



ERJU SYSTEM PILLAR

# Operational Vision Breakdown Alignment CCS System



# Operational Vision Breakdown Alignment - CCS System

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**Approval by reviewers**

(captured at end of 'In Review by System Pillar')

Type of Approval	 Document Review
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**Approval by approvers**

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# 1 Preamble

## 1.1 Purpose

This document includes the breakdown of operational- and stakeholder requirements from the Operational Vision for CCS and TM/CM which sketches a compressed operational picture of the CCS and TMS/CM future ([SPP-19402 - Operational Vision (Nov. 2022)]).

## 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 [SPP-19427], the Operational Vision Breakdown Alignment of the [SPMS-2098 - CCS System] is based on the following inputs:

- [SPP-19402 - Operational Vision (Nov. 2022)]:  
This document sketches a compressed operational picture of the CCS and TMS/CM future. The operational vision itself is derived from the [SPP-8684 - System Pillar Common Business Objectives (May 2022)].

Using this input ensures that the [SPMS-2098 - CCS System] fulfils the goals of the System Pillar and is aligned to the common business objectives envisioned for the SERA.

The Operational Vision Breakdown Alignment of the [SPMS-2098 - CCS System] itself is an input document for the subsequent Operational Requirements Specification and Stakeholder Requirements Specification of the [SPMS-2098 - CCS System].

The [SPP-18362 - Requirements Management Plan v2.0] explains in more detail the dependencies between the different documents. [SPP-19427] below shows the Operational Vision Breakdown Alignment in the context of the overall document list (see also [SPP-19283 - Release Note ESPR1.0]).

**System Pillar Core Group Documents**  
(Not part of OD + Traffic CS delivery scope)

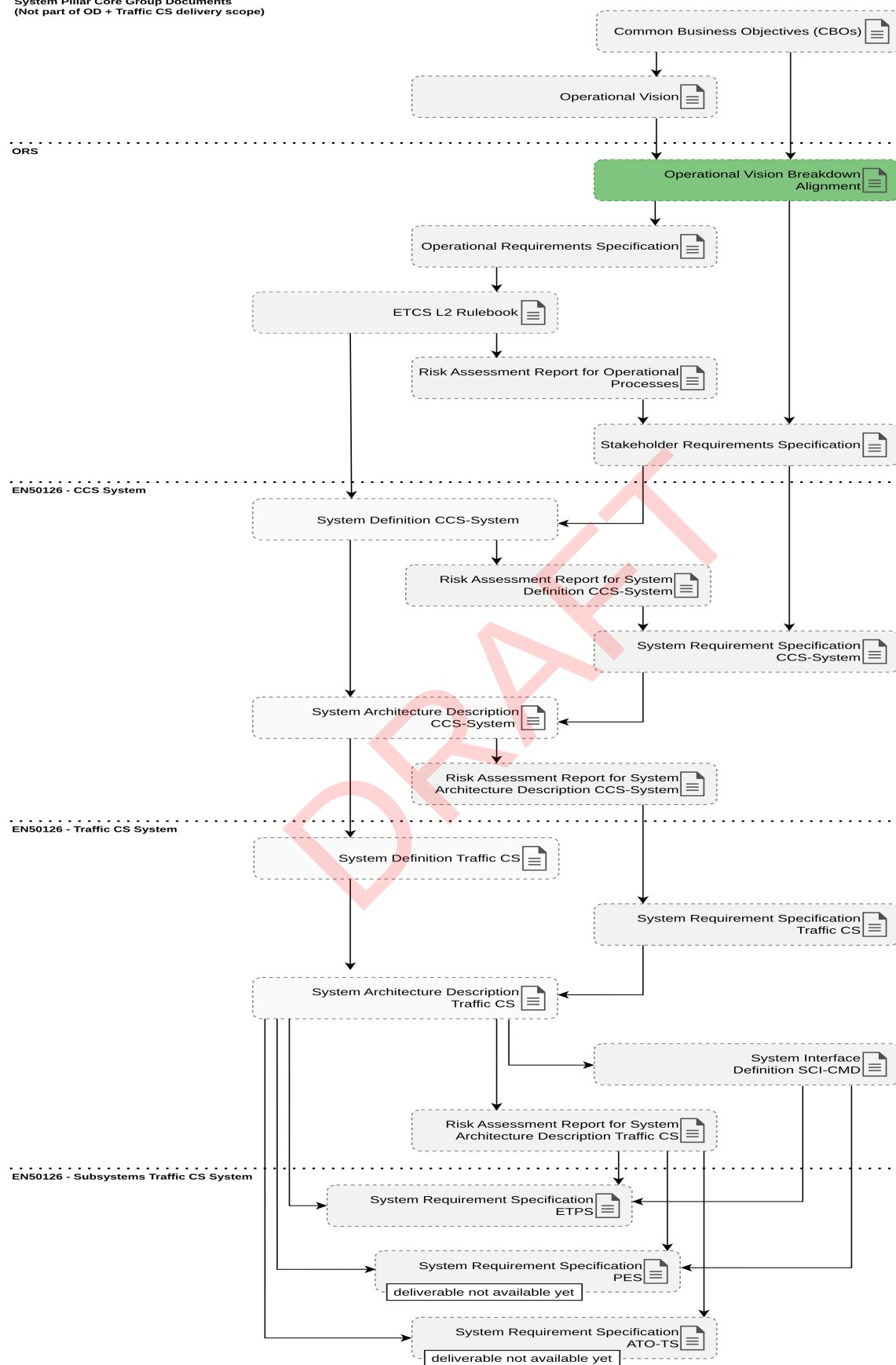



Figure 1 Operational Vision Breakdown Alignment in the context of the overall document list

[SPP-19427 ]

## 1.4 Glossary

### 1.4.1 Terms and definitions

Term	Definition
CCS System	The control command and signalling (CCS) system covers signalling, train control, positioning equipment and telecommunications. 
FFFIS - Form Fit Functional Interface Specification	In contrast to an FIS (Functional Interface Specification), FFFIS describes not only the functional requirements for an interface, but also its complete, specific design. An FFFIS has the requirement that all devices with an interface developed according to it are interchangeable. "FF - Form Fit" is a classification of interchangeable parts which are identical in shape, fit and function and are therefore interchangeable with one another. An FFFIS is therefore a clear description of an interface between devices or modules.
Infrastructure Manager	Means any body or undertaking that is responsible in particular for establishing and maintaining railway infrastructure. This may also include the management of infrastructure control and safety systems. The functions of the infrastructure manager on a corridor or part of a corridor may be allocated to different bodies or undertakings
Shunting movement	Way of moving vehicles without train data and controlled by shunting orders.
Single European Railway Area	Defining the fundamental design principles and process for adopting a functional architecture for rail as a system, with a focus on CCS, CMS and TMS supporting the implementation of the SERA (Single European Railway Area)

### 1.4.2 Abbreviations

Abbreviation	Definition
CMS	Capacity Management system
IM	Infrastructure Manager
RU	Railway Undertaking
SERA	Single European Railway Area
TMS	Traffic Management System

## 2 Operational Vision for CCS and TM/CM

### 2-1 - standard components

The operational vision for CCS and TM/CM is to change all operational processes on business level, production level and asset management level towards a much stronger CCS and TMS/CM production based on such “standardized application categories” and standard components (subsystems).

ID	SPT2OD-233
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#### 2-1.1 - Standard Components

*[Description of problem and general need in regard to CCS]*

Today's processes in rail operations are largely country-specific and the overall system architecture of TMS and CCS is not standardised. This leads to high costs and effort in railway operations as well as in the development, maintenance, configuration and commissioning of the corresponding systems. A standardised system architecture and suitable harmonised rail operating processes will reduce the complexity of processes and systems in future and therefore free human and monetary resources on both the railway and industry sides.

The following needs can be decomposed directly from the text: the need for **standard subsystem components**, the **ability of the subsystem components to interoperate within standard application configuration** - and thus migratable within (scalability) - that can be selected upon the specific implementation demands.



These needs can be directly associated to the business need to reduce the system's life-cycle cost by means of facilitating the creation of Economies of Scale and enabling strategic and economic migration paths.

The need for standard subsystem components is in this context meant from the perspective standard functional behaviour (black box) and not their implementation design. Therefore, the need is closely related to the requirement to create a defined **standardised functional architecture**, where subsystem components have a pre-defined **standard functional behaviour**. Furthermore, to achieve the desired interoperability, standard subsystem components must be **interconnected via standard interfaces**. This will also facilitate commercial competitiveness, which is another important business need.

In other to do so, however, the individual **operational production processes must be harmonised** across the whole system of interest. Dissimilar processes that don't make commercial sense to be harmonised - but that must be featured on the final standardised interoperable architecture - must be grouped into **application categories** (and by default the same must be done to the derived functional needs associated to these categorised processes).

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*


As an IM and as a RU, I want CCS to support harmonised operational processes in order to reduce technical and operational complexity.

-  SPT2OD-2925 - Singular harmonised processes
-  SPT2OD-2928 - System components classification into application categories







As an IM, I want CCS to connect and control a wide variety of trackside systems and technologies through standardised interfaces.

-  SPT2TRAFFIC-4495 - EULYNX Standard Communication Interfaces SCI-xx





















-  SPT2OD-3057 - Functionally standardised communication between modular subsystem components

As an IM and as RU, I want standardised generic products and standardised generic applications to benefit from an optimised rail- and system operation.

-  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture
-  SPP-6591 - CCS shall comply with the relevant CENELEC standards
-  SPT2TRAFFIC-5017 - Standardised interfaces (FFFIS, FIS) to decouple life cycles and safety cases
-  SPT2TRAFFIC-4495 - EULYNX Standard Communication Interfaces SCI-xx
-  SPT2OD-2957 - Modular system component's functional architecture design.
-  SPP-11716 - Categorisation of system components and functional variations according to application configuration(s).

#### [Application Conditions]

-  SPP-14771 - External Subsystems (e.g. TMS) shall interface with CCS via standard interfaces
-  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs

Linked Work Items	<p>is derived from :  SPT2OD-233 - standard components</p> <p>relates to :  SPP-11951 - Inside SPT2OD-3057 - Functionally standardised communication between modular sub...</p> <p>has parent :  SPT2OD-233 - standard components</p> <p>_ is derived by :  SPP-6591 - CCS shall comply with the relevant CENELEC standards</p> <p>_ is parent of :  SPP-6591 - CCS shall comply with the relevant CENELEC standards</p> <p>_ is derived by :  SPP-6991 - CCS shall support trains equipped with ETCS Baseline 3 (ETCS Level 2 only). This means CCS will implement ETCS System Version 2 on the trackside. The implemented ETCS System Versions can be raised over time</p> <p>_ is derived by :  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture</p> <p>_ is derived by :  SPP-11716 - Categorisation of system components and functional variations according to application configuration(s).</p> <p>_ is derived by :  SPP-14771 - External Subsystems (e.g. TMS) shall interface with CCS via standard interfaces</p> <p>_ is derived by :  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs</p> <p>_ is derived by :  SPP-28337 - Standardised interfaces (FFFIS, FIS) to decouple life cycles and safety cases</p> <p>_ is derived by :  SPP-28351 - EULYNX Standard Communication Interfaces SCI-xx</p> <p>_ is derived by :  SPT2OD-2925 - Singular harmonised processes</p> <p>_ is derived by :  SPT2OD-2928 - System components classification into application categories</p> <p>_ is derived by :  SPT2OD-2957 - Modular system component's functional architecture design.</p> <p>_ is derived by :  SPT2OD-3057 - Functionally standardised communication between modular subsystem components</p>
ID	SPP-6590

#### 2-1.1.1 - CCS shall comply with the relevant CENELEC standards

CCS shall comply with the relevant CENELEC standards (e.g. EN 50126, EN50128, EN50129, EN50159, EN50176). [SPP-6591]

## 2-2 - long-term evolution: modularisation

This means a market change in terms of stronger industrialisation and specialized large-scale market services on the long run, depending on the long-term evolution of the rational modularisation. Railway asset management organisations will focus more on designing and procuring asset capacity instead of designing special systems or maintaining special installations.

ID	SPT2OD-234
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### 2-2.1 - Long-term evolution: modularisation








*[Description of problem and general need in regard to CCS]*

Today's product development is largely national-specific and is driven by national-specific needs and operational requirements. This leads to specialised products that needs to be redefined or redesign for each new market. Stronger industrialisation and large-scale market solutions are not possible due to national operational concepts and rules for operational and risk assessment. In addition, the national solutions do not follow a standardized system architecture due to their different histories, conditions and needs. The resulting products are therefore often not clearly differentiated from one another, become monolithic and cannot be replaced by standard products.


The stakeholder need is instead for a **modular functional system architecture**. This need can be directly associated to the business needs to reduce the system's lifecycle cost by means of facilitating the creation of Economies of Scale in a more competitive market.













To achieve the desired enhancement in competitiveness, when speaking about modularisation it is important to remark the need for the **segregation of safety-related and non safety-related functions**, which have a direct impact on the complexity - and therefore the cost - for the production of such components. Furthermore, *standard subsystem components must to be interoperable*, and therefore the standard subsystem components must be **interconnected via standard interfaces**.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

- As an IM and RU, I want a standardised CCS to benefit from a changed market in terms of stronger industrialisation and specialised large-scale market services.
  -  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture
- As an IM, I want a modular CCS architecture to support the long-term development of the used systems.
  -  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture
- As an IM and as a RU, I want to focus on procuring asset capacity instead of maintaining specialised installations in order to ensure the long-term evolution of my installations.
  -  SPP-9274 - Upgradeability of Internal Components
  -  SPP-10245 - Upgradeability of adjacent systems
  -  SPP-10246 - Integration of external devices
- As a supplier, I want to develop standardised products instead of designing special systems that are only used in national markets or for individual customers.
  -  SPT2TRAFFIC-5037 - Provide a scalable and adaptable system architecture which is suitable for different contexts
  -  SPP-6860 - CCS shall be based on standardized products and configurations

### [Application Conditions]

-  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs

Linked Work Items	is derived from :  SPT2OD-234 - long-term evolution: modularisation has parent :  SPT2OD-234 - long-term evolution: modularisation _ is derived by :  SPP-6860 - CCS shall be based on standardized products and configurations _ is derived by :  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture _ is derived by :  SPP-7123 - Harmonized and scalable railway operation production _ is parent of :  SPP-7548 - CCS shall provide a scalable and adaptable system architecture that is suitable for different contexts depending on the IM use cases. _ is derived by :  SPP-9274 - Upgradeability of Internal Components _ is parent of :  SPP-9274 - Upgradeability of Internal Components _ is derived by :  SPP-10245 - Upgradeability of adjacent systems _ is derived by :  SPP-10246 - Integration of external devices _ is derived by :  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs _ is derived by :  SPP-28338 - Provide a scalable and adaptable system architecture which is suitable for different contexts
ID	SPP-7645

#### 2-2.1.1 - Upgradeability of Internal Components

The CCS shall support the upgradeability of internal components during system operation.  
[SPP-9274 ]

#### 2-2.1.2 - CCS shall provide a scalable and adaptable system architecture that is suitable for different contexts depending on the IM use cases.

CCS shall provide a scalable and adaptable system architecture that is suitable for different contexts depending on the IM use cases. [SPP-7548 ]

### 2-3 - Competitiveness

Overall, a very efficient process chain will allow to increase the competitiveness of the Railway system and to implement a faster improvement process and better evolvability.

ID	SPT2OD-235
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### 2-4 - Competitiveness through Merged Concept harmonized standardized processes, specifications and architectures

[Description of problem and general need in regard to CCS]






Today's railways are struggling to be competitive with other mobility solutions in terms of delivery times, service and costs. An efficient process chain from tendering, development, approval, introduction, operation and maintenance of the railway systems will increase the profitability and thus the competitiveness of the railways.

As described in the Railway Requirement description, to achieve the business target of *Competitiveness* there is a need to operate *efficient process chains*. In this context, the Stakeholder Requirements can be extracted from the introductory information in the chapter, which makes allusion to the shared use of *standardised operational production processes* and **standardised supporting documents** through a **centralised database**. This is only achievable when **standard**






**operational production procedures** and **standard commercial processes** are followed harmoniously within the different networks, supported by the implementation of *standard subsystem components* connected via *standard interfaces* and constructed respecting **harmonious engineering rules**.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

As an IM / RU, I want to benefit from an efficient process chain from tendering, development, approval, commissioning, operation and maintenance of the railway systems. The use of open standard specifications reduces the effort required for tendering and integration and allows cross-acceptance and faster deployment (from tendering to installation and commissioning).

-  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture
-  SPT2OD-2925 - Singular harmonised processes
-  SPP-9904 - CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update
-  SPP-7699 - Procedures and their implementation rules variations shall be harmonized
-  SPP-6860 - CCS shall be based on standardized products and configurations





As an IM / RU / Supplier, I want to benefit from a faster improvement process for the systems used and eventually faster rollout times.










-  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture
-  SPP-6860 - CCS shall be based on standardized products and configurations
-  SPT2OD-2925 - Singular harmonised processes
-  SPP-7123 - Harmonized and scalable railway operation production
-  SPP-7699 - Procedures and their implementation rules variations shall be harmonized

As an IM / RU, I want to benefit from systems that are easier to expand.

-  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture

As an IM / RU, I want to benefit from systems that are easier to modify.

-  SPP-10174 - Decoupling of hardware and software components
-  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture
-  SPP-9904 - CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update
-  SPP-7123 - Harmonized and scalable railway operation production

Linked Work Items	<p>is derived from :  SPT2OD-235 - Competitiveness</p> <p>has parent :  SPP-6574 - Operational Vision for CCS and TM/CM</p> <p>_ is derived by :  SPP-6860 - CCS shall be based on standardized products and configurations</p> <p>_ is derived by :  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture</p> <p>_ is derived by :  SPP-7699 - Procedures and their implementation rules variations shall be harmonized</p> <p>_ is derived by :  SPP-9904 - CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update</p> <p>_ is derived by :  SPP-10174 - Decoupling of hardware and software components</p> <p>_ is derived by :  SPP-11716 - Categorisation of system components and functional variations according to application configuration(s).</p> <p>_ is derived by :  SPT2OD-2925 - Singular harmonised processes</p>
ID	SPP-7690

## 2-5 - Procedures and their implementation rules variations shall be harmonized

The railway operation production procedures and their implementation rules variations - e.g. existing engineering rules that support the Railway System's progressive functional evolution paths - shall be harmonized. [SPP-7699 ]

### 3 CONUSE Vision for CCS and TM/CM

#### 3.1 Traffic Management / Capacity Management

See corresponding chapter  Operational Vision CMS\_TMS Part

#### 3.2 Traffic Control and Supervision

##### 3.2-1 - Traffic CS shall offer an optimized and automatized basic functionality to control and report any type of track usage

The basic vision for Traffic Control and Supervision (Traffic CS) is that this control layer offers a very precise interface for the traffic management (e.g. detailed speeds, train characteristics, progress of processes). This preciseness allows to optimize all movements in relation to each other (capacity, speed, energy consumption), to reduce train ahead times, dwelling times, delay times, and unproductive waiting times of maintenance teams or construction sites. The operational state includes detailed information about all actors and systems in the production. The communication to all actors is digitized and because of this automatable.

ID	SPT2OD-274
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##### 3.2-2 - CCS shall offer an optimized, precise and automatized basic functionality to control and report any type of track usage

*[Description of problem and general need in regard to CCS]*








The aim is to optimise traffic flow, trackside maintenance and construction work completely over the entire life cycle of each of those activities, e.g. maintenance.

Today's CCS systems do not offer the functionality to control and report any type of track usage and do not provide the information on the current operating situation to the extent, precision and availability required by the TMS to fully optimise traffic flow, trackside maintenance and construction work. Existing workflows often depend on manual activities, voice communication and written checklists, which are error-prone and time consuming.


This preciseness and availability allows TMS to optimize all movements in relation to each other (capacity, speed, energy consumption), to reduce train ahead times, dwelling times, delay times, and unproductive waiting times of maintenance teams or construction sites.






*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

As an IM, I want a CCS system that enables the TMS to manage and optimise the traffic flow automatically and in real time based on the current operational state.






-  SPT2OD-3057 - Functionally standardised communication between modular subsystem components
-  SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.
-  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.
-  SPP-10258 - Ensure fast response times
-  SPP-10259 - Timely reservation of track capacities
-  SPP-10260 - Prompt execution of requested plans
-  SPP-9300 - Support for changing Operational Plans

As an IM, I want a CCS system that enables the TMS to plan trackside maintenance and construction work automatically, and optimise it in real time based on the current operational situation.

-  SPT2OD-3057 - Functionally standardised communication between modular subsystem components




















-  SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.
-  SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.
-  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force
-  SPT2OD-4444 - Operational production optimisation centralised within the frame of railway traffic efficiency.
-  SPT2OD-6859 - Information availability relevance

*[Application Conditions]*

-  SPP-14899 - TMS shall optimize train movements in relation to each other (capacity, speed, energy consumption) and unproductive waiting times of maintenance teams or construction sites based on the track usage information received from CCS.
-  SPP-14900 - TMS shall receive and manage the information on the current operating situation sent by CCS
-  SPP-14667 - TMS shall consider driver availability and train availability due to maintenance routines, construction work, incident or delays to automatically schedule a service
-  SPP-14670 - TMS shall consider the track users requests and actual state of railway network to automatically schedule a service
-  SPP-14824 - TMS shall consider the status of the trackside assets and trains to automatically schedule a service

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Linked Work Items	<p>is derived from :  SPT2OD-274 - Traffic CS shall offer an optimized and automatized basic functionality to control and report any type of track usage</p> <p>has parent :  SPP-6577 - Traffic Control and Supervision</p> <p>_ is derived by :  SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.</p> <p>_ is derived by :  SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.</p> <p>_ is derived by :  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.</p> <p>_ is derived by :  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force</p> <p>_ is derived by :  SPP-9300 - Support for changing Operational Plans</p> <p>_ is derived by :  SPP-10258 - Ensure fast response times</p> <p>_ is derived by :  SPP-10259 - Timely reservation of track capacities</p> <p>_ is derived by :  SPP-10260 - Prompt execution of requested plans</p> <p>_ is derived by :  SPP-14667 - TMS shall consider driver availability and train availability due to maintenance routines, construction work, incident or delays to automatically schedule a service</p> <p>_ is derived by :  SPP-14670 - TMS shall consider the track users requests and actual state of railway network to automatically schedule a service</p> <p>_ is derived by :  SPP-14824 - TMS shall consider the status of the trackside assets and trains to automatically schedule a service</p> <p>_ is derived by :  SPP-14899 - TMS shall optimize train movements in relation to each other (capacity, speed, energy consumption) and unproductive waiting times of maintenance teams or construction sites based on the track usage information received from CCS.</p> <p>_ is derived by :  SPP-14900 - TMS shall receive and manage the information on the current operating situation sent by CCS</p> <p>_ is derived by :  SPP-24381 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.</p> <p>_ is derived by :  SPT2OD-3057 - Functionally standardised communication between modular subsystem components</p> <p>_ is derived by :  SPT2OD-4444 - Operational production optimisation centralised within the frame of railway traffic efficiency.</p> <p>_ is derived by :  SPT2OD-6859 - Information availability relevance</p>
ID	SPP-9034

### 3.2-3 - Support for changing Operational Plans

The CCS shall support modifications to an Operational Plan that is currently being executed. [SPP-9300 ]

### 3.2-4 - Ensure fast response times

The CCS shall ensure fast response times for the execution of requested changes to the Operational Plan. [SPP-10258 ]

### 3.2-5 - Timely reservation of track capacities

The CCS shall facilitate timely reservation and release of track capacities. [SPP-10259 ]

### 3.2-6 - Prompt execution of requested plans

The CCS shall enable the prompt execution of changes to the Operational Plan following user requests. [SPP-10260 ]

### 3.2-7 - ATO for normal and degraded modes

The second aspect of the basic operational vision is to highly automate Traffic CS (still allowing manual control) for normal and most of the degraded production situations, based on a scalable physical



architecture and in collaboration with the Traffic Management process. Technical and operational interoperability - as needed for the SERA - is based on a simple compatibility management that supports an economic migration and mixed generations. Executing an operational plan coming from Traffic Management processes in short intervals in real-time shall be automated in all aspects, based on cooperation rules and procedures. This includes movement permissions for normal train movements, shunting, joining, splitting or other manoeuvres (supported by automated coupling), as well as granting possessions for construction sites, track access for maintenance teams, warning processes, or the change of a point position that a maintenance team needs. The automation shall decrease effort and duration for operation and deployment, and increase reliability, safety, and precision/capacity.

ID	SPT2OD-275
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### 3.2-8 - ATO for normal and degraded modes








*[Description of problem and general need]*

Today's TMS and Trackside CCS systems do not cover the automation of the entire railway operation (e.g. normal train movement, shunting, train manoeuvres, construction sites, track access of maintenance teams, warning processes) and do not automate the workflow over the entire process life cycle (from planning and execution to the management of degraded situations). Many aspects are not or only partially automated and require manual activities, voice communication and written checklists, which are error-prone and inefficient. This is an obstacle to increase the reliability, safety and capacity of the railway system and the precision of operations.





Executing and optimizing an operational plan coming from Traffic Management processes in short intervals in real-time shall be automated in all aspects, based on cooperation rules and procedures. Traffic CS should still allow manual control for degraded situations and shall support migration managing mixed generations based on a scalable physical architecture.





*[Breakdown into specific needs in regard CCS, including links to System- or Operational Requirements]*

As an IM, I want the real-time optimization of railway operation to be supported by TMS and CCS



-  SPP-7067 - Real time management of routine operational production procedures
-  SPP-7068 - CCS shall in real time optimize the operational plans
-  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.
-  SPP-8839 - If driver is involved in the driving process, CCS shall support driving assistance recommendations
-  SPP-8840 - An harmonized process shall be defined to show the driver optimal energy-efficient driving and an optimised driving speed profile recommendations
-  SPT2TRAFFIC-4481 - ATO GoA1
-  SPT2TRAFFIC-4480 - ATO GoA2

As an IM / RU, I want different types of operational movements to be automatically managed by TMS and CCS (e.g. normal train movement, shunting, train manoeuvres).




-  SPP-7071 - Automated routine operational production procedures for train movements or shunting movements
-  SPP-7072 - Automated routine operational production procedures for field force work
-  SPP-7081 - CCS shall automatically supervise rail operation
-  SPT2TRAFFIC-4462 - Handling of train and shunting movements in Traffic CS

-  SPP-9043 - An harmonized process shall be defined to support automated , efficient and fully supervised joining manoeuvres
-  SPP-9045 - An harmonized process shall be defined to support automated splitting manoeuvres
-  SPT2TRAFFIC-4481 - ATO GoA1
-  SPT2TRAFFIC-4480 - ATO GoA2











As an IM, I want field force work (e.g. granting possessions for construction sites, track access for maintenance teams, warning processes, or the change of a point position that a maintenance team needs) to be automatically managed by TMS and CCS

-  SPP-7072 - Automated routine operational production procedures for field force work
-  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force



As an IM / RU, I want a highly automated system for normal situations and degraded situations, which still allows manual control

-  SPP-7083 - Manned intervention in automated operation
-  SPP-7084 - CCS shall handle different system capabilities supporting standard manual controls
-  SPP-9266 - Management of variable System Capabilities



As an IM / RU, I want to increase the reliability, safety and precision of railway operations through automation.

-  SPP-10233 - Supervision methodology
-  SPP-10234 - Compliance with safety-critical principles
-  SPP-10235 - Adherence to operational procedures
-  SPP-7098 - CCS shall achieve increased standards of reliability, precision and safety
-  SPP-8839 - If driver is involved in the driving process, CCS shall support driving assistance recommendations
-  SPP-8840 - An harmonized process shall be defined to show the driver optimal energy-efficient driving and an optimised driving speed profile recommendations
-  SPT2TRAFFIC-4481 - ATO GoA1
-  SPT2TRAFFIC-4480 - ATO GoA2
-  SPP-9266 - Management of variable System Capabilities
-  SPP-12094 - Automated portions of processes "hidden" to the interfacing actor(s)







As an IM, I want to reduce the effort and time required for the deployment of trackside systems through automation.

-  SPP-7107 - Automated regulation of infrastructure resources deployment
-  SPP-7111 - CCS shall optimize TCO through automation






As an IM / RU, I want the system to scale in terms of framework conditions such as the number of trains and infrastructure elements to be managed, the size of the area, the amount of data to be processed or even new functionalities

-  SPP-7123 - Harmonized and scalable railway operation production
-  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture



As an IM / RU, I want the system to support technical and operational interoperability.

-  SPP-7129 - Harmonised SERA operational rules
-  SPP-7130 - CCS shall support technical and operational interoperability
-  SPP-6991 - CCS shall support trains equipped with ETCS Baseline 3 (ETCS Level 2 only). This means CCS will implement ETCS System Version 2 on the trackside. The implemented ETCS System Versions can be raised over time
-  SPT2TRAFFIC-5028 - Able to provide a standard interface to manage handover of trains between SERA equipped areas
-  SPT2TRAFFIC-4961 - Implement interface designs that enable the determination of smallest common set of shareable functions
-  SPP-8866 - Implement standardised interfaces without hindering of innovation


































As an IM / RU, I want the system to support affordable migration and facilitate the movement of a mix fleet including partially supervise trains.








