




ERJU SYSTEM PILLAR

D1 Recommendations for current rollouts



D1 Recommendations for current rollouts

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Abstract	The objective of this deliverable is to provide recommendations for upcoming contracts in existing or planned upcoming rollouts. It shall be analyzed, which features and/or interfaces could be integrated already in tenders in the SERA pre-phase timeframe before 2030. Starting point is the formulation of general recommendations as well as the creation of a list of potential candidates. The SERA pre-phase integrability shall be evaluated with the help of pre-defined criteria. After listing and weighing arguments for or against an integration of these features into existing rollouts, general recommendations shall be provided.
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DRAFT

Approval by reviewers

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

Comments	<p>#1 Approval comment by Carlos Zieleman on 2025-08-25 15:39 Major: The document suddenly has eight items that are considered instead of six during the original review. And I strongly disagree with the analysis of the Computing Environment, as it is clearly stated there are no specifications available yet. How can you analyse something if you do not know what it is? That can only be done based on speculation. Also, there is very little concrete information in this document, everything is very vague. Some examples: unsure about the time for development ('it is challenging to provide a development forecast', the required efforts for maintenance are not quantitative ('continuous effort that needs to be quantified', 'not much effort'), applicability relies on non yet existing systems ('the connectivity of PES - TMS and ATO-TS -TMS') or other meaningless phrases without any explanation ('an important enabler to simplify the migration towards a SERA Architecture compliant system'). Therefore I do not feel comfortable to approve this document.</p> <p>#2 (reply to #1 Approval comment) by Philipp Nienheysen on 2025-08-29 10:42 [Rejected]</p> <p>"The document suddenly has eight items" -> The reason for this is the split of the object controller interface analyses in SCI/SDI/SMI, what was requested by a majority of reviewers. - No new evaluation candidates added, just a more specific evaluation.</p> <p>"Computing Environment... no specifications available yet" -> In the remit text for SC 2.4 and according to lots of discussions in the sector it was expected to present the status quo of the Computing Environment (CE) work from migration perspective -> the red traffic light in the evaluation clearly reflects the unavailability of specifications, but with a clear recommendation to observe further developments regarding CE -> The purpose of the document is to evaluate, what can be used already in SERA pre-phase; CE specifications are not yet available (08/25), but very probable they will be available in SERA pre-phase - with this document we want to raise awareness for these upcoming specifications -> Honestly also for other here presented candidates (e.g., SCI-OP) there are only technical concepts drafted; the basic architectural concept for CE is available and agreed, which is worth mentioning in this document according to the authors</p> <p>"there is very little concrete information in this document" -> That is the general problem, that we work with lots of uncertainties, as nearly all of the here listed candidates for an integration in SERA pre-phase, are still under development -> It is mentioned, that this document will be regularly updated (see 1.5 Disclaimers) and by every update, the uncertainty will decrease and the information will be more concrete -> Some sentences could have been written better, as always, especially when many different authors are involved, but we don't see this is a reason for disapproving the whole content.</p>
Approvals	<p>LOEFFLER Christian : Approved , Menschaert Hans : Waiting , Carlos Zieleman : Waiting , Thomas Laguerie : Waiting , Schöni Ulrich (I-NAT-GST-CCS) : Approved , TOMASSONI COMPAGNUCCI Franco (SNCF RESEAU / Directions Techniques Réseau / DGII DTR GE SF Solutions) : Approved , Karl-Albrecht Klinge : Waiting , Mirko Blazic : Approved</p>
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1 Introduction

1.1 Purpose of this document

SPT2TRAFFIC-13636 - In the document the questions **"What can be recommended for existing and/or planned upcoming roll-outs before 2030 (in the SERA pre-phase)?"** and **"Which System Pillar specifications for features and/or interfaces are ready for use or shall be taken into account for developing migration strategies?"** are assessed and recommendations are provided accordingly.

