099 - Localise train on railway infrastructure (Determine localisation information for one train)</p> <p>_C2P-involved_functions :  SPMS-6136 - Activate level crossing (Train approaching)</p> <p>_C2P-involved_functions :  SPMS-6137 - Deactivate level crossing (Train passed level crossing)</p> <p>_C2P-involved_functions :  SPMS-7140 - Execute end of mission</p> <p>_C2P-involved_functions :  SPMS-7142 - Execute end of mission</p> <p>_C2P-involved_functions :  SPMS-7150 - Execute end of mission - General</p> <p>_C2P-involved_functions :  SPMS-7219 - Execute end of mission</p> <p>_C2P-involved_functions :  SPMS-7224 - Execute end of mission - General</p> <p>_C2P-involved_functions : SPMS-7785 - Shorten movement permission (accepted)</p> <p>_C2P-involved_functions : SPMS-7961 - Execute end of mission - No communication remaining</p> <p>_C2P-involved_functions : SPMS-7968 - Execute end of mission - No communication remaining</p> <p>_is constrained by : SPRM-1736 - Integrity of received information for</p>
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determining train motion state
 _is constrained by : {c} SPRM-1739 - Consistency between information for determining train motion state
 _ is related to : ⚠ SPRM-2243 -
 _ is related to : ⚠ SPRM-2244 -
 _ is related to : ⚠ SPRM-2245 -
 _ is derived by : 📄 SPT2TRAFFIC-11902 - Report Train Object information based on trackside detection systems
 _ is derived by : 📄 SPT2TRAFFIC-11903 - Report Train Object information based on train position reports

3.3.2.1.2 Failure Modes and Effects Analysis

There are no output exchanges in scope of the analysed scenarios.

3.3.2.1.3 Constraints

Consistency between information for determining train motion state

A check of the consistency between wheel passing information received by the Wheel and geographical information received by a Rolling Stock Reference Point is needed.

ID	SPRM-1739
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Integrity of received information for determining train motion state

The CCS System handles transmission errors on received information used for determining the train motion state safely. The loss of input data is handled in a safe manner when determining the train motion state.

E.g. extending the section deemed occupied by the train.

ID	SPRM-1736
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3.3.2.2 Authorise movement permission

3.3.2.2.1 Functional description

Authorise movement permissions






























This function is allocated to 📄 SPMS-5062 - European Trackside Protection System.


































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

- supervises and verifies that the required trackside assets are in the required position
- allocates track paths over trackside assets (locking state is shown by the observe point position)
- checks whether there are no conflicting track paths already allocated to other train movements nor usage restrictions already defined
- checks that the track path for planned train movement is clear

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).

The function also releases track parts that are no longer planned to be used for train movement after











Input exchanges	Input exchanges	Source function	Function allocated to	
	 SPMS-6421 - Requested movement permission <ul style="list-style-type: none">  SPMS-4928 - movement_permission_request  SPMS-7786 - cooperative_shortening_request 	 SPMS-4878 - Control execution of movement permission request	 SPMS-5060 - Plan Execution	
	 SPMS-6408 - Observed point position <ul style="list-style-type: none">  SPMS-4933 - msg_point_position  SPMS-4934 - msg_ability_to_move_point  SPMS-4936 - msg_movement_failed 	 SPMS-4900 - Sense+Observe point position	 SPMS-5068 - Subsystem	
	 SPMS-6326 - Aggregated track occupancy and train status information <ul style="list-style-type: none">  SPMS-5119 - train_object 	 SPMS-4871 - Aggregate movable object information	 SPMS-5062 - European Train	
	No exchange items allocated on  SPMS-6363 - Activated state of configuration data.	 SPMS-4920 - Maintain European Trackside Protection System configuration data	 SPMS-5062 - European Train	
	 SPMS-6434 - Responded train-specific authorisation <ul style="list-style-type: none">  SPMS-4949 - 137_request_to_shorten_MA_is_granted  SPMS-4950 - 138_request_to_shorten_MA_is_rejected  SPMS-4951 - 146_acknowledgement 	 SPMS-4873 - Calculate safe speed profiles	 SPMS-5063 - European Train	
	 SPMS-7827 - Authorised usage restriction <ul style="list-style-type: none">  SPMS-7755 - restriction_area  SPMS-7822 - restriction_area_Op 	 SPMS-5724 - Authorise usage restriction areas	 SPMS-5062 - European Train	