-  SPP-7198 - Operational production shall support Migration
-  SPP-7199 - CCS shall be flexible enabling an efficient and affordable migration
-  SPT2TRAFFIC-5028 - Able to provide a standard interface to manage handover of trains between SERA equipped areas
-  SPP-11716 - Categorisation of system components and functional variations according to application configuration(s).
-  SPP-7199 - CCS shall be flexible enabling an efficient and affordable migration

*[Application Conditions]*

-  SPP-11496 - TMS shall automatically update the operational plan in real time (in short intervals) over the entire process life-cycle
-  SPP-14669 - In routine operation, TMS shall exchange information with CCS in a non-verbal, unambiguous and automatic way

### Linked Work Items

is derived from :  SPT2OD-275 - ATO for normal and degraded modes  
 has parent :  SPP-6577 - Traffic Control and Supervision  
 \_ is derived by :  SPP-6991 - CCS shall support trains equipped with ETCS Baseline 3 (ETCS Level 2 only). This means CCS will implement ETCS System Version 2 on the trackside. The implemented ETCS System Versions can be raised over time  
 \_ is derived by :  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.  
 \_ is derived by :  SPP-7067 - Real time management of routine operational production procedures  
 \_ is derived by :  SPP-7068 - CCS shall in real time optimize the operational plans  
 \_ is derived by :  SPP-7071 - Automated routine operational production procedures for train movements or shunting movements  
 \_ is derived by :  SPP-7072 - Automated routine operational production procedures for field force work  
 \_ is derived by :  SPP-7081 - CCS shall automatically supervise rail operation  
 \_ is derived by :  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force  
 \_ is derived by :  SPP-7083 - Manned intervention in automated operation  
 \_ is derived by :  SPP-7084 - CCS shall handle different system capabilities supporting standard manual controls  
 \_ is derived by :  SPP-7098 - CCS shall achieve increased standards of reliability, precision and safety  
 \_ is derived by :  SPP-7107 - Automated regulation of infrastructure resources deployment  
 \_ is derived by :  SPP-7111 - CCS shall optimize TCO through automation  
 \_ is derived by :  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture  
 \_ is derived by :  SPP-7123 - Harmonized and scalable railway operation production  
 \_ is derived by :  SPP-7129 - Harmonised SERA operational rules  
 \_ is derived by :  SPP-7130 - CCS shall support technical and operational interoperability  
 \_ is derived by :  SPP-7198 - Operational production shall support Migration  
 \_ is derived by :  SPP-7199 - CCS shall be flexible enabling an efficient and affordable migration  
 \_ is derived by :  SPP-8839 - If driver is involved in the driving process, CCS shall support driving assistance recommendations  
 \_ is derived by :  SPP-8840 - An harmonized process shall be defined to show the driver optimal energy-efficient driving and an optimised driving speed profile recommendations  
 \_ is derived by :  SPP-8866 - Implement standardised interfaces without hindering of innovation  
 \_ is derived by :  SPP-9043 - An harmonized process shall be defined to support automated , efficient and fully supervised joining manoeuvres  
 \_ is derived by :  SPP-9045 - An harmonized process shall be defined to support automated splitting manoeuvres  
 \_ is derived by :  SPP-9266 - Management of variable System Capabilities  
 \_ is derived by :  SPP-10233 - Supervision methodology  
 \_ is derived by :  SPP-10234 - Compliance with safety-critical principles  
 \_ is derived by :  SPP-10235 - Adherence to operational procedures  
 \_ is derived by :  SPP-11496 - TMS shall automatically update the operational plan in real time (in short intervals) over the entire process life-cycle  
 \_ is derived by :  SPP-11716 - Categorisation of system components and functional variations according to application configuration(s).  
 \_ is derived by :  SPP-12094 - Automated portions of processes "hidden" to

	<p>the interfacing actor(s)</p> <p>_ is derived by :  SPP-14669 - In routine operation, TMS shall exchange information with CCS in a non-verbal, unambiguous and automatic way</p> <p>_ is derived by :  SPP-28346 - Implement interface designs that enable the determination of smallest common set of shareable functions</p> <p>_ is derived by :  SPP-28347 - Handling of train and shunting movements in Traffic CS</p> <p>_ is derived by :  SPP-28354 - Able to provide a standard interface to manage handover of trains between SERA equipped areas</p> <p>_ is derived by :  SPT2TRAFFIC-4462 - Handling of train and shunting movements in Traffic CS</p> <p>_ is derived by :  SPT2TRAFFIC-4480 - ATO GoA2</p> <p>_ is derived by :  SPT2TRAFFIC-4481 - ATO GoA1</p>
ID	SPP-6670

### 3.2-9 - Real time management of routine operational production procedures

Predefined procedures shall be defined for ensuring real-time optimization of railway operation.

[SPP-7067 ]

### 3.2-10 - CCS shall in real time optimize the operational plans

CCS shall optimize in run-time the railway operation receiving and executing in real-time adaptation of the operational plans from the TMS. [SPP-7068 ]

### 3.2-11 - Automated routine operational production procedures for train movements or shunting movements

Operational production procedures shall support the automated and/or the unattended execution of the processes related to routine train movements or shunting movements; i.e. the processes executed during 'normal' operation and the processes that are routinely used for the management or recovery of degraded situations. [SPP-7071 ]

### 3.2-12 - Automated routine operational production procedures for field force work

Operational production procedures shall support the automated execution of the processes related to field force work (e.g. granting possessions for construction sites, track access for maintenance teams, warning processes, or the change of a point position that a maintenance team needs).

Note:

This includes, for example following operational processes: automatic warning of trackside personnel, management of slow speed sections and possessions, access and entry of a construction site vehicle (e.g. excavator, yellow fleet) into the construction site area, lubrication of points, composition of freight trains. [SPP-7072 ]

### 3.2-13 - CCS shall automatically supervise rail operation

CCS shall support automated supervised operation of passenger trains, freight trains, shunting, train manoeuvres, yellow fleet and stabling for a maximum grade of supervised rail operation. [SPP-7081 ]

### 3.2-14 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force

CCS shall enable the standardisation, automation and optimisation of operational processes involving trackside personnel and non-trackbound vehicles (e.g. maintenance work, construction work, shunting work) in order to minimise their impact on rail operations and to increase the safety of trackside personnel. [SPP-7082 ]

### 3.2-15 - Manned intervention in automated operation

Where automated operation is provided, standardized operational procedures shall be readily to an

operator while ensuring safety, production capacity and automation at the highest possible level.  
[SPP-7083 ]

### **3.2-16 - CCS shall handle different system capabilities supporting standard manual controls**

CCS shall handle different and changing system capabilities (e.g. degraded modes) supporting also manual and standardized controls for non-automated or semi-automated operational and system processes during normal and degraded operation.

Note: Ergonomics shall be taken into consideration. [SPP-7084 ]

### **3.2-17 - CCS shall achieve increased standards of reliability, precision and safety**

CCS shall ensure higher levels of reliability, precision and safety of the operations in normal and degraded modes regardless of the type of operation (automated, semi-automated or manual). [SPP-7098 ]

### **3.2-18 - Automated regulation of infrastructure resources deployment**

Operational production procedures shall allow for automated regulation of rail traffic and of deployment of CCS resources.

All the operational production needs, such as the use of available technical/physical or human resources shall be regulated with automation. [SPP-7107 ]

### **3.2-19 - CCS shall optimize TCO through automation**

CCS shall implement automated operational capabilities and shall support processes for the provisioning, configuration, maintenance and replacement of subsystems and components (CONEMP) in order to optimise the Total Cost of Ownership. [SPP-7111 ]

### **3.2-20 - Harmonized and scalable railway operation production**

The railway operation production shall be harmonized regardless of the framework conditions such as the number of trains and infrastructure elements to be managed, the size of the area, the amount of data to be processed or even new functionalities. [SPP-7123 ]

### **3.2-21 - Scalable, modular, multi-layered and standardised CCS architecture**

CCS shall implement a scalable, modular, multi-layered and standardised architecture that relies on a robust and comprehensive architecture framework.

Notes:

- Subsystems and interfaces within the CCS system are defined during the phase logical architecture of SEMP and will take into account SPT2 architecture guidelines such as "ARC-D2.3 Granularity Concepts and Principles".
- The requirement is to be refined with concrete concepts in further work. [SPP-7122 ]

### **3.2-22 - Harmonised SERA operational rules**

Railway operation shall be based on harmonised operational concept and harmonised operational rules in order to support a Single European Railway Area (SERA) [SPP-7129 ]

### **3.2-23 - CCS shall support technical and operational interoperability**

CCS shall support technical and operational interoperability ensuring compatibility among subsystems operating with different system versions. [SPP-7130 ]

### **3.2-24 - Operational production shall support Migration**

The operational production routines and procedures shall support affordable migration and manage the movement of mixed fleets accepting also partially supervised trains.

Note: in this context 'migration' is not strictly associated to the migration from current class A and B systems (legacy) to the target system, but the evolutionary paths within the capabilities/configurations of the target system

[SPP-7198 ]



### 3.2-25 - CCS shall be flexible enabling an efficient and affordable migration

CCS shall be flexible and able to manage full or partial supervision of shunting, train manoeuvres, yellow fleet and stabling during migration. [SPP-7199 ]

### 3.2-26 - An harmonized process shall be defined to support automated , efficient and fully supervised joining manoeuvres

An harmonized process shall be defined to support automated , efficient and fully supervised joining manoeuvres. [SPP-9043 ]

### 3.2-27 - An harmonized process shall be defined to support automated splitting manoeuvres

An harmonized process shall be defined to support automated splitting manoeuvres. [SPP-9045 ]

### 3.2-28 - Categorisation of system components and functional variations according to application configuration(s).

Changes of functionality to subsystem components, and changes to system component's capabilities or interfaces, to support the Railway System's progressive functional evolution paths shall be categorised according to its applicable configuration(s) [SPP-11716 ]

### 3.2-29 - Automated portions of processes "hidden" to the interfacing actor(s)

Functional procedure variants within a capability which have no impact to an interaction actor/system shall be AFARP implemented through functional automation. [SPP-12094 ]

### 3.2-30 - Supervision methodology

The CCS shall supervise operational production on infrastructure resources using any methodology (manual, automated, or partially automated). [SPP-10233 ]

### 3.2-31 - Compliance with safety-critical principles

The CCS shall ensure that operational production adheres to safety-critical principles throughout the supervision process. [SPP-10234 ]

### 3.2-32 - Adherence to operational procedures

The CCS shall ensure compliance with established operational procedures and rules during the supervision of operational production. [SPP-10235 ]

### 3.2-33 - Track user planning via Traffic Management process

All track user (vehicles, or field forces: e.g., track workers, operational services in the field, etc.) requests, needed actions, permissions, or asset changes are requested to and planned via the Traffic Management process in an optimized and integrated way. They can also be requested by field force applications or TM terminals in or near the train (e.g., to initiate remote controlled train movements), to allow a completely automated process. Non-track-bound track users or mobile objects (like a locatable construction site boundary marking device, or a localized person) are seamlessly integrated into the safety supervision process like normal trains to achieve a complete safety supervision.

ID	SPT2OD-276
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### 3.2-34 - Track user planning via Traffic Management process

*[Description of problem and general need in regard to CCS]*

In general, the Railway Requirement description makes reference to the operational objectives for the *optimisation of railway resources utilisation* (traffic, infrastructure or manned resources), and the capability *to control the deployment of railway resources*.

The aim is to optimise the track usage to perform train runs, trackside maintenance and construction work completely and over the entire life cycle (planning, execution, commissioning and decommissioning).

Today's CCS systems do not offer the functionality trackside maintenance and construction work. Existing workflows often depend on manual activities, voice communication and written checklists, which are error-

prone and inefficient. Usually, today's CCS require interaction with a signaller to perform functionalities like safeguarding a construction site or non-trackbound track users e.g. construction work equipment, field force, operational staff, mobile devices).

To achieve the optimisation goals, the Railway Requirement defines the need to support **automated management of traffic and resources deployment** and the connected requirement for the **integration of non track-bound mobile objects/users onto the safety supervision**.










This in turn this can only be achieved if **availability of digitalised information about resources that have direct relationship to the optimal operability of the railway network, or the general safety** is supported. It is assumed that the information related with resources is related with human or technical/ physical resources availability, maintenance routines, construction management, commissioning or incidents management. This could means for example TMS could have access to driver and train availability, and able to plan with this information if a train service can or can not take place. If a train is delayed that is needed for another train service, the last train service can not take place. TMS can use this information to the planned service offer, based on the available operating state information.

Furthermore, the text defines that **all related requests/demands are centralised around the process of traffic management**.

Additionally, beside the reference of the need from track users **to be able to request in-situ the control of infrastructure assets** - presumably to enable the execution of defined tasks under their responsibility - e.g. maintenance routines, shunting, degradation recovery routines -, the text also makes reference to the need for the support of **application configurations featuring the possibility to remotely control infrastructure assets at the lineside**, as well as **the possibility to remotely control vehicles in the rail network**.





*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

As an IM, I want for Traffic Management the possibility to fully control all requests of track users in order to coordinate them with the actual operational state of the railway network and to minimise the impact to the railway traffic.


-  SPP-6678 - CCS shall verify and process Traffic Management System requests to create, activate, amend, deactivate or delete track usage restrictions considering TMS optimized plan.
- [Application Condition]  SPP-17706 - All track users (e.g. vehicles, field force like track workers) shall send their requests, permission or needed action to TMS
-  SPP-7107 - Automated regulation of infrastructure resources deployment
-  SPT2OD-4444 - Operational production optimisation centralised within the frame of railway traffic efficiency.
-  SPT2OD-6859 - Information availability relevance
- [Application Condition]  SPP-14668 - For planned interventions, TMS shall request reservation of track areas for field forces
- [Application Condition]  SPP-14824 - TMS shall consider the status of the trackside assets and trains to automatically schedule a service
- [Application Condition]  SPP-14670 - TMS shall consider the track users requests and actual state of railway network to automatically schedule a service
- [Application Condition]  SPP-14667 - TMS shall consider driver availability and train availability due to maintenance routines, construction work, incident or delays to automatically schedule a service







As an IM, I want Traffic Management to request reservations of track areas for field forces in order to plan interventions.

-  SPP-6678 - CCS shall verify and process Traffic Management System requests to create, activate, amend, deactivate or delete track usage restrictions considering TMS optimized plan.
-  SPP-6679 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of planned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.
-  SPP-6680 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of unplanned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.
- [Application Condition]  SPP-14668 - For planned interventions, TMS shall request reservation of track areas for field forces





As an IM, I want CCS to report any type or change of track usage restrictions in order to optimise the traffic flow and to minimise the impact to the railway traffic.

-  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.




As an IM / RU, I want CCS to allow remotely controlled train movements in order to enable manual operation of trains without the driver being on-board, and remotely controlled infrastr

-  SPP-6686 - An harmonized process shall be defined to deal with remote train operation (RTO) including remote terminals (trackside or onsite).
- [Application Condition]  SPP-16383 - In fully automated processes, Field Force shall request process needed actions, permissions, or asset changes via field force applications or TM terminals in or near the train
- [Application Condition]  SPP-14787 - Track users shall be able to control vehicles remotely
- [Application Condition]  SPP-14786 - Track users shall be able to control infrastructure assets remotely for maintenance routine, degradation recovery routines


As an IM, I want CCS to support the non-track-bound track users or mobile objects in order to prevent collision of trains with them


-  SPP-6683 - An harmonized process shall be defined to supervise all possible track users
-  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.
-  SPP-6684 - CCS shall authorise movements only if they don't represent a danger for railway actors (such as driver or passengers), or the infrastructure and rolling stock assets, or non-track-bound track users or mobile objects and if these movements are part of plan or actions derived from degraded operation.
- [Application Condition]  SPP-14669 - In routine operation, TMS shall exchange information with CCS in a non-verbal, unambiguous and automatic way


As IM, I want the information exchange between interfacing actors to be non-verbal, unambiguous and automatable in routine operation.


-  SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.
-  SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.
- [Application Condition]  SPP-14785 - Track users shall be able to control infrastructure assets in-situ for maintenance routine, degradation recovery routines


### Linked Work Items


is derived from :  SPT2OD-276 - Track user planning via Traffic Management process


has parent :  SPP-6577 - Traffic Control and Supervision


\_ is derived by :  SPP-6678 - CCS shall verify and process Traffic Management System requests to create, activate, amend, deactivate or delete track usage restrictions considering TMS optimized plan.


\_ is derived by :  SPP-6679 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of planned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.


\_ is derived by :  SPP-6680 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of unplanned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.


\_ is derived by :  SPP-6683 - An harmonized process shall be defined to supervise all possible track users


\_ is derived by :  SPP-6684 - CCS shall authorise movements only if they don't represent a danger for railway actors (such as driver or passengers), or the infrastructure and rolling stock assets, or non-track-bound track users or mobile objects and if these movements are part of plan or actions derived from degraded operation.


\_ is derived by :  SPP-6686 - An harmonized process shall be defined to deal with remote train operation (RTO) including remote terminals (trackside or onsite).


\_ is derived by :  SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.


\_ is derived by :  SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.


\_ is derived by :  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.


\_ is derived by :  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.


\_ is derived by :  SPP-7107 - Automated regulation of infrastructure resources deployment


\_ is derived by :  SPP-14667 - TMS shall consider driver availability and train availability due to maintenance routines, construction work, incident or delays to automatically schedule a service


\_ is derived by :  SPP-14668 - For planned interventions, TMS shall request reservation of track areas for field forces


\_ is derived by :  SPP-14669 - In routine operation, TMS shall exchange information with CCS in a non-verbal, unambiguous and automatic way


\_ is derived by :  SPP-14670 - TMS shall consider the track users requests and actual state of railway network to automatically schedule a service





\_ is derived by :  SPP-14785 - Track users shall be able to control infrastructure assets in-situ for maintenance routine, degradation recovery routines

\_ is derived by :  SPP-14786 - Track users shall be able to control infrastructure assets remotely for maintenance routine, degradation recovery routines

\_ is derived by :  SPP-14787 - Track users shall be able to control vehicles remotely

\_ is derived by :  SPP-14824 - TMS shall consider the status of the trackside assets and trains to automatically schedule a service

\_ is derived by :  SPP-16383 - In fully automated processes, Field Force shall

	<p>request process needed actions, permissions, or asset changes via field force applications or TM terminals in or near the train</p> <p>_ is derived by :  SPP-17706 - All track users (e.g. vehicles, field force like track workers) shall send their requests, permission or needed action to TMS</p> <p>_ is derived by :  SPP-24381 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.</p> <p>_ is derived by :  SPT2OD-4444 - Operational production optimisation centralised within the frame of railway traffic efficiency.</p> <p>_ is derived by :  SPT2OD-6859 - Information availability relevance</p>
ID	SPP-6644

**3.2-35 - CCS shall verify and process Traffic Management System requests to create, activate, amend, deactivate or delete track usage restrictions considering TMS optimized plan.**

The CCS System shall verify and process Traffic Management System's request to create, activate, amend, deactivate or delete track usage restrictions considering TMS optimized plan. [SPP-6678 ]

**3.2-36 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of planned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.**

An harmonized process shall be defined to automatize and optimize the activation and deactivation of planned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions. [SPP-6679 ]

**3.2-37 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of unplanned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.**

An harmonized process shall be defined to automatize and optimize the activation and deactivation of unplanned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.

[SPP-6680 ]

**3.2-38 - An harmonized process shall be defined to supervise all possible track users**

An harmonized process shall be defined to incorporate the non-track-bound track users (e.g. excavator, crane) or mobile objects (e.g. a locatable construction site boundary marking device) or a localized person (e.g. passenger counters at the platform) or trackside personnel into the safe supervision process - similar to what is used currently for train supervision. The process shall show how the different sources of sensors' information is integrated.

[SPP-6683 ]

**3.2-39 - An harmonized process shall be defined to deal with remote train operation (RTO) including remote terminals (trackside or onsite).**

An harmonized process shall be defined to deal with remote train operation (RTO) including remote terminals (trackside or onsite). [SPP-6686 ]

**3.2-40 - CCS shall authorise movements only if they don't represent a danger for railway actors (such as driver or passengers), or the infrastructure and rolling stock assets, or non-track-bound track users or mobile objects and if these movements are part of plan or actions derived from degraded operation.**

The CCS System shall authorise movements only if they don't represent a danger for railway actors (such as driver or passengers), or the infrastructure and rolling stock assets, or non-track-bound track users or mobile objects and if these movements are part of plan or actions derived from degraded operation.

[SPP-6684 ]

**3.2-41 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.**

In routine operation, the CCS System shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller. [SPP-6687 ]

### 3.2-42 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.

In routine operation, the CCS System shall support the execution of requests without the need to use unambiguous or verbal communication between other actors. [SPP-6688 ]

### 3.2-43 - Safety assessment on run time

The Traffic Control process implements a “safety assessment on run time” method to assure flexible and scalable configurations, flexible and efficient migrations (deployment and evolvability), line access by heterogenous train types with different capabilities, asset changes on run-time, different asset capabilities, and degraded modes with still available production capacity and automation. The method shall follow the approach to assess dynamically and in real-time the available reliable information about configuration, track usage and asset conditions before allowing any change of status, movement, or new track usage.

ID	SPT2OD-277
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### 3.2-44 - Safety assessment on runtime








*[Description of problem and general need in regard to CCS]*

Today's CCS systems require a safety logic specifically designed for the Infrastructure Manager (IM) market, which must be tested, approved, and authorised in accordance with the requirements of a Safety Integrity Level 4 (SIL4) system before commissioning and whenever there are changes to the infrastructure. This approach primarily hinders the rapid rollout of ETCS Level 2 (ETCS-L2) and poses obstacles to the introduction of cross-system optimisation for capacity and safety.

For example, track capacity is currently lost due to the implementation of fixed routes that do not consider the real-time operational state. For instance, flank protection is always activated even when there is no risk of flank collision, such as when no train is nearby, or a large overlap is reserved when it is not needed. Implementing safety assessments during runtime enables the establishment of a generic safety case, as only generic safety checks that are independent of topological specifics can be approved.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*



#### • Flexible and scalable configurations

- As an IM, I want to use and deploy the system on different railway infrastructure without the need to adapt or re-approve the system. Different railway infrastructures include: different trackside equipment (different sensor types, different actor types), different topologies (e.g. different field elements, physical track properties, different track elements like tunnels or bridges), different usage of railway infrastructure (high-/low-density lines, passenger trains, cargo, shunting)
  -  SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits
  -  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data
  -  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data
  -  SPP-9303 - Execution of Safety Supervision based on predefined procedures
  -  SPP-10231 - Independence from pre-engineered safety critical logic
- As an IM, I want to change the characteristics of a railway infrastructure on runtime without the need to adapt or re-approve the system.
  -  SPP-9296 - CCS shall enable updates of Configuration Data on runtime
  -  SPP-8624 - An harmonised process shall be defined to systems configuration during rail operation



- SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data
- SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data
- SPP-9303 - Execution of Safety Supervision based on predefined procedures
- SPP-10231 - Independence from pre-engineered safety critical logic
- [Application Condition] SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time
- As an IM, I want to set a different set of national configurations on runtime without the need to adapt or re-approve the system.
  - SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits
  - SPP-9296 - CCS shall enable updates of Configuration Data on runtime
- As an IM, I want to update system configuration (e.g. security certificates, ip-addresses, ..) on runtime without the need to adapt or re-approve the system.
  - SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits
  - SPP-9296 - CCS shall enable updates of Configuration Data on runtime
- As an IM, I want to update/patch system software without impacting the railway operation.
  - SPP-9296 - CCS shall enable updates of Configuration Data on runtime
- **Flexible and efficient migrations (deployment and evolvability)**
  - As an IM, I want to minimise the deployment, rollout efforts and rollout times for the system, as well as, for the ETCS L2 rollout.
    - SPP-9301 - Support for efficient rollout processes
    - SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits
    - [Application Condition] SPP-15442 - TMS shall support the extension of automatic functions and the increased level of automation in functions already implemented.
    - [Application Condition] SPP-15528 - TMS shall enable the implementation of 'Generic Products' for its subsystems in accordance with CENELEC 50126
    - [Application Condition] SPP-15633 - TMS shall allow to define a 'Generic Application', in accordance with CENELEC 50126
  - As an IM, I want to reduce engineering and testing efforts for system deployment and system modifications.
    - SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits
    - SPP-9303 - Execution of Safety Supervision based on predefined procedures
    - SPP-10231 - Independence from pre-engineered safety critical logic
    - SPP-9297 - Reduction of engineering complexity
    - SPP-9298 - Minimum required Configuration Data implementation
  - As an IM, I want a system which does not need to be adapted or re-approved every time a new instance of the system or a subsystem is deployed on my given infrastructure.
    - SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits





### • Line access by heterogeneous train types with different capabilities

- As an RU, I want a system which support maximal amount of existing train types and on-board equipment and requires minimal effort for migration of existing train types (e.g. ETCS system version, w/o safe train length, w/o safe train integrity)
  -  SPP-9270 - Support for mixed fleet operation
  - [Application Condition]  SPP-15440 - TMS shall be able to manage train mixed fleets equipped with CCS on-boards with different system versions and/or supporting different capabilities



### • Asset changes on run-time

- As an IM, I want to change assets during run-time with no/minimal impact on rail operation and without the need to adapt or re-approve the system
  -  SPP-9296 - CCS shall enable updates of Configuration Data on runtime
  -  SPP-10246 - Integration of external devices



### • Components and system updates on run-time

- As an IM, I want to upgrade system and components during run-time with no/minimal impact on rail operation
  -  SPP-9274 - Upgradeability of Internal Components
  -  SPP-10245 - Upgradeability of adjacent systems


### • Different asset capabilities

- As an IM, I want a system which can cope with different trackside asset capabilities without the need to adapt or re-approve system in order to minimise migration efforts.
  -  SPP-9266 - Management of variable System Capabilities
  - [Application Condition]  SPP-15441 - TMS shall define a migration strategy able to be aligned with the CCS evolution plan





### • Degraded modes with still available production capacity and automation



- As an IM, I want a system which can automatically cope with degraded modes of trackside assets and trains in order to reduce manual user interaction, improve safety and minimise effect of degraded situations on rail operation
  -  SPP-9266 - Management of variable System Capabilities
  -  SPP-10232 - Automated triggering of mitigations


























### • Real-time assessment about track usage

- As an IM, I want the Traffic CS safety core to consider the real-time track usage in its safety conditions and safety reactions in order to increase track capacity.
  -  SPP-6947 - CCS shall allow movements from any point A to any point B without restrictions, if a route is available and is physically feasible.

#### [Application Conditions]

-  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time
-  SPP-15441 - TMS shall define a migration strategy able to be aligned with the CCS evolution plan
-  SPP-15442 - TMS shall support the extension of automatic functions and the increased level of automation in functions already implemented.
-  SPP-15528 - TMS shall enable the implementation of 'Generic Products' for its subsystems in accordance with CENELEC 50126

-  SPP-15633 - TMS shall allow to define a 'Generic Application', in accordance with CENELEC 50126
-  SPP-15440 - TMS shall be able to manage train mixed fleets equipped with CCS on-boards with different system versions and/or supporting different capabilities

Linked Work Items	<p>is derived from :  SPT20D-277 - Safety assessment on run time</p> <p>has parent :  SPP-6577 - Traffic Control and Supervision</p> <p>_ is derived by :  SPP-6947 - CCS shall allow movements from any point A to any point B without restrictions, if a route is available and is physically feasible.</p> <p>_ is derived by :  SPP-8624 - An harmonised process shall be defined to systems configuration during rail operation</p> <p>_ is derived by :  SPP-9266 - Management of variable System Capabilities</p> <p>_ is derived by :  SPP-9270 - Support for mixed fleet operation</p> <p>_ is derived by :  SPP-9274 - Upgradeability of Internal Components</p> <p>_ is derived by :  SPP-9296 - CCS shall enable updates of Configuration Data on runtime</p> <p>_ is derived by :  SPP-9297 - Reduction of engineering complexity</p> <p>_ is derived by :  SPP-9298 - Minimum required Configuration Data implementation</p> <p>_ is derived by :  SPP-9301 - Support for efficient rollout processes</p> <p>_ is derived by :  SPP-9303 - Execution of Safety Supervision based on predefined procedures</p> <p>_ is derived by :  SPP-10231 - Independence from pre-engineered safety critical logic</p> <p>_ is derived by :  SPP-10232 - Automated triggering of mitigations</p> <p>_ is derived by :  SPP-10245 - Upgradeability of adjacent systems</p> <p>_ is derived by :  SPP-10246 - Integration of external devices</p> <p>_ is derived by :  SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits</p> <p>_ is derived by :  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data</p> <p>_ is derived by :  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data</p> <p>_ is derived by :  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time</p> <p>_ is derived by :  SPP-15440 - TMS shall be able to manage train mixed fleets equipped with CCS on-boards with different system versions and/or supporting different capabilities</p> <p>_ is derived by :  SPP-15441 - TMS shall define a migration strategy able to be aligned with the CCS evolution plan</p> <p>_ is derived by :  SPP-15442 - TMS shall support the extension of automatic functions and the increased level of automation in functions already implemented.</p> <p>_ is derived by :  SPP-15528 - TMS shall enable the implementation of 'Generic Products' for its subsystems in accordance with CENELEC 50126</p> <p>_ is derived by :  SPP-15633 - TMS shall allow to define a 'Generic Application', in accordance with CENELEC 50126</p>
ID	SPP-7220

### 3.2-45 - Execution of Safety Supervision based on predefined procedures

The CCS shall execute safety supervision based on predefined procedures, as functional logic and rules, using real-time data related to configurations, track usage, and asset conditions. [SPP-9303 ]

### **3.2-46 - Independence from pre-engineered safety critical logic**

The CCS shall perform safety supervision independently of any pre-engineered safety critical logic models, such as fixed block sections. [SPP-10231 ]

### **3.2-47 - Automated triggering of mitigations**

The CCS shall have the capability to automatically trigger event-related mitigations or corrective actions when required. [SPP-10232 ]

### **3.2-48 - Management of variable System Capabilities**

The CCS shall automatically manage varying and changing system capabilities, including pre-defined degraded modes of supervised infrastructure and trains, while maintaining safety, production capacity, and automation at the highest achievable level. [SPP-9266 ]

### **3.2-49 - Support for mixed fleet operation**

The CCS shall support the mixed operation of trains, including those with and without train integrity monitoring systems. [SPP-9270 ]

### **3.2-50 - Upgradeability of adjacent systems**

The CCS shall support the upgradeability of adjacent systems during system operation. [SPP-10245 ]

### **3.2-51 - Integration of external devices**

The CCS shall support the integration of external devices during system operation. [SPP-10246 ]

### **3.2-52 - Allow configuration of Generic Application according to local needs within predefined limits**

The CCS shall allow to define a 'Generic Application', in accordance with CENELEC 50126, that can be configured according to local needs (combination of subsystems + system parametrisation) within predefined limits. [SPP-10253 ]


### **3.2-53 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data**

The CCS shall enable the implementation of 'Generic Products' for its subsystems. Each 'Generic Product' shall have a full generic product safety case in accordance with CENELEC 50126, that is independent of the Configuration Data (Infrastructure Data, Vehicle Data, Parameter Data) utilised. [SPP-10254 ]

### **3.2-54 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data**

The CCS shall enable the implementation of an 'Generic Application' based on 'Generic Products'. The 'Generic Application' shall have a full generic safety case in accordance with CENELEC 50126, that is independent of the Configuration Data (Infrastructure Data, Vehicle Data, Parameter Data) utilised. This 'Generic Application' shall have no repercussion on the european type approvals of the used 'Generic Products' of the CCS system. [SPP-10255 ]

### **3.2-55 - CCS shall enable updates of Configuration Data on runtime**

The CSS shall enable updates of  SPT2TS-127779 - Configuration Data on runtime. [SPP-9296 ]

### **3.2-56 - Reduction of engineering complexity**

The CCS shall be designed to standardise the implementation of internal components and interfaces, minimising unnecessary complexity and variant implementations. [SPP-9297 ]

### **3.2-57 - Minimum required Configuration Data implementation**

The CCS shall be implemented using only the minimum required set of configuration data necessary for operation. [SPP-9298 ]

### **3.2-58 - Support for efficient rollout processes**

The CCS shall support a predefined and efficient rollout process for specific configurations. [SPP-9301 ]

### **3.2-59 - Automation in degraded modes and system intervention**

One important improvement/requirement inside of this dynamic safety assessment is to allow some automation in degraded modes (if still possible) and to change infrastructures (or intervene into the



system) under production in a safe way. Instead of working in an “on/off/verify/on” way, the Traffic CS shall assess on the basis of its available operational state information (assets, trains, etc.) what automation in degraded modes (“rich degraded modes”, e.g. automatic command for sweeping a defect point by moving on sight) or what system intervention (e.g. diagnosis test run in a component under production) is still safe. This increases availability and efficiency.