This documents evaluates which of the already available System Pillar harmonisation results can be recommended, hereby assisting Infrastructure Managers/Suppliers in already integrating these recommendations in their current development plans and roll-out planning, hence safeguarding, as much as feasible with today's definitions, alignment with the future SERA design (expected by 2030). [ Open]

1.2 Context of this document

SPT2TRAFFIC-13531 - This document (**Deliverable D1**) is part of three deliverables on Traffic CS CCS Trackside Migration, as defined by Europe's Rail remit SC 2.4. [ Open]

SPT2TRAFFIC-13753 -

Europe's Rail System Pillar - Domain Traffic CS CCS Trackside Migration Group Overview of the Deliverables D1, D2, D3 of the Specific Contract SC 2.4 (10/2024-10/2025)		
Recommendations for current rollouts Link to Deliverable D1	Migration Planning Guideline <i>Guiding document for all deliverables</i> Link to Deliverable D2	CCS Trackside Integration Strategy Link to Deliverable D3
<ul style="list-style-type: none"> General recommendations for upcoming contracts in existing or planned upcoming rollouts List of potential candidates and evaluation criteria for an early integration (in the SERA pre-phase before 2030) Analysis, which features and/or interfaces can be fully or partly recommended for an early integration 	<ul style="list-style-type: none"> Guidance on how to develop a strategy and a plan to migrate to the harmonised operations and systems defined for the Single European Railway Area SERA +(e.g., considerations on migration steps, maintaining operation etc.) Guidance on how to migrate to Traffic CS by analyzing several Migration Scenarios and Adaptor solutions Definition of functional packages for CCS to simplify migration (e.g., PES+ETPS, ATO-TS etc.) 	<ul style="list-style-type: none"> Analysis of typical adaptor solutions and efforts to adapt legacy systems to the new harmonised interfaces Analysis of connecting Traffic CS to legacy TMS Analysis of handing over a train from Traffic CS to adjacent legacy CCS systems and vice versa
		Annex of CCS Trackside Integration Strategy Link to the Annex of Deliverable D3
		<ul style="list-style-type: none"> Detailed analysis of national legacy CCS architectures in the migration context and comparison to the Traffic CS Target architecture


[ Open]

1.3 Scope of this document

1.3.1 Deliverable description according to the remit of SC 2.4

SPT2TRAFFIC-10725 - Description according to the remit

Which interfaces can be integrated already in existing rollouts before 2030 – what is realistic and economically viable? (e.g. EULYNX TA SCI, T2CE I2/I3, OP, SDI/SMI, cybersec)

[ Open]

1.3.2 Further elaborated deliverable description

SPT2TRAFFIC-11516 - The objective of this deliverable is to provide recommendations for upcoming contracts in existing or planned upcoming rollouts. It shall be analyzed, which features and/or interfaces could be integrated already in tenders in the SERA pre-phase timeframe before 2030. Starting point is the formulation of general recommendations as well as the creation of a list of potential candidates.

Based on several input documents of the System and Innovation Pillar as well as discussions with the responsible developers, the SERA pre-phase integrability shall be evaluated with the help of pre-defined criteria. Possible criteria for evaluating the integrability can be the current maturity of features (considering if the features are already in use or in contrast still under development in the System/Innovation Pillar) as well as economic reasons (cost/benefits) if it is possible to evaluate them in a generic railway-overarching way. A detailed economic analysis cannot be performed in the scope of this deliverable and is therefore postponed to a later stage.

After listing and weighing arguments for or against an integration of these features into existing rollouts, general recommendations shall be provided. The outcome of the analysis can be also used for setting priorities regarding the upcoming specification work in the ERJU System Pillar.

[ Open]

1.4 Short version of this document

SPT2TRAFFIC-12205 - The objective of this deliverable is to provide recommendations for integrating features and/or interfaces already in existing or planned rollouts in the SERA pre-phase before 2030.