Output exchanges	Output exchanges	Target function	Function allocated to
	 SPMS-6339 - Authorised movement permission <ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-4913	 SPMS-6004 - Signaller Control
	 SPMS-6340 - Authorised movement permission <ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-4903	 SPMS-5062 - European Traffic
	 SPMS-6342 - Authorised movement permission <ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-5724	 SPMS-5062 - European Traffic
	 SPMS-6604 - Authorised movement permission <ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-5723	 SPMS-5062 - European Traffic
	 SPMS-6393 - Authorised movement permission <ul style="list-style-type: none">  SPMS-4945 - 03_movement_authority 	 SPMS-4873	 SPMS-5062 - European Traffic
	 SPMS-6441 - Authorised movement permission <ul style="list-style-type: none">  SPMS-7787 - cooperative_shortening_request_response  SPMS-7783 - movement_permission_request_response 	 SPMS-4878	 SPMS-5062 - European Traffic
	 SPMS-7953 - Authorised movement permission <ul style="list-style-type: none">  SPMS-7954 - movement_permission 	 SPMS-4871	 SPMS-5062 - European Traffic
	 SPMS-7980 - Authorised movement permission <ul style="list-style-type: none">  SPMS-7979 - 69_track_condition_station_platforms 	 SPMS-7844	 SPMS-5062 - European Traffic












3.3.2.2.2 Failure Modes and Effects Analysis

Early movement permission to PES











ID	SPRM-1415
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Failure Mode (Keyword)	Commission
Failure Description	ETPS sends movement permission information too early to PES.
Effect on Linked Functions Systems	Movement permission information is sent too early to the PES, which sends this information to TMS.
Effect on Railway System	No safety issues. TMS receiving early information about a Movement Permission has no safety impacts.
Risk Comment	This risk does not exist anymore, will be deleted.
Linked Work Items	<p>relates to :  SPMS-4883 - Authorise movement permissions</p> <p>relates to :  SPMS-6431 - to be deleted</p> <p>relates to :  SPMS-5893 - Release movement permission</p> <p>assesses :  SPRM-517 - No accident</p> <p>causes :  SPRM-517 - No accident</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>relates to :  SPMS-5014 - Grant movement permission</p> <p>relates to :  SPMS-4868 - Grant movement permission</p> <p>relates to :  SPMS-5886 - Release movement permission</p> <p>has parent :  SPRM-2148 - Detailed Failure Modes and Effect Analysis</p>

Early shortened movement permission response to PES












ID	SPRM-2017
Failure Mode (Keyword)	Commission
Failure Description	ETPS sends a shortened movement permission response too early to PES.
Effect on Linked Functions Systems	PES gets accepting or rejecting of a shorten movement permission request too early. Since the response is correct, there are no hazardous effects.
Effect on Railway System	None
Risk Comment	-
Linked Work Items	<p>relates to :  SPMS-4883 - Authorise movement permissions</p> <p>relates to :  SPMS-6441 - Authorised movement permission</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>causes :  SPRM-517 - No accident</p> <p>relates to :  SPMS-5177 - Shorten movement permission (Operational plan change, accepted)</p> <p>relates to :  SPMS-5221 - Shorten movement permission (Operational plan change, rejected)</p> <p>relates to :  SPMS-5222 - Shorten movement permission (Signaller request, accepted)</p> <p>relates to :  SPMS-5223 - Shorten movement permission (Signaller request, rejected)</p> <p>relates to :  SPMS-5474 - Shorten movement permission (Cooperative shortening of movement permission)</p> <p>relates to :  SPMS-4441 - Shorten movement permission</p> <p>has parent :  SPRM-2148 - Detailed Failure Modes and Effect Analysis</p>

