




ERJU SYSTEM PILLAR

# **Stakeholder Requirements Specification : Maintain & Monitor Infrastructure Capability**



# Stakeholder Requirements Specification : Maintain & Monitor Infrastructure Capability

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Abstract	The report below presents the functional description of the SP Task 1 architecture proposal for the railway network capability: Maintain and Monitor Infrastructure. On top of this, the SP Task 1 has issued a limited number of global recommendations for the Railway network architecture in order to reach the common business objectives set out and pain points for System Pillar.
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## 1 Preamble

### 1.1 Purpose

The objective of this project is to provide/propose an architectural solution applicable to most European railway networks. More specifically, in the context of MMI (Maintain and Monitor Infrastructures), it also aims to facilitate the flow of information to accelerate operations and provide information on the status of the infrastructure as quickly as possible.

### 1.2 Intended Audience

This document is addressed to the entire Pillar system for internal assessments and then mainly to all Infrastructure Managers and Railway Undertakings.

### 1.3 Document context

The document aims to be a second-level architecture with the aim of providing architectural solutions applicable to all European railways and beyond.

In the context of the MMI, it identifies and harmonizes the interactions between the various actors who are directly or indirectly affected by the Monitoring and Maintenance activities of the railway infrastructure.


Within the MMI framework, it identifies and harmonizes the interactions between the various stakeholders directly or indirectly affected by railway infrastructure monitoring and maintenance activities. The work produced is aligned with the resolution of pain points and the implementation of the CBOs highlighted in the past.

The architecture was reviewed in several steps to map all pain points and the associated CBOs, and then provide an objective response.


### 1.4 Glossary

#### 1.4.1 Terms


##### **Accident**

Accident' means an unwanted or unintended sudden event or a specific chain of such events which have harmful consequences; accidents are divided into the following categories: collisions; derailments; level crossing accidents; accidents to persons involving rolling stock in motion; fires and others.  Definition, SPT1RS-1000 ]


##### **Serious Accident**

Serious accident means any train collision or derailment of trains resulting in the death of at least one person or serious injuries to five or more persons or extensive damage to rolling stock, the infrastructure or the environment, and any other accident with the same consequences which has an obvious impact on railway safety regulation or the management of safety; 'extensive damage' means damage that can be immediately assessed by the investigating body to cost at least EUR 2 million in total.  Definition, SPT1RS-1001 ]


##### **Allocation**

Allocation means the allocation of railway infrastructure capacity by an infrastructure manager  Definition, SPT1RS-1002 ]


**Allocation Body**

An Allocation Body is an independent organization responsible for train path allocation to Railway Undertakings and other Applicants; this includes the designation of individual paths and the assessment of their availability. In most cases, the AB is the same organization as the Infrastructure Manager. But if the rail operator is not independent from the Infrastructure Manager, then path allocation must be carried out, according to Directive 2012/34/EU, by an independent Allocation Body.  Definition, SPT1RS-1003 ]


**Allocation process**

The process by which capacity is granted to an Applicant by the Infrastructure Manager or relevant capacity Allocation Body; this capacity is available for the duration of the working timetable period only.  Definition, SPT1RS-1004 ]


**Applicant**

Applicant means a railway undertaking or an international grouping of railway undertakings or other persons or legal entities, such as competent authorities under Regulation (EC) No 1370/2007 and shippers, freight forwarders and combined transport operators, with a public-service or commercial interest in procuring infrastructure capacity;  Definition, SPT1RS-1005 ]


**Holder of the vehicle type authorization**

Holder of the vehicle type authorization means the natural or legal person that has applied for and received the vehicle type authorization, or its legal successor  Definition, SPT1RS-1006 ]


**Certification body**

Certification body means a body, responsible for the certification of entities in charge of maintenance or for certification of the entity or organization that fulfill maintenance functions referred to in points (b), (c) or (d) of Article 14(3) of Directive (EU) 2016/798, or parts of those functions  Definition, SPT1RS-1007 ]


**Competent Authority**

Competent authority means any public authority or group of public authorities of a Member State or Member States which has the power to intervene in public passenger transport in a given geographical area or any body vested with such authority  Definition, SPT1RS-1008 ]

**Competent Local Authority**

Competent local authority means any competent authority whose geographical area of competence is not national  Definition, SPT1RS-1009 ]

**Coordination**

Coordination means the process through which the infrastructure manager and applicants will attempt to resolve situations in which there are conflicting applications for infrastructure capacity.  Definition, SPT1RS-1010 ]

**ECM**

Entity in charge of maintenance ('ECM') means an entity in charge of the maintenance of a vehicle, and registered as such in a vehicle register referred to in Article 47 of Directive (EU) 2016/797

The maintenance of vehicles is defined in the Article 14 of Directive (EU) 2016/798.

In particular, the four functions of ECMs are described in the Article 14 (3):

(a) a management function to supervise and coordinate the maintenance functions referred to in points (b) to (d) and to ensure the safe state of the vehicle in the railway system;


[editorial edition : ECM 1 in this document]

(b) a maintenance development function responsible to manage the maintenance documentation, including the configuration ation management, based on design and operational data as well as on performance and return on experience; [editorial edition : ECM 2 in this document]


(c) a fleet-maintenance management function to manage the vehicle's removal for maintenance and its return to operation after maintenance; [editorial edition : ECM 3 in this document]

(d) a maintenance delivery function to deliver the required technical maintenance of a vehicle or parts of it, including the release to service documentation. [editorial edition : ECM 4 in this document]

The entity in charge of maintenance shall carry out the management function itself, but may outsource the maintenance functions referred to in points (b) to (d), or parts thereof, to other contracting parties such as maintenance workshops.

 Definition, SPT1RS-1011 ]


### **Existing Railway System**

Existing rail system means the infrastructure composed of lines and fixed installations of the existing rail network as well as the vehicles of all categories and origins traveling on that infrastructure  Definition, SPT1RS-1012 ]


### **Fleet**

All the vehicles of the railway company  Definition, SPT1RS-1013 ]

### **Incident**

Incident means any occurrence, other than an accident or serious accident, affecting the safety of railway operations  Definition, SPT1RS-1014 ]


### **Infrastructure Capacity**

Infrastructure capacity means the potential to schedule train paths requested for an element of infrastructure for a certain period  Definition, SPT1RS-1015 ]

### **RNE Glossary**

Narrow definition: the maximum number of trains which can be planned to move in both directions over a specified section of track in a 24hour period.

General definition: the totality of potential train paths that can be accommodated on a railway line or a network

 Definition, SPT1RS-1016 ]

### **Infrastructure Manager**

Infrastructure manager means any body or firm responsible in particular for establishing,

managing and maintaining railway infrastructure, including traffic management and control-command and signalling; the functions of the infrastructure manager on a network or part of a network may be allocated to different bodies or firms. [📄 Definition, SPT1RS-1017 ]

#### **Innovative solutions**

The article 10 of the INFRA TSI shall be taken into account regarding innovative solutions for maintenance, upgrading and renewal of infrastructure. [📄 Definition, SPT1RS-1018 ]

#### **Keeper**

Keeper means the natural or legal person that, being the owner of a vehicle or having the right to use it, exploits the vehicle as a means of transport and is registered as such in a vehicle register referred to in Article 47 [📄 Definition, SPT1RS-1019 ]

#### **Exchanged Data**

Data interchanged between at least two entities (in this case, data generated and processed by the IMs). [📄 Definition, SPT1RS-1020 ]

#### **Monitoring data**

The entity in charge of maintenance shall, either directly or via the keeper provide information to the railway undertakings and infrastructure managers operating the vehicles, keepers, manufacturers, holders of vehicles authorizations and holders of the type authorization of vehicles, subsystems or components, as most appropriate and shall in particular, inform them of exceptional maintenance findings beyond wear and tear. [📄 Definition, SPT1RS-1021 ]

#### **National Safety Authority definition 1**

National safety authority means a safety authority as defined in point (7) of Article 3 of Directive (EU) 2016/798 [📄 Definition, SPT1RS-1022 ]

#### **National Safety Authority definition 2**

National safety authority means the national body entrusted with the tasks regarding railway safety in accordance with this Directive [ 2016 / 798 ] or any body entrusted by several Member States with those tasks in order to ensure a unified safety regime [📄 Definition, SPT1RS-1023 ]

#### **Network**

Network means the entire railway infrastructure managed by an infrastructure manager; [📄 Definition, SPT1RS-1024 ]

#### **Network Statement**

Network statement means the statement which sets out in detail the general rules, deadlines, procedures and criteria for charging and capacity-allocation schemes, including such other information as is required to enable applications for infrastructure capacity. [📄 Definition, SPT1RS-1025 ]

#### **Railway Infrastructure**

Railway infrastructure means the items listed in Annex I [of DIRECTIVE 2012/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 November 2012 establishing a single European railway area (recast) [📄 Definition, SPT1RS-1026 ]

#### **Railway Undertaking**

Railway undertaking means any public or private under taking licensed according to this

Directive, the principal business of which is to provide services for the transport of goods and/or passengers by rail with a requirement that the undertaking ensure traction; this also includes undertakings which provide traction only; [📄 Definition, SPT1RS-1027 ]

### **Regulatory authorities**

Under European Union legislation, each Regulatory Body (RB) has the task to oversee the application of Community rules and act as an appeal body in case of disputes.

DIRECTIVE 2012/34/EU, Article 55: 'Each Member State shall establish a single national regulatory body for the railway sector. Without prejudice to paragraph 2, this body shall be a stand-alone authority which is, in organizational, functional, hierarchical and decision-making terms, legally distinct and independent from any other public or private entity. It shall also be independent in its organization, funding decisions, legal structure and decision-making from any infrastructure manager, charging body, allocation body or applicant. It shall furthermore be functionally independent from any competent authority involved in the award of a public service contract.'

Thus it shall ensure that charges set by the Infrastructure Manager comply with Chapter II of 2001/14/EU and are non-discriminatory. The RB oversees negotiations between applicants and the IM and intervenes when the requirements of 2001/14 are likely to be contravened.

Applicants have the right to appeal to the RB if they believe that they have been unfairly treated, discriminated against or are in any other way aggrieved. In particular, they may appeal against decisions adopted by the IM (or where appropriate the Railway Undertaking) concerning: a) the network statement; b) criteria contained within it; c) the allocation process and its outcome; d) the charging scheme; e) level or structure of infrastructure fees which it is, or may be, required to pay; f) arrangements for access.

[📄 Definition, SPT1RS-1028 ]

### **Renewal**

Renewal means any major substitution work on a subsystem or part of it which does not change the overall performance of the subsystem; [📄 Definition, SPT1RS-1029 ]

### **Services**

Services are one of the two key components of economics, the other being goods. A service is a type of economic activity (or series of activities) that is of a more or less intangible nature, is not stored and does not result in ownership. Normally (but not necessarily) it takes place in interactions between the customer and service employees and /or systems of the service provider, provided as solutions to customer problems. Examples of services include the transfer of goods, such as the postal service delivering mail, and the use of expertise or experience, such as a person visiting a doctor. Services include the provision of what is necessary for maintenance of thing or operation, assistance and advice. RNE dictionary

[📄 Definition, SPT1RS-1030 ]

### **Service Facility**

Service facility means the installation, including ground area, building and equipment, which



has been specially arranged, as a whole or in part, to allow the supply of one or more services referred to in points 2 to 4 of Annex II of DIRECTIVE 2012/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 November 2012 establishing a single European railway area (recast). [📄 Definition, SPT1RS-1031 ]

#### **Substitution [in the framework of maintenance]**

Substitution in the framework of maintenance' means any replacement of components by parts of identical function and performance in the framework of preventive or corrective maintenance [📄 Definition, SPT1RS-1032 ]

#### **Timetable**

Document or system that gives details of a train(s) schedule over a particular route (OPE TSI appendix J)

This definition can be completed by the RNE definition:

' A schedule listing the times at which certain events, such as arrivals and departures at a transport station, are expected to take place. The timetable defines all planned train and rolling-stock movements which will take place on the relevant infrastructure during the period for which it is in force. Example: "annual timetable" ("yearly timetable" is incorrect)

[📄 Definition, SPT1RS-1033 ]

#### **Working Timetable**

Working timetable means the data defining all planned train and rolling-stock movements which will take place on the relevant infrastructure during the period for which it is in force

[📄 Definition, SPT1RS-1034 ]

#### **Traffic Management**

Traffic management shall ensure the safe, efficient and punctual operation of the railway, including effective recovery from service disruption.