General recommendations: (-> 2.1 - General recommendations)

- Apply for signalling deployments based on ETCS Level 2 without signals
- Follow the specific recommendations elaborated in this deliverable (regarding the candidates listed below)

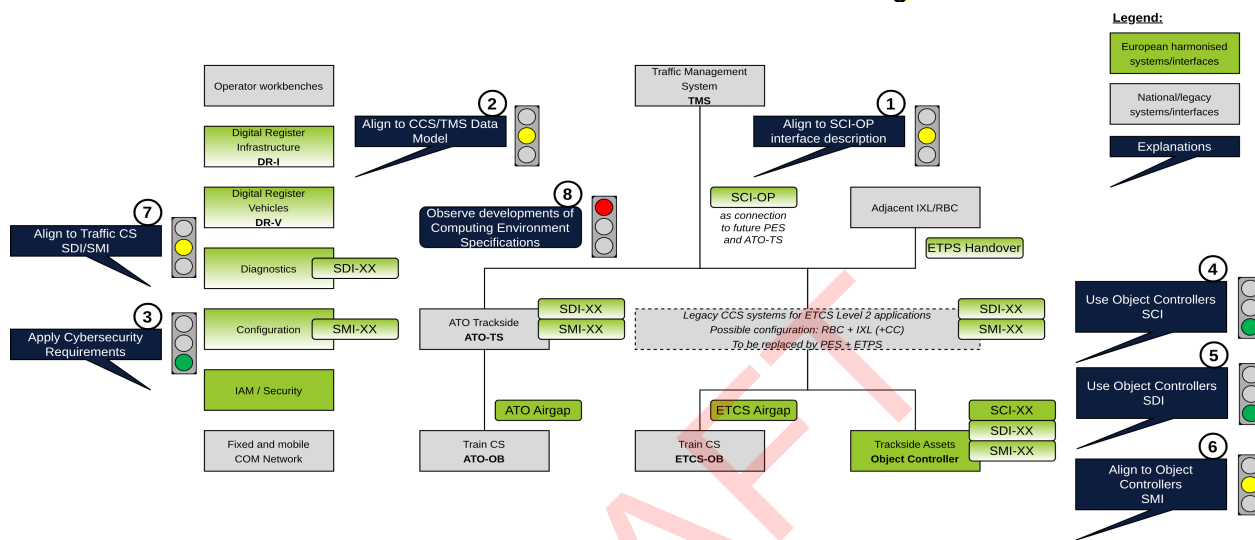
Potential candidates evaluated in this deliverable: (-> 2.2 - List of potential SERA Candidates)

- SCI-OP Interface (1)
- CCS/TMS Data Model (2)
- Cybersecurity Requirements (3)
- Object Controllers SCI (4)

- Object Controllers SDI (5)
- Object Controllers SMI (6)
- Traffic CS SDI/SMI (7)
- Computing Environment Specifications (8)

The SERA pre-phase integrability is evaluated in this document with the help of pre-defined criteria. After listing and weighing arguments for or against an integration of these features into existing rollouts, general recommendations are provided. [🔗 Open]

SPT2TRAFFIC-11515 - Recommendations for current rollouts - drawing



[🔗 Open]


SPT2TRAFFIC-12207 - The status of the evaluated SERA Candidates is indicated by the **traffic light colours**, which:

- are related to **objects** (i.e. subsystems, interfaces or specifications for them), which might become part (i.e. forming "SERA Candidates") of the future SERA Architecture (see figure above)
- represent a **Traffic CS recommendation** from customers (IM's) point of view regarding beneficial early usage of identified "SERA Candidates". It shall be understood from the perspectives of "what can be already used now?" and "what is compatible to and a step forward in direction to the System Pillar Target Architecture?"