ID	SPT2OD-279
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### 3.2-60 - Automation in degraded modes and system intervention

*[Description of problem and general need in regard to CCS]*


In today's CCS operation, system faults often lead to a full stop of train operation followed by manual procedures to allow train movements again. This often means a shift of responsibility for safe railway operation to the human resulting in high pressure situations which are prone to errors. The successful handling of these degraded situations is highly dependent on the experience of the staff who is involved which leads to inefficiencies and potentially unsafe situations.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*


As an IM, I want a system which guarantees a high degree of automation to manage and resolve degraded situations of trains and infrastructure (e.g. imposition of pre-defined speed limits, isolating the affected section of track, etc.) and in normal operation

-  SPP-9266 - Management of variable System Capabilities
-  SPP-7071 - Automated routine operational production procedures for train movements or shunting movements
-  SPP-7072 - Automated routine operational production procedures for field force work
-  SPP-7107 - Automated regulation of infrastructure resources deployment
- [Application Condition]  SPP-14899 - TMS shall optimize train movements in relation to each other (capacity, speed, energy consumption) and unproductive waiting times of maintenance teams or construction sites based on the track usage information received from CCS.
- [Application Condition]  SPP-14829 - TMS shall support CCS to automatically and safely handle pre-defined degraded modes during operation



As an IM and as a RU, I want CCS to support harmonised operational processes in order to reduce technical and operational complexity.


-  SPT2OD-2925 - Singular harmonised processes

As an IM, I want that the currently available line capacity can be optimally utilised in degraded situations of trains and infrastructure.





-  SPP-8864 - CCS able to handle different and changing system capabilities of its actors during operation













As an IM, I want to safely modify the infrastructure or the configuration during runtime with minimal impact on railway operations

-  SPP-9296 - CCS shall enable updates of Configuration Data on runtime
-  SPP-8624 - An harmonised process shall be defined to systems configuration during rail operation

- [Application Condition]  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time

As an IM, I want to safely intervene in the system (e.g. diagnosis test run in an component under production) or mitigation measures in case of an incident during runtime with minimal impact on railway operations to recover, identify the cause of the incident or remediate the degraded operation.

-  SPP-8625 - An harmonized process shall be defined to run diagnose test of a component during running time
-  SPP-8626 - CCS shall support diagnose test of a component during running time.
-  SPP-8650 - An harmonized process shall be defined to mitigation measures to react in case of an incident
- [Application Condition]  SPP-14828 - TMS shall support diagnose test of a component during running time

Linked Work Items	<p>is derived from :  SPT2OD-279 - Automation in degraded modes and system intervention</p> <p>has parent :  SPP-6577 - Traffic Control and Supervision</p> <p>_ is derived by :  SPP-7071 - Automated routine operational production procedures for train movements or shunting movements</p> <p>_ is derived by :  SPP-7072 - Automated routine operational production procedures for field force work</p> <p>_ is derived by :  SPP-7107 - Automated regulation of infrastructure resources deployment</p> <p>_ is derived by :  SPP-8624 - An harmonised process shall be defined to systems configuration during rail operation</p> <p>_ is derived by :  SPP-8625 - An harmonized process shall be defined to run diagnose test of a component during running time</p> <p>_ is derived by :  SPP-8626 - CCS shall support diagnose test of a component during running time.</p> <p>_ is derived by :  SPP-8650 - An harmonized process shall be defined to mitigation measures to react in case of an incident</p> <p>_ is derived by :  SPP-8864 - CCS able to handle different and changing system capabilities of its actors during operation</p> <p>_ is derived by :  SPP-9266 - Management of variable System Capabilities</p> <p>_ is derived by :  SPP-9296 - CCS shall enable updates of Configuration Data on runtime</p> <p>_ is derived by :  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time</p> <p>_ is derived by :  SPP-14828 - TMS shall support diagnose test of a component during running time</p> <p>_ is derived by :  SPP-14829 - TMS shall support CCS to automatically and safely handle pre-defined degraded modes during operation</p> <p>_ is derived by :  SPP-14899 - TMS shall optimize train movements in relation to each other (capacity, speed, energy consumption) and unproductive waiting times of maintenance teams or construction sites based on the track usage information received from CCS.</p> <p>_ is derived by :  SPT2OD-2925 - Singular harmonised processes</p>
ID	SPP-6813

### 3.2-61 - CCS shall support diagnose test of a component during running time.

CCS shall support diagnose test of a component during running time. [SPP-8626 ]

### 3.2-62 - An harmonised process shall be defined to systems configuration during rail operation

An harmonised process shall be defined to systems configuration during rail operation [SPP-8624 ]

### 3.2-63 - An harmonized process shall be defined to run diagnose test of a component during running time

An harmonized process shall be defined to run diagnose test of a component during running time. [SPP-8625 ]

### 3.2-64 - An harmonized process shall be defined to mitigation measures to react in case of an incident

An harmonized process shall be defined to mitigation measures to react in case of an incident (e.g. track section sweeping, deploying/requesting unplanned maintenance routines, etc.) [SPP-8650 ]

### 3.2-65 - Continuous supervision of railway production

The safety, condition and availability supervision of the railway production is a continuous process for all types of track users (track-bound or non-track-bound) in the same way and includes static as well as configurable event pattern recognition for automatically triggering event-related mitigations or measures. All types of more and more available mobile, train-born, or fixed sensor information (also from outside of the CCS and TM/CM system) and data sources (like WIFI detection or mobile maintenance apps) are included dynamically into and combined in this supervision (like person counters for platforms or car detectors on crossings) to increase the reliability, robustness, availability, and precision of this supervision process.

ID	SPT2OD-280
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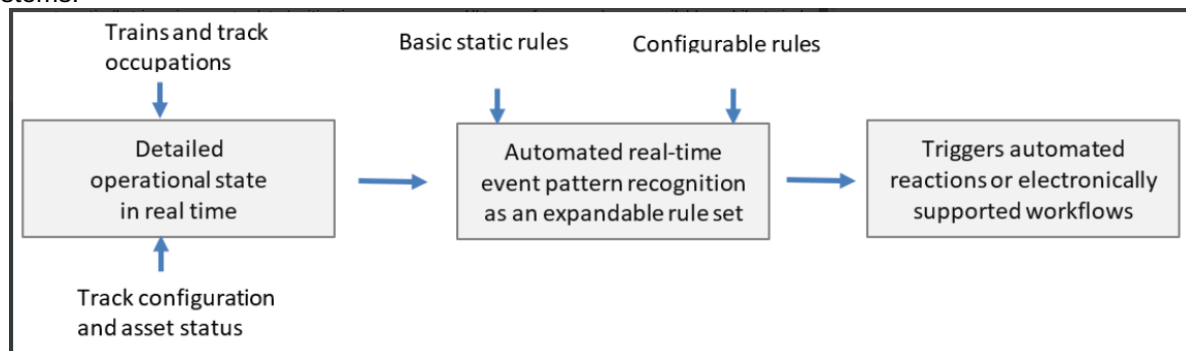
### 3.2-66 - Continuous supervision of railway production

[Description of problem and general need in regard to CCS]

In the context of this Railway Requirement, the *possibility to configure new rules* is meant as a feature that must be executable independent of configuration control. In other words, implementing modifications to a system is theoretically always possible if it is controlled via a new configuration (a new version), but in this case, this functionality is meant as the possibility of modifying part of a supervision logic (event pattern recognition) without affecting the base characteristics of the system in its current configuration. This is of course close relationship/contradiction to the requirement for *safety critical and non-safety related functional segregation*, as well as the business requirement for *the re-usability of safety cases*; because safety critical elements of a system shall not be editable without a close control loop.

**- With exception of safety critical and static processes (base) rules, configurable supervision (event pattern recognition) rules shall be supported.**


The expectation is that there are basic static rules set to trigger certain reaction or mitigation measures, and another configurable rules that can be adapted. The last rule set only possible for non-safety critical systems.










The possibility for - the **dynamic provision of advisory/assistive information locally to system actors** as they require them. This could contain information in the format of workflows.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*


As an IM, I want that the supervision is conducted by gathering sensor information from various sources such as the track, trains, and other data sources to improve reliability and availability of the supervision process.

-  SPP-6949 - CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state.






As an IM, I want that the available sensor information is dynamically utilised as it becomes accessible, and an easy integration of new sensor technologies to reduce the impact of the safety case

-  SPP-6957 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.
-  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects
-  SPP-6683 - An harmonized process shall be defined to supervise all possible track users
-  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.
-  SPP-9274 - Upgradeability of Internal Components
-  SPP-10245 - Upgradeability of adjacent systems
-  SPP-10246 - Integration of external devices



As an IM / RU, I want that abnormal events in the planned railway operation can be recognised and addressed automatically using static event pattern recognition or configurable event pattern recognition methods.

-  SPP-9041 - An harmonized process shall be defined to automatically or semi-automatic detect abnormal events in the railway production using real-time "sensor fusion" information.


As an IM / RU, I want that in case of a detected abnormality in the planned production, several actions should be taken to ensure a minimal production quality (i.e. minimum necessary functions for safe production). This includes triggering mitigation measures, which can be done either automatically or through electronically supported workflows that involve human intervention. As an IM/RU I want to have enough flexibility to configure (ej. modify, increase) new event rules that trigger the mitigation measures.

-  SPP-9037 - An harmonized process shall be defined to automatically or semi-automatic trigger pre-defined mitigation measures
-  SPP-9038 - For non safety critical systems, an harmonized process shall be defined to configure new rules to automatically or semi-automatic trigger pre-defined mitigation measures
-  SPP-9042 - An harmonized process shall be defined to display dynamically pre-defined assistive information
- [Application Condition]  SPP-14788 - IM shall train the operator in charge of configuration CCS System to create or adapt configurable rules for non safety critical
- [Application Condition]  SPP-14789 - IM shall train the operator interacting with CCS System to understand the advisory/assistive information and related limitations of CCS System in case of an incident or degraded situation















As an IM, I want to optimise the track capacity up to the full use of the physical track capacity

-  SPP-6817 - Defined application configuration(s) to supervise operational production of all types of infrastructure needs and users and to automatically trigger event-related mitigations or corrective measures.
-  SPP-6819 - CCS shall allow the definition of specific application configuration(s) for supporting the supervision of operational production of all types of infrastructure needs and users

As IM, I want to have availability of digitalised information about resources that are direct related with the optimal operation of the railway network, or in the general safety processes, and include such information, every time that more sensors' information is available (due to technology improvement).

-  SPP-6989 - An harmonized process shall be defined to incorporate additional standard subsystems sensory information sources

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Linked Work Items	<p>is derived from :  SPT2OD-280 - Continuous supervision of railway production</p> <p>has parent :  SPP-6577 - Traffic Control and Supervision</p> <p>_ is derived by :  SPP-6683 - An harmonized process shall be defined to supervise all possible track users</p> <p>_ is derived by :  SPP-6817 - Defined application configuration(s) to supervise operational production of all types of infrastructure needs and users and to automatically trigger event-related mitigations or corrective measures.</p> <p>_ is derived by :  SPP-6819 - CCS shall allow the definition of specific application configuration(s) for supporting the supervision of operational production of all types of infrastructure needs and users</p> <p>_ is derived by :  SPP-6949 - CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state.</p> <p>_ is derived by :  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects</p> <p>_ is derived by :  SPP-6957 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.</p> <p>_ is derived by :  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.</p> <p>_ is derived by :  SPP-6989 - An harmonized process shall be defined to incorporate additional standard subsystems sensory information sources</p> <p>_ is derived by :  SPP-9037 - An harmonized process shall be defined to automatically or semi-automatic trigger pre-defined mitigation measures</p> <p>_ is derived by :  SPP-9038 - For non safety critical systems, an harmonized process shall be defined to configure new rules to automatically or semi-automatic trigger pre-defined mitigation measures</p> <p>_ is derived by :  SPP-9041 - An harmonized process shall be defined to automatically or semi-automatic detect abnormal events in the railway production using real-time "sensor fusion" information.</p> <p>_ is derived by :  SPP-9042 - An harmonized process shall be defined to display dynamically pre-defined assistive information</p> <p>_ is derived by :  SPP-9274 - Upgradeability of Internal Components</p> <p>_ is derived by :  SPP-10245 - Upgradeability of adjacent systems</p> <p>_ is derived by :  SPP-10246 - Integration of external devices</p> <p>_ is derived by :  SPP-14788 - IM shall train the operator in charge of configuration CCS System to create or adapt configurable rules for non safety critical</p> <p>_ is derived by :  SPP-14789 - IM shall train the operator interacting with CCS System to understand the advisory/assistive information and related limitations of CCS System in case of an incident or degraded situation</p>
ID	SPP-9039

### 3.2-67 - An harmonized process shall be defined to automatically or semi-automatic trigger pre-defined mitigation measures

An harmonized process shall be defined to automatically or semi-automatic trigger pre-defined mitigation measures based on recognition of abnormal events in the railway production using real-time "sensor fusion" information. [SPP-9037 ]

### 3.2-68 - For non safety critical systems, an harmonized process shall be defined to configure new rules to automatically or semi-automatic trigger pre-defined mitigation measures

For non safety critical systems, an harmonized process shall be defined to configure new rules to



automatically or semi-automatic trigger pre-defined mitigation measures based on recognition of abnormal events in the railway production using real-time "sensor fusion" information. [SPP-9038 ]

**3.2-69 - An harmonized process shall be defined to automatically or semi-automatic detect abnormal events in the railway production using real-time "sensor fusion" information.**

An harmonized process shall be defined to automatically or semi-automatic detect abnormal events in the railway production using real-time "sensor fusion" information. [SPP-9041 ]

**3.2-70 - An harmonized process shall be defined to display dynamically pre-defined assistive information**

An harmonized process shall be defined to display dynamically pre-defined assistive information (e.g. proposing workflows, alternatives) to the operator when an abnormal event in the railway production (in a specific situation or location) is detected to facilitate the execution of the operator's activities. [SPP-9042 ]

**3.2-71 - Improved ETCS performance**

This includes for example precise braking and speed regime, complete supervision in all normal situations (like for shunting), fast and simple border transitions, fast change of direction, all types of movements (like propelling of yellow fleet trains) or fast start of mission.

ID	SPT2OD-282
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**3.2-72 - Improved ETCS performance**

*[Description of problem and general need in regard to CCS]*

The important next evolution step for ETCS is to tune the existing architecture to the performance and cost that it was designed for and like it is visible in some CBTC implementations (higher performance, less cost for trackside assets, simple deployment).

Starting from the title, the first definition is that **this project shall utilise ETCS as a basis**, bringing up changes to the standard only where justified by pertinent performance improvements.








The description of this vision is done through a list of business improvement targets. These are individually decomposed in the following derived requirements:

- precise braking and speed regime: refers to the possibility to flexibly and precisely (and possibly automatedly) determine optimal acceleration and braking regimes based on the individual train configuration and current capabilities.
- complete supervision in all normal situations (like for shunting), all types of movements (like propelling of yellow fleet trains): refers to the need for extending the ability to execute the operation of most routine rolling stock maneuvers under the safety full supervision of the CCS system. This is of course an enabler to the business objectives for automation, and it is therefore closely related to the requirement that *automated and unattended train operations shall be supported*, and will only be achievable within the target system boundary (i.e. Europe), if operational harmonisation is successful.
- fast and simple border transitions, fast change of direction, fast start of mission: refers to the need to optimise (in terms of accelerate) the operational/commercial processes. The means by which the processes are to be optimised are not here defined, but it entails the aforementioned needs for operational harmonisation, automated and unattended train operation targets and the simplification of processes through information digitalization and availability.


*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

As an IM and RU, I want to improve the operation of ETCS L2 processes by increasing efficiency and


reducing complexity.

-  SPP-6991 - CCS shall support trains equipped with ETCS Baseline 3 (ETCS Level 2 only). This means CCS will implement ETCS System Version 2 on the trackside. The implemented ETCS System Versions can be raised over time
-  SPP-7081 - CCS shall automatically supervise rail operation
-  SPP-7021 - CCS shall allow manoeuvres with cab-signalling (with no light signals) or using not-harmonised dwarf light signals.
-  SPP-7025 - CCS shall be designed to use ETCS L2 without optical (light) signals.
-  SPP-7051 - The operational processes shall be simplified in order to optimize as much as possible the commercial and operational production processes within the Railway System boundary.
-  SPP-7052 - A process shall feature the ability of executing rolling stock routine manoeuvres for commercial operational production.
-  SPP-7053 - CCS shall support the dynamic automated determination of train characteristics





As an IM and RU, I want to improve the performance of train runs with ETCS L2.

-  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.


As an IM and RU, I want all movements on the railway network to be covered by ETCS L2 processes.

-  SPP-7052 - A process shall feature the ability of executing rolling stock routine manoeuvres for commercial operational production.














As an IM, I want to reduce the effort and complexity to roll-out ETCS L2.

-  SPP-6991 - CCS shall support trains equipped with ETCS Baseline 3 (ETCS Level 2 only). This means CCS will implement ETCS System Version 2 on the trackside. The implemented ETCS System Versions can be raised over time
-  SPP-6857 - CCS shall minimize the number of configuration parameters for Generic and Specific Applications
-  SPP-6860 - CCS shall be based on standardized products and configurations
-  SPP-7025 - CCS shall be designed to use ETCS L2 without optical (light) signals.

*[Application Conditions]*

-  SPP-14776 - TMS shall support the track capacity optimization through a correct and efficient use of the operational state received from CCS.



Linked Work Items	<p>is derived from :  SPT2OD-282 - Improved ETCS performance</p> <p>has parent :  SPP-6577 - Traffic Control and Supervision</p> <p>_ is derived by :  SPP-6857 - CCS shall minimize the number of configuration parameters for Generic and Specific Applications</p> <p>_ is derived by :  SPP-6860 - CCS shall be based on standardized products and configurations</p> <p>_ is derived by :  SPP-6991 - CCS shall support trains equipped with ETCS Baseline 3 (ETCS Level 2 only). This means CCS will implement ETCS System Version 2 on the trackside. The implemented ETCS System Versions can be raised over time</p> <p>_ is derived by :  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.</p> <p>_ is derived by :  SPP-7021 - CCS shall allow manoeuvres with cab-signalling (with no light signals) or using not-harmonised dwarf light signals.</p> <p>_ is derived by :  SPP-7025 - CCS shall be designed to use ETCS L2 without optical (light) signals.</p> <p>_ is derived by :  SPP-7051 - The operational processes shall be simplified in order to optimize as much as possible the commercial and operational production processes within the Railway System boundary.</p> <p>_ is derived by :  SPP-7052 - A process shall feature the ability of executing rolling stock routine manoeuvres for commercial operational production.</p> <p>_ is derived by :  SPP-7053 - CCS shall support the dynamic automated determination of train characteristics</p> <p>_ is derived by :  SPP-7081 - CCS shall automatically supervise rail operation</p> <p>_ is derived by :  SPP-14776 - TMS shall support the track capacity optimization through a correct and efficient use of the operational state received from CCS.</p>
ID	SPP-6990

**3.2-73 - CCS shall support trains equipped with ETCS Baseline 3 (ETCS Level 2 only). This means CCS will implement ETCS System Version 2 on the trackside. The implemented ETCS System Versions can be raised over time**

CCS shall support trains equipped with ETCS Baseline 3 and above (ETCS Level 2 only). This means Traffic CS will initially implement ETCS System Version 2. The implemented ETCS System Versions can be raised over time. [SPP-6991 ]

**3.2-74 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.**

CCS shall provide to Traffic Management System a complete, consistent, accurate and up-to-date operating state.

The operating state contains the train location and characteristics, track usages (track path reservations, usage restrictions, occupancies) and the state of the trackside assets in the area of control. [SPP-7020 ]

**3.2-75 - CCS shall allow manoeuvres with cab-signalling (with no light signals) or using not-harmonised dwarf light signals.**

CCS shall allow manoeuvres with cab-signalling (with no light signals) or using harmonised dwarf light signals. [SPP-7021 ]

**3.2-76 - CCS shall be designed to use ETCS L2 without optical (light) signals.**

Traffic CS shall be designed to use ETCS L2 without non-harmonised, optical signals. [SPP-7025 ]

**3.2-77 - The operational processes shall be simplified in order to optimize as much as possible the commercial and operational production processes within the Railway System boundary.**

The operational processes shall be simplified in order to optimize as much as possible the commercial and operational production processes within the Railway System boundary. [SPP-7051 ]

**3.2-78 - A process shall feature the ability of executing rolling stock routine manoeuvres for commercial operational production.**

Based on defined application configuration(s), a process shall feature the ability of executing rolling stock routine manoeuvres for commercial operational production (including shunting/marshalling yard

operations) under the complete safety supervision of CCS.

*Note: complete safety supervision is meant as a minimum as the supervision of all the variables which are today supervised in the mode "FS", and it is independent of GoA levels. This does not preclude that with advancement of technology, "complete supervision" could include the supervision which is total undertaken by a Driver. Variables are configured to support risk mitigation related to the procedure, which is also interlinked with trackside CCS safety supervision. E.g.: Override by driver-actor is only allowed onboard if the trackside has allowed it based on the required imposition of mitigation measures; or shunting within AoC is supervised with regards its path (including and of authorised path) and speed; etc. [SPP-7052 ]*

### 3.2-79 - CCS shall support the dynamic automated determination of train characteristics

CCS shall support the ability to automatically determine predefined train characteristics - e.g. length, composition, train formation, braking state, adhesion conditions, train acceleration/deceleration regimes on run-time based on the train's current capabilities, etc..

The automatic functionality may follow specific procedural triggers - such as train initialisation procedures - or may be triggered by conditional event recognition - e.g. low adhesion -. [SPP-7053 ]

### 3.2-80 - Optimizing track capacity

The relevance of track occupancy information including safety margins shall be taken into account for optimizing track capacity. Traffic CS of today on mainline does not make the full use of the physical track capacity in this way. Diffuse operational states (e.g., track position of a starting train) are reported and control optimisations do not take train capabilities into account.

ID	SPT2OD-283
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### 3.2-81 - Optimizing track capacity

*[Description of problem and general need in regard to CCS]*

Today's CCS trackside infrastructure often limits the track capacity (maximum train density). With the current level of inaccuracy the overall railway infrastructure capacity cannot be exploit to its maximum. In the future, the operational plan and its execution shall consider more detailed information such as precise train position, train integrity status and consistent and accurate status of operational state in order to increase the capacity of the infrastructure. In future, the track capacity shall only be limited by the physical track, and more precise train-track occupancy determination layout and not by the capabilities of the trackside systems and assets.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

As an IM, I want to optimise the track capacity up to the full use of the physical track capacity

-  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.
-  SPP-6949 - CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state.
-  SPP-9303 - Execution of Safety Supervision based on predefined procedures
-  SPP-10231 - Independence from pre-engineered safety critical logic
-  SPP-10232 - Automated triggering of mitigations
-  SPP-6817 - Defined application configuration(s) to supervise operational production of all types of infrastructure needs and users and to automatically trigger event-related mitigations or corrective measures.
-  SPP-6819 - CCS shall allow the definition of specific application configuration(s) for supporting the supervision of operational production of all types of infrastructure needs and users

- SPP-6662 - Limited allocation of infrastructure resources to train movements
- SPP-6820 - CCS shall support the onboard determination of track occupation - i.e. train position, length and integrity, including safety margins.
- SPP-6821 - Dynamic track path determination

#### [Application Conditions]

- SPP-14776 - TMS shall support the track capacity optimization through a correct and efficient use of the operational state received from CCS.
- SPP-11496 - TMS shall automatically update the operational plan in real time (in short intervals) over the entire process life-cycle

Linked Work Items	<p>is derived from : SPT2OD-283 - Optimizing track capacity</p> <p>has parent : SPP-6577 - Traffic Control and Supervision</p> <p>_ is derived by : SPP-6662 - Limited allocation of infrastructure resources to train movements</p> <p>_ is derived by : SPP-6817 - Defined application configuration(s) to supervise operational production of all types of infrastructure needs and users and to automatically trigger event-related mitigations or corrective measures.</p> <p>_ is derived by : SPP-6819 - CCS shall allow the definition of specific application configuration(s) for supporting the supervision of operational production of all types of infrastructure needs and users</p> <p>_ is derived by : SPP-6820 - CCS shall support the onboard determination of track occupation - i.e. train position, length and integrity, including safety margins.</p> <p>_ is derived by : SPP-6821 - Dynamic track path determination</p> <p>_ is derived by : SPP-6949 - CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state.</p> <p>_ is derived by : SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.</p> <p>_ is derived by : SPP-9303 - Execution of Safety Supervision based on predefined procedures</p> <p>_ is derived by : SPP-10231 - Independence from pre-engineered safety critical logic</p> <p>_ is derived by : SPP-10232 - Automated triggering of mitigations</p> <p>_ is derived by : SPP-11496 - TMS shall automatically update the operational plan in real time (in short intervals) over the entire process life-cycle</p> <p>_ is derived by : SPP-14776 - TMS shall support the track capacity optimization through a correct and efficient use of the operational state received from CCS.</p>
ID	SPP-6604

### 3.2-82 - Defined application configuration(s) to supervise operational production of all types of infrastructure needs and users and to automatically trigger event-related mitigations or corrective measures.

Defined application configuration(s) shall guarantee :

- the ability to supervise operational production of all types of infrastructure needs and users (track-bound or non track-bound) against predefined or dynamic targets related to resources condition and availability;
- the ability to automatically trigger event-related mitigations or corrective measures

#### [SPP-6817]

### 3.2-83 - CCS shall allow the definition of specific application configuration(s) for supporting the supervision of operational production of all types of infrastructure needs and users

The CCS System shall allow the definition of specific application configuration(s) for supporting the supervision of the operational production of all types of infrastructure needs and users  
[SPP-6819 ]

### 3.2-84 - Limited allocation of infrastructure resources to train movements

The CCS System shall limit the length of the path for a train to move to the lowest possible length whilst guaranteeing that:

- the train speed supervision curve does not enter into the braking phase before a new movement authority can be requested, processed, issued, received, applied.
- trackside asset restrictions are not violated - e.g. non-stop areas, end of block sections, etc.

[SPP-6662 ]

### 3.2-85 - CCS shall support the onboard determination of track occupation - i.e. train position, length and integrity, including safety margins.

The CCS System shall support the onboard determination of track occupation - i.e. train position, length and integrity, including safety margins. [SPP-6820 ]

### 3.2-86 - Dynamic track path determination

The CCS System shall support the ability for the trackside CCS to dynamically segmentate and allocate track paths to performed planned operations in the most track capacity-optimal manner in relation to the real time operating state of the network and its assets. [SPP-6821 ]

### 3.2-87 - Stable and backwards compatible air gap interface

This does not mean to significantly change the interoperability-related specifications for the air gap interface as defined in the TSI CCS. Here only some dedicated extensions will be needed in future for automation, higher performance, less migration effort, and more scalability (e.g., driverless ATO GoA 4, support for enhanced onboard localisation, coexistence of ETCS system versions on a line (to a limited extend), supporting degraded modes on lines without trackside train detection, etc.).

ID	SPT2OD-284
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### 3.2-88 - Stable and backward compatible air-gap interface

*[Description of problem and general need]*

The current ETCS and ATO track-to-train interfaces are limited to GoA1 and GoA2 operation:

- in GoA1 (non-automated train operation), the train is driven manually;
- in GoA2 (semi-automated train operation), train driving and stopping is done automatically while other tasks are done manually by the driver or other actors.

In the future the track-to-train interfaces shall support a full automation of all the train tasks through an incremental integration of new automation functions in the railway system. It is of primary importance that during the migration the progressive introduction of these functions will preserve a full compatibility of the track-to-train interface (i.e. these function will be introduced as compatible functions).

Note: this incremental integration of automation will affect also the TMS.


#### Background:

- incompatible functionalities introduced in different System Versions limit the trackside to use new functionality with trains that are already capable because the trackside always has to support the trains with the "lowest" set of capabilities;
- indeed the current track-to-train interface does not allow ETCS on-board having a system version lower than trackside to operate on the same line.
- This causes very high costs for migration which prove to be unsurmountable especially for RUs.









Note: this limitation has been not replicated in the ATO track-to-train interface that backward compatible in both trackside and on-board, while in ETCS track-to-train interface only on-board is backward compatible (i.e. it can adapt the airgap interface to manage trackside with lower system versions).

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*




As an IM / RU, I want CCS to implement European legislation in order to be compliant to a common normative basis across Europe:

-  SPP-7663 - Implementation of TSI





As IM and RU, I want to achieve GoA4 operation (unattended train operation). This means all train functions are done automatically without the train attendant nor the driver intervention. To achieve this, the extend or adaption the trackside-to-train air gap interfaces of TSI CCS might be necessary.

-  SPP-8863 - CCS designed to reduce OPEX
-  SPP-8864 - CCS able to handle different and changing system capabilities of its actors during operation
-  SPP-7668 - ATO GoA 3/4
-  SPP-7021 - CCS shall allow manoeuvres with cab-signalling (with no light signals) or using not-harmonised dwarf light signals.
-  SPP-8839 - If driver is involved in the driving process, CCS shall support driving assistance recommendations
-  SPP-8840 - An harmonized process shall be defined to show the driver optimal energy-efficient driving and an optimised driving speed profile recommendations
-  SPP-9266 - Management of variable System Capabilities
-  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force





As IM, I want to increase the railway capacity. This means more trains running in the same infrastructure. To achieve this, the extend or adaption the trackside-to-train air gap interfaces of TSI CCS might be necessary.