The infrastructure manager shall determine procedures and means for:

- the real time management of trains,
- operational measures to maintain the highest possible performance of the infrastructure in case of delays or incidents, whether actual or anticipated, and
- the provision of information to the railway undertaking(s) in such cases.

Any additional processes required by the railway undertaking and which affect the interface with the infrastructure manager(s) may be introduced after being agreed with the infrastructure manager.

[📄 Definition, SPT1RS-1035 ]

#### **Operation and Traffic Management**

The procedures and related equipment permitting coherent operation of the various structural subsystems, during both normal and degraded operation, including in particular train composition and train driving, traffic planning and management. [📄 Definition, SPT1RS-1036 ]

#### **Traffic Monitoring**

The monitoring of railway traffic involves systematically keeping track of (or supervising) and collecting information concerning parameters such as: train location, train speed, train direction. It uses graphical systems. The main graphic screens of these systems show



two kinds of diagrams: train tracks and train schedules. Train track diagrams indicate the actual layout of railway tracks, signals, stations, and so on. They indicate the current position of trains, the condition of signals, the direction of switches, and so on, using simplified drawings of actual railway tracks and signals. To notify operators of this information, the color of tracks and signals are displayed, and a train's number is displayed in text that dynamically changes according to supervisory data. Train schedule diagrams consist of lines which correspond to the movements of trains, train numbers for each train line, and horizontal lines which show the positions of stations. They are presented as charts that illustrate train movements in actual time depicted along a horizontal axis. [📄 Definition, SPT1RS-1037 ]

### **Train**

Eurostat/ITF/UNECE definition: one or more railway vehicles hauled by one or more locomotives or rail-cars, or one rail-car traveling alone, running under a given number or specific designation from an initial fixed point to a terminal fixed point. (A light engine, i.e. a locomotive traveling on its own, is not considered to be a train.)

UNISIG definition for ERTMS: a traction unit (vehicle from where a train is operated) with or without coupled railway vehicles or a train set of vehicles with train data available.

General definition: one or more railway vehicles capable of being moved. It may consist of a locomotive (sometimes more than one) to provide power with various unpowered vehicles attached to it. It may consist of a multiple unit, i.e. several vehicles formed into a fixed formation or set, which carry their own power and do not require a locomotive. A train may be only a locomotive running light (deadheading) to a point elsewhere on the railway. A train may carry passengers, freight or, rarely nowadays, both.

[📄 Definition, SPT1RS-1038 ]

### **Train crew**

Members of the on-board staff of a train, who are certified as competent and appointed by a railway undertaking to carry out specific, designated safety related tasks on the train, for example the driver or the guard. [📄 Definition, SPT1RS-1039 ]

### **Train dispatch**

The indication to the person driving the train that all station or depot activities are completed and that, as far as the staff responsible are concerned, movement authority has been granted for the train. [📄 Definition, SPT1RS-1040 ]

### **Train Driver**

Train driver means a person capable and authorized to drive trains, including locomotives, shunting locomotives, work trains, maintenance railway vehicles or trains for the carriage of passengers or goods by rail in an autonomous, responsible and safe manner. [📄 Definition, SPT1RS-1041 ]

### **Train Path**

Train path means the infrastructure capacity needed to run a train between two places over a given period. [📄 Definition, SPT1RS-1042 ]

### **Train preparation**

Ensuring that a train is in a fit condition to enter service, that the train equipment is

correctly deployed and the train composition matches the train's designated route(s). Train preparation also includes technical inspections carried out prior to the train entering service. [📄 Definition, SPT1RS-1043 ]

### **Upgrading**

Upgrading means any major modification work on a subsystem or part of it which results in a change in the technical file accompanying the 'EC' declaration of verification, if that technical file exists, and which improves the overall performance of the subsystem. [📄 Definition, SPT1RS-1044 ]

### **Vehicle**

Vehicle means a railway vehicle suitable for circulation on wheels on railway lines, with or without traction; a vehicle is composed of one or more structural and functional subsystems. [📄 Definition, SPT1RS-1045 ]

## **1.4.2 Abbreviations**

This paragraph contains the definition, abbreviations and symbols used by the Arcadia method with Capella throughout the all document.

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### Operational Capability



Capability of an organization to provide a high level service leading to an operational objective being reached (for example Provide weather forecasts, etc.);

### Operational Entity



Entity belonging to the real world (organization, existing system, etc.) whose role is to interact with the system being studied or with its users (for example Crew, Ship, etc.);

### Operational Actor



Particular case of a (human) non-decomposable operational entity (for example Pilot, etc.);

### Operational Activity



Process step carried out in order to reach a precise objective by an operational entity, which might need to use the future system in order to do so (for example Detect a threat, Collect meteorological data, etc.);

### Operational Interaction



Exchange of information or of unidirectional matter between operational activities (for example meteorological data, etc.);

### Operational Process



Series of activities and of interactions that contribute toward an operational capability.

### Operational Scenario



Scenario that describes the behavior of entities and and/or operational activities in the context of an operational capability. It is commonly represented as a sequence diagram, with the vertical axis representing time.

## 2 Introduction

### 2.1 Maintain & Monitor Infrastructure Capability

Maintenance of the railway infrastructure is another key element for the correct functioning of the railway network.

This has a close connection to the signalling system adopted on a specific line.

The work carried out in task 1 was to analyse the current state of the art of the architecture for diagnostics and maintenance of the railway infrastructure and then in the future define how this will have to evolve to be more efficient and interactive.

During the work, the current architecture was updated several times to make it as consistent as possible with the varied situation that is present in the various countries of the union. This synthesis activity also

made it possible to highlight some inefficiencies that the definition activities of the proposed future solution should eliminate.

This process has highlighted that not only a harmonization activity in the description of the information is necessary but also a common definition of the anomaly.

Currently there is no automatic and direct connection with the signalling systems to provide the CTC or TMS with the status of each line and its portion.

## 2.2 Upgrade or renew infrastructure network capabilities Capability

Similarly, there is no single shared procedure for the renewal and updating of lines. Even the certification aspects do not always follow the same process.

In a perspective of simplifying procedures, some points of improvement and convergence have been identified during the activities of describing the current situation.

The work reports an architecture that is close to almost all the countries taken into consideration.

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### 3 Maintain & Monitor Infrastructure Architecture Description

#### 3.1 AS-IS

The description of the AS-IS is a static picture of the Railway sector as it exists today. The view is an idealized view of the system, it is therefore assumed that in the AS-IS all currently applicable TSIs are fully implemented.

##### 3.1.1 Process followed

The activities pursued on the AS-IS architecture were the following:

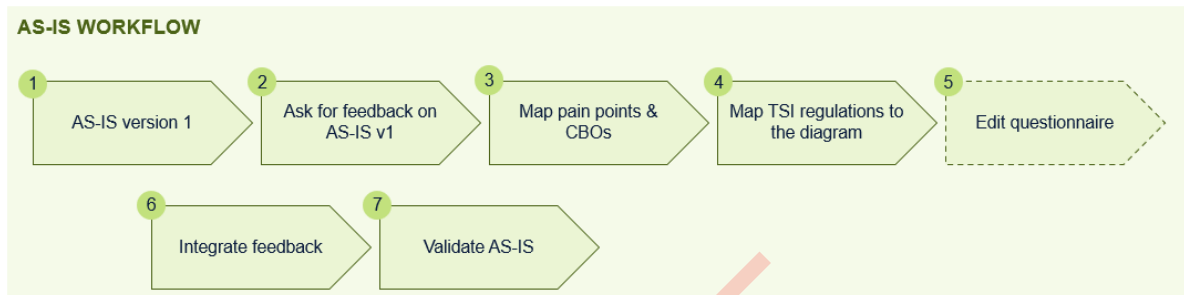





Figure 1 : AS-IS workflow

where:

- AS-IS Version 1: refers to the deliverable from last year, SC2.1:  240307 SP-LOT2-TASK1-Deliverables-SC2\_1-v1-1
- Ask for feedback on AS-IS v1: Last year's deliverable was sent out to all contributors of System Pillar in order to collect feedback.
- Map Pain Points & CBOs: From previous years and programs, a list of pain points and Common Business Objectives (CBOs) have been compiled, this activity consisted in locating them on the Maintain & Monitor Infrastructure capability view.
  - Pain points: are described in the document: *SPT1RailwaySystem/Pain Points/Pain points list : 724240* . The aim of the mapping was to identify current difficulties observed with the 'Maintain & Monitor Infrastructure' capability and identify the associated activities. A visual representation of the mapping is included in the annexes of this report.
  - Common Business Objectives: are described in the document:  Common Business Objectives . The aim of the mapping is to identify areas of potential improvement of the architecture. A visual representation of the mapping is included in the annexes of this report.
- Map TSI regulations to the diagram: consisted in identifying the field of application of the various TSIs, described in this document:  TSIs & other regulations . The objective for this activity is to identify areas of the diagram that are already constrained or optimised. A visual representation of this mapping is included in the annexes of this report.
- Edit questionnaire: consisted in listing questions relative to the Maintain & Monitor Infrastructure capability that were either difficult to address or need to be assessed by a broader audience. Therefore, the questionnaire could be sent out to a wider audience and was a different means of collecting feedback. This activity was never finished and sent outside of Task 1, however a draft version was compiled and is included in the annexes of this document.