The identified "SERA Candidates" have currently a divergent COMPATIBILITY and subsequently also MATURITY STATUS in terms of their SERA Applicability. Therefore, the Traffic CS Recommendation for early usage of SERA Candidates is given on base of traffic light colours with following meaning:


	<p>There are already objects available, projected as stable and compatible to future harmonised Traffic CS products and their usage is recommended.</p> <p>There is a high</p>		<p>There are already objects available, partly stable, partly compatible and probably upgradable to future harmonised Traffic CS products and an alignment to these is recommended.</p> <p>There is a medium likelihood that current versions will be com</p>		<p>There are no objects available, or the usage of those objects is not recommended. Further developments shall be carefully observed.</p>
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	likelihood that current versions will be compatible with future Traffic CS target architecture.		patible with future Traffic CS target architecture.		There is an uncertainty that current versions (if existent) will be compatible with the future Traffic CS target architecture.
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[ Open]

SPT2TRAFFIC-12206 - Recommendations for current rollouts - short description

1. SCI-OP Interface
2. Align to the basic structure and content of SCI-OP and observe further specification work in System Pillar (finalization of the data model, possible changes due to future detailed CCS technical specifications and other SP Domains inputs such as Operational Harmonisation).
3. CCS/TMS Data Model
4. Align to the Data Model and evaluate using it for new product development, observe the further specification work in Traffic CS as changes in these specifications could impact the Data Model.
5. Cybersecurity Requirements
6. Apply the EU-Rail Cybersecurity Specifications as published 04/2025 for every new system/ component development and tender.
7. Object Controllers SCI
8. Use the SCI interfaces as prepared in EULYNX Baseline 4 documents between Interlocking and Trackside Assets Objects Controllers.
9. Object Controllers SDI
10. Use the SDI interfaces with OPC UA protocol as prepared in EULYNX Baseline 4 documents between MDM and Trackside Assets Objects Controllers.
11. Object Controllers SMI
12. The use of the SMI interfaces with OPC UA protocol as prepared in EULYNX Baseline 4 documents (based on SMIv2) between MDM and Trackside Assets Objects Controller, would expected to simplify later introduction (e.g. by upgradeability of OC's) of SP Standard interfaces prepared by Transversal CCS SMI (see following item)
13. Traffic CS SDI/SMI
14. SDI and SMI should be implemented as per Transversal CCS (TCCS) domain future work outcome concerning the Diagnostic and Configuration for the SERA Architecture. Upon release they will be applied in all SP Subsystems being part of the SERA Architecture, including ATO-TS, PES and ETPS. Accordingly the interfaces SDI and SMI can be applied for diagnosis and maintenance of Object Controllers (based on SMIv3).
15. Computing Environment Specifications
16. Observe developments of Computing Environment Interface specifications. As soon as mature and tested specifications will be available, their use would be already beneficial in the SERA pre-phase.

The detailed evaluation of the features and interfaces can be found here: [3 - Criteria-based evaluation](#) [ Open]

1.5 Disclaimers

SPT2TRAFFIC-11923 - Disclaimers

The following disclaimers must be used in conjunction with the assessments in this document:

- In general, it cannot yet be fully proven that the here recommended features and/or interfaces will have a long term compliance to the SERA target architecture. But especially from migration perspective, there is a strong need to ensure this long term compliance. The direction of the foreseen migration paths shall only be adjusted, if there is a clear, assessed and agreed reason to do so.
- As parts of the input documents and references will change due to other work within the System Pillar, it is anticipated that regular updates of this document will be done.
- In general, it is understood that development and installation updates of (sub) systems could happen twice or more (meaning changing later on), having specifications changing over time, that could create incompatibility to earlier versions. This should be managed through agreed baselines.
- There is the necessity of an iterative design process towards the SERA target architecture, which requires an independent and flexible possibility to modify the associated System Pillar standard interface specifications until CENELEC Phase 5 is reached for the first time (i.e. crossing the red line with handover of the specifications to the manufacturers). From then on, the System Pillar must establish an independent change and release management system for its standard interfaces.
- As far as SP Specifications used in a SERA Pre-phase - which not have passed phase 5 according to CENELEC 50126 - there cannot be given a guaranty on backward compatibility for future specification changes (due to ongoing major design work). Backward compatibility of SP Specifications - based on a release and change management process - will be established after the SP specifications have passed once phase 5. It is expected to reach this state in 2027.
- The economic impact of an early integration of System Pillar specification can vary because of the initial local situation or the local market offer. The final decision should always be based on a local economic assessment of the integration variants and the available market offer.