-  SPP-7668 - ATO GoA 3/4
-  SPP-8839 - If driver is involved in the driving process, CCS shall support driving assistance recommendations
-  SPP-8840 - An harmonized process shall be defined to show the driver optimal energy-efficient driving and an optimised driving speed profile recommendations


As IM, I want to reduce the migration effort from legacy systems to target system architecture. To achieve this, the extension or adaption of the TSI CCS track-to-train interfaces might be necessary.

-  SPP-8865 - CCS shall reduce engineering complexity
-  SPT2TRAFFIC-5028 - Able to provide a standard interface to manage handover of trains between SERA equipped areas
-  SPP-7664 - Application configurations shall support backward compatibility
-  SPP-11716 - Categorisation of system components and functional variations according to application configuration(s).




As IM, I want to have a more scalable system architecture. To achieve this, the extend or adaption of the trackside-to-train air gap interfaces of TSI CCS might be necessary

-  SPP-8866 - Implement standardised interfaces without hindering of innovation
-  SPP-8867 - Support Backward compatibility within the Target System architecture
-  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture
-  SPT2TRAFFIC-5037 - Provide a scalable and adaptable system architecture which is suitable for different contexts



As IM and RU, I want to support the enhanced onboard localisation. To achieve this, the extend or adaption the trackside-to-train air gap interfaces of TSI CCS might be necessary

-  SPP-6949 - CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state.



As IM and RU, I want to facilitate the coexistence of different versions of train control system (e.g. ETCS) on the same line. To achieve this, the extension or adaption of TSI CCS track-to-train interfaces might be necessary.

-  SPP-7025 - CCS shall be designed to use ETCS L2 without optical (light) signals.
-  SPP-6991 - CCS shall support trains equipped with ETCS Baseline 3 (ETCS Level 2 only). This means CCS will implement ETCS System Version 2 on the trackside. The implemented ETCS System Versions can be raised over time
-  SPT2TRAFFIC-4961 - Implement interface designs that enable the determination of smallest common set of shareable functions




As IM, I want to allow trains to move in degraded modes on lines without trackside train detection. To achieve this, the extension or adaption of the TSI CCS track-to-train interfaces might be necessary.

-  SPP-9266 - Management of variable System Capabilities
-  SPP-7084 - CCS shall handle different system capabilities supporting standard manual controls






























As an IM, I want to allow shunting with harmonised line-side signals in order to support the trains with the "lowest" set of capabilities.

-  SPP-7025 - CCS shall be designed to use ETCS L2 without optical (light) signals.
-  SPP-6991 - CCS shall support trains equipped with ETCS Baseline 3 (ETCS Level 2 only). This means CCS will implement ETCS System Version 2 on the trackside. The implemented ETCS System Versions can be raised over time

#### *[Application Conditions]*

-  SPP-15441 - TMS shall define a migration strategy able to be aligned with the CCS evolution plan
-  SPP-15442 - TMS shall support the extension of automatic functions and the increased level of automation in functions already implemented.
-  SPP-15538 - TMS shall support CCS backwards compatibility feature



Linked Work Items	<p>is derived from :  SPT2OD-284 - Stable and backwards compatible air gap interface</p> <p>has parent :  SPP-6577 - Traffic Control and Supervision</p> <p>_ is derived by :  SPP-6949 - CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state.</p> <p>_ is derived by :  SPP-6991 - CCS shall support trains equipped with ETCS Baseline 3 (ETCS Level 2 only). This means CCS will implement ETCS System Version 2 on the trackside. The implemented ETCS System Versions can be raised over time</p> <p>_ is derived by :  SPP-7021 - CCS shall allow manoeuvres with cab-signalling (with no light signals) or using not-harmonised dwarf light signals.</p> <p>_ is derived by :  SPP-7025 - CCS shall be designed to use ETCS L2 without optical (light) signals.</p> <p>_ is derived by :  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force</p> <p>_ is derived by :  SPP-7084 - CCS shall handle different system capabilities supporting standard manual controls</p> <p>_ is derived by :  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture</p> <p>_ is derived by :  SPP-7663 - Implementation of TSI</p> <p>_ is derived by :  SPP-7664 - Application configurations shall support backward compatibility</p> <p>_ is derived by :  SPP-7668 - ATO GoA 3/4</p> <p>_ is derived by :  SPP-8839 - If driver is involved in the driving process, CCS shall support driving assistance recommendations</p> <p>_ is derived by :  SPP-8840 - An harmonized process shall be defined to show the driver optimal energy-efficient driving and an optimised driving speed profile recommendations</p> <p>_ is derived by :  SPP-8863 - CCS designed to reduce OPEX</p> <p>_ is derived by :  SPP-8864 - CCS able to handle different and changing system capabilities of its actors during operation</p> <p>_ is derived by :  SPP-8865 - CCS shall reduce engineering complexity</p> <p>_ is derived by :  SPP-8866 - Implement standardised interfaces without hindering of innovation</p> <p>_ is derived by :  SPP-8867 - Support Backward compatibility within the Target System architecture</p> <p>_ is derived by :  SPP-9266 - Management of variable System Capabilities</p> <p>_ is derived by :  SPP-11716 - Categorisation of system components and functional variations according to application configuration(s).</p> <p>_ is derived by :  SPP-15441 - TMS shall define a migration strategy able to be aligned with the CCS evolution plan</p> <p>_ is derived by :  SPP-15442 - TMS shall support the extension of automatic functions and the increased level of automation in functions already implemented.</p> <p>_ is derived by :  SPP-15538 - TMS shall support CCS backwards compatibility feature</p> <p>_ is derived by :  SPP-24424 - Implementation of TSI</p> <p>_ is derived by :  SPP-28338 - Provide a scalable and adaptable system architecture which is suitable for different contexts</p> <p>_ is derived by :  SPP-28346 - Implement interface designs that enable the determination of smallest common set of shareable functions</p> <p>_ is derived by :  SPP-28354 - Able to provide a standard interface to manage handover of trains between SERA equipped areas</p> <p>_ is derived by :  SPT2TRAFFIC-16562 - Implementation of TSI</p>
ID	SPP-7268



### 3.2-89 - Application configurations shall support backward compatibility

With exception of the first configuration, CCS application configurations shall AFARP support interoperability among mixed-generation of subsystems, on behalf of the backward compatibility. [SPP-7664 ]

### 3.2-90 - Implementation of TSI

CCS shall implement the TSI (Technical Specifications for Interoperability) in order to enable cutting edge technologies, harmonised operational processes and operational rules and to support a Single European Railway Area (SERA). [SPP-7663 ]

### 3.2-91 - ATO GoA 3/4

CCS shall support automatic train operation in GoA 3/4 with ATO over ETCS. [SPP-7668 ]

### 3.2-92 - CCS designed to reduce OPEX

CCS shall be designed to reduce Opex by prioritising simplification, standardization and automation of Opex processes as far as this is economically justifiable.

Note:

- Opex includes efforts for the following processes: railway operation, railway maintenance, railway migration of CCS system (trackside and trainside), railway engineering as well as system operation, system maintenance and system development and management of system life cycle. [SPP-8863 ]

### 3.2-93 - CCS able to handle different and changing system capabilities of its actors during operation

CCS shall manage varying and changing system capabilities, including degraded modes of supervised infrastructure and trains, while ensuring safety and maintaining optimal production capacity and automation. [SPP-8864 ]

### 3.2-94 - CCS shall reduce engineering complexity

CCS shall design the internal components and internal and external interfaces in such a way that they can be implemented in a standardised way and without unnecessary variants implementation, support of isolated cases or unneeded complexity. [SPP-8865 ]

### 3.2-95 - Implement standardised interfaces without hindering of innovation

CCS shall implement standardised interfaces which ensure backward compatibility between systems and subsystems, while allowing different implementations of core functions to ensure innovation. [SPP-8866 ]

### 3.2-96 - Support Backward compatibility within the Target System architecture

CCS shall support backward compatibility between the subsystems of the target system architecture where technically and economically justifiable.

Note: for Traffic CS this would be an enhanced feature to be technically and economically assessed [SPP-8867 ]

## 3.3 Train Control and Supervision

### 3.3-1 - Train CS shall offer all basic onboard functionalities for subprocesses concerning TM/ CM, ATO and ATP (ETCS) happening in trains or train units

This is the roof requirement for all standard capabilities that Train CS shall offer

ID	SPT2OD-286
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### 3.3-2 - Train CS (CCS onboard) for mainline traffic today has a low grade of automation...

Train CS (CCS onboard) for mainline traffic today has a low grade of automation and creates out of this higher operational cost and unnecessary capacity usage.

Missing integration into the train and insufficient technology quality leads to a lack of information about the train, that reduces the precision for trackside planning and control processes.

ID	SPT2OD-287
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### 3.3-3 - ATO

The operational vision for the Train CS (CCS onboard) contains fully automated (ATO) and interoperable (ETCS) train operations even for shunting or joining/splitting (digital automated coupling) processes.

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### 3.3-4 - Driver advisory systems

When train drivers are needed for the process, they are supported by assistance systems that support an optimal driving process concerning traffic flow and energy consumption.

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### 3.3-5 - SPT2TRAFFIC-6084 - Driver advisory systems





*[Description of problem and general need in regard to CCS]*

Today's railway system implement C-DAS functionality which support energy efficient driving and providing valuable advisory information to the driver to improve the overall driving process for Class B as well as ETCS Level 0 to Level 2. The trackside-to-train interface is usually realised with a Mobile Device and User Interface which can be used and introduced within a manageable period of time, as it does not require any fixed installations in the driver's cab. The target architecture shall therefore support C-DAS functionality for ETCS L2 and also allow the further usage of existing C-DAS solutions, as proposed by the detailed analysis done by SPCoregroupPublic/Topic 08 C-DAS/Position Paper for C-DAS : 725933.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

As an IM and RU, I want to benefit from energy-efficient driving and an optimised driving process

-  SPP-8839 - If driver is involved in the driving process, CCS shall support driving assistance recommendations
-  SPP-8840 - An harmonized process shall be defined to show the driver optimal energy-efficient driving and an optimised driving speed profile recommendations

Linked Work Items	is derived from :  SPT2OD-289 - Driver advisory systems has parent :  SPP-6570 - Train Control and Supervision _ is derived by :  SPP-8839 - If driver is involved in the driving process, CCS shall support driving assistance recommendations _ is derived by :  SPP-8840 - An harmonized process shall be defined to show the driver optimal energy-efficient driving and an optimised driving speed profile recommendations
ID	SPP-8841

### 3.3-6 - If driver is involved in the driving process, CCS shall support driving assistance recommendations

If driver is involved in the driving process, CCS shall support driving assistance recommendations.  
[SPP-8839 ]

### 3.3-7 - An harmonized process shall be defined to show the driver optimal energy-efficient driving and an optimised driving speed profile recommendations

An harmonied process shall be defined to show the driver optimal energy-efficient driving and an optimised driving speed profile recommendations. [SPP-8840 ]

### 3.3-8 - Optimizing track capacity

The train protection processes onboard are tuned in a way that allows the optimal use of the physical capacity without blocking capacity too early or too much.

ID	SPT2OD-290
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## 3.4 Field forces processes and trackworker safety


### 3.4-1 - Field Force Applications, Control and Supervision shall support a safe and performant trackusage (basif functionality) for objects, vehicles and persons which are not track-bound and which shall not create dangers for the traffick on track

This is the roof requirement for all capabilities concerning Field Force applications. These include for exmaple trackworker safety systems, integration of non-trackbound vehicles into the safety logic, or production status information for operational people near the track.

ID	SPT2OD-292
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### 3.4-2 - Field Force safety applications for non-trackbound objects, vehicles and persons









[Description of problem and general need in regard to CCS]

Historically, there was no need for interlockings and control centres to integrate technical safety measures for track workers and maintenance equipment including vehicles (e.g. excavators), because of low traffic density. Nowadays though, with dense timetables and highly utilised tracks, there are less and less time windows available for performing construction and maintenance work. This results in high pressure put on the field force to perform their tasks during operation in minimal time while relying on human-based methods (voice communication, having a "lookout") for their safety. Many railways register the highest rate of accidents and incidents on construction and maintenance activities and identified a high need to raise the level of safety in this area. Today, warning signal towards track workers is issued typically from a locally installed warning system in form of an acoustic and visual warning signal within and/or along a warning area around the maintenance/construction site. Improvements of these technical possibilities like the integration of a technical protection layer into safety systems are already being pursued like e.g. in Switzerland by interfacing the "advanced warning and protection system (AWAP) with control centres. Note: This concept aspect has an overlap with  SPP-6644 - Track user planning via Traffic Management process




[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]

As an IM, I want to identify and protect non-trackbound vehicles and construction equipment near tracks during maintenance and construction activities.




-  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force

-  SPP-6679 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of planned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.
-  SPP-6680 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of unplanned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.
-  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects
-  SPP-6953 - An harmonized process shall be defined to access and entry of a construction site vehicle
-  SPP-6954 - An harmonized process shall be defined to locally operate trackside assets or local maintenance of trackside assets and define the role of Field Force during this operation.
-  SPP-6955 - An harmonized process shall be defined to perform manually train composition and define the role of Field Force and Driver during this operation.
-  SPP-6957 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.
-  SPP-7107 - Automated regulation of infrastructure resources deployment



As an IM, I want CCS to support the non-track-bound track users or mobile objects in order to prevent collision of trains with them.




-  SPP-6683 - An harmonized process shall be defined to supervise all possible track users
-  SPP-6684 - CCS shall authorise movements only if they don't represent a danger for railway actors (such as driver or passengers), or the infrastructure and rolling stock assets, or non-track-bound track users or mobile objects and if these movements are part of plan or actions derived from degraded operation.
-  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.

As an IM, I want to identify and protect railway workers and other operational personnel near tracks during maintenance and construction activities.









-  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects
-  SPP-6683 - An harmonized process shall be defined to supervise all possible track users
-  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.

As IM, I want the information exchange between interfacing actors to be nonverbal, unambiguous and automatable in routine operation.

-  SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.
-  SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.

-  SPT2OD-6859 - Information availability relevance
-  SPT2OD-4444 - Operational production optimisation centralised within the frame of railway traffic efficiency.
- [Application Condition]  SPP-14793 - In routine operation, track workers and drivers shall use the non-verbal, unambiguous communication with CCS instead of the verbal communication with Signaller

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Linked Work Items	<p>is derived from :  SPT2OD-292 - Field Force Applications, Control and Supervision shall support a safe and performant trackusage (basif functionality) for objects, vehicles and persons which are not track-bound and which shall not create dangers for the traffick on track</p> <p>has parent :  SPP-6571 - Field forces processes and trackworker safety</p> <p>_ is derived by :  SPP-6679 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of planned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.</p> <p>_ is derived by :  SPP-6680 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of unplanned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.</p> <p>_ is derived by :  SPP-6683 - An harmonized process shall be defined to supervise all possible track users</p> <p>_ is derived by :  SPP-6684 - CCS shall authorise movements only if they don't represent a danger for railway actors (such as driver or passengers), or the infrastructure and rolling stock assets, or non-track-bound track users or mobile objects and if these movements are part of plan or actions derived from degraded operation.</p> <p>_ is derived by :  SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.</p> <p>_ is derived by :  SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.</p> <p>_ is derived by :  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects</p> <p>_ is derived by :  SPP-6953 - An harmonized process shall be defined to access and entry of a construction site vehicle</p> <p>_ is derived by :  SPP-6954 - An harmonized process shall be defined to locally operate trackside assets or local maintenance of trackside assets and define the role of Field Force during this operation.</p> <p>_ is derived by :  SPP-6955 - An harmonized process shall be defined to perform manually train composition and define the role of Field Force and Driver during this operation.</p> <p>_ is derived by :  SPP-6957 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.</p> <p>_ is derived by :  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.</p> <p>_ is derived by :  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force</p> <p>_ is derived by :  SPP-7107 - Automated regulation of infrastructure resources deployment</p> <p>_ is derived by :  SPP-14793 - In routine operation, track workers and drivers shall use the non-verbal, unambiguous communication with CCS instead of the verbal communication with Signaller</p> <p>_ is derived by :  SPP-24381 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.</p> <p>_ is derived by :  SPT2OD-4444 - Operational production optimisation centralised within the frame of railway traffic efficiency.</p> <p>_ is derived by :  SPT2OD-6859 - Information availability relevance</p>
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### **3.4-3 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects**

An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects (during e.g. maintenance work, construction work, shunting work) near the track in a rapid, efficient, cheap, reliable and safe way. [SPP-6952 ]

### **3.4-4 - An harmonized process shall be defined to access and entry of a construction site vehicle**

An harmonized process shall be defined to access and entry of a construction site vehicle (e.g. excavator, yellow fleet) into the construction site area. [SPP-6953 ]

### **3.4-5 - An harmonized process shall be defined to locally operate trackside assets or local maintenance of trackside assets and define the role of Field Force during this operation.**

An harmonized process shall be defined to locally operate trackside assets or local maintenance of trackside assets and define the role of Field Force during this operation. [SPP-6954 ]

### **3.4-6 - An harmonized process shall be defined to perform manually train composition and define the role of Field Force and Driver during this operation.**

An harmonized process shall be defined to perform manually train composition and define the role of Field Force and Driver during this operation. [SPP-6955 ]

### **3.4-7 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.**

CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track. [SPP-6960 ]

### **3.4-8 - Reduce production impact**

The productivity of field forces, especially track workers, and the effort for preparing, starting, and stopping operations on the track or influencing trackside assets shall be automated to shorten the duration of maintenance windows (reduce production impact) and to increase the safety.

ID	SPT2OD-293
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### **3.4-9 - Reduce railway service production impact**

*[Description of problem and general need in regard to CCS]*

The processes around maintenance (with/without blocked tracks) or construction are fully reliant on voice communication steps between track workers and signallers. Digitalised interactions are often not part of the process and if they are, then the solutions are widely different for each country. Integrating the protection of the field force into CCS can shorten these processes and would allow to execute more maintenance under production without blocking a track. The speed limit impact of construction sites on neighbour tracks could be reduced if the dynamic status of a construction site is digitally known to CCS as well.

Most of the content of this Railway Requirement has been included in ☐ SPT2OD-276 and ☐ SPT2OD-275. To reduce production impact requires that **all resource interventions (train traffic or supporting routines) are planned** and that **full automation of all routine operations (e.g. the deployment, granting of access and local remote control) must be supported**.

It must be highlighted that the vision also includes **automation for routines related to the field-**


























**forces influencing trackside assets**, and (from the linked CBOs), **the (shunting) operations in yards**.

The automatable process requires **availability of digitalised information about resources that have direct relationship to the optimal operability of the railway network, or the general safety**, and that **non-verbal communication to/from all actors must be supported** within the *harmonised operational production processes*.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

As IM, I want to automatise the plan and execution of the field forces' maintenance activities looking for safety and the least impact on the railway operation.

-  SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.
-  SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.
-  SPP-7054 - CCS shall autonomously supervise the routine procedures for the handing over of safety responsibility
-  SPP-7107 - Automated regulation of infrastructure resources deployment
-  SPP-7071 - Automated routine operational production procedures for train movements or shunting movements
-  SPP-7072 - Automated routine operational production procedures for field force work
-  SPP-7052 - A process shall feature the ability of executing rolling stock routine manoeuvres for commercial operational production.
-  SPT2OD-4444 - Operational production optimisation centralised within the frame of railway traffic efficiency.
-  SPT2OD-6859 - Information availability relevance
-  SPP-6957 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.
-  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects
-  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.
-  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force
-  SPP-6683 - An harmonized process shall be defined to supervise all possible track users
-  SPP-15529 - CCS shall support carrying out maintenance activities under production without blocking a track
-  SPP-15530 - An harmonised process and its limitation shall define to carry out maintenance activities under production without the need of blocking a track
- [Application Conditions]  SPP-15531 - Field Force applications shall support a safe and performant track usage for trackbound and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.
- [Application Conditions]  SPP-15865 - In normal operation, Field Forces shall support non verbal communication with CCS in the execution of railway services
- [Application Conditions]  SPP-14667 - TMS shall consider driver availability and train availability due to maintenance routines, construction work, incident or delays to automatically schedule a service
- [Application Conditions]  SPP-14669 - In routine operation, TMS shall exchange information with CCS in a non-verbal, unambiguous and automatic way
- [Application Conditions]  SPP-15532 - IM/RU shall plan routine operations including train traffic routines and supporting routines like construction and maintenance activities

Linked Work Items	<p>is derived from :  SPT2OD-293 - Reduce production impact</p> <p>has parent :  SPP-6571 - Field forces processes and trackworker safety</p> <p>_ is derived by :  SPP-6683 - An harmonized process shall be defined to supervise all possible track users</p> <p>_ is derived by :  SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.</p> <p>_ is derived by :  SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.</p> <p>_ is derived by :  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects</p> <p>_ is derived by :  SPP-6957 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.</p> <p>_ is derived by :  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.</p> <p>_ is derived by :  SPP-7052 - A process shall feature the ability of executing rolling stock routine manoeuvres for commercial operational production.</p> <p>_ is derived by :  SPP-7054 - CCS shall autonomously supervise the routine procedures for the handing over of safety responsibility</p> <p>_ is derived by :  SPP-7071 - Automated routine operational production procedures for train movements or shunting movements</p> <p>_ is derived by :  SPP-7072 - Automated routine operational production procedures for field force work</p> <p>_ is derived by :  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force</p> <p>_ is derived by :  SPP-7107 - Automated regulation of infrastructure resources deployment</p> <p>_ is derived by :  SPP-14667 - TMS shall consider driver availability and train availability due to maintenance routines, construction work, incident or delays to automatically schedule a service</p> <p>_ is derived by :  SPP-14669 - In routine operation, TMS shall exchange information with CCS in a non-verbal, unambiguous and automatic way</p> <p>_ is derived by :  SPP-15529 - CCS shall support carrying out maintenance activities under production without blocking a track</p> <p>_ is derived by :  SPP-15530 - An harmonised process and its limitation shall define to carry out maintenance activities under production without the need of blocking a track</p> <p>_ is derived by :  SPP-15531 - Field Force applications shall support a safe and performant track usage for trackbound and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.</p> <p>_ is derived by :  SPP-15532 - IM/RU shall plan routine operations including train traffic routines and supporting routines like construction and maintenance activities</p> <p>_ is derived by :  SPP-15865 - In normal operation, Field Forces shall support non verbal communication with CCS in the execution of railway services</p> <p>_ is derived by :  SPP-24381 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.</p> <p>_ is derived by :  SPT2OD-4444 - Operational production optimisation centralised within the frame of railway traffic efficiency.</p> <p>_ is derived by :  SPT2OD-6859 - Information availability relevance</p>
ID	SPP-9269

### 3.4-10 - CCS shall support carrying out maintenance activities under production without blocking a track

CCS shall support carrying out maintenance activities under production without blocking a track  
[SPP-15529 ]

### 3.4-11 - Automated field force protection


Persons, blocking devices or tagged obstacles on track shall be identified and protected automatically.

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### 3.4-12 - Automated field force protection










*[Description of problem and general need in regard to CCS]*

In today's safety systems, only trackbound objects like trains or vehicles with an OBU can be sensed, positioned and protected. In order to technically protect other obstacles (e.g. construction equipment left on track) and persons (e.g. field force or operational personnel), additional detection devices and warning systems need to be interfaced resulting in high planning and development and operating effort.

Note: Most of the content of this Railway Requirement has been included in  SPT2OD-275 - ATO for normal and degraded modes  SPT2OD-276 - Track user planning via Traffic Management process and  SPT2OD-280 - Continuous supervision of railway production. From there we decomposed the requirement for the **integration of non track-bound mobile objects/users onto the safety supervision**, which must be able to **dynamically incorporate new sensory information into its (safety, condition and availability) supervision processes**. This in turn this can only be achieved if **availability of digitalised information about resources that have direct relationship to the optimal operability of the railway network, or the general safety** is supported.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

As an IM, I want to identify and protect non-trackbound vehicles, construction equipment, and tagged objects near tracks during maintenance and construction activities in order to minimise their impact on rail operations, prevent collision of trains with them. and to increase the safety of trackside personnel.

-  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force
-  SPP-6679 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of planned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.
-  SPP-6680 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of unplanned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.
-  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects
-  SPP-6953 - An harmonized process shall be defined to access and entry of a construction site vehicle
-  SPP-6954 - An harmonized process shall be defined to locally operate trackside assets or local maintenance of trackside assets and define the role of Field Force during this operation.
-  SPP-6955 - An harmonized process shall be defined to perform manually train composition and define the role of Field Force and Driver during this operation.
-  SPP-6683 - An harmonized process shall be defined to supervise all possible track users
-  SPP-6957 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.

- SPP-6684 - CCS shall authorise movements only if they don't represent a danger for railway actors (such as driver or passengers), or the infrastructure and rolling stock assets, or non-track-bound track users or mobile objects and if these movements are part of plan or actions derived from degraded operation.
- SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.
- SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.
- SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.
- [Application Condition] SPP-14794 - During maintenance and construction activities, non-trackbound vehicles, construction equipment, and tagged objects shall be trackable bear the tracks

As an IM, I want to identify and protect railway workers and other operational personnel near tracks during maintenance and construction activities.





















- SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects
- SPP-6683 - An harmonized process shall be defined to supervise all possible track users
- SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.

As IM, I want the information exchange between interfacing actors to be nonverbal, unambiguous and automatable in routine operation.

- SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.
- SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.
- [Application Condition] SPP-15531 - Field Force applications shall support a safe and performant track usage for trackbound and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.
- [Application Condition] SPP-15865 - In normal operation, Field Forces shall support non verbal communication with CCS in the execution of railway services

As IM, I want to have availability of digitalised information about resources that are direct related with the optimal operation of the railway network, or in the general safety processes, and include such information, every time that more sensors' information is available (due to technology improvement).

- SPP-6989 - An harmonized process shall be defined to incorporate additional standard subsystems sensory information sources

Linked Work Items	<p>is derived from :  SPT2OD-294 - Automated field force protection</p> <p>has parent :  SPP-6571 - Field forces processes and trackworker safety</p> <p>_ is derived by :  SPP-6679 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of planned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.</p> <p>_ is derived by :  SPP-6680 - An harmonized process shall be defined to automatize and optimize the activation and deactivation of unplanned usage restriction and to define the role or tasks carried out by trackside personnel and non-trackbound vehicles during those restrictions.</p> <p>_ is derived by :  SPP-6683 - An harmonized process shall be defined to supervise all possible track users</p> <p>_ is derived by :  SPP-6684 - CCS shall authorise movements only if they don't represent a danger for railway actors (such as driver or passengers), or the infrastructure and rolling stock assets, or non-track-bound track users or mobile objects and if these movements are part of plan or actions derived from degraded operation.</p> <p>_ is derived by :  SPP-6687 - In routine operation, CCS shall support Field Force requests without the need of Field Force to have unambiguous or verbal communication with the signaller.</p> <p>_ is derived by :  SPP-6688 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.</p> <p>_ is derived by :  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects</p> <p>_ is derived by :  SPP-6953 - An harmonized process shall be defined to access and entry of a construction site vehicle</p> <p>_ is derived by :  SPP-6954 - An harmonized process shall be defined to locally operate trackside assets or local maintenance of trackside assets and define the role of Field Force during this operation.</p> <p>_ is derived by :  SPP-6955 - An harmonized process shall be defined to perform manually train composition and define the role of Field Force and Driver during this operation.</p> <p>_ is derived by :  SPP-6957 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.</p> <p>_ is derived by :  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.</p> <p>_ is derived by :  SPP-6989 - An harmonized process shall be defined to incorporate additional standard subsystems sensory information sources</p> <p>_ is derived by :  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force</p> <p>_ is derived by :  SPP-14794 - During maintenance and construction activities, non-trackbound vehicles, construction equipment, and tagged objects shall be trackable bear the tracks</p> <p>_ is derived by :  SPP-15531 - Field Force applications shall support a safe and performant track usage for trackbound and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.</p> <p>_ is derived by :  SPP-15865 - In normal operation, Field Forces shall support non verbal communication with CCS in the execution of railway services</p> <p>_ is derived by :  SPP-24381 - In routine operation, CCS shall support the execution of requests without the need use ambiguous or verbal communication between other actors.</p>
ID	SPP-7022



### 3.4-13 - An harmonized process shall be defined to incorporate additional standard subsystems sensory information sources

An harmonized process shall be defined to incorporate additional standard subsystems sensory information sources into the supervision procedures on run time ("plug-and-play").

[SPP-6989 ]

### 3.4-14 - Efficient and cheaper warning systems


Efficient and cheaper warning systems (with very low number of wrong alarms) allow a rapid set up and end warning areas with high reliability and safety.

ID	SPT2OD-295
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### 3.4-15 - Efficient and cheaper warning systems







[Description of problem and general need in regard to CCS]

Warning systems with low reliability (either missing detection of a threat to the field force or false alarms) negatively impact the railway operation. This could lead to longer travel times for passengers or freight train which have to wait until the false alarm has been identified. In the worst case, when failing to warn the field force of danger, it leads to serious safety incidents and accidents, both for the field force and for passengers in a train that's e.g. colliding with a working machine.




Note: There is an overlap with the Concept Aspects  SPP-7022 - Automated field force protection  SPP-6946 - Field Force safety applications for non-trackbound objects, vehicles and persons

[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]


As an IM, I want to identify and protect non-trackbound vehicles, tagged objects, and construction equipment near tracks during maintenance and during construction activities in order to minimise their impact on rail operations and to increase the safety of trackside personnel.












-  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects
-  SPP-7054 - CCS shall autonomously supervise the routine procedures for the handing over of safety responsibility
-  SPP-7055 - An harmonized process shall defined to execution safety-related mitigation measures for Track Workers protection
- [Application Condition]  SPP-14819 - Warning system shall be reliable (low number of false positives and low number false negatives)
- [Application Condition]  SPP-16242 - Warning system shall detect threats for non-trackbound vehicles, tagged objects, and construction equipment near tracks during maintenance and during construction activities
- [Application Condition]  SPP-14820 - Warning system shall be rapid to install

As an IM, I want to identify and protect railway workers and other operational personnel near tracks during maintenance and construction activities and minimise their impact on rail operations

-  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects
-  SPP-6683 - An harmonized process shall be defined to supervise all possible track users
-  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.

As an IM and RU, I want to improve the operational processes by increasing efficiency and reducing complexity.

-  SPP-7051 - The operational processes shall be simplified in order to optimize as much as possible the commercial and operational production processes within the Railway System boundary.