##### 3.1.2 Functional Description

On the following page is a view of the validated AS-IS capability view for Maintain & Monitor Infrastructure:

**[OAB] Maintain and monitor infrastructure [Operational activity allocation]**

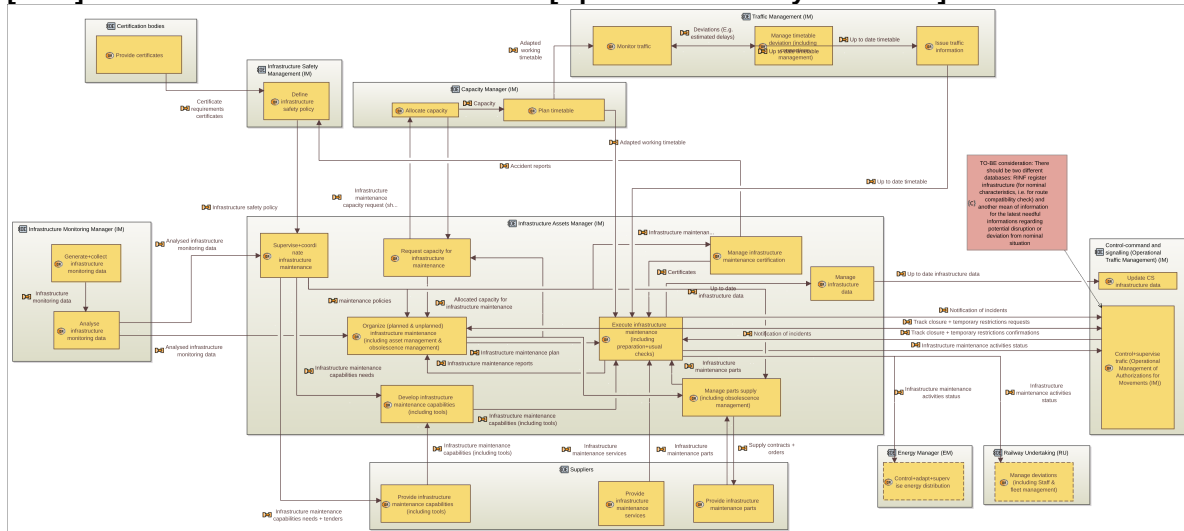


Figure 2 Diagram [OAB] Maintain and monitor infrastructure [Operational activity allocation]

[SPMS-3889]

The view of the AS-IS Infrastructure capabilities has been improved in 2024. The view above is the second iteration on this view, the first having been published in the end of year report 2023. The main modifications between these two versions are:

- Refining exchanges with Operate train entities – namely Traffic Management and Signalling.
- Adding ECM
- Changing exchanges with certification bodies

### 3.1.2.1 Operational Artefacts (Capability, Entity & activity)

## Maintain and monitor infrastructure

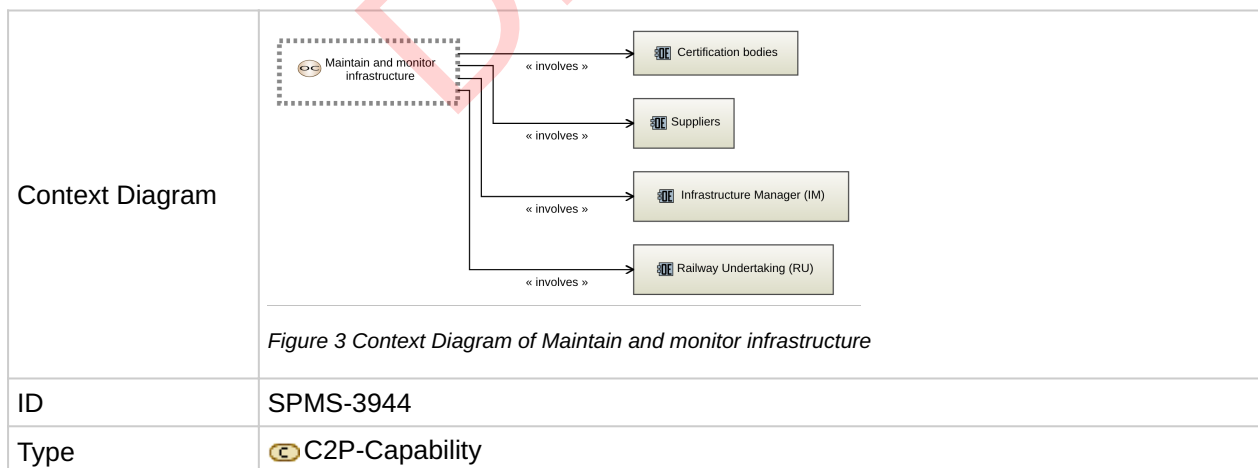


Figure 3 Context Diagram of Maintain and monitor infrastructure

### [COC] Maintain and monitor infrastructure [Single operational capability context]

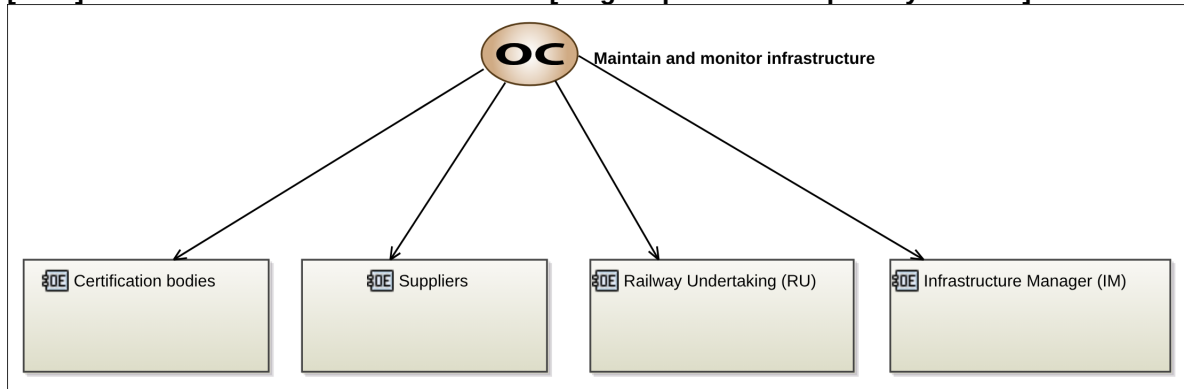


Figure 4 Diagram [COC] Maintain and monitor infrastructure [Single operational capability context]












### [SPMS-3890 ]

The Operational Capability "Maintain and monitor infrastructure" is composed of 4 operational entities which are:

- Infrastructure Manager (IM)
- Railway Undertaking (RU)
- Suppliers
- Certification bodies

#### 3.1.2.1.1 Infrastructure Manager (IM)

##### Infrastructure Manager (IM)

Type	 C2P-Operational Entity
ID	SPMS-4049
Children	<ul style="list-style-type: none"> <li>•  SPMS-4052 - Infrastructure Monitoring Manager (IM)</li> <li>•  SPMS-4055 - Commercial Services (IM)</li> <li>•  SPMS-4058 - Connections Operator (IM)</li> <li>•  SPMS-4060 - Control-command and signalling (Operational Traffic Management) (IM)</li> <li>•  SPMS-4067 - Infrastructure Safety Management (IM)</li> <li>•  SPMS-4068 - Traffic Management (IM)</li> <li>•  SPMS-4081 - Infrastructure Assets Manager (IM)</li> <li>•  SPMS-4086 - Infrastructure Designer (IM)</li> <li>•  SPMS-4090 - Capacity Manager (IM)</li> <li>•  SPMS-4091 - Station manager and other facilities (IM)</li> </ul>

The Operational Entity "Infrastructure Manager (IM)" is composed of 6 operational entities which are:

- Traffic Management (IM)
- Capacity Manager (IM)
- Infrastructure Safety Management (IM)
- Infrastructure Monitoring Manager (IM)
- Control-command and signalling (Operational Traffic Management) (IM)
- Infrastructure Assets Manager (IM)

### Traffic Management (IM)

**OPERATE TRAIN:** Traffic management shall ensure the safe, efficient and punctual operation of the railway, including effective recovery from service disruption.

The infrastructure manager shall determine procedures and means for:

- The real time management of trains,
- Operational measures to maintain the highest possible performance of the infrastructure in case of delays or incidents, whether actual or anticipated, and
- The provision of information to the railway undertaking(s).







Any additional processes required by the railway undertaking and which affect the interface with the infrastructure manager(s) may be introduced after being agreed with the infrastructure manager.'

COMMISSION IMPLEMENTING REGULATION (EU) 2019/773 of 16 May 2019 on the technical specification for interoperability relating to the operation and traffic management subsystem of the rail system within the European Union and repealing Decision 2012/757/EU Annex – Article 4.2.3.4.1.

This definition could be completed by the following: Operation and Traffic Management: The procedures and related equipment permitting coherent operation of the various structural subsystems, during both normal and degraded operation, including in particular train composition and train driving, traffic planning and management.

DIRECTIVE (EU) 2016/797 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on the interoperability of the rail system within the European Union (recast) – Annex II - Article 2

**MANAGE ENERGY:** 'Infrastructure Manager' means any body or firm responsible in particular for establishing, managing and maintaining railway infrastructure, including traffic management and control-command and signalling; the functions of the infrastructure manager on a network or part of a network may be allocated to different bodies or firms (DIRECTIVE 2012/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 November 2012 establishing a single European railway area (recast) - Article 3)

Type	 C2P-Operational Entity
ID	SPMS-4068
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3947 - Monitor traffic (for another IM)</li> <li>•  SPMS-3990 - Consume electrical energy</li> <li>•  SPMS-4031 - Manage timetable deviation (including connections management)</li> <li>•  SPMS-4033 - Issue traffic information</li> <li>•  SPMS-4043 - Monitor traffic</li> </ul>

The Operational Entity "Traffic Management (IM)" is composed of 3 operational activities which are:

- Monitor traffic
- Handle timetable deviation
- Issue traffic information

### Issue traffic information

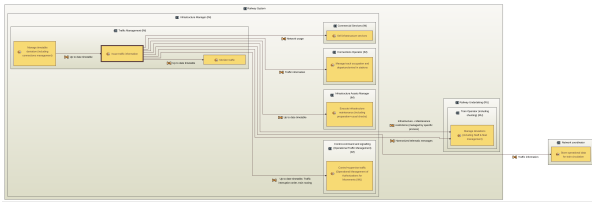
Record & Share the traffic management information & decisions.

This activity is realized by the following function defined through the functional architecture of SPT3:

- Process events and decisions
- Publish real-time operational plan





Type	 C2P-Operational Activity
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Context Diagram	 <p>Figure 5 Context Diagram of Issue traffic information</p>
ID	SPMS-4033

### Capacity Manager (IM)



Entity in charge of the timetable design.

Type	 C2P-Operational Entity
ID	SPMS-4090
Allocated	<ul style="list-style-type: none"> <li> SPMS-3965 - Plan timetable</li> <li> SPMS-3972 - Plan long term capacity</li> <li> SPMS-4020 - Allocate capacity</li> </ul>

The Operational Entity "Capacity Manager (IM)" is composed of 2 operational activities which are:

- Allocate capacity
- Plan timetable

### Allocate capacity

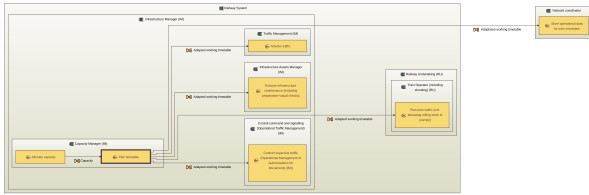
Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 6 Context Diagram of Allocate capacity</p>
ID	SPMS-4020

### Plan timetable

Directive 2012/34/EU: Infrastructure managers shall manage rail infrastructure capacity through a planning and allocation process comprising three phases: (a) strategic capacity planning; (b) scheduling and allocation of infrastructure capacity; (c) adaptation and rescheduling of allocated capacity. This activity is realized by the following function defined in the functional architecture of SPT3 :

- Export Capacity Plan
- Capture Capacity Plan
- Build Operational Plan

Type	 C2P-Operational Activity
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Context Diagram	 <p>Figure 7 Context Diagram of Plan timetable</p>
ID	SPMS-3965

An exchange with Task 3 is pending and will take place next year 2026. For this reasons this upgrade will be done later after interacting with TASK3.

### Infrastructure Safety Management (IM)

Entity responsible for the application of the Safety Directive 2016/798 , in accordance to the safety processes defined in the Safety Management System.


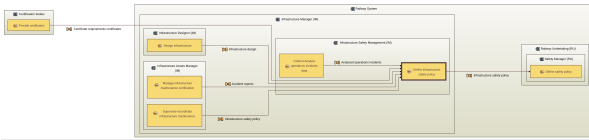
This entity is intervening in off-line to analyze operational incidents and redefines procedures in order to prevent that the same operational incidents are repeated.