Incorrect movement permission to PES










ID	SPRM-1416
Failure Mode (Keyword)	Incorrect
Failure Description	ETPS sends incorrect movement permission information to PES.
Effect on Linked Functions Systems	Incorrect Movement permission information is sent to the PES, which sends this information to TMS. Incorrect means that the distance, end point or speed of the Movement permission are wrong but within the constraints already identified for this function. So ETPS could create a movement permission to a wrong location with an incorrect speed (not according to the operational plan movement).
Effect on Railway System	No safety issues but operational disturbances since train could make unplanned (but safe) movements. TMS can make changes on the operational plan according to the incorrect given movement permission and send an updated plan based on the incorrect movement permission. However, even if the movement permissions are incorrect they are safely issued by ETPS. There may be operational impacts but no safety impacts.
Risk Comment	This risk does not exist anymore, and will be deleted.
Linked Work Items	<p>relates to :  SPMS-4883 - Authorise movement permissions</p> <p>relates to :  SPMS-6431 - to be deleted</p> <p>relates to :  SPMS-5893 - Release movement permission</p> <p>assesses :  SPRM-517 - No accident</p> <p>causes :  SPRM-517 - No accident</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>relates to :  SPMS-5014 - Grant movement permission</p> <p>relates to :  SPMS-4868 - Grant movement permission</p> <p>relates to :  SPMS-5886 - Release movement permission</p> <p>has parent :  SPRM-2148 - Detailed Failure Modes and Effect Analysis</p>

Incorrect shortened movement permission response to PES

ID	SPRM-2018
Failure Mode (Keyword)	Incorrect
Failure Description	ETPS sends an incorrect shortened movement permission response to PES.
Effect on Linked Functions Systems	PES receives an accepted movement permission shortening instead of a rejection. This means that PES shortens the movement permission and send this status to TMS for calculating the operational plan. TMS might plan conflicting movements that will be rejected by ETPS. If PES receives a rejected movement permission shortening instead of an accepted one, then available infrastructure will not be used for train movements by TMS which results in an unoptimized operational plan.
Effect on Railway System	Disturbed operation












Risk Comment	Internal failure of this function to be analysed later: ETPS shortens MP although it received a rejection from train. Worst case: train moves on unsecured path because ETPS removes the reservation of the track.
Linked Work Items	<p>relates to :  SPMS-4883 - Authorise movement permissions</p> <p>relates to :  SPMS-6441 - Authorised movement permission</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>causes :  SPRM-517 - No accident</p> <p>relates to :  SPMS-5177 - Shorten movement permission (Operational plan change, accepted)</p> <p>relates to :  SPMS-5221 - Shorten movement permission (Operational plan change, rejected)</p> <p>relates to :  SPMS-5222 - Shorten movement permission (Signaller request, accepted)</p> <p>relates to :  SPMS-5223 - Shorten movement permission (Signaller request, rejected)</p> <p>relates to :  SPMS-5474 - Shorten movement permission (Cooperative shortening of movement permission)</p> <p>relates to :  SPMS-4441 - Shorten movement permission</p> <p>has parent :  SPRM-2148 - Detailed Failure Modes and Effect Analysis</p>

Late movement permission to PES

ID	SPRM-1534
Failure Mode (Keyword)	Omission
Failure Description	ETPS sends movement permission information too late or not at all to PES.
Effect on Linked Functions Systems	Movement permission information is sent too late to the PES, which sends this information to TMS.
Effect on Railway System	No safety issues. TMS receiving late information about a Movement Permission has no safety impacts. TMS can make changes on the operational plan according to the outdated movement permission and send an updated plan based on the outdated movement permission. However, the movement permissions are safely issued by ETPS. There may be operational impacts but no safety impacts.
Risk Comment	-
Linked Work Items	<p>relates to :  SPMS-4883 - Authorise movement permissions</p> <p>relates to :  SPMS-6431 - to be deleted</p> <p>relates to :  SPMS-5893 - Release movement permission</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>causes :  SPRM-517 - No accident</p> <p>relates to :  SPMS-5014 - Grant movement permission</p> <p>relates to :  SPMS-4868 - Grant movement permission</p> <p>relates to :  SPMS-5886 - Release movement permission</p> <p>has parent :  SPRM-2148 - Detailed Failure Modes and Effect Analysis</p>