Linked Work Items	<p>is derived from :  SPT2OD-295 - Efficient and cheaper warning systems</p> <p>has parent :  SPP-6571 - Field forces processes and trackworker safety</p> <p>_ is derived by :  SPP-6683 - An harmonized process shall be defined to supervise all possible track users</p> <p>_ is derived by :  SPP-6952 - An harmonized process shall be defined to automatically warn and advise trackside personnel, non-trackbound vehicles, and tagged objects</p> <p>_ is derived by :  SPP-6960 - Field Force applications and CCS shall support a safe and performant track usage for trackbound (e.g. vehicles) and non-trackbound vehicle, and persons without creating a dangers for the traffic on the track.</p> <p>_ is derived by :  SPP-7051 - The operational processes shall be simplified in order to optimize as much as possible the commercial and operational production processes within the Railway System boundary.</p> <p>_ is derived by :  SPP-7054 - CCS shall autonomously supervise the routine procedures for the handing over of safety responsibility</p> <p>_ is derived by :  SPP-7055 - An harmonized process shall defined to execution safety-related mitigation measures for Track Workers protection</p> <p>_ is derived by :  SPP-14819 - Warning system shall be reliable (low number of false positives and low number false negatives)</p> <p>_ is derived by :  SPP-14820 - Warning system shall be rapid to install</p> <p>_ is derived by :  SPP-16242 - Warning system shall detect threats for non-trackbound vehicles, tagged objects, and construction equipment near tracks during maintenance and during construction activities</p>
ID	SPP-7024

### 3.4-16 - CCS shall autonomously supervise the routine procedures for the handing over of safety responsibility

CCS shall autonomously supervise the routine procedures for the handing over of safety responsibility between two interfacing actors or subsystems - e.g. the granting of working-site possessions, or the provision of a movement authority without complete supervision, etc. -. [SPP-7054 ]

### 3.4-17 - An harmonized process shall defined to execution safety-related mitigation measures for Track Workers protection

An harmonized process shall defined to execution safety-related mitigation measures for Track Workers protection - e.g. warnings initialisation, emergency train-braking application commands, etc. [SPP-7055 ]



### 3.5 Trackage Assets Control and Supervision

#### 3.5-1 - Trackage Asset CS allows to control a broad heterogeneity of systems and technologies in a standardized way

This is the roof requirement for all basic standard functionalities for Trackage Asset CS (currently for point-machines, crossings and trackage sensors).

ID	SPT2OD-297
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#### 3.5-2 - CCS allows to control a broad heterogeneity of trackage assets technologies in a standardized way

*[Description of problem and general need in regard to CCS]*



By the title it is possible to establish that as far as reasonably practicable, processes variability resulting from trackage assets functional heterogeneity should be removed from the central CCS processes, segregating the functional heterogeneity through a standard communication interface between the system components.

The system should:



- support the removal of trackage asset and promote effective solutions;
- Increase market size (cost efficiency and quality) for standardized solutions and through regular update of standardized modular components;
- Harmonising this system architecture approach at European level, including standardisation of interfaces, communications and data exchange that would Guarantee the compatibility of subsystems and components;

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*


As an IM and as a RU, I want CCS to support harmonised operational processes in order to reduce technical and operational complexity.






-  SPT2OD-3057 - Functionally standardised communication between modular subsystem components
-  SPP-8810 - CCS shall base the information exchange to/from subsystem component on standard communication interfaces that shall be defined up to the physical layer.

As an IM, I want CCS to connect and control a wide variety of trackage systems and technologies through standardised interfaces.


-  SPT2OD-3057 - Functionally standardised communication between modular subsystem components
-  SPT2OD-6797 - Trackage assets' functional heterogeneity "hidden" from core operational production

As an IM and as RU, I want standardised generic products and standardised generic applications to benefit from an optimised rail- and system operation.

-  SPP-8810 - CCS shall base the information exchange to/from subsystem component on standard communication interfaces that shall be defined up to the physical layer.

Linked Work Items	is derived from :  SPT2OD-297 - Trackside Asset CS allows to control a broad heterogeneity of systems and technologies in a standardized way has parent :  SPP-6572 - Trackside Assets Control and Supervision _ is derived by :  SPP-8810 - CCS shall base the information exchange to/from subsystem component on standard communication interfaces that shall be defined up to the physical layer. _ is derived by :  SPT2OD-3057 - Functionally standardised communication between modular subsystem components _ is derived by :  SPT2OD-6797 - Trackside assets' functional heterogeneity "hidden" from core operational production
ID	SPP-8622

### 3.5-3 - CCS shall base the information exchange to/from subsystem component on standard communication interfaces that shall be defined up to the physical layer.

Information exchange to/from subsystem components within interoperable configurations of the defined modular functional system architecture shall be specified in function and form - i.e. the standard communication interface shall be defined up to the physical layer and it shall constitute a FFFIS - Form Fit Functional Interface Specification (see definition in  SPT2OD-6831). [SPP-8810]

## 3.6 Transversal Systems

### 3.6-1 - The Transversal Systems shall offer efficient and automated support to manage asset data, technical asset status information (for diagnostics), configurations of CCS systems, security, and integrated user interfaces

This is the roof requirement for all basic functionalities of the transversal systems

ID	SPT2OD-299
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### 3.6-2 - Merged Concept Aspect

To Be Completed

Linked Work Items	has parent :  SPP-6573 - Transversal Systems
ID	SPP-9395

## 3.7 CCS PRAMSS targets and production cost

### 3.7-1 - The quantitative targets for PRAMSS shall fulfil the needs of the System Pillar stakeholders, in a scalable relation to the cost they create

PRAMSS targets shall be analysed and agreed together with the stakeholders. Targets can, if needed and agreed concerning risk acceptance, have a bandwidth with a defined minimum. The bandwidth should relate to scalable but also agreed cost bandwidth.

ID	SPT2OD-301
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### 3.7-2 - Scalable PRAMSS targets agreed with stakeholders



[Description of problem and general need in regard to CCS]

Performance, Reliability, Availability, Maintainability, Safety and Security (PRAMSS) are indicators that play a key role in meeting the business needs. These range from coping with the passenger and freight demands, reducing the number of failures and their impact on the operation, improving the quality of service (more punctuality), offering a safe system, and reducing the risk of cybersecurity attacks. However, it also needs to be considered that the higher the target of these indicators are set, the more expensive the system or its subsystems will be. Therefore, the definition of the PRAMSS targets shall consider a balance between the needs of all the System Pillar stakeholders, the output of a risk analysis, and the estimated costs to achieve such targets.

The agreed PRAMSS targets should refer to a minimum value and to an acceptable range to be related to a comparable scalable economical effort.





*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

As a supplier, I want to provide Traffic CS components which support scalable PRAMSS targets (bandwidth with defined minimum) in order to fulfil needs of different stakeholders.

-  SPP-9470 - PRAMSS targets agreed by all the stakeholders
-  SPP-9469 - CCS shall support scalable PRAMSS targets

*[Application Conditions]*

-  SPP-15534 - TMS shall consider the CCS PRAMSS requirements when defining TMS PRAMSS requirements

Linked Work Items	has parent :  SPP-6563 - CCS PRAMSS targets and production cost _ is derived by :  SPP-9469 - CCS shall support scalable PRAMSS targets _ is derived by :  SPP-9470 - PRAMSS targets agreed by all the stakeholders _ is derived by :  SPP-15534 - TMS shall consider the CCS PRAMSS requirements when defining TMS PRAMSS requirements
ID	SPP-9460

### 3.7-3 - PRAMSS targets agreed by all the stakeholders

The definition of the PRAMSS targets shall consider a balance between the needs of all System Pillar stakeholders, the output of a risk analysis and the costs needed to meet such targets. [SPP-9470]

### 3.7-4 - CCS shall support scalable PRAMSS targets

CCS shall support scalable PRAMSS target requirements (range of acceptable target values). [SPP-9469]

## 4 CONEMP Vision for CCS and TM/CM

### 4.1 Reducing TCO of CCS and TM/CM (total cost of ownership)

Besides of supporting lower energy consumption, resilience, and sustainability with the right choice of technology, control processes and materials the reduction of the total cost of ownership (TCO) for CCS and TM/CM is the primary target.

#### 4.1-1 - Reduced TCO

Reducing TCO is directly driven by the customer perspective. It allows to generate lower transport prices or to afford more capacity or service. It is the primary factor for the railway system's competitiveness and urgently needed for it's the change towards SERA.








ID	SPT2OD-304
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#### 4.1-2 - Achieving a reduced TCO

*[Description of problem and general need regarding CCS]*

The total cost of ownership of a system describes the total cost of the system over its whole lifecycle. The reduction of TCO of the CCS will lead to benefits for the end-customer in the form of lower transport fares and better railway service (also in rural areas and on international services). This also reduces the so-called cost of capacity, or the cost of the business to expand operations/increase capacity. Today, in economic comparisons the full lifecycle cost approach is often not used but instead decisions are made according to the first pure investment cost. In a digital CCS landscape, higher costs are incurred in the lifecycle for operation and maintenance compared to the initial cost of first implementation and built.

*[Breakdown into specific needs regarding to CCS, including links to System- or Operational Requirements]*

- As an IM, I want to speed up deployment of CCS solutions and make more investments possible, e.g. in areas where there is no business case to improve the existing installations.
  -  SPT2TRAFFIC-5037 - Provide a scalable and adaptable system architecture which is suitable for different contexts
- As an IM, I want to reduce lifecycle costs for safety-critical equipment, e.g. the high cost for supervision of the correct behaviour of the system.
  -  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data
  -  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data
- As an IM, I want to have a CCS architecture (trackside) whose design and architecture reduces the overall life cycle costs and considers the development of solutions that can be adapted to different application requirements and local needs.
  -  SPP-9870 - CCS shall follow modular design principles
- As an IM / RU, I want to reduce the life cycle costs for operation and maintenance through standardisation and digitalisation in order to lower the TCO
  -  SPP-7084 - CCS shall handle different system capabilities supporting standard manual controls
  -  SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force
  -  SPP-9644 - CCS shall acquire the static properties of the infrastructure (e.g. tracks with speed and gradient profiles) from a centralised service).

- SPP-9647 - CCS shall acquire the static properties of the trains (e.g. loading gauge) from a centralised service.
- SPP-9645 - CCS shall acquire system configuration data from a centralised service via a standardised interface, based on EULYNX SMI-xx.

Linked Work Items	<p>is derived from : SPT2OD-304 - Reduced TCO</p> <p>has parent : SPP-6566 - Reducing TCO of CCS and TM/CM(total cost of ownership)</p> <p>_ is derived by : SPP-7082 - CCS shall minimize the impact of track work on railway operations and increase the safety for the field force</p> <p>_ is derived by : SPP-7084 - CCS shall handle different system capabilities supporting standard manual controls</p> <p>_ is derived by : SPP-9644 - CCS shall acquire the static properties of the infrastructure (e.g. tracks with speed and gradient profiles) from a centralised service).</p> <p>_ is derived by : SPP-9645 - CCS shall acquire system configuration data from a centralised service via a standardised interface, based on EULYNX SMI-xx.</p> <p>_ is derived by : SPP-9647 - CCS shall acquire the static properties of the trains (e.g. loading gauge) from a centralised service.</p> <p>_ is derived by : SPP-9870 - CCS shall follow modular design principles</p> <p>_ is derived by : SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data</p> <p>_ is derived by : SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data</p> <p>_ is derived by : SPP-28338 - Provide a scalable and adaptable system architecture which is suitable for different contexts</p>
ID	SPP-9472

#### 4.1-3 - CCS shall follow modular design principles

CCS shall follow modular design principles. [SPP-9870 ]

#### 4.1-4 - Positive business case

Positive business cases are a strong prerequisite for the operational and technical change and for the fast deployment of ERTMS. The economic advantage needs to be significant for any type of innovation, otherwise the railway system will not evolve. The investments needed for multi-modal transport chains will only be affordable if the TCO are reduced to the needed level.

ID	SPT2OD-305
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#### 4.1-5 - Positive business case

*[Description of problem and general need regarding CCS]*

The average annual cost of the current CCS architecture and the new SP CCS architecture must be compared to quantify the Total Cost of Ownership (TCO). This comparison is essential to demonstrate that the TCO has been reduced. Only then the positive cash flow can be utilized, for instance, to lower ticket prices, offer more railway connections, expand the railway network, or potentially avoid planned new installations and the construction of additional railway tunnels or lines due to capacity gains that are possible with CCS.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

As an IM, I want to reduce the price of interlocking and RBC hardware and software replacements

and renewals.

- SPP-9496 - CCS shall be adaptable to local performance requirements by ensuring the scalability of its software components
- SPP-10174 - Decoupling of hardware and software components

As an IM, I want to reduce the newly incurred reinvestment costs on e.g. OCs, data centres etc. due to the new CCS architecture.

- SPP-7199 - CCS shall be flexible enabling an efficient and affordable migration
- SPT2TRAFFIC-5029 - Enable the system integration of legacy systems

As an IM / RU, I want the costs of upgrading and evolving CCS to be smaller compared to legacy systems (mainly IXL, control systems, RBC).

- SPP-6934 - CCS shall be able to handle the specific capabilities and characteristics of the train units when executing train movements

As an IM / RU, I want a simplification of European processes, e.g. regarding risk assessment, interoperability testing, etc.














- SPP-9469 - CCS shall support scalable PRAMSS targets
- SPP-14326 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9)
- SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data
- SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data
- SPP-6934 - CCS shall be able to handle the specific capabilities and characteristics of the train units when executing train movements

As an IM, I want CCS to allow flexibility of solutions in order to fulfilling different need of remote railway lines and high-capacity areas in a cost-effective way.

- SPP-9513 - CCS shall be based on Generic Products that can be configured using openly available configuration parameters to address varying application needs

#### *[Application Conditions]*

- SPP-15046 - TMS shall support harmonized operational process instead of national specific needs

Linked Work Items	<p>is derived from :  SPT2OD-305 - Positive business case</p> <p>has parent :  SPP-6566 - Reducing TCO of CCS and TM/CM(total cost of ownership)</p> <p>_ is derived by :  SPP-6934 - CCS shall be able to handle the specific capabilities and characteristics of the train units when executing train movements</p> <p>_ is derived by :  SPP-7199 - CCS shall be flexible enabling an efficient and affordable migration</p> <p>_ is derived by :  SPP-9469 - CCS shall support scalable PRAMSS targets</p> <p>_ is derived by :  SPP-9496 - CCS shall be adaptable to local performance requirements by ensuring the scalability of its software components</p> <p>_ is derived by :  SPP-9513 - CCS shall be based on Generic Products that can be configured using openly available configuration parameters to address varying application needs</p> <p>_ is derived by :  SPP-10174 - Decoupling of hardware and software components</p> <p>_ is derived by :  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data</p> <p>_ is derived by :  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data</p> <p>_ is derived by :  SPP-14326 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9)</p> <p>_ is derived by :  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs</p> <p>_ is derived by :  SPP-28352 - Enable the system integration of legacy systems</p>
ID	SPP-9495

#### 4.1-6 - CCS shall be adaptable to local performance requirements by ensuring the scalability of its software components

CCS shall be adaptable to local performance requirements by ensuring the scalability of its software components and their configuration and installation procedures. [SPP-9496 ]

#### 4.1-7 - CCS shall be based on Generic Products that can be configured using openly available configuration parameters to address varying application needs

CCS shall be based on Generic Products that can be configured using openly available configuration parameters to address varying application needs. [SPP-9513 ]

#### 4.1-8 - TCO Optimization

The TCO are influenced by

1. The number of needed assets for CCS and TM/CM (effects also energy consumption and disturbances)
2. The grade of automation of processes in the life cycle (planning of infrastructures and vehicles, construction, configuration, maintenance, monitoring, updates, upgrades, add-ons, etc.)
3. The architecture quality e.g. concerning the "intelligence" of the traffic management and traffic control that reduce the need for physical assets
4. The development cost caused by heterogeneity, instability of requirements, and lack of specification quality
5. The needed specialist skills for special systems
6. The number of standby expert resources during the full lifecycle
7. The missing forward and backward compatibility or modularity of assets causing early replacements/changes and preventing selective component replacements
8. The integration cost for components increased by complex and diverse interface structures



9. Ineffective/inefficient safety assurance processes with a high amount of bureaucracy, control processes without impacts, missing modular homologation, and low maintainability of safety case documentation
10. The marketing, training, procurement, and distribution cost caused by a high variety of systems (coming from heterogenous requirements)
11. The unit prices for systems and their lifetime duration

ID	SPT2OD-306
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#### 4.1-9 - TCO optimization

*[Description of problem and general need in regard to CCS]*

The Total Cost of Ownership (TCO) of CCS throughout its lifecycle - including design, planning, construction, maintenance, operation, technological fixed costs, skill assurance and system operations - directly correlates with the number of physical trackside assets and the level of process automation in planning, construction, and maintenance. While the purchase price of individual asset components typically accounts for less than 20% of lifecycle costs, the overall expenses are heavily influenced by the complexity of their functionalities (e.g., configuration automation), compatibility (which can limit lifespan), and non-functional attributes like robustness.

Additionally, the low order volumes and limited number of qualified suppliers contribute to high unit prices.

To reduce these costs, a viable strategy is to increase demand by consolidating orders across multiple railways for the same products. This approach requires harmonized operational rules and standardized processes. Moreover, enhancing supply by allowing new suppliers to enter the market through standardized interfaces and functionalities—similar to the EULYNX initiative—can significantly lower development and purchasing costs for Infrastructure Managers (IMs) and Railway Undertakings (RUs).

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*



As an IM, I want to decrease the number of trackside assets, e.g. signals, trackside train detection.

*Note: The shift of functionality from Traffic CS to other CCS systems needs to be considered from a holistic system view.*


As an IM, I want automated processes in engineering, maintenance and planning, especially for processes in operation centres and operational work in order to increase productivity, reduce reaction times and to manage complexity for operators.

-  SPP-7111 - CCS shall optimize TCO through automation




As an IM, I want to cluster systems / subsystems (CCS trackside) that perform functions with similar requirements regarding safety-criticality, availability, etc. to minimize the SIL 4 footprint, enable the architecture to handle complexities of the application and to minimize roll-out times, project realization times and assurance efforts.

-  SPP-9555 - CCS shall ensure decoupled lifecycles for its components to simplify asset management
-  SPP-9554 - CCS shall follow a generic safety approach in encapsulating safety relevant functions within building blocks with a separate safety approvals



As an IM / RU, I want coherent system specifications with less national and project-specific dependencies.

-  SPP-9553 - CCS Hardware, Software and Engineering Data shall be independently upgradeable to minimize engineering efforts and reduce deployment time.




As an IM / RU / Supplier, I want to grow a large pool of personal that can develop, operate and maintain the systems by increasing the attractiveness and future perspectives of the railway industry, e.g by more homogenous systems across Europe so that skills can be applied more broadly and reducing the barriers for future innovations.

-  SPT2TRAFFIC-4361 - As a Supplier, I want a Traffic CS system implementing an architecture based on on standardized interfaces
-  SPP-6858 - CCS shall rely on a standardized set of manual controls for normal operations, based on harmonised operational rules
-  SPP-6859 - CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules




As an IM / RU, I want to avoid high sunk cost because of early replacement of systems due to the end of the lifespan of certain parts of the system that cannot be exchanged without replacing the whole system.















-  SPT2TRAFFIC-4361 - As a Supplier, I want a Traffic CS system implementing an architecture based on on standardized interfaces
-  SPP-9553 - CCS Hardware, Software and Engineering Data shall be independently upgradeable to minimize engineering efforts and reduce deployment time.

As an IM / RU / Supplier, I want to enable modular safety assurance. (Please note, that this is highly dependent on the legislative and administrative structure in Europe and cannot work without establishing new organisations, e.g. a centralised European Safety Authority.)

-  SPP-6857 - CCS shall minimize the number of configuration parameters for Generic and Specific Applications
-  SPP-9554 - CCS shall follow a generic safety approach in encapsulating safety relevant functions within building blocks with a separate safety approvals
-  SPP-9894 - CCS shall implement an architecture based on standardised interfaces to facilitate independent safety cases and approval processes for each subsystem

#### *[Application Conditions]*

-  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs
-  SPP-14771 - External Subsystems (e.g. TMS) shall interface with CCS via standard interfaces
-  SPP-15079 - Track users shall support harmonized operational processes instead of national specific needs

Linked Work Items	<p>is derived from :  SPT2OD-306 - TCO Optimization</p> <p>has parent :  SPP-6566 - Reducing TCO of CCS and TM/CM(total cost of ownership)</p> <p>_ is derived by :  SPP-6857 - CCS shall minimize the number of configuration parameters for Generic and Specific Applications</p> <p>_ is derived by :  SPP-6858 - CCS shall rely on a standardized set of manual controls for normal operations, based on harmonised operational rules</p> <p>_ is derived by :  SPP-6859 - CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules</p> <p>_ is derived by :  SPP-7111 - CCS shall optimize TCO through automation</p> <p>_ is derived by :  SPP-9553 - CCS Hardware, Software and Engineering Data shall be independently upgradeable to minimize engineering efforts and reduce deployment time.</p> <p>_ is derived by :  SPP-9554 - CCS shall follow a generic safety approach in encapsulating safety relevant functions within building blocks with a separate safety approvals</p> <p>_ is derived by :  SPP-9555 - CCS shall ensure decoupled lifecycles for its components to simplify asset management</p> <p>_ is derived by :  SPP-9894 - CCS shall implement an architecture based on standardised interfaces to facilitate independent safety cases and approval processes for each subsystem</p> <p>_ is derived by :  SPP-14771 - External Subsystems (e.g. TMS) shall interface with CCS via standard interfaces</p> <p>_ is derived by :  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs</p> <p>_ is derived by :  SPP-15079 - Track users shall support harmonized operational processes instead of national specific needs</p> <p>_ is derived by :  SPP-28353 - As a Supplier, I want a Traffic CS system implementing an architecture based on standardized interfaces</p>
ID	SPP-9542

#### 4.1-10 - CCS Hardware, Software and Engineering Data shall be independently upgradeable to minimize engineering efforts and reduce deployment time.

CCS Hardware, Software and Engineering Data shall be independently upgradeable in order to minimize engineering efforts and reduce deployment time. [SPP-9553 ]

#### 4.1-11 - CCS shall follow a generic safety approach in encapsulating safety relevant functions within building blocks with a separate safety approvals

CCS shall follow a generic safety approach in encapsulating safety relevant functions within building blocks, allowing for separate safety approvals. [SPP-9554 ]

#### 4.1-12 - CCS shall ensure decoupled lifecycles for its components to simplify asset management

CCS shall ensure decoupled lifecycles for its components in order to simplify asset management. [SPP-9555 ]

#### 4.1-13 - CCS shall implement an architecture based on standardised interfaces to facilitate independent safety cases and approval processes for each subsystem

CCS shall implement an architecture based on standardised interfaces to facilitate independent safety cases and approval processes for each subsystem. [SPP-9894 ]

#### 4.1-14 - Unit prices

The CONEMP vision is to significantly reduce all these cost factors. The last factor – the unit price – may



increase (smart automation) when the other factors are reduced. Since unit prices make only a very small part in the TCO in most cases, this automation effect is acceptable.

ID	SPT2OD-307
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#### 4.1-15 - Unit prices


*[Description of problem and general need regarding CCS]*

Unit prices are part of the Total Cost of Ownership (TCO) and are directly influenced by supply and demand in the market.

Reducing large parts of the TCOs (relatively speaking to the unit prices) can lead to higher unit prices due to factors like complex product requirements that necessitate the implementation of new features. However, these improvements are expected to reduce operating costs (e.g. through reduced labour costs due to automation) and are therefore acceptable according to  SPT2OD-304 - Reduced TCO and  SPT2OD-305 - Positive business case.





*[Breakdown into specific needs regarding Traffic CS, including links to System- or Operational Requirements]*

As an IM, I want CCS trackside systems to handle complex product requirements regarding high automation and the implementation of new features.

-  SPP-8864 - CCS able to handle different and changing system capabilities of its actors during operation

As an IM, I want to reduce the amount of Safety Related Application Conditions (SRACs) and integration conditions to ensure safety in order to facilitate the installation and operation of new CCS trackside systems.

-  SPP-6860 - CCS shall be based on standardized products and configurations

Linked Work Items	is derived from :  SPT2OD-307 - Unit prices has parent :  SPP-6566 - Reducing TCO of CCS and TM/CM(total cost of ownership) _ is derived by :  SPP-6860 - CCS shall be based on standardized products and configurations _ is derived by :  SPP-8864 - CCS able to handle different and changing system capabilities of its actors during operation
ID	SPP-9556

## 4.2 Process design and requirements management on sector level

### 4.2-1 - Operational process harmonization

The large business case of “reusability of nearly everything” is based on standardisation. Standardisation is based on harmonized requirements. To reach this goal, a large part of the requirements (change) management has to be done on sector level. Most of the requirements come from operational process design, which therefore needs also to be standardized in detail.

ID	SPT2OD-309
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### 4.2-2 - Operational process harmonization

*[Description of problem and general need in regard to CCS]*

Today's historically evolved operational processes are a result of different operational needs, technical possibilities and options available to Infrastructure Managers. The approach of standardisation in this segment was in the past treated to standardise an interlocking platform such as EURO-Interlocking and




INESS and the definition of a unified Standard Communication Interface for interfacing Control Centres (SCI-CC) and others (SCI-ILS, SCI-RBC, etc.) within EULYNX framework.

Without a genuine operational standardisation, a uniform interface between operational procedures and the safeguarding of movements cannot be established. Consequently, derived products will not be generic and will continue to require significant development efforts, , resulting in high engineering and safety approval costs.




Operational harmonisation among all stakeholders is essential to significantly reduce configuration efforts and the engineering processes required for compliance with SIL 4 development.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*


As an IM and as a RU, I want CCS to support harmonised operational processes in order to reduce technical and operational complexity.








-  SPP-6857 - CCS shall minimize the number of configuration parameters for Generic and Specific Applications
-  SPP-6858 - CCS shall rely on a standardized set of manual controls for normal operations, based on harmonised operational rules
-  SPP-6859 - CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules

As an IM and as RU, I want standardised generic products and standardised generic applications to benefit from an optimised rail- and system operation.

-  SPP-6858 - CCS shall rely on a standardized set of manual controls for normal operations, based on harmonised operational rules
-  SPP-6859 - CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules
-  SPP-6860 - CCS shall be based on standardized products and configurations

*[Application Conditions]*

-  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs

Linked Work Items	<p>is derived from :  SPT2OD-309 - Operational process harmonization</p> <p>has parent :  SPP-6558 - Process design and requirements management on sector level</p> <p>_ is derived by :  SPP-6857 - CCS shall minimize the number of configuration parameters for Generic and Specific Applications</p> <p>_ is derived by :  SPP-6858 - CCS shall rely on a standardized set of manual controls for normal operations, based on harmonised operational rules</p> <p>_ is derived by :  SPP-6859 - CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules</p> <p>_ is derived by :  SPP-6860 - CCS shall be based on standardized products and configurations</p> <p>_ is derived by :  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs</p>
ID	SPP-6664

#### 4.2-3 - CCS shall minimize the number of configuration parameters for Generic and Specific Applications

The CCS System shall minimize the number of configuration parameters for Generic and Specific Applications [SPP-6857 ]

#### 4.2-4 - CCS shall rely on a standardized set of manual controls for normal operations, based on harmonised operational rules

CCS shall rely on a standardized set of manual controls for normal operations, based on harmonized operational rules. This approach minimizes national variations in Generic Applications. [SPP-6858 ]

#### 4.2-5 - CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules

CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules. This approach minimizes national variations in Generic Applications. [SPP-6859 ]

#### 4.2-6 - CCS shall be based on standardized products and configurations

The CCS System shall be based on standardized products and configurations to minimize site-specific engineering efforts and project-specific adaptations. [SPP-6860 ]

#### 4.2-7 - Re-use

Based on this, products, procurement documentation, education and know how, handbooks, rulebooks, integration methods, safety cases, test facilities, market services, etc. can be reused cross-company and cross-country. This reduction of effort, the simplification and homogenisation of skill needs is not only reducing the TCO in every aspect – it also allows the change of market towards specialized services for certain process areas that can work with high efficiency and at large scale. Also, the development and innovation, which no longer has to implement individual solutions for every customer, can afford higher investments in system quality and automation which again reduces the TCO by automating many life cycle processes.

ID	SPT2OD-310
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#### 4.2-8 - Re-use

*[Description of problem and general need regarding CCS]*

According to the definition of SPT2ARC-1012 - Reusability, the primary benefits include a reduction in lifecycle costs and an increased attractiveness of a system for various European stakeholders by simplifying bureaucratic and administrative hurdles in the authorization process. However, for Infrastructure Managers and Operators to adopt other rulebooks, handbooks, etc., the perceived benefits must be significant enough to encourage them to abandon their historically developed rulebooks. The same applies to suppliers; the establishment of common testing facilities and the "de-specialization" of products and platforms must present a viable business model. In both scenarios, reusability could significantly enhance the volume of projects executed concurrently.




*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

As an IM / RU, I want standardised rulebooks across Europe in order to facilitate interoperability and lower the maintenance of national rulebooks.




-  SPP-6881 - The operational processes involving trackside personnel and non-trackbound vehicles shall be optimized, in order to reduce their impact on railway operations.












As an IM, I want to reuse CCS trackside systems from different European actors and suppliers to reduce bureaucratic and administrative effort.

-  SPP-9614 - CCS shall implement an architecture based on standardized interfaces to enable the integration of components from multiple suppliers
-  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data
-  SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits

As a Supplier, I want less specialised products and platforms in order to take on more orders at the same time and to maintain a smaller number of different but very similar products.

-  SPP-6858 - CCS shall rely on a standardized set of manual controls for normal operations, based on harmonised operational rules
-  SPP-6859 - CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules
-  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data

Linked Work Items	<p>is derived from :  SPT2OD-310 - Re-use</p> <p>has parent :  SPP-6558 - Process design and requirements management on sector level</p> <p>_ is derived by :  SPP-6858 - CCS shall rely on a standardized set of manual controls for normal operations, based on harmonised operational rules</p> <p>_ is derived by :  SPP-6859 - CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules</p> <p>_ is derived by :  SPP-6881 - The operational processes involving trackside personnel and non-trackbound vehicles shall be optimized, in order to reduce their impact on railway operations.</p> <p>_ is derived by :  SPP-9614 - CCS shall implement an architecture based on standardized interfaces to enable the integration of components from multiple suppliers</p> <p>_ is derived by :  SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits</p> <p>_ is derived by :  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data</p> <p>_ is derived by :  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data</p>
ID	SPP-9613

#### 4.2-9 - CCS shall implement an architecture based on standardized interfaces to enable the integration of components from multiple suppliers

CCS shall implement an architecture based on standardized interfaces to enable the integration of components from multiple suppliers. [SPP-9614 ]

#### 4.2-10 - Upgradeability

Homogenous requirements lead in the end to homogenous systems, and this is the basis for simple and efficient upgradeability. Upgradeability means to keep all systems up-to-date, to reduce the cost of heterogeneity, to have access to more market products, and much higher security. Upgradeability and updateability is one of the very first important steps of the architecture and process optimisation, based on



modularity, automated tool chains, support systems for continuous process changes, and simplified integration methods.