Type	 C2P-Operational Entity
ID	SPMS-4067
Allocated	<ul style="list-style-type: none"> <li> SPMS-3961 - Raise operations incidents</li> <li> SPMS-4012 - Collect+Analyze operations incidents data</li> <li> SPMS-4028 - Define infrastructure safety policy</li> </ul>

The Operational Entity "Infrastructure Safety Management (IM)" is composed of 1 operational activity which is:







- Define infrastructure safety policy

### Define infrastructure safety policy

Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 8 Context Diagram of Define infrastructure safety policy</p>
ID	SPMS-4028

### Infrastructure Monitoring Manager (IM)

Type	 C2P-Operational Entity
ID	SPMS-4052


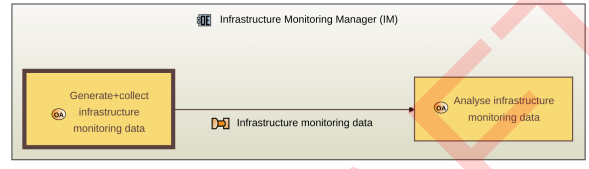
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3951 - Analyse infrastructure monitoring data</li> <li>•  SPMS-3969 - Issue Infra Asset condition info</li> <li>•  SPMS-3985 - Generate+collect infrastructure monitoring data</li> <li>•  SPMS-4036 - Monitor track infrastructure</li> <li>•  SPMS-4041 - Monitor Energy infrastructure</li> <li>•  SPMS-4042 - Monitor Civil infrastructure</li> </ul>
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The Infrastructure Monitoring Manager (IM) is a figure that can be represented by different offices and at different levels more or less centralized depending in which country we are.


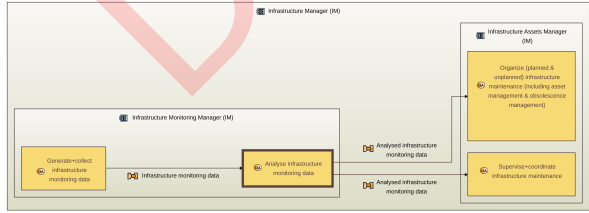
The Operational Entity "Infrastructure Monitoring Manager (IM)" is composed of 2 operational activities which are:

- Generate+collect infrastructure monitoring data
- Analyse infrastructure monitoring data

### Generate+collect infrastructure monitoring data






Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 9 Context Diagram of Generate+collect infrastructure monitoring data</p>
ID	SPMS-3985

### Analyse infrastructure monitoring data

Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 10 Context Diagram of Analyse infrastructure monitoring data</p>
ID	SPMS-3951

### Control-command and signalling (Operational Traffic Management) (IM)


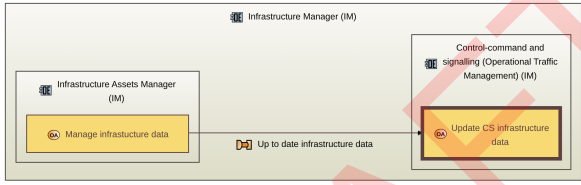
Issues the movement permission for a given train, provided conditions controlled by the IM are fulfilled (e.g., interlocking, flank protection, train spacing...). This can be done by several ways depending on implemented technology (line side signalling, cab signals, written orders, ETCS movement authority...). It is composed of the fixed installations (as per CCS definition : All the equipment necessary to ensure safety and to command and control movements of trains authorized to travel on the network), and the signaller who operates them.

Type	 C2P-Operational Entity
ID	SPMS-4060
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3949 - Update CS infrastructure data</li> <li>•  SPMS-4019 - Control+Supervise field staff</li> <li>•  SPMS-4023 - Control+Supervise trackside assets</li> <li>•  SPMS-4040 - Control+supervise traffic (Operational Management of Authorizations for Movements (IM))</li> </ul>

The Operational Entity "Control-command and signalling (Operational Traffic Management) (IM)" is composed of 2 operational activities which are:


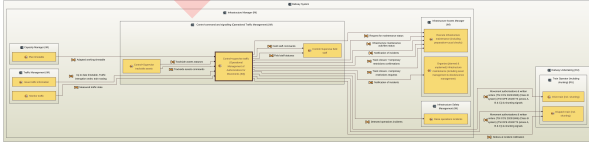
- Update CS infrastructure data
- Control+supervise traffic (Operational traffic management (incl. shunting))

### Update CS infrastructure data

Type	 C2P-Operational Activity
Context Diagram	 <p>The diagram shows the 'Infrastructure Manager (IM)' as a container. Inside, there are two sub-diagrams: 'Infrastructure Assets Manager (IM)' and 'Control-command and signalling (Operational Traffic Management) (IM)'. The 'Infrastructure Assets Manager (IM)' contains a task 'Manage infrastructure data'. The 'Control-command and signalling (Operational Traffic Management) (IM)' contains a task 'Update CS infrastructure data'. A data flow labeled 'Up to date infrastructure data' connects the 'Manage infrastructure data' task to the 'Update CS infrastructure data' task.</p> <p><i>Figure 11 Context Diagram of Update CS infrastructure data</i></p>
ID	SPMS-3949

### Control+supervise traffic (Operational Management of Authorizations for Movements (IM))

Issues movement permission, controls switches and signals

Type	 C2P-Operational Activity
Context Diagram	 <p>The diagram shows a complex system architecture with multiple components and their interactions. It includes various functional blocks and data flows, representing the 'Control+supervise traffic (Operational Management of Authorizations for Movements (IM))'.</p> <p><i>Figure 12 Context Diagram of Control+supervise traffic (Operational Management of Authorizations for Movements (IM))</i></p>
ID	SPMS-4040

An exchange with Task 2 is pending and will take place next year 2026. For this reasons this upgrade will be done later after interacting with TASK2.

### Infrastructure Assets Manager (IM)


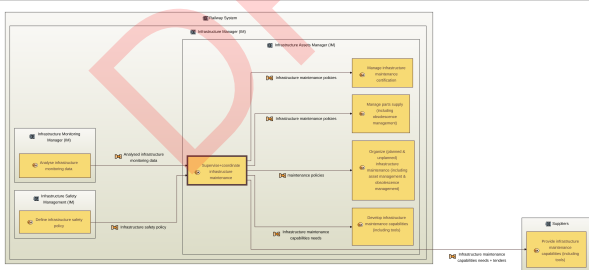
Type	 C2P-Operational Entity
ID	SPMS-4081

Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3956 - Manage infrastructure maintenance certification</li> <li>•  SPMS-3958 - Manage infrastructure data</li> <li>•  SPMS-3973 - Plan works</li> <li>•  SPMS-3984 - Request capacity for infrastructure maintenance</li> <li>•  SPMS-3986 - Organize (planned &amp; unplanned) infrastructure maintenance (including asset management &amp; obsolescence management)</li> <li>•  SPMS-3987 - Develop infrastructure maintenance capabilities (including tools)</li> <li>•  SPMS-3988 - Execute infrastructure maintenance (including preparation+usual checks)</li> <li>•  SPMS-3993 - Manage parts supply (including obsolescence management)</li> <li>•  SPMS-4005 - Request an infrastructure certification</li> <li>•  SPMS-4035 - Supervise+coordinate infrastructure maintenance</li> </ul>
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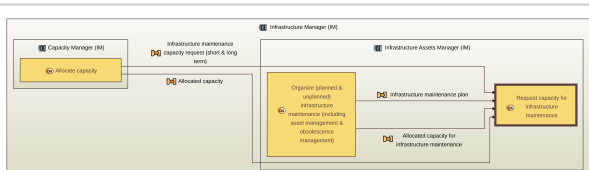
The Operational Entity "Infrastructure Assets Manager (IM)" is composed of 8 operational activities which are:

- Supervise+coordinate infrastructure maintenance
- Request capacity for infrastructure maintenance
- Organize (planned & unplanned) infrastructure maintenance
- Manage parts supply
- Manage infrastructure maintenance certification
- Manage infrastructure data
- Execute infrastructure maintenance
- Develop infrastructure maintenance capabilities

### Supervise+coordinate infrastructure maintenance

Type	 C2P-Operational Activity
Context Diagram	 <p>The diagram shows the 'Infrastructure Assets Manager (IM)' as the central system. It is connected to several external systems: 'Infrastructure Maintenance Plan (IM)' for planning, 'Infrastructure Maintenance Data (IM)' for data management, 'Infrastructure Maintenance Certification (IM)' for certification, 'Infrastructure Maintenance Parts Supply (IM)' for parts supply, and 'Infrastructure Maintenance Tools (IM)' for tool development. The IM system itself contains several internal components: 'Infrastructure Maintenance Plan (IM)', 'Infrastructure Maintenance Data (IM)', 'Infrastructure Maintenance Certification (IM)', 'Infrastructure Maintenance Parts Supply (IM)', 'Infrastructure Maintenance Tools (IM)', 'Infrastructure Maintenance Assets Management (IM)', 'Infrastructure Maintenance Obsolescence Management (IM)', and 'Infrastructure Maintenance Capacity Management (IM)'.</p> <p>Figure 13 Context Diagram of Supervise+coordinate infrastructure maintenance</p>
ID	SPMS-4035

### Request capacity for infrastructure maintenance

Type	 C2P-Operational Activity
Context Diagram	 <p>The diagram shows the 'Infrastructure Assets Manager (IM)' as the central system. It is connected to several external systems: 'Capacity Manager (IM)' for capacity management, 'Infrastructure Maintenance Plan (IM)' for planning, 'Infrastructure Maintenance Data (IM)' for data management, 'Infrastructure Maintenance Certification (IM)' for certification, 'Infrastructure Maintenance Parts Supply (IM)' for parts supply, and 'Infrastructure Maintenance Tools (IM)' for tool development. The IM system itself contains several internal components: 'Capacity Manager (IM)', 'Infrastructure Maintenance Plan (IM)', 'Infrastructure Maintenance Data (IM)', 'Infrastructure Maintenance Certification (IM)', 'Infrastructure Maintenance Parts Supply (IM)', 'Infrastructure Maintenance Tools (IM)', 'Infrastructure Maintenance Assets Management (IM)', 'Infrastructure Maintenance Obsolescence Management (IM)', and 'Infrastructure Maintenance Capacity Management (IM)'.</p> <p>Figure 14 Context Diagram of Request capacity for infrastructure maintenance</p>

ID	SPMS-3984
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**Organize (planned & unplanned) infrastructure maintenance (including asset management & obsolescence management)**

[illegible]

**Manage parts supply (including obsolescence management)**

[illegible]



## Manage infrastructure data

Type	C2P-Operational Activity
Context Diagram	 <p>The diagram shows a central process box labeled 'Manage infrastructure data' with a yellow background. It is connected to several external systems: 'Infrastructure Manager (IM)' on the left, 'Infrastructure Manager (IM)' on the right, 'Infrastructure Manager (IM)' on the top left, 'Infrastructure Manager (IM)' on the top right, and 'Infrastructure Manager (IM)' on the bottom right. The connections are labeled with data flows: 'Infrastructure data', 'Infrastructure data', 'Infrastructure data', 'Infrastructure data', and 'Infrastructure data'.</p> <p><i>Figure 17 Context Diagram of Manage infrastructure data</i></p>
ID	SPMS-3958


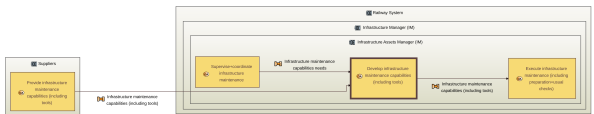
## Manage infrastructure maintenance certification

Type	C2P-Operational Activity
Context Diagram	<p>Figure 18 Context Diagram of Manage infrastructure maintenance certification</p>
ID	SPMS-3956