Late shortened movement permission response to PES

ID	SPRM-2019
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Failure Mode (Keyword)	Omission
Failure Description	ETPS sends the shortened movement permission response too late or not at all to PES.
Effect on Linked Functions Systems	PES and TMS continue to operate with outdated Movement Permission (too long in case shortening is accepted), maintaining reservation of track sections no longer needed. TMS receives outdated information so available infrastructure will not be used for train movements by TMS which results in an unoptimized operational plan.
Effect on Railway System	No safety impact but operational efficiency is affected.
Risk Comment	-
Linked Work Items	<p>relates to :  SPMS-4883 - Authorise movement permissions</p> <p>relates to :  SPMS-6441 - Authorised movement permission</p> <p>assesses :  SPRM-516 - No safety hazard</p> <p>causes :  SPRM-517 - No accident</p> <p>relates to :  SPMS-5177 - Shorten movement permission (Operational plan change, accepted)</p> <p>relates to :  SPMS-5221 - Shorten movement permission (Operational plan change, rejected)</p> <p>relates to :  SPMS-5222 - Shorten movement permission (Signaller request, accepted)</p> <p>relates to :  SPMS-5223 - Shorten movement permission (Signaller request, rejected)</p> <p>relates to :  SPMS-5474 - Shorten movement permission (Cooperative shortening of movement permission)</p> <p>relates to :  SPMS-4441 - Shorten movement permission</p> <p>has parent :  SPRM-2148 - Detailed Failure Modes and Effect Analysis</p>

3.3.2.2.3 Constraints

All STAs in the required path are in the required position

All switchable trackside assets in the required path are in the required position.

ID	SPRM-2312
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Maximum authorised distance is within Movement Permission

The end of the MA has to be within the secured path for the movement (i.e. the Movement Permission).

ID	SPRM-1776
----	-----------

Requested track path adheres to train-side restrictions

Requested track path adheres to trainside restrictions e.g. possible braking curves, maximum speed of train, train length etc.

ID	SPRM-1758
----	-----------

Authorised speed is less or equal to the maximum allowed track speed

The authorised speed of the movement permission of the train is less or equal to the maximum allowed track speed.

ID	SPRM-1563
----	-----------

Movement permission is distinct from other Movement Permissions

The movement permission of the train uses only a track path that is distinct from movement permissions of other trains. This means that Movements Permissions do not overlap.

ID	SPRM-1562
----	-----------

Movement permission is free of occupancies

The movement permission of the train uses only a track path that is free of occupancies by other trains and vehicles.

ID	SPRM-1561
----	-----------

Maximum authorised distance ends ahead of occupied track

Maximum authorised distance is at the most the start of the next occupied track. This means that the end of authority cannot be in an occupied track (occupied by train or by another movement permission).

ID	SPRM-1447
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Requested track path is distinct from other authorised track paths


Requested track path for one train does not contain any track paths already set for other trains.

ID	SPRM-1444
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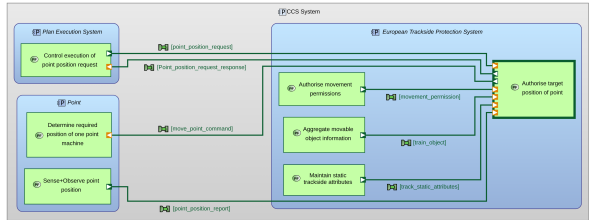





















3.3.2.3 Authorise target state of one point

3.3.2.3.1 Functional description

Authorise target position of point

This function is allocated to  SPMS-5062 - European Trackside Protection System.

This function checks if the requested point position can be implemented safely and sends the related command if so. In case it can not be safely implemented the request is rejected.