ID	SPT2OD-311
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#### 4.2-11 - Upgradeability

*[Description of problem and general need regarding CCS]*

See definition of Upgradeability:  SPT2ARC-936 - Upgradeability

Upgradeability and upwards compatibility are mainly measured by a cost-benefit calculation (cost of complete replacement vs. cost of upgrade and the resulting benefit). Upgradeability should allow for responsiveness of the offering market to the railway automation needs, which means that an architecture that is easier to modify and extend is required.

Some cases, why there is a negative cost-benefit-balance in today's applications are:




- upgrade is necessary for technological compatibility due to a change in an interfacing system without benefit for the other system, so stakeholders that don't benefit from a change have anyway to pay (partially) for the upgrade;
- the upgrade takes a lot of time and effort due to limited resources.

This can be observed in today's strategy for ETCS implementation. The bulk of the upgrade effort lies with the RUs, because changes on the infrastructure are typically a lot more expensive than upgrades on trains. However, the sheer volume of trains that need to be upgraded is a challenge for most IMs and RUs today and lead to extremely long ETCS Level 2 rollout durations. Furthermore, despite being on RU side, these upgrades often do not have a real benefit to the core RU business.


Last, we should learn for other (more mature) markets and copy smartly, such as moving to more ICT-like way of working.

*[Breakdown into specific needs regarding Traffic CS, including links to System- or Operational Requirements]*




As an IM / RU, I want to reduce the cost of replacement of Traffic CS subsystems/CCS components

-  SPP-9901 - CCS shall be designed in such a way that specified components can be replaced and interconnected without the need to re-approve other components
-  SPT2TRAFFIC-5037 - Provide a scalable and adaptable system architecture which is suitable for different contexts
-  SPP-10174 - Decoupling of hardware and software components




As an IM / RU, I want to reduce the cost of upgrade of Traffic CS subsystems/CCS components

-  SPT2TRAFFIC-5037 - Provide a scalable and adaptable system architecture which is suitable for different contexts



As an IM / RU, I want to reduce the need of upgrade of Traffic CS subsystems/CCS components










-  SPP-6938 - CCS shall implement functionalities that allow the use and combination of different types of sensor technologies and information
-  SPT2TRAFFIC-4961 - Implement interface designs that enable the determination of smallest common set of shareable functions
-  SPP-10174 - Decoupling of hardware and software components

As an IM / RU, I want to reduce the need of replacement of Traffic CS subsystems/CCS components

-  SPT2TRAFFIC-4961 - Implement interface designs that enable the determination of smallest common set of shareable functions
-  SPP-8866 - Implement standardised interfaces without hindering of innovation
-  SPP-10174 - Decoupling of hardware and software components

As an IM / RU, I want to increase the benefit of an upgrade of Traffic CS subsystems/CCS components

-  SPP-8864 - CCS able to handle different and changing system capabilities of its actors during operation
-  SPT2TRAFFIC-4961 - Implement interface designs that enable the determination of smallest common set of shareable functions

Linked Work Items	<p>is derived from :  SPT2OD-311 - Upgradeability</p> <p>has parent :  SPP-6558 - Process design and requirements management on sector level</p> <p>_ is derived by :  SPP-6938 - CCS shall implement functionalities that allow the use and combination of different types of sensor technologies and information</p> <p>_ is derived by :  SPP-8864 - CCS able to handle different and changing system capabilities of its actors during operation</p> <p>_ is derived by :  SPP-8866 - Implement standardised interfaces without hindering of innovation</p> <p>_ is derived by :  SPP-9901 - CCS shall be designed in such a way that specified components can be replaced and interconnected without the need to re-approve other components</p> <p>_ is derived by :  SPP-10174 - Decoupling of hardware and software components</p> <p>_ is derived by :  SPP-28338 - Provide a scalable and adaptable system architecture which is suitable for different contexts</p> <p>_ is derived by :  SPP-28346 - Implement interface designs that enable the determination of smallest common set of shareable functions</p>
ID	SPP-9615

#### 4.2-12 - CCS shall be designed in such a way that specified components can be replaced and interconnected without the need to re-approve other components

CCS shall be designed in such a way that specified components can be replaced and interconnected without the need to re-approve other components. [SPP-9901 ]

### 4.3 Enhanced System Architecting and Integration processes for CCS and TM/CM

#### 4.3-1 - Simplified, modular architecture to avoid redundancies

The basic vision of an enhanced architecting and integration process is based on a simplified, and modular architecture that simplifies and decouples the architecting and integration processes including decoupling homologation/authorisation/life cycle processes for trackside systems, trains, and trackside assets. The number of systems and the functional size of the systems is reduced and the functional volume for safety assurance is reduced. All functional redundancies are eliminated, and architecting can focus on improving single components instead of handling large-architecture complexities and dependencies. Asset owners just chose from existing standard configurations and architectures.





ID	SPT2OD-315
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#### 4.3-2 - Simplified, modular architecture to avoid redundancies




















*[Description of problem and general need regarding CCS]*

















Today's architecture results from decades of incremental transformations and the integration of new systems, leading to a CCS architecture that resembles a patchwork of old and new philosophies, particularly in mainline railways across Europe. This patchwork features numerous redundancies—such as between interlockings and RBC, ATO and ETCS (ATP) processes, and various control and planning systems. While these redundancies add complexity to lifecycle processes like synchronisation, hazard management, and integration safety cases, they are essential in a safety-critical system like Traffic CS to ensure high availability, safety, and quick recovery. Redundancies may still be included in the new Traffic CS architecture when required, for example, to comply with PRAMS requirements.

In terms of modularity, defined by the number of subsystems and their functional size, the granularity

concept from the Architecture and Release Coordination Team ( System Concept\_CCS - Granularity Concepts and Principles - Main) should be considered. This framework evaluates the benefits and risks of modularisation and establishes rules to achieve an appropriate balance of granularity. Key principles to follow at this stage of Traffic CS system analysis include maintaining a balanced relationship between modularity and the efforts needed for integration, certification, and maintenance (see  SPT2ARC-1275,  SPT2ARC-1270 and  SPT2ARC-1271).

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

- As an IM, I want to decrease integration effort of CCS through planned modularisation of CCS subsystems.
  -  SPP-9870 - CCS shall follow modular design principles
  -  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture
- As an IM, I want to decrease the certification effort of CCS through planned modularisation of CCS subsystems.
  -  SPP-9870 - CCS shall follow modular design principles
- As an IM, I want to decrease the maintenance effort of CCS through planned modularisation of CCS subsystems.
  -  SPP-9870 - CCS shall follow modular design principles
- As an IM, I want cheaper redundancies e.g. by improved synchronisation, integration and compatibility.
  -  SPP-9660 - CCS shall disclose incompatibilities between its subsystems and their interfaces during runtime.
  -  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.
  -  SPP-9274 - Upgradeability of Internal Components
  -  SPP-10245 - Upgradeability of adjacent systems
  -  SPP-10246 - Integration of external devices
  - [Application Condition]  SPP-15534 - TMS shall consider the CCS PRAMSS requirements when defining TMS PRAMSS requirements
  - [Application Condition]  SPP-15535 - TMS shall comply with the ARC-D2.3 Granularity Concepts and Principles for designing TMS architecture
- As an IM, I want systematic redundancy for central CCS functions of CCS in order to be able to update on runtime and therefore reduce system downtime.
  -  SPP-9296 - CCS shall enable updates of Configuration Data on runtime
  -  SPP-9274 - Upgradeability of Internal Components
  -  SPP-10245 - Upgradeability of adjacent systems
  -  SPP-10246 - Integration of external devices
  - [Application Condition]  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time
- As an IM, I want CCS to be based on modern IT technologies when possible.
  -  SPP-9942 - Use standard hardware components
  -  SPP-10174 - Decoupling of hardware and software components
  -  SPP-9856 - Usage of FRMCS and GSM-R

Linked Work Items	<p>is derived from :  SPT2OD-315 - Simplified, modular architecture to avoid redundancies</p> <p>has parent :  SPP-6559 - Enhanced System Architecting and Integration processes for CCS and TM/CM</p> <p>_ is derived by :  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.</p> <p>_ is derived by :  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture</p> <p>_ is derived by :  SPP-9274 - Upgradeability of Internal Components</p> <p>_ is derived by :  SPP-9296 - CCS shall enable updates of Configuration Data on runtime</p> <p>_ is derived by :  SPP-9660 - CCS shall disclose incompatibilities between its subsystems and their interfaces during runtime.</p> <p>_ is derived by :  SPP-9856 - Usage of FRMCS and GSM-R</p> <p>_ is derived by :  SPP-9870 - CCS shall follow modular design principles</p> <p>_ is derived by :  SPP-9942 - Use standard hardware components</p> <p>_ is derived by :  SPP-10174 - Decoupling of hardware and software components</p> <p>_ is derived by :  SPP-10245 - Upgradeability of adjacent systems</p> <p>_ is derived by :  SPP-10246 - Integration of external devices</p> <p>_ is derived by :  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time</p> <p>_ is derived by :  SPP-15534 - TMS shall consider the CCS PRAMSS requirements when defining TMS PRAMSS requirements</p> <p>_ is derived by :  SPP-15535 - TMS shall comply with the ARC-D2.3 Granularity Concepts and Principles for designing TMS architecture</p>
ID	SPP-9927

#### 4.3-3 - Decoupling of hardware and software components

The CCS shall ensure the decoupling of hardware and software components to allow independent life cycles, utilising virtualisation, standard communication buses, and standardised software-hardware interfaces. This will also ensure continuous supply improvement and avoid obsolescence issues.

[SPP-10174 ]

#### 4.3-4 - Usage of FRMCS and GSM-R

The CCS shall support use of FRMCS and GSM-R as the radio connection to vehicles. [SPP-9856 ]



#### 4.3-5 - Improved change process and backwards compatibility


After the migration from legacy to the target system, the evolution inside of the target system architecture versions will – because of architecture qualities like the reduced dependency structure and higher modularity, layered architecture, and smarter interfaces - allow an improved backwards compatibility, scalable and modular implementations, and a change process with much lower impacts.

ID	SPT2OD-316
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#### 4.3-6 - Improved change process and backwards compatibility

[Description of problem and general need regarding Traffic CS]



















The granularity concept from the Architecture and Release Coordination Team ( System Concept\_CCS - Granularity Concepts and Principles - Main) includes a rule for backward compatibility ( SPT2ARC-1280), highlighting its benefits for adaptability, changeability, updatability, evolvability, scalability, and investment protection. It is essential to consider the technical feasibility and economic viability for railways (RU, IM), suppliers, customers (end-users), and investors.













The level of backward compatibility can be assessed on a case-by-case basis, particularly when discussing trackside multi-version management of different ETCS versions ("Dynamic RBC"), as proposed in the detailed analysis conducted by Traffic CS ( Analysis Enhanced Backward Compatibility). This

assessment depends on factors such as the feasibility of upgrading rolling stock using the trackside infrastructure and the urgency for railways to capitalise on new trackside enhancements. These factors also influence how quickly a positive business case can be established (see [SPT2OD-305](#) - Positive business case).

One strategy to address these primarily economic dependencies is to offer various options ("grades") of backward compatibility that can be enhanced as the need for backward compatibility evolves. For instance, while some railways may not currently benefit from the existing multi-version management of ETCS versions, this may change with future developments. Therefore, the ability to easily enhance the backward compatibility of Traffic CS by integrating additional, standardised subsystems can effectively address potential issues that may arise in the future for infrastructure managers (IMs) and railway undertakings (RUs).

*[Breakdown into specific needs inregarding Traffic CS, including links to System- or Operational Requirements]*

- As an IM, I want to improve the adaptability and changeability of Traffic CS through backwards compatibility of central CCS component.
  -  SPP-8863 - CCS designed to reduce OPEX
  -  SPP-9274 - Upgradeability of Internal Components
  -  SPP-10245 - Upgradeability of adjacent systems
  -  SPP-10246 - Integration of external devices
  -  SPP-10221 - Support for backward compatibility
  -  SPP-15837 - Level of backward compatibility for Traffic CS
  - [Application Condition]  SPP-15538 - TMS shall support CCS backwards compatibility feature
  - [Application Condition]  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time
  - [Application Condition]  SPP-15442 - TMS shall support the extension of automatic functions and the increased level of automation in functions already implemented.
- As an IM, I want to improve the Traffic CS scalability through backwards compatibility of central CCS component.
  -  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture
  -  SPP-10221 - Support for backward compatibility
- As an IM, I want to protect my investments in CCS infrastructure through backwards compatibility of central CCS component.
  -  SPP-8863 - CCS designed to reduce OPEX
  -  SPP-10221 - Support for backward compatibility
- As an IM, I want to increase the updateability and evolvability of Traffic CS through backwards compatibility to central CCS components.
  -  SPP-9274 - Upgradeability of Internal Components
  -  SPP-10245 - Upgradeability of adjacent systems
  -  SPP-10246 - Integration of external devices
  -  SPP-10221 - Support for backward compatibility
  - [Application Condition]  SPP-15441 - TMS shall define a migration strategy able to be aligned with the CCS evolution plan

Linked Work Items	has parent :  SPP-6559 - Enhanced System Architecting and Integration processes for CCS and TM/CM _ is derived by :  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture _ is derived by :  SPP-8863 - CCS designed to reduce OPEX _ is derived by :  SPP-9274 - Upgradeability of Internal Components _ is derived by :  SPP-10221 - Support for backward compatibility _ is derived by :  SPP-10245 - Upgradeability of adjacent systems _ is derived by :  SPP-10246 - Integration of external devices _ is derived by :  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time _ is derived by :  SPP-15441 - TMS shall define a migration strategy able to be aligned with the CCS evolution plan _ is derived by :  SPP-15442 - TMS shall support the extension of automatic functions and the increased level of automation in functions already implemented. _ is derived by :  SPP-15538 - TMS shall support CCS backwards compatibility feature _ is derived by :  SPP-15837 - Level of backward compatibility for Traffic CS
ID	SPP-10178

#### 4.3-7 - Support for backward compatibility

The CCS shall support backward compatibility within the target system architecture, provided it is economically justifiable. [SPP-10221]

#### 4.3-8 - Level of backward compatibility for Traffic CS

The level of backward compatibility for Traffic CS needs to be agreed having in mind the goal to reduce the effort to adapt CCS and to avoid the inclusion of interfaces for the multitude of legacy systems. [SPP-15837]

#### 4.3-9 - Decoupling of asset life cycle



Technology and asset life cycles of components are completely decoupled which reduces the overall complexity for the architecting, integration, and asset management processes. Every technology can be designed, managed, procured, installed, and configured in an isolated and independent industrial process for a whole infrastructure or fleet. Integration and system compatibility is just a matter of automated compliance testing which is in some cases only done on run-time.

ID	SPT2OD-317
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#### 4.3-10 - Decoupling of asset life cycle

*[Description of problem and general need regarding CCS]*

Today, high architectural dependencies lead to the need for “large and complete” asset replacements, with high project risks, very large budgets in short time periods and imbalanced asset age structures as a long-term consequence.


That's why the granularity concept by the Architecture and release coordination team  System Concept\_CCS - Granularity Concepts and Principles - Main stipulates the rule to ensure coherent and consistent lifecycles to achieve independent lifecycle management for each of the subsystems (see  SPT2ARC-1278).

This means at this stage of the CCS system analysis, that the different lifecycle profiles of the different CCS functionalities, e.g. safety logic vs. plan execution, have to be identified and will lead to architecture decisions for the logical and physical architecture.


*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*





As an IM, I want to reduce engineering efforts of CCS trackside systems to lower project risk and time.

-  SPP-9553 - CCS Hardware, Software and Engineering Data shall be independently upgradeable to minimize engineering efforts and reduce deployment time.


As a Supplier, I want to reduce engineering effort to save effort in maintaining different sets of engineering data with complex dependencies to hardware/software.







-  SPP-9553 - CCS Hardware, Software and Engineering Data shall be independently upgradeable to minimize engineering efforts and reduce deployment time.

As IM, I want to decouple the replacement of trackside assets and interlocking technologies in order to avoid replacing systems prematurely.

-  SPT2TRAFFIC-4495 - EULYNX Standard Communication Interfaces SCI-xx
-  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture

As an IM / RU, I want to reduce compliance testing effort in order to demonstrate system compatibility.

-  SPP-14326 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9)

Linked Work Items	<p>is derived from :  SPT2OD-317 - Decoupling of asset life cycle</p> <p>has parent :  SPP-6559 - Enhanced System Architecting and Integration processes for CCS and TM/CM</p> <p>_ is derived by :  SPP-7122 - Scalable, modular, multi-layered and standardised CCS architecture</p> <p>_ is derived by :  SPP-9553 - CCS Hardware, Software and Engineering Data shall be independently upgradeable to minimize engineering efforts and reduce deployment time.</p> <p>_ is derived by :  SPP-14326 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9)</p> <p>_ is derived by :  SPP-28351 - EULYNX Standard Communication Interfaces SCI-xx</p>
ID	SPP-9621

#### 4.3-11 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9)

CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9). [SPP-14326 ]

## 4.4 The vision concerning skill management

### 4.4-1 - Reduced amount of skill needs

The vision concerning skill management is addressing the reduced amount of skill needs by using more standard IT technologies and the creation of isolated specialist areas per smaller CCS and TM/CM architecture zone, that is scoped, interfaced, and specified by a standard architecture. Smarter



components and advisory system demand less knowledge from users, maintainers, planners, or integrators.

ID	SPT2OD-320
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#### 4.4-2 - Reduced amount of skill needs

*[Description of problem and general need regarding CCS]*


Today, project engineering and operational rules are dependent on the technical and functional properties of proprietary systems and on national rules. In today's CCS technology, the operational processes, system functions/requirements, architectures, hazards analysis and project rules are not linked, and the connections are not obvious. Oftentimes the connections are only stored in the minds of highly specialised resources. The development, engineering, integration and assurance of these systems require a great deal of expertise about the whole system landscape and ties up highly specialised resources. Overall, this leads to a heavy reliance on these resources and significant effort in terms of training and retaining scarce specialised knowledge. On top of that, designing such products/systems doesn't attract a lot of personal because, e.g. the high specialisation in outdated technologies that is not beneficial in any other area, minor changes can result in numerous trouble reports and impact other parts of the system. Thus, CCS system shall support the reduction or generalisation of skill needs of CCS users.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*





As an IM, I want CCS trackside system with Centralized Diagnostic Functionalities in order to simplify fault detection and allow fault prediction.

-  SPP-9679 - CCS shall implement standardised diagnostics functions and standardised interfaces for faster root cause analysis, recovery processes, failure prediction and prevention.
-  SPP-9681 - An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system.



As a Supplier, I want automated engineering tools that assist engineers during data preparation.

-  SPP-9904 - CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update





As an IM / RU, I want Human Machine Interfaces that assist signallers and maintainers step-by-step during procedures in order to increase safety reducing the possibility of human errors.

-  SPP-9935 - Standardisation and automation of operational processes to reduce training and increase safety of personnel
-  SPP-6881 - The operational processes involving trackside personnel and non-trackbound vehicles shall be optimized, in order to reduce their impact on railway operations.
-  SPT2TRAFFIC-4365 - As a Maintainer, I want a Traffic CS system that assists me showing on the HMI a digital checklist of the checks to perform before activate safety-critical emergency commands
-  SPT2TRAFFIC-5351 - As a Signaller, I want a Traffic CS system that assists me in degraded situation...



As an IM / Supplier, I want to decouple skill areas by reducing the importance of preservation of knowledge regarding older CCS trackside systems for railways and industry.

-  SPP-6860 - CCS shall be based on standardized products and configurations
-  SPP-9942 - Use standard hardware components



As an IM / Supplier, I want simplified engineering rules to reduce the skill needs of staff.

-  SPP-9297 - Reduction of engineering complexity
-  SPP-9298 - Minimum required Configuration Data implementation
-  SPP-7129 - Harmonised SERA operational rules
-  SPP-7130 - CCS shall support technical and operational interoperability




As an IM / Supplier, I want to decouple skill areas by reducing the importance of preservation of knowledge regarding older CCS trackside systems for railways and industry.

-  SPP-6860 - CCS shall be based on standardized products and configurations
-  SPP-9942 - Use standard hardware components











As a Supplier, I want less custom-made requirements and solutions that lead to more complexity in the products.

-  SPP-6858 - CCS shall rely on a standardized set of manual controls for normal operations, based on harmonised operational rules
-  SPP-6859 - CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules

*[Application Conditions]*

-  SPP-14896 - IMs and RUs shall train operators and drivers using the harmonized operational processes instead of national rules
-  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs
-  SPP-15079 - Track users shall support harmonized operational processes instead of national specific needs

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Linked Work Items	<p>is derived from :  SPT2OD-320 - Reduced amount of skill needs</p> <p>has parent :  SPP-6560 - The vision concerning skill management</p> <p>_ is derived by :  SPP-6858 - CCS shall rely on a standardized set of manual controls for normal operations, based on harmonised operational rules</p> <p>_ is derived by :  SPP-6859 - CCS shall rely on a standardized set of manual controls for degraded operations, based on harmonized operational rules</p> <p>_ is derived by :  SPP-6860 - CCS shall be based on standardized products and configurations</p> <p>_ is derived by :  SPP-6881 - The operational processes involving trackside personnel and non-trackbound vehicles shall be optimized, in order to reduce their impact on railway operations.</p> <p>_ is derived by :  SPP-7129 - Harmonised SERA operational rules</p> <p>_ is derived by :  SPP-7130 - CCS shall support technical and operational interoperability</p> <p>_ is derived by :  SPP-9297 - Reduction of engineering complexity</p> <p>_ is derived by :  SPP-9298 - Minimum required Configuration Data implementation</p> <p>_ is derived by :  SPP-9679 - CCS shall implement standardised diagnostics functions and standardised interfaces for faster root cause analysis, recovery processes, failure prediction and prevention.</p> <p>_ is derived by :  SPP-9681 - An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system.</p> <p>_ is derived by :  SPP-9904 - CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update</p> <p>_ is derived by :  SPP-9935 - Standardisation and automation of operational processes to reduce training and increase safety of personnel</p> <p>_ is derived by :  SPP-9942 - Use standard hardware components</p> <p>_ is derived by :  SPP-14896 - IMs and RUs shall train operators and drivers using the harmonized operational processes instead of national rules</p> <p>_ is derived by :  SPP-15046 - TMS shall support harmonized operational process instead of national specific needs</p> <p>_ is derived by :  SPP-15079 - Track users shall support harmonized operational processes instead of national specific needs</p> <p>_ is derived by :  SPT2TRAFFIC-4365 - As a Maintainer, I want a Traffic CS system that assists me showing on the HMI a digital checklist of the checks to perform before activate safety-critical emergency commands</p> <p>_ is derived by :  SPT2TRAFFIC-5351 - As a Signaller, I want a Traffic CS system that assists me in degraded situation...</p>
ID	SPP-9928

#### 4.4-3 - Standardisation and automation of operational processes to reduce training and increase safety of personnel

CCS shall support the standardisation and automation of operational processes involving trackside and on-board personnel and non-trackbound vehicles, in order to reduce training effort and increase safety. [SPP-9935]

#### 4.4-4 - Use standard hardware components

CCS shall use standard hardware components and ensure safety by software measures. [SPP-9942]

#### 4.4-5 - Scalability of skills

Out of this the skill pool, training facilities and advisory systems can scale, and smaller specialization areas allow to enlarge the pool of available skills.

ID	SPT2OD-321
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#### 4.4-6 - Scalability of skills

*[Description of problem and general need in regard to CCS]*



Today, project engineering and operational rules are dependent on the technical and functional properties of proprietary systems. In today's interlocking and train control technology, the operational processes, system functions/requirements, architectures, and projection rules are not linked, and the connections are not obvious. Oftentimes the connections are only stored in the minds of highly specialised resources. The development, engineering, integration and assurance of these systems require a great deal of expertise about the whole system landscape and ties up highly specialised resources. By generalising the skills and reducing the skill needs, potential scalability effects in the sense of enlarging the available skill pool and attracting new resources can be envisioned.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*


As an IM / RU, I want an increased skill pool of staff.







-  SPP-6881 - The operational processes involving trackside personnel and non-trackbound vehicles shall be optimized, in order to reduce their impact on railway operations.

As an IM / RU, I want less specialised advisory systems for staff in order to reduce the costs of operating and maintaining them.

-  SPP-6882 - CCS shall support advisory systems
-  SPP-14326 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9)

*[Application Conditions]*

-  SPP-14896 - IMs and RUs shall train operators and drivers using the harmonized operational processes instead of national rules

Linked Work Items	is derived from :  SPT2OD-321 - Scalability of skills has parent :  SPP-6560 - The vision concerning skill management _ is derived by :  SPP-6881 - The operational processes involving trackside personnel and non-trackbound vehicles shall be optimized, in order to reduce their impact on railway operations. _ is derived by :  SPP-6882 - CCS shall support advisory systems _ is derived by :  SPP-14326 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9) _ is derived by :  SPP-14896 - IMs and RUs shall train operators and drivers using the harmonized operational processes instead of national rules
ID	SPP-6874

#### 4.4-7 - The operational processes involving trackside personnel and non-trackbound vehicles shall be optimized, in order to reduce their impact on railway operations.

The operational processes involving trackside personnel and non-trackbound vehicles shall be optimized, in order to reduce their impact on railway operations. [SPP-6881 ]

#### 4.4-8 - CCS shall support advisory systems

The CCS System shall support advisory systems for its actors by providing the needed real-time data.

*Note: It depends on the interfacing advisory system which data from Traffic CS is needed. [SPP-6882]*

## 4.5 Infrastructure asset management

### 4.5-1 - Reduction of trackside CCS assets

The amount of trackside CCS assets is reduced by more than 50% (in the long-term just radio antenna, a strongly reduced number of balises and train detection sensors, and controller for points and crossings). Trackside control and safety systems are centralized to reduce maintenance, cost, and to simplify upgrades/updates.









ID	SPT2OD-326
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### 4.5-2 - Reduction of trackside CCS assets




*[Description of problem and general need regarding CCS]*














The development of a CCS system based on ERTMS L2 allows to remove signals and as a consequence to reduce the amount of trackside assets (and need for cabling). In addition, a consistent reduction of trackside train detection system, like track circuit and axle counters, can be performed with on-board train integrity monitoring. It is also an enabler for moving block or virtual fixed block that, in addition to the TCO reduction, allows also an increase of track capacity. Once trains will be able to perform supervised SH movement, there will be an opportunity to eventually remove Shunting signals and boards.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

- As an IM, I want to remove line-side signals as much as possible.
  -  SPP-7025 - CCS shall be designed to use ETCS L2 without optical (light) signals.
- As an IM, I want to have complete information about the state of the railway even when trackside CCS assets are reduced.
  -  SPP-6931 - CCS shall allow a visual representation of the complete, consistent and accurate status of the operational situation
  -  SPP-6932 - Signaller shall have a visual representation of the complete, consistent and accurate status of the operational situation
  -  SPP-6935 - Signaller shall have a visual representation of malfunctioning devices and their impact on the operational situation
  -  SPP-6936 - CCS shall allow a visual representation malfunctioning devices and their impact on the operational situation
- As an IM, I want to use axle counters, track circuits and on-board position and integrity information in a flexible way.
  -  SPP-6938 - CCS shall implement functionalities that allow the use and combination of different types of sensor technologies and information
- As an IM, I want to reduce trackside CCS assets by centralising their functionalities in one place instead of having many assets along the line.
  -  SPP-10109 - CCS shall support system deployment on centralised data centers.
  -  SPP-10110 - CCS shall support the separation between the central system and decentralised lineside devices

### [Application Conditions]

-  SPP-14776 - TMS shall support the track capacity optimization through a correct and efficient use of the operational state received from CCS.
-  SPP-14824 - TMS shall consider the status of the trackside assets and trains to automatically schedule a service
-  SPP-11496 - TMS shall automatically update the operational plan in real time (in short intervals) over the entire process life-cycle

Linked Work Items	<p>is derived from :  SPT2OD-326 - Reduction of trackside CCS assets</p> <p>has parent :  SPP-6561 - Infrastructure asset management</p> <p>_ is derived by :  SPP-6931 - CCS shall allow a visual representation of the complete, consistent and accurate status of the operational situation</p> <p>_ is derived by :  SPP-6932 - Signaller shall have a visual representation of the complete, consistent and accurate status of the operational situation</p> <p>_ is derived by :  SPP-6935 - Signaller shall have a visual representation of malfunctioning devices and their impact on the operational situation</p> <p>_ is derived by :  SPP-6936 - CCS shall allow a visual representation malfunctioning devices and their impact on the operational situation</p> <p>_ is derived by :  SPP-6938 - CCS shall implement functionalities that allow the use and combination of different types of sensor technologies and information</p> <p>_ is derived by :  SPP-7025 - CCS shall be designed to use ETCS L2 without optical (light) signals.</p> <p>_ is derived by :  SPP-10109 - CCS shall support system deployment on centralised data centers.</p> <p>_ is derived by :  SPP-10110 - CCS shall support the separation between the central system and decentralised lineside devices</p> <p>_ is derived by :  SPP-11496 - TMS shall automatically update the operational plan in real time (in short intervals) over the entire process life-cycle</p> <p>_ is derived by :  SPP-14776 - TMS shall support the track capacity optimization through a correct and efficient use of the operational state received from CCS.</p> <p>_ is derived by :  SPP-14824 - TMS shall consider the status of the trackside assets and trains to automatically schedule a service</p>
ID	SPP-10108

#### 4.5-3 - CCS shall support system deployment on centralised data centers.

CCS shall support system deployment on centralised data centers. [SPP-10109]

#### 4.5-4 - CCS shall support the separation between the central system and decentralised lineside devices

CCS shall support the separation between the central system and decentralised lineside devices. [SPP-10110]

#### 4.5-5 - Simplified process for planning and installing CCS systems

Safety cases or signalling planning processes for new installations become simple, just - component compliance tests, plug the assets, and operate.