**Execute infrastructure maintenance (including preparation+usual checks)**

Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 19 Context Diagram of Execute infrastructure maintenance (including preparation+usual checks)</p>
ID	SPMS-3988

### Develop infrastructure maintenance capabilities (including tools)










Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 20 Context Diagram of Develop infrastructure maintenance capabilities (including tools)</p>
ID	SPMS-3987

### 3.1.2.1.2 Railway Undertaking (RU)

#### Railway Undertaking (RU)

'Railway Undertaking' means any public or private undertaking licensed according to this Directive, the principal business of which is to provide services for the transport of goods and/or passengers by rail with a requirement that the undertaking ensure traction; this also includes undertakings which provide traction only;

DIRECTIVE 2012/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 November 2012 establishing a single European railway area (recast) – Article 3 definition 1

Type	 C2P-Operational Entity
ID	SPMS-4063
Children	<ul style="list-style-type: none"> <li> SPMS-4050 - Commercial Services (RU)</li> <li> SPMS-4078 - Safety Manager (RU)</li> <li> SPMS-4080 - Fleet Manager (RU)</li> <li> SPMS-4084 - Train Operator (including shunting) (RU)</li> </ul>
Allocated	<ul style="list-style-type: none"> <li> SPMS-3978 - ME_Generate electrical energy from regenerative breaking</li> <li> SPMS-3983 - Measure electrical energy consumption</li> <li> SPMS-4037 - Consume+transform+store electrical energy</li> <li> SPMS-7896 - Consume non electric energy</li> </ul>

The Operational Entity "Railway Undertaking (RU)" is composed of 1 operational activity which is:


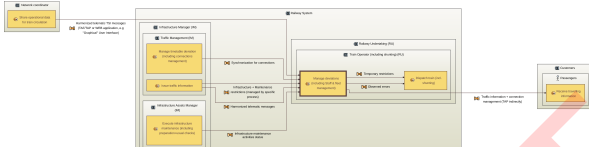
- Handle deviations (including Staff & fleet management)

### Manage deviations (including Staff & fleet management)

Directive 2012/34/EU:

1. Traffic management during normal operating conditions involving the management of incidents resulting in limited deviations from the working timetable ;
2. Disruption management to address significant disturbances to network operations requiring concerted action;
3. Traffic management during crisis situations.

These three aspects are mainly done by the IM-TMS.

Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 21 Context Diagram of Manage deviations (including Staff &amp; fleet management)</p>
ID	SPMS-4030


### 3.1.2.1.3 Suppliers

#### Suppliers









**ROLLING STOCK:** The concerned actors are the contracting entities as defined in Article 5 of ECM Regulation including their suppliers and service providers, or the certification bodies as defined in Article 6 of ECM Regulation. (Guide for the application of Article 14 of Directive (EU) 2016/798 and Commission Implementing Regulation (EU) No 2019/779 on a system of certification of entities in charge of maintenance for vehicles, § 1.1. Scope (Note 2))

#### INFRA:

- EN 14969:2006 (Railway applications - Track - Qualification system for railway trackwork contractors): This European Standard specifies the definitions, procedures, criteria and their assessment as well as the respective documentation related to a qualification system of trackwork contractors, which relates to the Directive 2004/17/EC). This qualification system identifies trackwork contractors that can be invited for tendering trackwork contracts. Evaluation of the contractors applying for parts of the contract, which are not trackwork, is not covered by this standard. This European Standard may also be used for a qualification system of trackwork contractors applying for contracts with a value below the minimum limit as defined in the Directive 2004/17/EC.
- ISO 22163:2023 (Quality management in the railway sector)

Type	 C2P-Operational Entity
ID	SPMS-4074


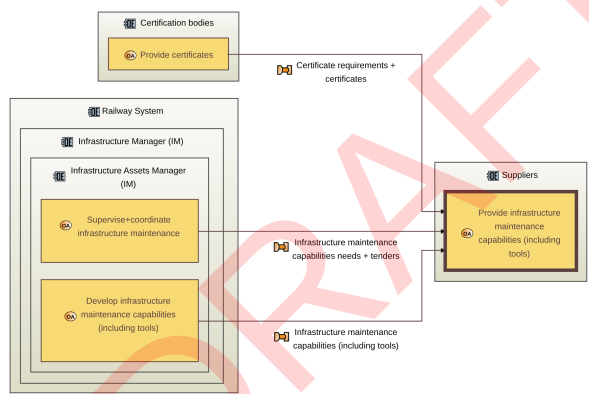


Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3950 - Provide infrastructure maintenance capabilities (including tools)</li> <li>•  SPMS-3954 - Provide infrastructure maintenance services</li> <li>•  SPMS-3989 - Provide certified interoperable system / constituent</li> <li>•  SPMS-3994 - Provide infrastructure maintenance parts</li> <li>•  SPMS-3998 - Provide rolling stock maintenance services</li> <li>•  SPMS-3999 - Provide rolling stock maintenance capabilities (tools, software, infrastructures etc.)</li> <li>•  SPMS-4000 - Sell rolling stock assets</li> <li>•  SPMS-4009 - Provide rolling stock maintenance parts</li> </ul>
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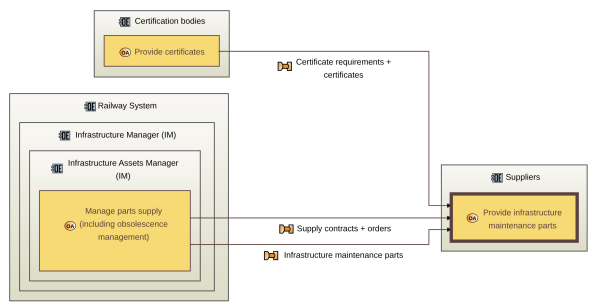
The Operational Entity "Suppliers" is composed of 3 operational activities which are:

- Provide infrastructure maintenance capabilities
- Provide infrastructure maintenance services
- Provide infrastructure maintenance parts

### Provide infrastructure maintenance capabilities (including tools)

Type	 C2P-Operational Activity
Context Diagram	 <p><i>Figure 22 Context Diagram of Provide infrastructure maintenance capabilities (including tools)</i></p>
ID	SPMS-3950

### Provide infrastructure maintenance parts

Type	 C2P-Operational Activity
Context Diagram	 <p><i>Figure 23 Context Diagram of Provide infrastructure maintenance parts</i></p>
ID	SPMS-3994






### 3.1.2.1.4 Certification bodies

#### Certification bodies

**ROLLING STOCK:** As per Directive (EU) 2019/779 - article 2 - body responsible for the certification of entities in charge of maintenance or for certification of the entity or organisation that fulfil maintenance functions referred to in points (b), (c) or (d) of article 14 (3) of Directive (EU) 2016/798, or parts of those functions.

#### INFRA:

- EN 14969:2006 (Railway applications - Track - Qualification system for railway trackwork contractors): This European Standard specifies the definitions, procedures, criteria and their assessment as well as the respective documentation related to a qualification system of trackwork contractors, which relates to the Directive 2004/17/EC). This qualification system identifies trackwork contractors that can be invited for tendering trackwork contracts. Evaluation of the contractors applying for parts of the contract, which are not trackwork, is not covered by this standard. This European Standard may also be used for a qualification system of trackwork contractors applying for contracts with a value below the minimum limit as defined in the Directive 2004/17/EC.
- ISO 22163:2023 (Quality management in the railway sector)

Type	 C2P-Operational Entity
ID	SPMS-4061
Children	<ul style="list-style-type: none"> <li>•  SPMS-4070 - Notified Bodies (NoBo)</li> <li>•  SPMS-4071 - Designated Bodies (DeBo)</li> <li>•  SPMS-4075 - Assessment Bodies (AsBo)</li> </ul>
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-4015 - Provide certificates</li> </ul>

The Operational Entity "Certification bodies" is composed of 1 operational activity which is:

- Provide certificates

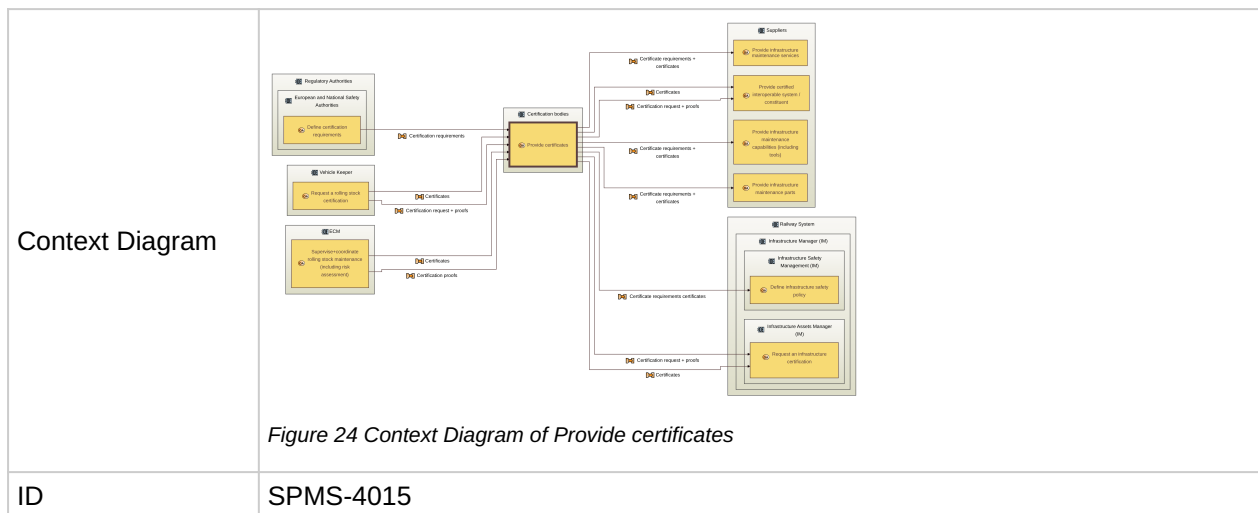
#### Provide certificates

**ROLLING STOCK:** The certification system is defined in article 3 of Directive (EU) 2016/798 and Commission Implementing Regulation (EU) No 2019/779 on a system of certification of entities in charge of maintenance for vehicles.

#### INFRA:

- EN 14969:2006 (Railway applications - Track - Qualification system for railway trackwork contractors): This European Standard specifies the definitions, procedures, criteria and their assessment as well as the respective documentation related to a qualification system of trackwork contractors, which relates to the Directive 2004/17/EC). This qualification system identifies trackwork contractors that can be invited for tendering trackwork contracts. Evaluation of the contractors applying for parts of the contract, which are not trackwork, is not covered by this standard. This European Standard may also be used for a qualification system of trackwork contractors applying for contracts with a value below the minimum limit as defined in the Directive 2004/17/EC.
- ISO 22163:2023 (Quality management in the railway sector)

Type	 C2P-Operational Activity
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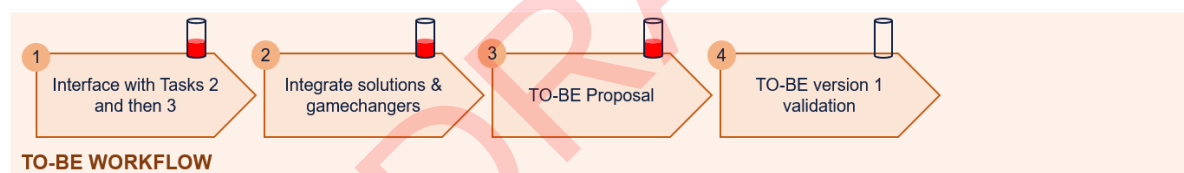


### 3.2 TO-BE

The TO-BE architecture constitutes a "target architecture" and therefore is formalized by recommendations on the issues to tackle to improve the performance of the railway sector. There is need to handle the migration from AS-IS to TO-BE, but this topic is not described in this report.