ID	SPMS-4903		
Context Diagram	 <p>The context diagram shows the function 'Authorise target position of point' (SF) within the 'European Trackside Protection System' (ECCS System). It interacts with the 'Plan Execution System' (PES) and the 'Subsystem - Point' (P). Data flows include: 'point_position_request' from PES to the function; 'movement_permission' from the function to PES; 'train_object' from the function to PES; 'point_position_report' from the function to PES; 'point_position_request_response' from PES to the function; 'point_position_command' from the function to P; and 'point_position_report' from P to the function.</p>		
Input exchanges	Input exchange items	Source function	Function allocated to
	<ul style="list-style-type: none">  SPMS-4926 - signaller_point_position_request 	 SPMS-4877 - Control execution of switchable trackside asset request	 SPMS-5060 - Plan Execution System
	<ul style="list-style-type: none">  SPMS-4933 - msg_point_position 	 SPMS-4900 - Sense+Observe point position	 SPMS-5068 - Subsystem - Point
	<ul style="list-style-type: none">  SPMS-4931 	 SPMS-4920 - Maintain European Trackside Protection System configuration data	 SPMS-5062 - European Trackside Protection System
	<ul style="list-style-type: none">  SPMS-5119 - train_object 	 SPMS-4871 - Aggregate movable object information	 SPMS-5062 - European Trackside Protection System
Output exchanges	<ul style="list-style-type: none">  SPMS-2372 - movement_permission 	 SPMS-4883 - Authorise movement permissions	 SPMS-5062 - European Trackside Protection System
	Output exchange items	Target function	Function allocated to
	<ul style="list-style-type: none">  SPMS-4935 - cd_move_point 	 SPMS-4883 - Authorise movement permissions	 SPMS-5068 - Subsystem - Point
	<ul style="list-style-type: none">  SPMS-5191 - switchable_trackside_asset_request_response 	 SPMS-4877 - Control execution of switchable trackside asset request	 SPMS-5060 - Plan Execution System

3.3.2.3.2 Failure Modes and Effects Analysis

There are no output exchanges in scope of the analysed scenarios.















3.3.2.3.3 Constraints

No constraints allocated to this function.

DRAFT

4 Appendix

4.1 References

ID	Description
[ SPT2TRAFFIC-4141 - ERJU Safety Guideline]	The ERJU Safety Guideline practical guidance for ERJU Safety and System Engineers.
[ SPP-18060 - TCS_System Architecture Description CCS System V0.3]	System Architecture of the CCS System according to  SPPRAMSS-349 - [EN 50126-1:2017].
[ SPP-18076 - System Definition Traffic CS]	System Definition of the Traffic CS System according to  SPPRAMSS-349 - [EN 50126-1:2017].
[ SPP-18102 - System Requirement Specification ETPS]	System Requirement Specification of the ETPS System according to  SPPRAMSS-349 - [EN 50126-1:2017].
[ SPP-20332 - System Requirement Specification PES]	System Requirement Specification of the PES System according to  SPPRAMSS-349 - [EN 50126-1:2017].
[ SPP-20333 - System Requirement Specification ATP-TS]	System Requirement Specification of the ATO-TS System according to  SPPRAMSS-349 - [EN 50126-1:2017].
[ SPT2TRAFFIC-13108 - ERJU Hazard Database - Main Document]	This document details the European Railway Harmonized Hazards Database to be used for risk assessment by ERJU SP Domains in accordance with ERJU PRAMS Plan and guidelines.
 SPT2TRAFFIC-13107 - ERJU PRAMS Plan	This Safety Plan according to Phase 2.EN50126-1 shows the planned safety activities of ERJU System Pillar. It reflects the discussion in the ERJU Workgroup RAMS.
 SPT2TRAFFIC-13109 - ERJU Risk Assessment Process & Template	This document describes the basic steps for performing risk assessment (focus safety) within ERJU. In addition it provides templates and examples for the risk assessment to be done by the ERJU System Pillar Domain Safety Managers.