ID	SPT2OD-327
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#### 4.5-6 - Simplified process for planning and installing CCS systems

[Description of problem and general need in regard to CCS]












Today's rollouts "station by station" or "line by line" are not the most efficient ones. Network-wide

preparation programs e.g. with single changes of trackside assets that go directly into production would often be the best choice for the early usage of the new technical capacity. Because of the overhead of CCS construction projects that comes with the characteristics of today's CCS systems this choice today is not often possible.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

- As an IM, I want to simplify safety cases, by using generic application safety cases, for new installations as much as possible.
  -  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data
  -  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data
  - [Application Condition]  SPP-15528 - TMS shall enable the implementation of 'Generic Products' for its subsystems in accordance with CENELEC 50126
  - [Application Condition]  SPP-15633 - TMS shall allow to define a 'Generic Application', in accordance with CENELEC 50126
- As an IM, I want to simplify signalling planning processes for new installations as much as possible.
  -  SPP-9297 - Reduction of engineering complexity
  -  SPP-9298 - Minimum required Configuration Data implementation
- As an IM, I want to make use of highly automated compliance testing for new installation.
  -  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data
  -  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data
  -  SPP-14326 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9)
  -  SPP-9614 - CCS shall implement an architecture based on standardized interfaces to enable the integration of components from multiple suppliers
  - [Application Condition]  SPP-14821 - Railway Authorities shall be trained of the scope and respectively limitations of the SERA automated compliance testing for new installation



Linked Work Items	<p>is derived from :  SPT2OD-327 - Simplified process for planning and installing CCS systems</p> <p>has parent :  SPP-6561 - Infrastructure asset management</p> <p>_ is derived by :  SPP-9297 - Reduction of engineering complexity</p> <p>_ is derived by :  SPP-9298 - Minimum required Configuration Data implementation</p> <p>_ is derived by :  SPP-9614 - CCS shall implement an architecture based on standardized interfaces to enable the integration of components from multiple suppliers</p> <p>_ is derived by :  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data</p> <p>_ is derived by :  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data</p> <p>_ is derived by :  SPP-14326 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9)</p> <p>_ is derived by :  SPP-14821 - Railway Authorities shall be trained of the scope and respectively limitations of the SERA automated compliance testing for new installation</p> <p>_ is derived by :  SPP-15528 - TMS shall enable the implementation of 'Generic Products' for its subsystems in accordance with CENELEC 50126</p> <p>_ is derived by :  SPP-15633 - TMS shall allow to define a 'Generic Application', in accordance with CENELEC 50126</p>
ID	SPP-9686

#### 4.5-7 - Selective on demand replacements

Combined with an integrated and automated toolchain, upgradeable architectures in the trackside cheaper migration, and selective replacements lead to fast and efficient industrial deployments and low total cost of ownership.






ID	SPT2OD-328
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#### 4.5-8 - Selective on demand replacements









*[Description of problem and general need in regard to Traffic CS]*

Today, the replacement of CCS components requires a traditionally handcrafted process for planning, construction, and maintenance of individual installations or lines. Selective replacement of single components often results in high sunk costs and may not be feasible on-demand.

*[Breakdown into specific needs in regard to Traffic CS, including links to System- or Operational Requirements]*

- As an IM, I want to increase the speed of rollout to be able to handle upcoming replacement peaks and lower the TCO.
  -  SPP-9274 - Upgradeability of Internal Components
  -  SPP-10245 - Upgradeability of adjacent systems
  -  SPP-10246 - Integration of external devices
  - [Application Condition]  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time
- As an IM, I want to achieve an industrialised rollout of the new Traffic CS to lower the number of handovers to legacy systems.
  -  SPP-9301 - Support for efficient rollout processes

- As an IM, I want cheap, on-demand replacements on a component-by-component basis, or horizontally for one function for the full network.
  -  SPP-10230 - Integration of external devices

Linked Work Items	is derived from :  SPT2OD-328 - Selective on demand replacements has parent :  SPP-6561 - Infrastructure asset management _ is derived by :  SPP-9274 - Upgradeability of Internal Components _ is derived by :  SPP-9301 - Support for efficient rollout processes _ is derived by :  SPP-10230 - Integration of external devices _ is derived by :  SPP-10245 - Upgradeability of adjacent systems _ is derived by :  SPP-10246 - Integration of external devices _ is derived by :  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time
ID	SPP-10228

#### 4.5-9 - Integration of external devices

The CCS shall facilitate the integration of external devices with minimal manual configuration and testing requirements. [SPP-10230 ]

#### 4.5-10 - Optimizing track capacity

The ability to combine, mix and use all modern sensor technologies (scalability) even on the same line delivers a precise perception of the operational state and exact traffic flow. Combined with precise and dynamic control algorithms the traffic flow is tuned to the physical capacity limit.

ID	SPT2OD-329
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#### 4.5-11 - Optimizing track capacity

*[Description of problem and general need in regard to CCS]*

Today, due to fixed-length track occupancy sections, often combined with pre-emptive considerations of worst-case scenarios, the track capacity cannot be fully utilised with today's technology of interlockings. The analysis on train-centric track occupancy management for the future Traffic CS has been done by the Traffic CS domain. With train-centric approach the trackside focus is on representing a railway vehicle with an extent in a topology rather than on representing anonymous occupancy states of fixed sizes reported by TTD systems as in today's conventional block-centric signalling systems. In other words, the term "train-centric" refers to a "train-oriented" view of the trackside system about the track occupation caused by a railway vehicle, e.g., an ETCS-equipped train. This view is achieved by fusion of localisation information from both train and trackside.

A train-centric track occupancy determination is based primarily on localisation information received from the railway vehicle, e.g., from trains sent via ETCS Train Position Reports with or without train-integrity status. The trackside system will also take into account additional trackside localisation information if available such as Trackside Train Detection (TTD) inputs, for example to:

- Adjust the trackside view of track occupancy by train, based on clear TTD sections at the front or rear of the train

- Detect movement of non-communicating railway vehicles, e.g., trains/wagons not equipped with ETCS and trains equipped with ETCS that have lost communication
- Handle degraded situations, such as loss of train integrity.

Thus, the strategy for Traffic CS can be to support the route setting based on the current characteristics of trains and the operational situation. From a CONEMP perspective, Traffic CS should handle today's and possible future sensor technologies with no or minimal impact to change Traffic CS subsystems (or even the whole Traffic CS) to be "future-proof". Also, scalability of sensor density (mix and use all modern sensor technologies) for different line types can be used to lower the costs associated with a higher train density.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

As a Signaller, I want to have a visual representation of the complete, consistent and accurate status of the operational situation, of the malfunctioning devices and their impact on the operational situation.

- SPP-6931 - CCS shall allow a visual representation of the complete, consistent and accurate status of the operational situation
- SPP-6932 - Signaller shall have a visual representation of the complete, consistent and accurate status of the operational situation
- SPP-6935 - Signaller shall have a visual representation of malfunctioning devices and their impact on the operational situation
- SPP-6936 - CCS shall allow a visual representation malfunctioning devices and their impact on the operational situation

As a Railway Undertaking, I want CCS to be able to handle specific capabilities and characteristics of the train units when executing train movements, in order to benefit early from stepwise introduced new Rolling Stock functionality.

- SPP-6934 - CCS shall be able to handle the specific capabilities and characteristics of the train units when executing train movements



As an Infrastructure Manager, I want a system that implements functionality to use and combine different types of sensor technologies and information. I want a system able also to deploy and use future sensor technology without having to change Traffic CS safety logic in order to have an easily upgradeable system.













- SPP-6938 - CCS shall implement functionalities that allow the use and combination of different types of sensor technologies and information
- SPP-6940 - CCS shall deploy and use future sensor technology, based on defined Standard Interfaces) with no impact on the Traffic CS safety logic

As an Infrastructure Manager, I want Traffic CS to perform periodical self-tests and self-diagnostics of its vital functions in order to prevent system failures and enable fast recovery times.

- SPP-6941 - CCS shall perform periodical self-tests and self-diagnostics of its vital functions

*[Application Conditions]*

-  SPP-14776 - TMS shall support the track capacity optimization through a correct and efficient use of the operational state received from CCS.
-  SPP-11496 - TMS shall automatically update the operational plan in real time (in short intervals) over the entire process life-cycle

Linked Work Items	<p>is derived from :  SPT2OD-329 - Optimizing track capacity</p> <p>has parent :  SPP-6561 - Infrastructure asset management</p> <p>_ is derived by :  SPP-6931 - CCS shall allow a visual representation of the complete, consistent and accurate status of the operational situation</p> <p>_ is derived by :  SPP-6932 - Signaller shall have a visual representation of the complete, consistent and accurate status of the operational situation</p> <p>_ is derived by :  SPP-6934 - CCS shall be able to handle the specific capabilities and characteristics of the train units when executing train movements</p> <p>_ is derived by :  SPP-6935 - Signaller shall have a visual representation of malfunctioning devices and their impact on the operational situation</p> <p>_ is derived by :  SPP-6936 - CCS shall allow a visual representation malfunctioning devices and their impact on the operational situation</p> <p>_ is derived by :  SPP-6938 - CCS shall implement functionalities that allow the use and combination of different types of sensor technologies and information</p> <p>_ is derived by :  SPP-6940 - CCS shall deploy and use future sensor technology, based on defined Standard Interfaces) with no impact on the Traffic CS safety logic</p> <p>_ is derived by :  SPP-6941 - CCS shall perform periodical self-tests and self-diagnostics of its vital functions</p> <p>_ is derived by :  SPP-11496 - TMS shall automatically update the operational plan in real time (in short intervals) over the entire process life-cycle</p> <p>_ is derived by :  SPP-14776 - TMS shall support the track capacity optimization through a correct and efficient use of the operational state received from CCS.</p>
ID	SPP-6890

**4.5-12 - CCS shall allow a visual representation of the complete, consistent and accurate status of the operational situation**

The CCS System shall allow a visual representation of the complete, consistent and accurate status of the operational situation. [SPP-6931 ]

**4.5-13 - Signaller shall have a visual representation of the complete, consistent and accurate status of the operational situation**

Signaller shall have a visual representation of the complete, consistent and accurate status of the operational situation in order to react to incidents that have the potential to limit the railway safety and track capacity. [SPP-6932 ]

**4.5-14 - CCS shall be able to handle the specific capabilities and characteristics of the train units when executing train movements**

The CCS System shall be able to handle the specific capabilities and characteristics of the train units when executing train movements, in order to benefit early from stepwise introduced new Rolling Stock functionality. [SPP-6934 ]

**4.5-15 - Signaller shall have a visual representation of malfunctioning devices and their impact on the operational situation**

Signaller shall have a visual representation of malfunctioning devices and their impact on the operational situation in order to initiate appropriate measures in case of equipment failure. [SPP-6935 ]

#### 4.5-16 - CCS shall allow a visual representation malfunctioning devices and their impact on the operational situation

CCS shall provide to the Signaller a visual representation of malfunctioning devices and their impact on the operational situation in order to initiate appropriate measures in case of equipment failure.  
[SPP-6936 ]

#### 4.5-17 - CCS shall implement functionalities that allow the use and combination of different types of sensor technologies and information

CCS shall implement functionalities that allow the use and combination of different types of sensor technologies and information, in order to increase system availability limiting degraded situation occurrences due to sensor faults. [SPP-6938 ]

#### 4.5-18 - CCS shall deploy and use future sensor technology, based on defined Standard Interfaces) with no impact on the Traffic CS safety logic

The CCS System shall deploy and use future sensor technology, based on defined Standard Interfaces) with no impact on the Traffic CS safety logic  
[SPP-6940 ]

#### 4.5-19 - CCS shall perform periodical self-tests and self-diagnostics of its vital functions

CCS shall perform periodical self-tests and self-diagnostics of its vital functions in order to prevent system failures and enable fast recovery times. [SPP-6941 ]

#### 4.5-20 - Optimizing track capacity (SPT2OD-329)

*[Description of problem and general need in regard to CCS]*

Today's CCS interface to traffic management systems and trains cannot always make use of all available information, like train specific properties and speed optimizations to use the full track capacity. Today it is very expensive to allow to connect multiple types of on-board, mobile or trackside sensors and information systems to retrieve and combine information about production objects (e.g. trains, persons on track, trackside assets) like IDs, occupancy status, and to aggregate, store and forward the status history.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*



As an Infrastructure Manager, I want CCS to allow movements from any point A to any point B without restrictions, if a route is available and is physically feasible.













- SPP-6947 - CCS shall allow movements from any point A to any point B without restrictions, if a route is available and is physically feasible.
- SPP-6948 - Traffic CS shall support driving in relative braking distance, managed by trackside infrastructure.
- SPP-6949 - CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state.
- SPP-6950 - CCS shall support virtual coupling of trains, with train-to-train communication.
- SPP-6957 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.
- SPP-10259 - Timely reservation of track capacities

As an Infrastructure Manager, I want CCS to make available a complete, consistent, accurate and up-to-date operating state.

- SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.

### [Application Conditions]

-  SPP-14776 - TMS shall support the track capacity optimization through a correct and efficient use of the operational state received from CCS.
-  SPP-11496 - TMS shall automatically update the operational plan in real time (in short intervals) over the entire process life-cycle

Linked Work Items	<p>is derived from :  SPT2OD-329 - Optimizing track capacity</p> <p>has parent :  SPP-6561 - Infrastructure asset management</p> <p>_ is derived by :  SPP-6947 - CCS shall allow movements from any point A to any point B without restrictions, if a route is available and is physically feasible.</p> <p>_ is derived by :  SPP-6948 - Traffic CS shall support driving in relative braking distance, managed by trackside infrastructure.</p> <p>_ is derived by :  SPP-6949 - CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state.</p> <p>_ is derived by :  SPP-6950 - CCS shall support virtual coupling of trains, with train-to-train communication.</p> <p>_ is derived by :  SPP-6956 - As an Infrastructure Manager, I want Traffic CS to make available a complete, consistent, accurate and up-to-date operating state.</p> <p>_ is derived by :  SPP-6957 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.</p> <p>_ is derived by :  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.</p> <p>_ is derived by :  SPP-10259 - Timely reservation of track capacities</p> <p>_ is derived by :  SPP-11496 - TMS shall automatically update the operational plan in real time (in short intervals) over the entire process life-cycle</p> <p>_ is derived by :  SPP-14776 - TMS shall support the track capacity optimization through a correct and efficient use of the operational state received from CCS.</p>
ID	SPP-6930

#### 4.5-21 - CCS shall allow movements from any point A to any point B without restrictions, if a route is available and is physically feasible.

CCS shall allow movements from any point A to any point B without restrictions, if a route is available and is physically feasible.. [SPP-6947 ]

#### 4.5-22 - Traffic CS shall support driving in relative braking distance, managed by trackside infrastructure.

Traffic CS shall support driving in relative braking distance, managed by trackside infrastructure. [SPP-6948 ]

#### 4.5-23 - CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state.

CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state. [SPP-6949 ]

#### 4.5-24 - CCS shall support virtual coupling of trains, with train-to-train communication.

CCS shall support virtual coupling of trains, with train-to-train communication. [SPP-6950 ]

#### 4.5-25 - CCS shall support the integration of complementary sensor information and data sources that enable the supervision of vehicles as well as trackside personnel and rail customers.

CCS shall support the integration of complementary sensor information and data sources that enable the supervision of trackbound and non-trackbound vehicles (e.g. excavator, crane) as well as trackside personnel and rail customers (e.g. passenger counters at the platform) to enable the comprehensive and continuous supervision of the railway operation. [SPP-6957 ]



#### 4.5-26 - Mixed system versions

Migration can make use of older system versions or very new versions (trackside and onboard) on the same line because the smart trackside control and safety logic can use on the basis of the currently available information mix and control features the optimal way of interaction and production.

ID	SPT2OD-330
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#### 4.5-27 - Mixed ETCS System Versions

*[Description of problem and general need regarding CCS]*

The current ETCS on-board equipment is a significant cost driver in today's CCS applications. Software upgrades for existing on-board equipment are complex, expensive, and often result in a complete replacement of the equipment. Currently, even minor upgrades require re-certification of the vehicle. Thus, upgrading a fleet of trains not only takes a long time but also oftentimes triggers discussions with regulatory authorities due to the high reinvestment costs for vehicle components that are not end of life. For many countries, the current inhomogeneous vehicle mix results in long transition periods to newer system versions.

That is why currently Infrastructure Managers cannot implement trackside innovations that will prevent trains with old system versions to run. Traffic CS backward compatibility would allow to use the most recent trackside functionalities for trains with a high enough version and still support trains with older system versions on the same track.


From a CONEMP perspective, backward compatibility should not only be an on-board feature but the whole CCS should support backward compatibility (e.g. following the strategies mentioned in

 SPT2TRAFFIC-4901).

The level of backward compatibility needs to be agreed for Traffic CS. For example, during the first ETCS rollouts (and partially still today), while trains still need to be equipped with one or more STM systems this is not envisioned for Traffic CS. Similar thoughts shall be put into the backwards compatibility to legacy interlockings / control / diagnostic systems to ensure the handover of trains from legacy technology to harmonized CCS.

Two strategies can be adopted:

- 1) Including existing interfaces to legacy trackside signalling systems. The multitude of inhomogeneous legacy interfaces that are partly defined as FIS only, could lead to high additional development effort and complexity for trackside CCS.
- 2) No specific change in the legacy systems and trackside CCS shall be designed to avoid any additional integration effort. This can be achieved by using an adapter for transferring the information between both systems including adaption of the functional behaviour.

Note: strategy 2 is the preferred solution and it is reflected in the System Requirement  SPP-14133

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*




As an IM, I want to reduce the effort to adapt CCS when introducing new functional and non-functional requirements.

-  SPP-14132 - CCS subsystems and their interfaces version compatibility









As a IM, I want to avoid having to include interfaces to the multitude of legacy systems inside of Traffic CS.

-  SPP-14133 - CCS system shall provide standardised interfaces

*[Application Conditions]*

-  SPP-14897 - From a CONEMP perspective, backward compatibility should not only be an on-board...
-  SPP-15440 - TMS shall be able to manage train mixed fleets equipped with CCS on-boards with different system versions and/or supporting different capabilities
-  SPP-15441 - TMS shall define a migration strategy able to be aligned with the CCS evolution plan



Linked Work Items	is derived from :  SPT2OD-330 - Mixed system versions has parent :  SPP-6561 - Infrastructure asset management _ is derived by :  SPP-14132 - CCS subsystems and their interfaces version compatibility _ is derived by :  SPP-14133 - CCS system shall provide standardised interfaces _ is derived by :  SPP-14897 - From a CONEMP perspective, backward compatibility should not only be an on-board... _ is derived by :  SPP-15440 - TMS shall be able to manage train mixed fleets equipped with CCS on-boards with different system versions and/or supporting different capabilities _ is derived by :  SPP-15441 - TMS shall define a migration strategy able to be aligned with the CCS evolution plan _ is derived by :  SPP-24384 - CCS subsystems and their interfaces version compatibility
ID	SPP-10107

#### 4.5-28 - CCS subsystems and their interfaces version compatibility

CCS subsystems and their interfaces shall have as little version dependency as possible in order to reduce adaptation efforts. [SPP-14132 ]

#### 4.5-29 - CCS system shall provide standardised interfaces

CCS system shall provide standardised interfaces, enabling the connectivity of adapters (which are to be developed by the legacy party) from legacy side in order to avoid any customizations (e.g. to legacy national scenarios/requirements like Class B ATP systems) in the harmonized CCS systems and products. [SPP-14133 ]

#### 4.5-30 - Independent asset life cycle

Trackside assets are replaced with completely independent lifecycles and safety cases, which eliminates a dependency for 80% of the asset capital.



ID	SPT2OD-331
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#### 4.5-31 - Independent asset life cycle








*Description of problem and general need regarding CCS]*

Today's CCS architecture historically evolved and therefore contains a large package of unnecessary legacies. In addition, the main parts of CCS are a complex combination of functions for securing the train run and additionally operational functions for traffic management. Operational needs are mostly "hard coded" by technical solution and only a minor choice of possible implemented configuration e.g. train routes are possible for operational flexible usage. Removing these functional dependencies allows the automation of complex asset lifecycle processes.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

- As an IM, I want to safely modify the infrastructure or the configuration during runtime with minimal impact on railway operations
  -  SPP-9296 - CCS shall enable updates of Configuration Data on runtime
  -  SPP-8624 - An harmonised process shall be defined to systems configuration during rail operation

- [Application Condition]  SPP-14825 - TMS shall acquire system configuration data for infrastructure and vehicle systems from the same centralised service used by CCS using a standard interface
- [Application Condition]  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time
- [Application Condition]  SPP-14823 - TMS shall have a completely independent lifecycle

Linked Work Items	is derived from :  SPT2OD-331 - Independent asset life cycle has parent :  SPP-6561 - Infrastructure asset management _ is derived by :  SPP-8624 - An harmonised process shall be defined to systems configuration during rail operation _ is derived by :  SPP-9296 - CCS shall enable updates of Configuration Data on runtime _ is derived by :  SPP-14823 - TMS shall have a completely independent lifecycle _ is derived by :  SPP-14825 - TMS shall acquire system configuration data for infrastructure and vehicle systems from the same centralised service used by CCS using a standard interface _ is derived by :  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time
ID	SPP-9687

#### 4.5-32 - Data acquisition

Map, topology, and asset information is acquired automatically over multiple channels (running trains, measurement trains, satellite pictures, drones, etc.)

ID	SPT2OD-332
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#### 4.5-33 - Data acquisition








*[Description of problem and general need in regard to CCS]*











Today's systems create many manual tasks because of unavailable status or property data (e.g. actual speed or breaking behaviour or exact track occupation position of trains) or missing detailed properties of trackside assets or vehicles and train sets. Manual human operations are not only expensive and unsafe, but the communication also slows down or hinders the production on all sides – they extend maintenance windows, track occupancies for shunting manoeuvres, or start of mission. Missing detailed information about the traffic flow lead to overly generic planning methods that generate unnecessary capacity reserves in the schedule.

Additionally, the input to create the data configuration is usually done manually, and it is prone to human mistakes. In future, the operational and engineering processes should support automatic acquisition of input data (e.g. topology, gradients) through different sources (e.g. LiDAR models, satellites)

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

- As an IM, I want CCS to consume Infrastructure Data and system configuration data from centralised source in order to enable data consistency with other systems (e.g. TMS, Trackside assets) outside Traffic CS which are operated in the same infrastructure area.
  -  SPP-9644 - CCS shall acquire the static properties of the infrastructure (e.g. tracks with speed and gradient profiles) from a centralised service).
  -  SPP-9645 - CCS shall acquire system configuration data from a centralised service via a standardised interface, based on EULYNX SMI-xx.

- [Application Condition]  SPP-14825 - TMS shall acquire system configuration data for infrastructure and vehicle systems from the same centralised service used by CCS using a standard interface
- As an IM, I want CCS to consume static train data from a centralised source in order to facilitate the sharing of train properties that are relevant for safe guarding the rail operation between different CCS systems.
  -  SPP-9647 - CCS shall acquire the static properties of the trains (e.g. loading gauge) from a centralised service.
- As an IM, I want CCS to use the outputs of different sensors in real time for the accurate computation of track capacity.
  -  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state.
- As an IM and RU and supplier, I want an standardised process for CCS to get static information of Infrastructure
  -  SPP-14116 - An harmonized process shall be defined to acquire data configuration related with railway infrastructure
- As an IM and RU and supplier, I want an standardised process for CCS to get static information of train configuration
  -  SPP-14117 - An harmonized process shall be defined to acquire data configuration related with train composition
- As an IM and RU and supplier, I want an automatic generation of data configuration using different technologies to reduce human errors in the data preparation, increase accuracy of the data configuration
  -  SPP-14118 - An harmonized process shall be defined for automatic generation of data configuration using different technologies
- As an IM and RU, I want TMS to consider all status information to get reliable schedules
  - [Application Condition]  SPP-14824 - TMS shall consider the status of the trackside assets and trains to automatically schedule a service

Linked Work Items	is derived from :  SPT2OD-332 - Data acquisition has parent :  SPP-6561 - Infrastructure asset management _ is derived by :  SPP-7020 - CCS shall provide to Traffic Management System a complete, consistent and accurate status of the operational state. _ is derived by :  SPP-9644 - CCS shall acquire the static properties of the infrastructure (e.g. tracks with speed and gradient profiles) from a centralised service). _ is derived by :  SPP-9645 - CCS shall acquire system configuration data from a centralised service via a standardised interface, based on EULYNX SMI-xx. _ is derived by :  SPP-9647 - CCS shall acquire the static properties of the trains (e.g. loading gauge) from a centralised service. _ is derived by :  SPP-14116 - An harmonized process shall be defined to acquire data configuration related with railway infrastructure _ is derived by :  SPP-14117 - An harmonized process shall be defined to acquire data configuration related with train composition _ is derived by :  SPP-14118 - An harmonized process shall be defined for automatic generation of data configuration using different technologies _ is derived by :  SPP-14824 - TMS shall consider the status of the trackside assets and trains to automatically schedule a service
ID	SPP-9648

#### 4.5-34 - CCS shall acquire the static properties of the trains (e.g. loading gauge) from a centralised service.

CCS shall acquire the static properties of the trains (e.g. loading gauge) from a centralised service.

[SPP-9647 ]

#### 4.5-35 - An harmonized process shall be defined to acquire data configuration related with railway infrastructure

An harmonized process shall be defined to acquire data configuration related with infrastructure

[SPP-14116 ]

#### 4.5-36 - An harmonized process shall be defined to acquire data configuration related with train composition

An harmonized process shall be defined to acquire data configuration related with train composition

[SPP-14117 ]

#### 4.5-37 - An harmonized process shall be defined for automatic generation of data configuration using different technologies

An harmonized process shall be defined for automatic generation of data configuration using different technologies [SPP-14118 ]

#### 4.5-38 - Reduced special hardware

The extended vision for Traffic CS asset management is built on the idea of moving more and more to ICT-like system landscapes and asset management principles to reduce TCO, increase availability, and automate/simplify asset management processes. Expensive special safe hardware is replaced by safe software container technologies and virtualisation to reduce the cost for the software life cycle, increase the availability, and simplify upgrades or network wide deployments. Hardware extensions or replacements are simpler because of standard communication busses and a standardisation of software<->hardware interfaces, which also make the use of centralized clouds possible.

ID	SPT2OD-333
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#### 4.5-39 - Reduce special hardware

*[Description of problem and general need regarding CCS]*


Today's CCS systems are very different in the countries which leads to high fixed costs per country on all sides (Infrastructure managers and Manufacturers). Therefore, the supply and procurement strategies of customers are often inflexible. The strongest effect comes from the fact that hardware obsolescence is very fast, leading to software updates requiring a recertification due to the new hardware. The decoupling of hardware and software components is a strategy to achieve continuous supply improvement, avoid obsolescence issues and make use of modern, standard ICT hard- and software solutions.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

As an IM / Supplier, I want the encapsulation of safety critical software in safe software containers.

-  SPP-9942 - Use standard hardware components
-  SPP-10174 - Decoupling of hardware and software components

As an IM, I want CCS to support easy horizontal scaling should the amounts of traffic or workload increase.

-  SPP-9496 - CCS shall be adaptable to local performance requirements by ensuring the scalability of its software components

As an IM, I want CCS to support easy vertical scaling should the required amount of processing power increase.

- SPP-9496 - CCS shall be adaptable to local performance requirements by ensuring the scalability of its software components

As an IM, I want CCS to make use of COTS products.

- SPP-10174 - Decoupling of hardware and software components
- SPP-9942 - Use standard hardware components

As an IM, I want CCS to make use of virtualisation technologies.

- SPP-10174 - Decoupling of hardware and software components

Linked Work Items	is derived from : SPT2OD-333 - Reduced special hardware has parent : SPP-6561 - Infrastructure asset management _ is derived by : SPP-9496 - CCS shall be adaptable to local performance requirements by ensuring the scalability of its software components _ is derived by : SPP-9942 - Use standard hardware components _ is derived by : SPP-10174 - Decoupling of hardware and software components
ID	SPP-9943

#### 4.5-40 - Data center deployment

Traffic CS is an architecture based on small or big data centres with central management, and decentral independent device life cycles with plug & play features and industrial replacements under production. Software and hardware components of an open market are freely combinable on run-time. Reliable and redundant communication architectures based on freely combinable communication stacks (scalable) are used, to use any type of public or private carrier network or combination, inside of the constraints of interoperability. System construction and maintenance is supported by smart, automated, and learning management systems. Scalable market services for "Software as a Service" (SaaS), or "Traffic control interface as a service" become possible.

ID	SPT2OD-334
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#### 4.5-41 - Data center deployment







*[Description of problem and general need in regard to CCS]*











Deploying CCS central system into a few data centres can be designed with minimal failures.

However, in the event of failure, the centralised nature can have significant impact on the operation of CCS and consequently on the railway operation. Appropriate strategies such as mentioned in SPT2OD-333 - Reduced special hardware have to be considered, like e.g. using redundancies while in operation to perform maintenance of interior facilities (horizontal scaling) resulting in shorter switching intervals.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

- SPP-10109 - CCS shall support system deployment on centralised data centers.
- SPP-10110 - CCS shall support the separation between the central system and decentralised lineside devices

-  SPP-9904 - CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update
-  SPP-9679 - CCS shall implement standardised diagnostics functions and standardised interfaces for faster root cause analysis, recovery processes, failure prediction and prevention.
-  SPP-9681 - An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system.
- [Application Condition]  SPP-14826 - TMS shall use the same centralized diagnostic service used by CCS using a standard interface
- [Application Condition]  SPP-15534 - TMS shall consider the CCS PRAMSS requirements when defining TMS PRAMSS requirements
- [Application Condition]  SPP-14825 - TMS shall acquire system configuration data for infrastructure and vehicle systems from the same centralised service used by CCS using a standard interface

Linked Work Items	<p>is derived from :  SPT2OD-334 - Data center deployment</p> <p>has parent :  SPP-6561 - Infrastructure asset management</p> <p>_ is derived by :  SPP-9679 - CCS shall implement standardised diagnostics functions and standardised interfaces for faster root cause analysis, recovery processes, failure prediction and prevention.</p> <p>_ is derived by :  SPP-9681 - An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system.</p> <p>_ is derived by :  SPP-9904 - CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update</p> <p>_ is derived by :  SPP-10109 - CCS shall support system deployment on centralised data centers.</p> <p>_ is derived by :  SPP-10110 - CCS shall support the separation between the central system and decentralised lineside devices</p> <p>_ is derived by :  SPP-14825 - TMS shall acquire system configuration data for infrastructure and vehicle systems from the same centralised service used by CCS using a standard interface</p> <p>_ is derived by :  SPP-14826 - TMS shall use the same centralized diagnostic service used by CCS using a standard interface</p> <p>_ is derived by :  SPP-15534 - TMS shall consider the CCS PRAMSS requirements when defining TMS PRAMSS requirements</p>
ID	SPP-10111

## 4.6 Asset management for the Train Control and supervision systems

### 4.6-1 - Data acquisition

The CCS onboard delivers all needed information about the train and can control all functions needed for automatic train operations, automated shunting under full supervision, and remote train control for example for stabling trains.