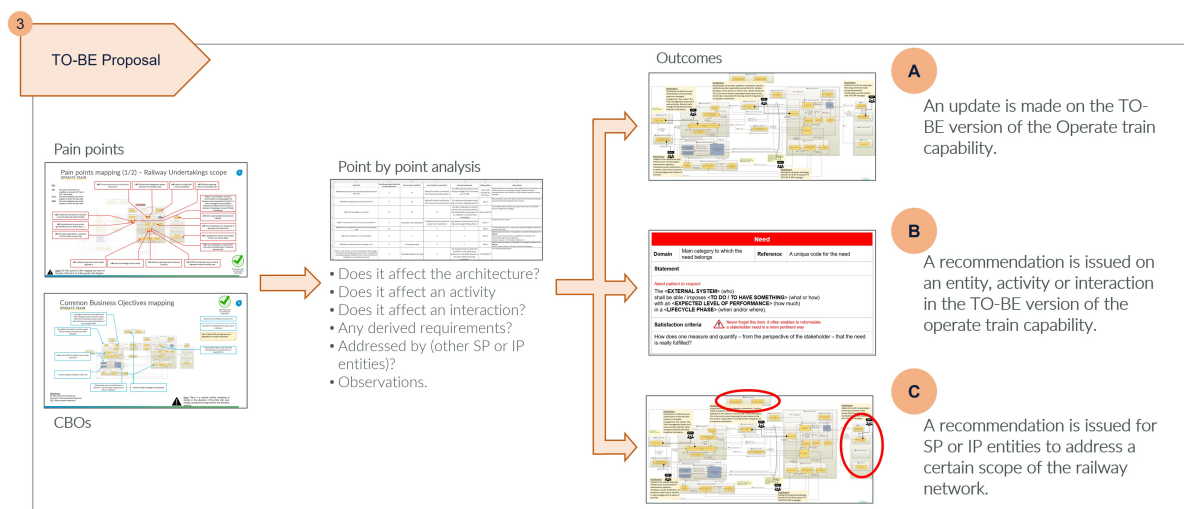
#### 3.2.1 Process followed

The activities pursued for the TO-BE architecture:



*Figure 25 : TO-BE Workflow*

Moreover, the results of the AS-IS were used as inputs for the work on the TO-BE following the process below:



*Figure 26 : TO-BE outcomes*

The important information from the schema above is the fact that the outcomes of the TO-BE architecture analysis can be of three different formats:

- A. **An update in the diagram:** Some proposed modifications can be seen directly on the capability view and therefore appear as an update from the AS-IS architecture to the TO-BE.
- B. **A recommendation issued on a modelling artefact:** Many modifications may be significant but do not involve a tangible modification of the view since the impact is in the level of performance associated to the Entity, Activity or interaction. In this case, the modification (or suggestion) is described in the form of a recommendation following a structured template.
- C. **An Open point:** A possible outcome is also to identify areas of the diagram that are highlighted in the analysis as being a space for improvement but which isn't addressed in the current scope of work.

### 3.2.2 Recommendations from SC2.4

Recommendations are issued on certain aspects of the TO-BE architecture, the recommendations are organized according to the aspect they contribute to. These recommendations are written using the following template:







- Task 1 recommends that *<Operational Entity/ Activity or interaction>* should *<Level of performance>* to contribute to *<associated CBO>*.

#### 3.2.2.1 Recommendations issued from the pain point list

#### 3.2.2.2 Recommendations issued from the CBO list

**Common Business Objective statement:** Guarantee the compatibility of subsystems and components e.g. with the aid of standardized interfaces + Harmonizing this system architecture approach at European level, including standardization of interfaces, communications and data exchange + 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) + The system design shall anticipate the need for updates at minimum effort as a driver to optimize the economic migration path towards future solutions + Changeability and upgrade-ability shall ensure business continuity along the life-cycle with optimized investment scheme.

**Task 1 recommends that System Pillar works on standardization of function allocation and functional interfaces of subsystems in order to reduce costs and the interchangeability of equipment at European level.**

Status	 Open
Linked Work Items	is derived from :  SPT1RS-247 - standardized architecture(2) is derived from :  SPT1RS-221 - standardized architecture(1) is derived from :  SPT1RS-223 - SERA, single European railway area is derived from :  SPT1RS-189 - Changeability and upgradeability(2) is derived from :  SPT1RS-190 - Changeability and upgradeability(1)
ID	SPT1RS-989

**Common Business Objective statement:** Reducing the impact of disturbances - intelligent incident handling as well as process and functional assistance of works enabling a smooth operation

**Hypothesis:** Introduction of new A.I and IOT in the maintain and monitor process.

**Task 1 recommends that System Pillar and Innovation Pillar support introduction of new smart methods for preventing infrastructure incident.**

Status	🟢 Open
Linked Work Items	is derived from : 🚩 SPT1RS-155 - smart/assisted incidence handling
ID	SPT1RS-990

**Common Business Objective statement:** Improve efficiency of RUs to move the volume of passengers and freight according to end customer needs in real time.

**Hypothesis:** Computation of the algorithm for the volume of passenger and freight has to take into account the information coming from maintain and monitor infrastructure.

**Task 1 recommends for reaching this functionality to use also the information coming from maintain and monitor infrastructure (the capability provides the status of the infrastructure).**

Status	🟢 Open
Linked Work Items	is derived from : 🚩 SPT1RS-183 - RU transport efficiency/volume/timing
ID	SPT1RS-991

**Common Business Objective statement:** Rapid responses to capacity requests and planning changes + Every use should be planned, with different details during time, to sustain quality. All trains for passengers or every movement/use of track also on stabling tracks and movement to and on yards. The latter makes the plan complete. It shall also consider the use of infra for maintenance.

**Hypothesis:** Example of KPI has to be provided. The measurement of the time has to be provided for the maintenance of the specific issue (for instance : how long time the maintainer take to repair the switch).



**Task 1 recommends that Traffic Management System through Task 3 implement KPI measurement at European level in order to check the improvement of the System Pillar TASK3 and FP1 .**

Status	🟢 Open
Linked Work Items	is derived from : 🚩 SPT1RS-157 - rapid response to capacity request is derived from : 🚩 SPT1RS-152 - enhanced information for plan optimisation(2)
ID	SPT1RS-992

**Common Business Objective statement:** Rules and procedures and a code of behavior shall define, amongst others, an efficient decision and working methodology

**Hypothesis:** The predictive maintenance is a way to prevent a fault. The measurement could be the number of action to made for preventing a fault (i.e for a month).



**Task 1 recommends to implement where relevant predictive maintenance in order to avoid the issue of fault or abnormal event.**

Status	 Open
Linked Work Items	is derived from :  SPT1RS-241 - efficient decision and working methodolog
ID	SPT1RS-996

**Common Business Objective statement:** Provides valuable information to refine the procedures for incidents.

**Hypothesis:** Transfer the incident indication to the PIS (passenger information system).

**Task1 recommends to use the incident indication for providing the right information to the passenger.**

Status	 Open
Linked Work Items	is derived from :  SPT1RS-162 - analytical information for passenger flow/ incidents(2)
ID	SPT1RS-997

DRAFT

## 4 Upgrade and Renew Infrastructure Network Capabilities Architecture Description

### 4.1 AS-IS

#### 4.1.1 Process followed

The activities pursued on the AS-IS architecture were the following:

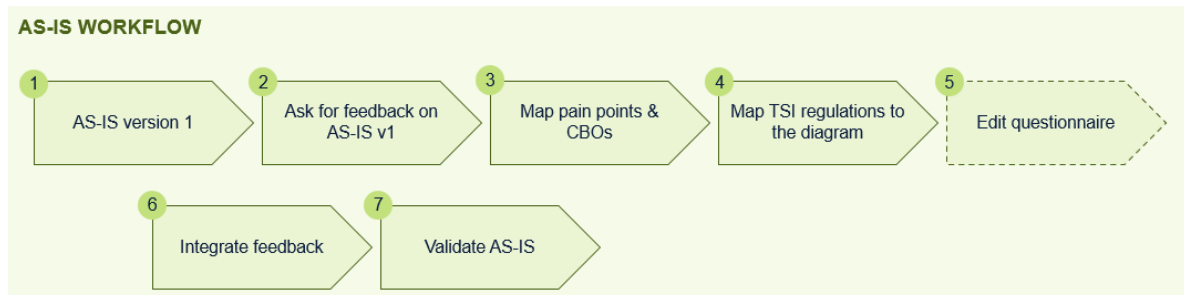





Figure 27 : AS-IS workflow

where:

- AS-IS Version 1: refers to the deliverable from last year, SC2.1:  240307 SP-LOT2-TASK1-Deliverables-SC2\_1-v1-1
- Ask for feedback on AS-IS v1: Last year's deliverable was sent out to all contributors of System Pillar in order to collect feedback.
- Map Pain Points & CBOs: From previous years and programs, a list of pain points and Common Business Objectives (CBOs) have been compiled, this activity consisted in locating them on the Upgrade and Renew Infrastructure Network Capabilities capability view.
  - Pain points: are described in the document: *SPT1RailwaySystem/Pain Points/Pain points list : 724240* . The aim of the mapping was to identify current difficulties observed with the 'Upgrade and Renew Infrastructure Network Capabilities' capability and identify the associated activities. A visual representation of the mapping is included in the annexes of this report.
  - Common Business Objectives: are described in the document:  Common Business Objectives . The aim of the mapping is to identify areas of potential improvement of the architecture. A visual representation of the mapping is included in the annexes of this report.
- Map TSI regulations to the diagram: consisted in identifying the field of application of the various TSIs, described in this document:  TSIs & other regulations . The objective for this activity is to identify areas of the diagram that are already constrained or optimised. A visual representation of this mapping is included in the annexes of this report.
- Edit questionnaire: consisted in listing questions relative to the Upgrade and Renew Infrastructure Network Capabilities capability that were either difficult to address or need to be assessed by a broader audience. Therefore, the questionnaire could be sent out to a wider audience and was a different means of collecting feedback. This activity was never finished and sent outside of Task 1, however a draft version was compiled and is included in the annexes of this document.

#### 4.1.2 Functional Description

On the following page is a view of the validated AS-IS capability view for Upgrade and Renew Infrastructure Network Capabilities:

The diagram illustrates the transition from the current state (AS-IS) to the target state (TO-BE) for the European railway system. It shows the roles of various stakeholders and the flow of information and processes.

**AS-IS (Current State):**

- Regulatory Authorities:** European regulation authorities and European and National Safety Authorities. They define certification requirements and authorize upgrades or renewals of infrastructure or rolling stock.
- Suppliers:** Provide certified interoperable systems or subsystems.
- Infrastructure Manager (IM):** Manages infrastructure data, requests new infrastructure certification, and manages interoperability maintenance.
- Infrastructure Designer (ID):** Designs infrastructure and manages infrastructure requirements.
- Infrastructure Assets Manager (IAM):** Requests new infrastructure configuration and manages infrastructure data.
- Infrastructure Safety Manager (ISM):** Defines infrastructure safety policy and manages infrastructure safety requirements.
- Vehicle Keeper:** Requests a rolling stock certification and manages rolling stock compatibility.
- Railway Undertaking (RU):** Manages rolling stock compatibility and defines safety policy.

**TO-BE (Target State):**

- Regulatory Authorities:** Define certification requirements and authorize upgrades or renewals of infrastructure or rolling stock.
- Suppliers:** Provide certified interoperable systems or subsystems.
- Infrastructure Manager (IM):** Manages infrastructure data, requests new infrastructure certification, and manages interoperability maintenance.
- Infrastructure Designer (ID):** Designs infrastructure and manages infrastructure requirements.
- Infrastructure Assets Manager (IAM):** Requests new infrastructure configuration and manages infrastructure data.
- Infrastructure Safety Manager (ISM):** Defines infrastructure safety policy and manages infrastructure safety requirements.
- Vehicle Keeper:** Requests a rolling stock certification and manages rolling stock compatibility.
- Railway Undertaking (RU):** Manages rolling stock compatibility and defines safety policy.

**Key Challenges and Solutions:**

- AS-IS pain point:** 1) Pre-authorization process is going to be 2) lack of authority in process installation.
- TO-BE possible solutions:** 1) define a "border station" where the hardware is considered 2) include the transition between two different networks in the interoperability testing.
- AS-IS pain point:** when upgrading infrastructure, involved infrastructure managers and safety authorities must participate.
- AS-IS pain point:** we are not able to provide continuous interoperability across networks borders (lying hardware, due to different and sometimes incompatible) design rules from one state to another.
- AS-IS pain point:** Test campaigns for vehicle in authorization (e.g. ESC test).
- AS-IS pain point:** balance between CCS on board and CCS on infrastructure.

The diagram shows the flow of information and processes between these stakeholders, with arrows indicating the direction of flow. The transition from AS-IS to TO-BE is driven by the need for interoperability and safety.

[SPMS-3887]

Upgrade or **renew** infrastructure network capabilities (single operational capability set)

OC

Infrastructure Manager (IM)

Railway Undertaking (RU)

Vehicle Keeper

Certification bodies

Regulatory Authorities

Suppliers

[SPMS-3892 ]

- Infrastructure Manager (IM)
- Railway Undertaking (RU)
- Vehicle Keeper
- Certification bodies
- Regulatory Authorities



- Suppliers








#### 4.1.2.1.1 Infrastructure Manager (IM)

##### SPMS-4049 - Infrastructure Manager (IM)

The Operational Entity "Infrastructure Manager (IM)" is composed of 4 operational entities which are:

- Infrastructure Designer (IM)
- Capacity Manager (IM)
- Infrastructure Safety Management (IM)
- Infrastructure Assets Manager (IM)


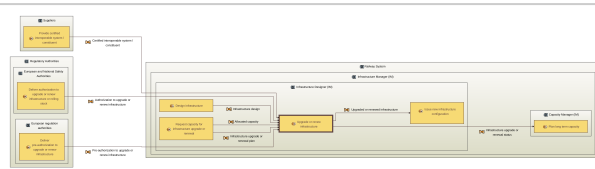
##### Infrastructure Designer (IM)

Type	 C2P-Operational Entity
ID	SPMS-4086
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3959 - Provide infrastructure data</li> <li>•  SPMS-3963 - Design infrastructure</li> <li>•  SPMS-3970 - Issue new infrastructure configuration</li> <li>•  SPMS-3971 - Manage new capacity request</li> <li>•  SPMS-4026 - Upgrade or renew infrastructure</li> <li>•  SPMS-4027 - Request capacity for infrastructure upgrade or renewal</li> </ul>

The Operational Entity "Safety Manager (RU)" is composed of 6 operational activities which are:

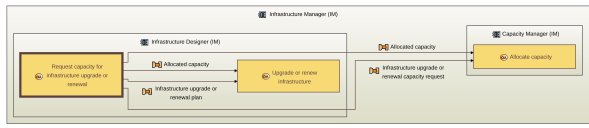
- Upgrade or renew infrastructure
- Request capacity for infrastructure upgrade or renewal
- Provide infrastructure data
- Manage new capacity request
- Issue new infrastructure configuration
- Design infrastructure

##### Upgrade or renew infrastructure



Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 30 Context Diagram of Upgrade or renew infrastructure</p>
ID	SPMS-4026

##### Request capacity for infrastructure upgrade or renewal


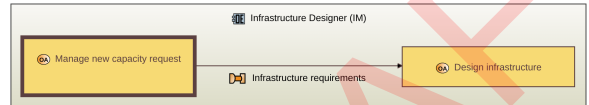
Type	 C2P-Operational Activity
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Context Diagram	 <p>Figure 31 Context Diagram of Request capacity for infrastructure upgrade or renewal</p>
ID	SPMS-4027



### Provide infrastructure data

Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 32 Context Diagram of Provide infrastructure data</p>
ID	SPMS-3959

### Manage new capacity request



Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 33 Context Diagram of Manage new capacity request</p>
ID	SPMS-3971

### Issue new infrastructure configuration

Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 34 Context Diagram of Issue new infrastructure configuration</p>
ID	SPMS-3970

### Design infrastructure

Includes the design of infrastructure maintenance and infrastructure power supply strategy


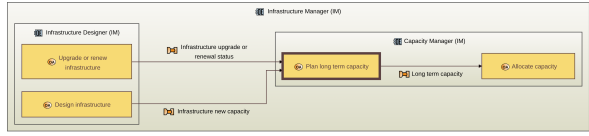
Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 35 Context Diagram of Design infrastructure</p>
ID	SPMS-3963

## SPMS-4090 - Capacity Manager (IM)

The Operational Entity "Safety Manager (RU)" is composed of 2 operational activities which are:

- Plan long term capacity
- Allocate capacity

### Plan long term capacity

Type	 C2P-Operational Activity
Context Diagram	 <p>The diagram shows the 'Plan long term capacity' activity within the 'Capacity Manager (IM)' boundary. It is connected to 'Infrastructure Designer (IM)' via 'Infrastructure upgrade or renewal status' and 'Infrastructure new capacity' interfaces. It also connects to 'Allocate capacity' within the same boundary via a 'Long term capacity' interface.</p> <p>Figure 36 Context Diagram of Plan long term capacity</p>
ID	SPMS-3972

## SPMS-4020 - Allocate capacity

## SPMS-4067 - Infrastructure Safety Management (IM)

The Operational Entity "Safety Manager (RU)" is composed of 1 operational activity which is:

- Define infrastructure safety policy

## SPMS-4028 - Define infrastructure safety policy


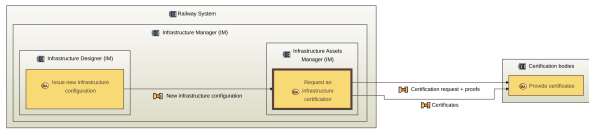
## SPMS-4081 - Infrastructure Assets Manager (IM)

The Operational Entity "Safety Manager (RU)" is composed of 3 operational activities which are:

- Supervise+coordinate infrastructure maintenance
- Request an infrastructure certification
- Manage infrastructure data

## SPMS-4035 - Supervise+coordinate infrastructure maintenance

### Request an infrastructure certification

Type	 C2P-Operational Activity
Context Diagram	 <p>The diagram shows the 'Request an infrastructure certification' activity within the 'Infrastructure Assets Manager (IM)' boundary. It is connected to 'Infrastructure Designer (IM)' via a 'New infrastructure configuration' interface. It also connects to 'Certification bodies' via a 'Certification request + proofs' interface, which then provides 'Certification' back to the 'Infrastructure Assets Manager (IM)'.</p> <p>Figure 37 Context Diagram of Request an infrastructure certification</p>
ID	SPMS-4005

## SPMS-3958 - Manage infrastructure data

#### 4.1.2.1.2 Railway Undertaking (RU)

##### SPMS-4063 - Railway Undertaking (RU)





The Operational Entity "Railway Undertaking (RU)" is composed of 2 operational entities which are:

- Safety Manager (RU)
- Fleet Manager (RU)

##### **Safety Manager (RU)**

Entity responsible for the application of the safety directive 2016/798, in accordance to the safety processes defined in the Safety Management System.

Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety.



Type	 C2P-Operational Entity
ID	SPMS-4078
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3960 - Raise operations incidents</li> <li>•  SPMS-3962 - Define safety policy</li> <li>•  SPMS-4011 - Collect+Analyze operations incidents data</li> </ul>

The Operational Entity "Safety Manager (RU)" is composed of 1 operational activity which is:

- Define safety policy

##### **Define safety policy**



Safety policy is a basic element of the safety management system and is approved by the organizations / executive and communicated to all staff. (DIRECTIVE (EU) 2016/798 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on railway safety, art 9.3 (a))

Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 38 Context Diagram of Define safety policy</p>
ID	SPMS-3962

##### **Fleet Manager (RU)**

The Fleet Maintenance Management covers the removal from/return to operation before/after maintenance and the management of relations with ECM internal/external entities delivering maintenance. (Guide for the application of Article 14 of Directive (EU) 2016/798 and Commission Implementing Regulation (EU) No 2019/779 on a system of certification of entities in charge of maintenance for vehicles, §4.11. What is the ECM)

Type	 C2P-Operational Entity
ID	SPMS-4080


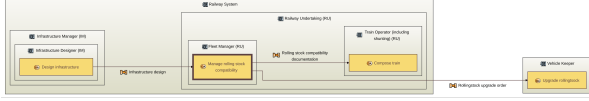
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3964 - Manage rolling stock compatibility</li> <li>•  SPMS-3996 - Define rolling stock usage profile &amp; performance targets</li> </ul>
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The Operational Entity "Fleet Manager (RU)" is composed of 1 operational activity which is:

- Manage rolling stock compatibility

### Manage rolling stock compatibility






Identify restrictions on rolling stock running conditions (speed, loading...), depending on the route. The Route Compatibility Check (RCC) is performed, and the resulting documentation for operational staff is compiled, prior to operations under the RU responsibility.

Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 39 Context Diagram of Manage rolling stock compatibility</p>
ID	SPMS-3964

#### 4.1.2.1.3 Vehicle Keeper

### Vehicle Keeper



As per Directive (EU) 2016/798 - article 3 - definition 19: natural or legal person that, being the owner of a vehicle or having the right to use it, exploits the vehicle as a means of transport and is registered as such in a vehicle register referred to in article 47 of Directive (EU) 2016/797.

Type	 C2P-Operational Entity
ID	SPMS-4076
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-4006 - Nominate ECM</li> <li>•  SPMS-4013 - Provide rolling stock assets</li> <li>•  SPMS-4024 - Request a rolling stock certification</li> <li>•  SPMS-4025 - Upgrade rollingstock</li> </ul>

The Operational Entity "Vehicle Keeper" is composed of 2 operational activities which are:


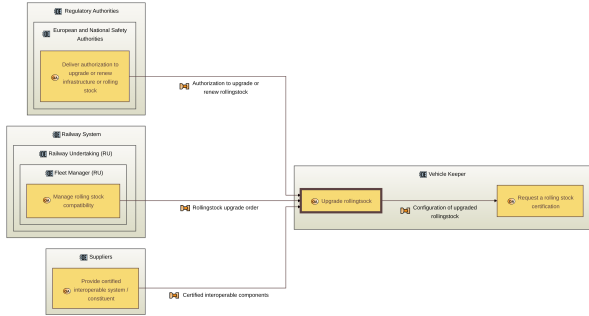
- Request a rolling stock certification
- Upgrade rolling stock

### Request a rolling stock certification

Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 40 Context Diagram of Request a rolling stock certification</p>

ID	SPMS-4024
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### Upgrade rollingsock

Type	 C2P-Operational Activity
Context Diagram	 <p>The diagram shows the context of the 'Upgrade rollingsock' activity. It is a central activity within a 'Vehicle Keeper' boundary. It receives inputs from three external entities: 'Regulatory Authorities' (via 'Authorization to upgrade or renew rollingsock'), 'Railway System' (via 'Rollingsock upgrade order'), and 'Suppliers' (via 'Certified interoperable components'). The 'Regulatory Authorities' entity contains sub-entities 'European and National Safety Authorities' and 'Order authorization to upgrade or renew rollingsock or rolling stock'. The 'Railway System' entity contains 'Railway Undertaking (RU)' and 'Fleet Manager (FM)', with 'Fleet Manager (FM)' containing 'Manage rolling stock consistency'. The 'Suppliers' entity contains 'Provide certified interoperable system / component'. The 'Vehicle Keeper' boundary contains 'Upgrade rollingsock', 'Configuration of upgraded rollingsock', and 'Request a rolling stock certification'.</p> <p>Figure 41 Context Diagram of Upgrade rollingsock</p>
ID	SPMS-4025

#### 4.1.2.1.4 Certification bodies

##### SPMS-4061 - Certification bodies

The Operational Entity "Certification bodies" is composed of 1 operational activity which is:

- Provide certificates

##### SPMS-4015 - Provide certificates

#### 4.1.2.1.5 Regulatory Authorities

##### Regulatory Authorities








Under European Union legislation, each Regulatory Body (RB) has the task to oversee the application of Community rules and act as an appeal body in case of disputes.