ID	SPT2OD-339
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### 4.6-2 - Remote upgrade

The extended vision includes a higher maintainability with onboard platforms for different software



products, that can be upgraded remotely, to ensure the train behaviour is always “state of the art” and with a high security protection.

ID	SPT2OD-340
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#### 4.6-3 - Driver Support Systems

The onboard ICT provides all needed information for the driver to avoid special training for knowledge about routes or special procedures (e.g., when entering a shunting yard or using a terminal).

ID	SPT2OD-341
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### 4.7 Simplified asset configuration management

#### 4.7-1 - Simplified asset configuration management

To reduce software effort (avoiding translating functionality), configuration effort and to simplify interfaces between CCS and TMS/CM systems the exchanged information about network-wide configurations (like the track topology or addresses of communication services) shall be standardized and the data acquisition and deployment shall follow a centralized approach to avoid redundant data creation or manual data transport. Configuration data shall be openly available for infrastructure and vehicle systems, or partly also for public data services.

ID	SPT2OD-343
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#### 4.7-2 - Simplified asset configuration management



*[Description of problem and general need regarding CCS]*

In today's CCS projects, the optimisation of CCS asset configurations and the optimisation of track layout for a certain traffic mix are highly interdependent and both project steps are repeated iteratively. A centralised source of information from where all systems acquire all data, would reduce the amount of engineering work, and therefore the cost, of configuring all different systems by reusing all the information from one single system.

A simplified asset configuration management allows for a reduce software and configuration effort, thus decreasing the total cost of ownerships (TCO) by implementing more efficient processes, leading to a lower OPEX costs and also to a decrease of potential errors.

Possible configuration parameters should be openly available like it is done for example in the EULYNX Subsystem Light Signal: There is a generic use case to set a corresponding signal aspect, all possible signal aspects are described in the signal aspect table, So, one generic development and national configuration (specific applications) are needed.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

- As an IM / RU, I want to have a central source of infrastructure data and system configuration in order to avoid redundant data creation or manual data transport.
  -  SPP-9644 - CCS shall acquire the static properties of the infrastructure (e.g. tracks with speed and gradient profiles) from a centralised service).
  -  SPP-9645 - CCS shall acquire system configuration data from a centralised service via a standardised interface, based on EULYNX SMI-xx.

- [Application Condition] 📁 SPP-14825 - TMS shall acquire system configuration data for infrastructure and vehicle systems from the same centralised service used by CCS using a standard interface
- As an IM, I want CCS to consume static train data from a centralised source in order to facilitate the sharing of train properties that are relevant for safe guarding the rail operation between different CCS systems.
  - 🌐 SPP-9647 - CCS shall acquire the static properties of the trains (e.g. loading gauge) from a centralised service.
- As an IM, I want the possibility to configure CCS to my local needs in order to benefit from the deployment of standardised products but also keeping the approval and project configuration effort low.
  - 🌐 SPP-6857 - CCS shall minimize the number of configuration parameters for Generic and Specific Applications
  - [Application Condition] 📁 SPP-16201 - TMS shall minimize the number of configuration parameters for Generic and Specific Applications
- As an IM / RU, I want the configuration parameters of CCS to be openly available so I can customized my operation.
  - 🌐 SPP-9513 - CCS shall be based on Generic Products that can be configured using openly available configuration parameters to address varying application needs

Linked Work Items	is derived from : 📁 SPT2OD-343 - Simplified asset configuration management has parent : 📁 SPP-6568 - Simplified asset configuration management _ is derived by : 🌐 SPP-6857 - CCS shall minimize the number of configuration parameters for Generic and Specific Applications _ is derived by : 🌐 SPP-9513 - CCS shall be based on Generic Products that can be configured using openly available configuration parameters to address varying application needs _ is derived by : 🌐 SPP-9644 - CCS shall acquire the static properties of the infrastructure (e.g. tracks with speed and gradient profiles) from a centralised service). _ is derived by : 🌐 SPP-9645 - CCS shall acquire system configuration data from a centralised service via a standardised interface, based on EULYNX SMI-xx. _ is derived by : 🌐 SPP-9647 - CCS shall acquire the static properties of the trains (e.g. loading gauge) from a centralised service. _ is derived by : 📁 SPP-14825 - TMS shall acquire system configuration data for infrastructure and vehicle systems from the same centralised service used by CCS using a standard interface _ is derived by : 📁 SPP-16201 - TMS shall minimize the number of configuration parameters for Generic and Specific Applications
ID	SPP-9646

#### 4.7-3 - CCS shall acquire the static properties of the infrastructure (e.g. tracks with speed and gradient profiles) from a centralised service).

CCS shall acquire the static properties of the infrastructure (e.g. tracks with speed and gradient profiles) from a centralised service). [SPP-9644 ]

#### 4.7-4 - CCS shall acquire system configuration data from a centralised service via a standardised interface, based on EULYNX SMI-xx.

CCS shall acquire system configuration data from a centralised service via a standardised interface, based on EULYNX SMI-xx. Examples for this system configuration data: software updates, configuration values [SPP-9645 ]

## 4.8 Integrated diagnostic systems

### 4.8-1 - Standard diagnostic features

To reduce the duration of troubleshooting and recovery processes the CCS and TMS/CM architecture shall introduce standard diagnostic features for every CCS and TMS/CM system which allow a centralized and fast diagnosis of root causes, an automated monitoring of the asset conditions and analytical functions for supporting continuous improvements process to foresee and avoid disturbances.

ID	SPT2OD-345
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### 4.8-2 - Standard diagnostic features







*Description of problem and general need regarding CCS]*

An efficient diagnostic system with an automated monitoring of the asset conditions and analytical functions is required to supports continuous improvements process and reduce the fault detection time. Use of standard diagnostics enables better and faster preventive and corrective maintenance of the systems belonging to CCS as there is less need for engineering data activities at project level to adapt interfaces and data models. This has an impact on TCO (reducing OPEX costs) and on project deployment times. Standardisation allows to remove technical barriers such as the lack of standard formats, and possible data misinterpretation. It also allows sharing of data and information.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

It has been identified as part of the CCS System Concept the need for centralised diagnostics system in a standard format, based on EULYNX standardized diagnostic interface SDI-xx.

- As an IM, I want CCS to implement a diagnostic interface in a standard format to remove technical barriers of data sharing, to shorten the duration of root cause analysis and recovery processes, as well as failure prediction and prevention reducing the number of failure events..
  -  SPP-9679 - CCS shall implement standardised diagnostics functions and standardised interfaces for faster root cause analysis, recovery processes, failure prediction and prevention.
  -  SPP-9681 - An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system.
- As an IM, I want to centrally collect CCS diagnostic data using a standard interface to facilitate the troubleshooting.
  -  SPP-9681 - An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system.
  -  SPP-9680 - CCS shall provide diagnostic information based on the generic part of the EULYNX/EU-Rail System Pillar standardised diagnostic interface, called SDI-xx.
  - [Application Condition]  SPP-14826 - TMS shall use the same centralized diagnostic service used by CCS using a standard interface

Linked Work Items	<p>is derived from :  SPT2OD-345 - Standard diagnostic features</p> <p>has parent :  SPP-6569 - Integrated diagnostic systems</p> <p>_ is derived by :  SPP-9679 - CCS shall implement standardised diagnostics functions and standardised interfaces for faster root cause analysis, recovery processes, failure prediction and prevention.</p> <p>_ is derived by :  SPP-9680 - CCS shall provide diagnostic information based on the generic part of the EULYNX/EU-Rail System Pillar standardised diagnostic interface, called SDI-xx.</p> <p>_ is derived by :  SPP-9681 - An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system.</p> <p>_ is derived by :  SPP-14826 - TMS shall use the same centralized diagnostic service used by CCS using a standard interface</p>
ID	SPP-9683

#### 4.8-3 - CCS shall implement standardised diagnostics functions and standardised interfaces for faster root cause analysis, recovery processes, failure prediction and prevention.

CCS shall implement standardised diagnostics functions and standardised interfaces for faster root cause analysis, recovery processes, failure prediction and prevention. [SPP-9679 ]

#### 4.8-4 - CCS shall provide diagnostic information based on the generic part of the EULYNX/EU-Rail System Pillar standardised diagnostic interface, called SDI-xx.

CCS shall provide diagnostic information based on the generic part of the EULYNX/EU-Rail System Pillar standardised diagnostic interface, called SDI-xx. [SPP-9680 ]

#### 4.8-5 - An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system.

An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system. [SPP-9681 ]

#### 4.8-6 - Sharing of diagnostic information

Diagnostic information shall be shared between involved participants in the maintenance and asset life cycle process.

ID	SPT2OD-346
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#### 4.8-7 - Sharing of diagnostic information

*[Description of problem and general need regarding CCS]*





Today, CCS systems have their own diagnostics features integrated or are interfaced to diagnostic systems. There's a lot of variation in the technical features for automated root causes analysis for system faults, automated field-force and maintenance management (ticketing), diagnostic user interfaces and automated analysis of larger historical diagnostic data.







To implement standardised diagnostics functions and interfaces, in order to collect all the diagnostic information in a unique, centralised system allows for a holistic diagnostic evaluation of the CCS system. The potential of what can be done with the data will depend on the technical solutions, but some possibilities are:

- It improves coordination between system for a holistic system evaluation with more complete information.
- Enables a faster and more accurate diagnosis, improving fault prediction and prevention reducing the number of failure events.
- Enables a better use of predictive maintenance.

- Increases efficiency by potential for verification of original results with alternative or supplementary analyses, advancement of knowledge by providing new results by testing new hypotheses, larger scale analyses (including predictive maintenance) based on individual data, enhanced multidisciplinary cooperation. This allows to improve/achieve RAM targets.
- Reduced cost and time for diagnostic and events research.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

- As an IM, I want fast recovery time of Traffic CS in order to minimise the impact on operation and safety.
  -  SPP-6941 - CCS shall perform periodical self-tests and self-diagnostics of its vital functions
- As an IM, I want to evaluate the CCS system in a holistic way.
  -  SPP-9679 - CCS shall implement standardised diagnostics functions and standardised interfaces for faster root cause analysis, recovery processes, failure prediction and prevention.
  -  SPP-9681 - An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system.
  - [Application Condition]  SPP-14826 - TMS shall use the same centralized diagnostic service used by CCS using a standard interface

Linked Work Items	is derived from :  SPT2OD-346 - Sharing of diagnostic information has parent :  SPP-6569 - Integrated diagnostic systems _ is derived by :  SPP-6941 - CCS shall perform periodical self-tests and self-diagnostics of its vital functions _ is derived by :  SPP-9679 - CCS shall implement standardised diagnostics functions and standardised interfaces for faster root cause analysis, recovery processes, failure prediction and prevention. _ is derived by :  SPP-9681 - An harmonized process shall be defined to report, store and distribute diagnosis information to/from a centralised system. _ is derived by :  SPP-14826 - TMS shall use the same centralized diagnostic service used by CCS using a standard interface
ID	SPP-9684

## 4.9 Enhanced security management processes

### 4.9-1 - Enhanced Security Management

The implementation of state-of-the-art security management processes is based on an architecture with multiple protections layers, enhanced authentication and authorisation methods, continuous monitoring of attacks or insufficient protection levels, a continuous improvement process and "security by design".

ID	SPT2OD-348
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### 4.9-2 - Security by Design

Security by design means to integrate multiple protection mechanisms in every software or hardware function as well as every data item that can be attacked with relevant consequences.

ID	SPT2OD-349
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### 4.9-3 - Security by Design

*[Description of problem and general need regarding CCS]*



In today's CCS systems, Cyber Security measures are often implemented as an "afterthought" and are not integrated into lifecycle considerations. Products that are Secure-by-Design are those where the security of the customers is a core business goal, not just a technical feature. Secure-by-Design products start with that goal before development starts. Secure-by-Default products are those that are secure to use "out of the box" with little to no configuration changes necessary and security features available without additional cost. Secure-by-Design means that technology products are built in a way that reasonably protects against malicious cyber actors successfully gaining access to devices, data, and connected infrastructure. Software manufacturers should perform a risk assessment to identify and enumerate prevalent cyber threats to critical systems, and then include protections in product blueprints that account for the evolving cyber threat landscape.

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*

As an IM, I want to reduce the chances that customers will fall victim to security incidents resulting from misconfigurations, insufficiently fast patching, or many other common issues. I want as well to reduce configuration effort to a Maintainer/Infrastructure Manager.

-  SPP-9905 - CCS system shall be developed using a security-by-design process, in order to avoid attacks to hardware or software components



As an IM, I want to prevent adversary activity from compromising systems or obtaining unauthorized access to sensitive data.

-  SPP-9906 - CCS system shall be protected by managing access in centralised access and identification Systems
-  SPP-9905 - CCS system shall be developed using a security-by-design process, in order to avoid attacks to hardware or software components



As an IM / Supplier, I want CCS to interface to centralised security services and shall be developed according to security-by-design process, e.g. a security analysis shall be performed at every CCS analysis level (system, logical, physical) to identify security requirements.

-  SPP-14106 - CCS shall interface to centralised security services










As an IM, I want CCS to be able to manage frequent security patches and upgrades with as little operational impact as possible.

-  SPP-9296 - CCS shall enable updates of Configuration Data on runtime
-  SPP-9904 - CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update

*[Application Conditions]*

-  SPP-16199 - TMS shall be developed using a security-by-design process
-  SPP-16200 - TMS shall use a centralised access management and identification system



Linked Work Items	is derived from :  SPT2OD-349 - Security by Design has parent :  SPP-6562 - Enhanced security management processes _ is derived by :  SPP-9296 - CCS shall enable updates of Configuration Data on runtime _ is derived by :  SPP-9904 - CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update _ is derived by :  SPP-9905 - CCS system shall be developed using a security-by-design process, in order to avoid attacks to hardware or software components _ is derived by :  SPP-9906 - CCS system shall be protected by managing access in centralised access and identification Systems _ is derived by :  SPP-14106 - CCS shall interface to centralised security services _ is derived by :  SPP-16199 - TMS shall be developed using a security-by-design process _ is derived by :  SPP-16200 - TMS shall use a centralised access management and identification system
ID	SPP-9903

#### 4.9-4 - CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update

CCS shall support the tool chain provided by centralised services e.g. regarding diagnostics, configuration management, topology update. [SPP-9904 ]

#### 4.9-5 - CCS system shall be developed using a security-by-design process, in order to avoid attacks to hardware or software components

CCS system shall be developed (including security) using a security-by-design process, in order to avoid attacks to hardware or software components. [SPP-9905 ]

#### 4.9-6 - CCS system shall be protected by managing access in centralised access and identification Systems

CCS system shall be protected by managing access in centralised access and identification Systems. [SPP-9906 ]

#### 4.9-7 - CCS shall interface to centralised security services

CCS shall interface to centralised security services. [SPP-14106 ]

### 4.10 Enhanced safety assurance process

#### 4.10-1 - Enhanced Safety Assurance Process

The enhancement and simplification of the safety assurance process plays a key role as a catalyst for the evolution and innovation of CCS. It is a big lifecycle cost driver and THE development obstacle today that hinders CCS to make use of all modern technologies "cross-sector".

ID	SPT2OD-351
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#### 4.10-2 - Modular Safety

- Because of a high architecture quality safe integration of components to a whole safe application is just done by a centralized (online) compliance test (certificate), that is done once (strategy “modular safety”)

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#### 4.10-3 - Modular Safety

*[Description of problem and general need regarding CCS]*

The safety assurance process plays a key role as a catalyst for the evolution and innovation of CCS.

Today, it is a big lifecycle cost driver and the major development obstacle today that hinders CCS to make use of all modern technologies “cross-sector”.

The definition of the CCS architecture follows the approach to form parts with similar functionality or required safety targets to a set of functions in a bundle as a smallest possible potential functional subsystem. Different aspects are to be considered in the early stage of the definition of architecture and system functions:

- Bundling of similar systems functions, e.g. fitting to exactly one defined layer of application
- Bundling of similar systems functions with the same safety needs/requirements concerning safety and security targets
- Forming a small functional subsystem could result in exactly one exchangeable generic product
- Balancing of small functional subsystems in the architecture with a high number of interfaces vs. products with high complexity but less interfaces according to the conceptual guidance in  SPP-9927 - Simplified, modular architecture to avoid redundancies
- Modular safety requires agreement on the required module granularity, the functionality included, and the definition of standard interfaces


The idea of a modular system consisting of generic subsystems and functions allows a simplified rollout and safety demonstration. This simplified, modular safety approach in practice could look like this.

The generic system has to include all functions that are realised through CCS, and therefore can be configured as required by the operational needs. This means that the reference system consists of the full functional implementation and offers the possibility to exclude functions and to set parameters, e.g. On high-density lines the functionality of ATO might lead to a positive business case whereas in other areas it will not. Therefore, the functionality should be adaptable to the local needs.

Although the possible combinations of functions and the values of their parameters are covered by the safety argumentation of the generic system, national parameters have to be considered in the corresponding safety case if an impact analysis identified new or additional risks that have not been covered by the generic safety case.



In any case, proper risk mitigation has to be demonstrated independently as much as possible. The generic system approach allows to reuse the same integration test strategy. Specific (national) implementations require additional testing of e.g. unstable communication systems, set of parameters, etc. The same test strategy can be applied for generic system tests in a reusable test environment (static and live data, automated testing etc.). For the safety demonstration a generic product approval for e.g. different combinations of Traffic CS components must be ensured.

From a CONEMP perspective, CCS aims to gain a generic safety approval with forwarding of implementation conditions including a hazard log. Due to the subsystems having a large generic part, the need for extensive interface coordination e.g. to the development of on-board installations, is significantly reduced as the additional implementation effort can be derived by reusing the safety demonstration of existing lines using the same or similar configuration within a predefined range of parameters.




*Please note: Principles for modular safety should be common across all systems across the System Pillar to simplify processes and allow for a simpler integration of safety cases. The segregation of the CCS system into safety modules must consider the granularity concept by the Architecture and release coordination team  System Concept\_CCS - Granularity Concepts and Principles - Main.*

*[Breakdown into specific needs regarding CCS, including links to System- or Operational Requirements]*


As an IM, I want to configure the safety features of the products according to the application and local needs.

-  SPP-9870 - CCS shall follow modular design principles
-  SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits




As an IM, I want faster rollout times and facilitate replacements, maintenance and updates in order to minimize roll-out times, project realization times and assurance efforts.

-  SPP-9554 - CCS shall follow a generic safety approach in encapsulating safety relevant functions within building blocks with a separate safety approvals
-  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data
-  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data



As an IM, I want to use products in my applications that don't entail Safety Relevant Application Conditions to minimise additional effort in the deployment and to reduce impacts on safety management system.














-  SPP-9620 - CCS shall avoid as much as possible exported Safety-Related Application Conditions

As an IM, I want exchangeable products that don't require a new safety assurance process when replaced.

-  SPP-9894 - CCS shall implement an architecture based on standardised interfaces to facilitate independent safety cases and approval processes for each subsystem
-  SPP-9901 - CCS shall be designed in such a way that specified components can be replaced and interconnected without the need to re-approve other components
-  SPP-8866 - Implement standardised interfaces without hindering of innovation

*[Application Conditions]*

-  SPP-15535 - TMS shall comply with the ARC-D2.3 Granularity Concepts and Principles for designing TMS architecture
-  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time

Linked Work Items	<p>is derived from :  SPT2OD-352 - Modular Safety</p> <p>has parent :  SPP-6564 - Enhanced safety assurance process</p> <p>_ is derived by :  SPP-8866 - Implement standardised interfaces without hindering of innovation</p> <p>_ is derived by :  SPP-9554 - CCS shall follow a generic safety approach in encapsulating safety relevant functions within building blocks with a separate safety approvals</p> <p>_ is derived by :  SPP-9620 - CCS shall avoid as much as possible exported Safety-Related Application Conditions</p> <p>_ is derived by :  SPP-9870 - CCS shall follow modular design principles</p> <p>_ is derived by :  SPP-9894 - CCS shall implement an architecture based on standardised interfaces to facilitate independent safety cases and approval processes for each subsystem</p> <p>_ is derived by :  SPP-9901 - CCS shall be designed in such a way that specified components can be replaced and interconnected without the need to re-approve other components</p> <p>_ is derived by :  SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits</p> <p>_ is derived by :  SPP-10254 - Enable implementation of Generic Products with Safety Cases independent of Configuration Data</p> <p>_ is derived by :  SPP-10255 - Enable implementation of Generic Applications with Safety Cases independent of Configuration Data</p> <p>_ is derived by :  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time</p> <p>_ is derived by :  SPP-15535 - TMS shall comply with the ARC-D2.3 Granularity Concepts and Principles for designing TMS architecture</p>
ID	SPP-9868

#### 4.10-4 - Risk assessment quality

- The quality of validation/testing and practical risk assessment for components and “system of systems” reaches a quality level, that allows to simplify bureaucratic development processes of today

ID	SPT2OD-353
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#### 4.10-5 - Risk assessment quality

*[Description of problem and general need regarding CCS]*

The safety assurance process plays a key role as a catalyst for the evolution and innovation of CCS. Today, it is a big lifecycle cost driver and the major development obstacle today that hinders CCS to make use of all modern technologies “cross-sector”.

A common European risk analysis and safety assessment procedures needs to be agreed to simplify the process and reuse the results across SERA.

To achieve this, proper risk mitigation has to be demonstrated independently as much as possible. The generic system approach allows to reuse the same integration test strategy. Specific (national) implementations require additional testing of e.g. unstable communication systems, set of parameters, etc. The same test strategy can be applied for generic system tests in a reusable test environment (static and live data, automated testing etc.). For the safety demonstration a generic product approval for e.g. different combinations of Traffic CS components must be ensured.

*[Breakdown into specific needs regarding Traffic CS, including links to System- or Operational*

### Requirements]

- As an IM, I want a reusable European testing strategy and implementations for Traffic CS to shorten deployment times for project execution and roll-out.
  - SPP-9554 - CCS shall follow a generic safety approach in encapsulating safety relevant functions within building blocks with a separate safety approvals
  - SPP-9620 - CCS shall avoid as much as possible exported Safety-Related Application Conditions
  - SPP-14326 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9)

### [Application Conditions]

- SPP-15534 - TMS shall consider the CCS PRAMSS requirements when defining TMS PRAMSS requirements

Linked Work Items	is derived from : SPT2OD-353 - Risk assessment quality has parent : SPP-6564 - Enhanced safety assurance process _ is derived by : SPP-9554 - CCS shall follow a generic safety approach in encapsulating safety relevant functions within building blocks with a separate safety approvals _ is derived by : SPP-9620 - CCS shall avoid as much as possible exported Safety-Related Application Conditions _ is derived by : SPP-14326 - CCS shall use reference models, reference laboratories and automated compliance testing in accordance with the European approval procedure (CENELEC phases 6 to 9) _ is derived by : SPP-15534 - TMS shall consider the CCS PRAMSS requirements when defining TMS PRAMSS requirements
ID	SPP-9619

#### 4.10-6 - CCS shall avoid as much as possible exported Safety-Related Application Conditions

When implementing safety relevant functions, CCS shall avoid as much as possible exported Safety-Related Application Conditions. [SPP-9620 ]

#### 4.10-7 - Dynamic change of system configurations

- Independent/redundant/stable safety monitoring systems and actor advisory systems allow a more dynamic change of systems and diversity of configurations and support a continuous improvement process.














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

#### 4.10-8 - Dynamic change of system configurations

[Description of problem and general need in regard to CCS]

Today the grade of automation supporting the change of CCS installations is low which leads to high cost when changing the system configuration. The technological solutions and processes today don't allow an instant network wide continuous improvement of the trackside CCS subsystem configuration. The strategy of managing updates of subsystems has to be based on avoiding impact on other parts of the system. Advantages of standardised systems that are already interoperable and do not require a lot of engineering effort shall not be diminished e.g. by establishing manually supported processes and validation steps.

*[Breakdown into specific needs in regard to CCS, including links to System- or Operational Requirements]*

- As an IM, I want to safely modify the infrastructure or the configuration during runtime with minimal impact on railway operations
  -  SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits
  -  SPP-9296 - CCS shall enable updates of Configuration Data on runtime
  -  SPP-8624 - An harmonised process shall be defined to systems configuration during rail operation
  -  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time
  - [Application Condition]  SPP-14828 - TMS shall support diagnose test of a component during running time
  - [Application Condition]  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time
- As an IM, I want to benefit from an independent, redundant and stable safety monitoring system in order to implement a continuous "system" improvement process.
  -  SPP-8625 - An harmonized process shall be defined to run diagnose test of a component during running time
  -  SPP-8626 - CCS shall support diagnose test of a component during running time.
  -  SPP-14828 - TMS shall support diagnose test of a component during running time
  -  SPP-8650 - An harmonized process shall be defined to mitigation measures to react in case of an incident
  -  SPP-9660 - CCS shall disclose incompatibilities between its subsystems and their interfaces during runtime.
  - [Application Condition]  SPP-14826 - TMS shall use the same centralized diagnostic service used by CCS using a standard interface
- As an IM, I want to benefit from an actor advisory system in order to implement a continuous "system" improvement process.
  -  SPP-6882 - CCS shall support advisory systems

Linked Work Items	<p>is derived from :  SPT2OD-354 - Dynamic change of system configurations</p> <p>has parent :  SPP-6564 - Enhanced safety assurance process</p> <p>_ is derived by :  SPP-6882 - CCS shall support advisory systems</p> <p>_ is derived by :  SPP-8624 - An harmonised process shall be defined to systems configuration during rail operation</p> <p>_ is derived by :  SPP-8625 - An harmonized process shall be defined to run diagnose test of a component during running time</p> <p>_ is derived by :  SPP-8626 - CCS shall support diagnose test of a component during running time.</p> <p>_ is derived by :  SPP-8650 - An harmonized process shall be defined to mitigation measures to react in case of an incident</p> <p>_ is derived by :  SPP-9296 - CCS shall enable updates of Configuration Data on runtime</p> <p>_ is derived by :  SPP-9660 - CCS shall disclose incompatibilities between its subsystems and their interfaces during runtime.</p> <p>_ is derived by :  SPP-10253 - Allow configuration of Generic Application according to local needs within predefined limits</p> <p>_ is derived by :  SPP-14826 - TMS shall use the same centralized diagnostic service used by CCS using a standard interface</p> <p>_ is derived by :  SPP-14827 - TMS shall support changes of system configuration of internal and external components during running time</p> <p>_ is derived by :  SPP-14828 - TMS shall support diagnose test of a component during running time</p>
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ID	SPP-9661
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**4.10-9 - CCS shall disclose incompatibilities between its subsystems and their interfaces during runtime.**

CCS shall disclose incompatibilities between its subsystems and their interfaces during runtime.

[SPP-9660 ]

DRAFT

## 5 Appendix

### 5.1 References

Id	Description	Reference
[  SPP-19402 - Operational Vision (Nov. 2022)]	This document sketches a compressed operational picture of the CCS and TMS/CM future.	Link
[  SPP-19283 - Release Note ESPR1.0]	This Release Note describes the scope of the ESPR1.0.	Link
[  SPP-8684 - System Pillar Common Business Objectives (May 2022)]	Common Business Objectives (CBO) – targets and improvements - to guide the development of the outputs of the System Pillar within Europe's Rail Joint Undertaking.	Link

### 5.2 Open points

The following list contains known open points which will be fixed in future release of this documents.

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#### **SPP-11951 : Inside SPT2OD-3057 - Functionally standardised communication between modular sub...**


Inside SPT2OD-3057 - Functionally standardised communication between modular subsystem components there is a reference to definition "SPT2OD-6830 - FIS - Functional Interface Specification" which is empty. It should be likely completed.

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#### **SPP-17075 : Unclear Stakeholder Requirements**

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#### **SPP-17026 : Some links between the Stakeholder Requirement and CCS System Definition (shunting)**

Some links between the Stakeholder Requirement and CCS System Definition is postponed until the topic of shunting in OD and Traffic CS is clarified.  20 System Definition CCS System

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#### **SPP-17051 : Some links between the Stakeholder Requirement and CCS System Definition (field force)**

Some links between the Stakeholder Requirement and CCS System Definition is postponed until the topic of field force is addressed in OD

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#### **SPP-17054 : Some links between the Stakeholder Requirement and CCS System Definition (diagnosis)**

Some links between the Stakeholder Requirement and CCS System Definition is postponed until the topic of diagnosis is addressed in CCS and OD

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### **SPP-17082 : Some links between the Stakeholder Requirement and CCS System Definition (degraded operation)**

Some links between the Stakeholder Requirement and CCS System Definition is postponed until the topic of degraded operation is addressed in CCS and OD

### **SPP-17080 : Verify if functional exchange between maintain configuration and maintain railway infrastructure data and maintain CCS train data is missing**

There should be a functional exchange between  SPMS-2182 - Maintain configuration data and  SPMS-2183 and  SPMS-2178

### **SPP-17081 : Verify CCS System Definition to include**

-  SPMS-2192 - Sense+Observe motion of one train AN INPUT WITH trackside sources (e.g. track occupancy) for determining train position, so CCS can fulfilled the req  SPP-6949 - CCS shall merge localisation information from train-side (e.g. position and speed) and trackside sources (e.g. track occupancy) into one safe representation as part of the operating state.
- Which function is in charge of  SPP-7053 - CCS shall support the dynamic automated determination of train characteristics ?
- Does  SPMS-2137 - Ensure safe movement of trains includes  SPP-6662 - Limited allocation of infrastructure resources to train movements ?
-  SPP-6882 - CCS shall support advisory systems missing recommendations for Signaller

### **SPP-17076 : Some links between the Stakeholder Requirement and CCS System Definition (security)**

Some links between the Stakeholder Requirement and CCS System Definition is postponed until the there is more clarity regarding Security implementation in CCS System Definition

### **SPP-17087 : Some links between the Stakeholder Requirement and CCS System Definition (virtual coupling)**

Some links between the Stakeholder Requirement and CCS System Definition is postponed until the topic of virtual coupling in CCS is clarified.