DIRECTIVE 2012/34/EU, Article 55: 'Each Member State shall establish a single national regulatory body for the railway sector. Without prejudice to paragraph 2, this body shall be a stand-alone authority which is, in organizational, functional, hierarchical and decision- making terms, legally distinct and independent from any other public or private entity. It shall also be independent in its organization, funding decisions, legal structure and decision- making from any infrastructure manager, charging body, allocation body or applicant. It shall furthermore be functionally independent from any competent authority involved in the award of a public service contract.' Thus it shall ensure that charges set by the Infrastructure Manager comply with Chapter II of 2001/14/EU and are nondiscriminatory. The RB oversees negotiations between applicants and the IM and intervenes when the requirements of 2001/14 are likely to be contravened. Applicants have the right to appeal to the RB if they believe that they have been unfairly treated, discriminated against or are in any other way aggrieved. In particular, they may appeal against decisions adopted by the IM (or where appropriate the Railway Undertaking) concerning: a) the network statement; b) criteria contained within it; c) the allocation process and its outcome; d) the charging scheme; e) level or structure of infrastructure fees which it is, or may be, required to pay; f) arrangements for access.

DIRECTIVE 2012/34/EU, Article 55, all TSI regulations and regulation 2016/798, safety directive, art 3 (8) Beyond this definition, from the operational and technical point of view, regulatory bodies may also be

responsible for checking compliance to:



- the european rules, stated in TSIs;
- the 'national rules': means all binding rules adopted in a Member State, irrespective of the body issuing them, which contain railway safety or technical requirements, other than those laid down by Union or international rules, and which are applicable within that Member State to railway undertakings, infrastructure managers or third parties (regulation 2016/798, safety directive, art 3 (8))

Type	 C2P-Operational Entity
ID	SPMS-4087
Children	<ul style="list-style-type: none"> <li>•  SPMS-4047 - European regulation authorities</li> <li>•  SPMS-4053 - Member states</li> <li>•  SPMS-4057 - European and National Safety Authorities</li> <li>•  SPMS-4088 - Public transport authorities</li> </ul>
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3976 - Define infrastructure operations regulations</li> <li>•  SPMS-3977 - Define rolling stock operations regulations</li> </ul>

The Operational Entity "Regulatory Authorities" is composed of 2 operational entities which are:

- European regulation authorities
- European and National Safety Authorities


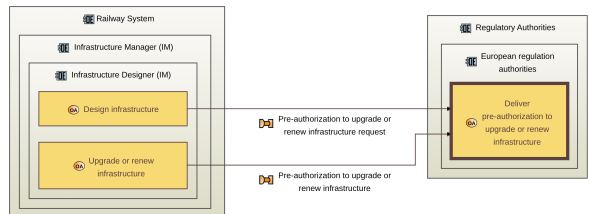
#### European regulation authorities

Type	 C2P-Operational Entity
ID	SPMS-4047
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3952 - Deliver pre-authorization to upgrade or renew infrastructure</li> </ul>

The Operational Entity "Regulatory Authorities" is composed of 1 operational activity which is:






- Deliver pre-authorization to upgrade or renew infrastructure

#### Deliver pre-authorization to upgrade or renew infrastructure

Type	 C2P-Operational Activity
Context Diagram	 <p>Figure 42 Context Diagram of Deliver pre-authorization to upgrade or renew infrastructure</p>
ID	SPMS-3952

### European and National Safety Authorities


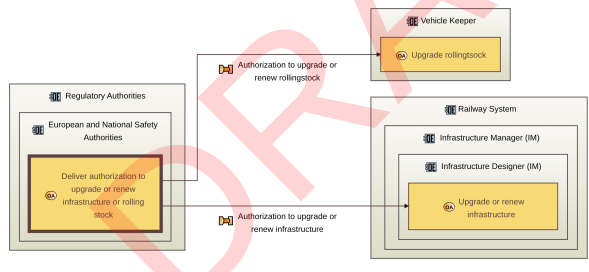
'National safety authority' means the national body entrusted with the tasks regarding railway safety in accordance with this Directive [ 2016 / 798 ] or any body entrusted by several Member States with those tasks in order to ensure a unified safety regime.

Type	 C2P-Operational Entity
ID	SPMS-4057
Allocated	<ul style="list-style-type: none"> <li>•  SPMS-3953 - Deliver authorization to upgrade or renew infrastructure or rolling stock</li> <li>•  SPMS-3997 - Define certification requirements</li> <li>•  SPMS-7048 - Store nominal data</li> <li>•  SPMS-7049 - Share nominal data</li> </ul>

The Operational Entity "European and National Safety Authorities" is composed of 2 operational activities which are:

- Deliver authorization to upgrade or renew infrastructure or rolling stock
- Define certification requirements

### Deliver authorization to upgrade or renew infrastructure or rolling stock

Type	 C2P-Operational Activity
Context Diagram	 <p>The diagram shows the context of the activity 'Deliver authorization to upgrade or renew infrastructure or rolling stock' (represented by a yellow box with a gear icon). This activity is part of the 'European and National Safety Authorities' (represented by a grey box). It interacts with two external entities: 'Regulatory Authorities' and 'Railway System'. The 'Regulatory Authorities' entity contains a 'Vehicle Keeper' role and an 'Upgrade rollingstock' activity. The 'Railway System' entity contains an 'Infrastructure Manager (IM)' role and an 'Infrastructure Designer (ID)' role, both of which have an 'Upgrade or renew infrastructure' activity. Arrows indicate the flow of 'Authorization to upgrade or renew rollingstock' from the Regulatory Authorities to the European and National Safety Authorities, and 'Authorization to upgrade or renew infrastructure' from the Railway System to the European and National Safety Authorities.</p> <p><i>Figure 43 Context Diagram of Deliver authorization to upgrade or renew infrastructure or rolling stock</i></p>
ID	SPMS-3953


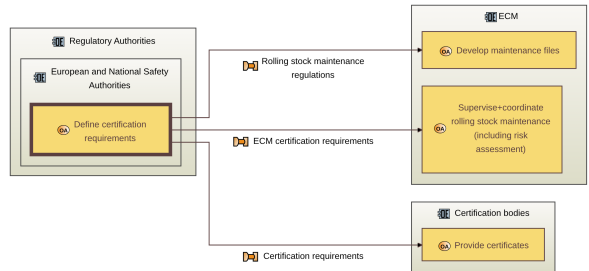
### Define certification requirements

**ROLLING STOCK:** The certification requirements are defined in Annex 2 of Directive (EU) 2016/798 and Commission Implementing Regulation (EU) No 2019/779 on a system of certification of entities in charge of maintenance for vehicles.

#### INFRA:

- EN 14969:2006 (Railway applications - Track - Qualification system for railway trackwork contractors): This European Standard specifies the definitions, procedures, criteria and their assessment as well as the respective documentation related to a qualification system of trackwork contractors, which relates to the Directive 2004/17/EC). This qualification system identifies trackwork contractors that can be invited for tendering trackwork contracts. Evaluation of the contractors applying for parts of the contract, which are not trackwork, is not covered by this standard. This European Standard may also be used for a qualification system of trackwork contractors applying for contracts with a value below the minimum limit as defined in the Directive 2004/17/EC.
- ISO 22163:2023 (Quality management in the railway sector)



Type	 C2P-Operational Activity
Context Diagram	 <p>The diagram shows the context for the 'Define certification requirements' activity. It is part of the 'Regulatory Authorities' (European and National Safety Authorities). It receives 'Rolling stock maintenance regulations' and provides 'ECM certification requirements' to the 'ECM' (European Central Maintenance) system. The 'ECM' system includes 'Develop maintenance files' and 'Supervise+coordinate rolling stock maintenance (including risk assessment)'. The 'ECM' also provides 'Certification requirements' to 'Certification bodies', which then 'Provide certificates'.</p> <p><i>Figure 44 Context Diagram of Define certification requirements</i></p>
ID	SPMS-3997


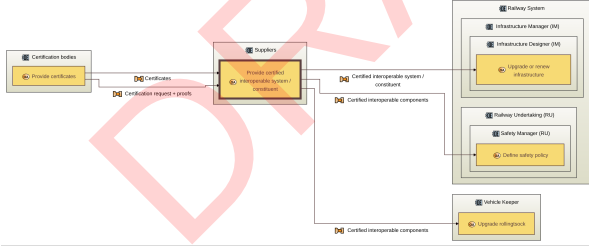
#### 4.1.2.1.6 Suppliers

##### SPMS-4074 - Suppliers

The Operational Entity "Suppliers" is composed of 1 operational activity which is:

- Provide certified interoperable system / constituent

##### **Provide certified interoperable system / constituent**

Type	 C2P-Operational Activity
Context Diagram	 <p>The diagram shows the context for the 'Provide certified interoperable system / constituent' activity. It is part of the 'Suppliers' system. It receives 'Certification bodies' and 'Certification requirements' and provides 'Certified interoperable system / constituent' to the 'Railway System'. The 'Railway System' includes 'Infrastructure Manager (IM)', 'Infrastructure Designer (ID)', 'Upgrade in service infrastructure', 'Railway Undertaking (RU)', 'Safety Manager (SM)', 'Define safety policy', and 'Vehicle keeper'. The 'Vehicle keeper' provides 'Upgrade rollingstock' to the 'Railway System'.</p> <p><i>Figure 45 Context Diagram of Provide certified interoperable system / constituent</i></p>
ID	SPMS-3989

## 5 Conclusion

### 5.1 Maintain & Monitor Infrastructure Capability

According to the defined milestones, during S.C 2.4 the MMI Capability aimed to create the To-Be architecture based on the already agreed As-Is architecture, addressing the identified CBOs and Pain Points.

As requested in the remit, interface and interaction activities were carried out with Task 5 and TCCS. The outcomes of these tasks were exchanged, and the MMI Capability shared the As-Is architecture in the Klaxoon environment with other tasks to collect their feedback. The high-level approach of Task 5 was analysed by MMI. It was jointly agreed that once the Task 5 architecture is further developed, interactions with MMI will be consolidated in the upcoming contracts.

The created To-Be architectures were validated by the Task-1 Members during the In Person Workshop in Frankfurt DB Infra Go Premises on 26.09.2025.

### 5.2 Upgrade or renew infrastructure network capabilities Capability

No conclusion for this year.

DRAFT