[🔗 Open]

1.6 Document structure




SPT2TRAFFIC-11640 - This document is structured as follows:


- 1 - Introduction Remit description, input documents and references, glossary of terms used
- 2 - Signaling System related Rollout Strategy List of potential candidates, approach of and criteria for evaluating potential candidates for current rollouts
- 3 - Criteria-based evaluation In depth evaluation of a candidate for current rollouts
- 4 - Conclusions & Summary Conclusions on recommendations for current rollouts

As parts of the input documents and references will change due to other work within the System Pillar, it is anticipated that regular updates of this document will be done. [🔗 Open]

1.7 General input documents & references

Id	Description	Reference
[🔗] SPP-28723 - SPT2MIG-1625 - MIG SC 2.3 D1 CCS Features Indivisible for deployment]	Relationships between those (candidate) CCS	Link

Id	Description	Reference
	features which make up the packages indivisible for deployment.	
[ SPP-28721 - SPT2MIG-2121 - MIG SC 2.3 D2 Scope for System Pillar Reference Architecture B1R1 and further releases]	Assessments and recommendations for a scope for SPRA B1R1 (first release of the System Pillar Reference Architecture) and succeeding releases according to the STIP (Standardisation and Input Plan)	Link
[ SPP-28758 - T3-Interface Specification TMSCCS DRAFT v1.5]	The main goal of this document is to show the complete set of data to be exchanged...The main goal of this document is to show the complete set of data to be exchanged and how they are organized in structures and messages, keeping full alignment with the data model specified by the Task 2 transversal team. Some examples are provided as a guideline, to show how data can be represented. Open	Link
[ SPP-28757 - Traffic CS - System Concept V1.5]	The System Concept was created to enable an early collaboration about the architecture and functionality of Traffic CS with other SP domains, IP projects and other stakeholders. The	Link

Id	Description	Reference
	present document summarizes the most important system requirements for Traffic CS and explains in the solution concept how it is foreseen to fulfil these requirements. Furthermore, assumptions and expectations to external systems outside of Traffic CS are stated and roadmap is presented.	
[ SPT2TRAIN-3716 - STIP EU-RAIL Standardisation and TSI Input Plan (STIP), 02.07.2024, v1.0 final...]	STIP EU-RAIL Standardisation and TSI Input Plan (STIP), 02.07.2024, v1.0 final.	-

1.8 Glossary

1.8.1 Abbreviations

Abbreviation	Definition
ATO	Automatic Train Operation
ATO-TS	ERTMS/ATO Trackside
CBA	Cost Benefit Analysis
CBO	Common Business Objective
CCS	Control-Command and Signalling
CER	Community of European Railway and Infrastructure Companies
CRA	Cyber Resilience Act
DAC	Digital Automated Coupling
DATO	Digital Automated Train Operation
EIM	European Rail Infrastructure Managers
ETPS	European Trackside Protection System
EU-Rail	Europe's Rail
FRMCS	Future Railway Mobile Communication System
GSL	Geometric Safety Logic
PES	Plan Execution System
SCI	Standard Communication Interface
SCI-OP	Standard Communications Interface – Operational Plan
SDI	Standard Diagnostic Interface
SERA	Single European Railway Area
SMI	Standard Maintenance Interface
SP	System Pillar
SPRA	System Pillar Reference Architecture
SSI	Standard Security Interface

Abbreviation	Definition
STIP	Standardisation and TSI Input Plan
TMS	Traffic Management System
TSI	Technical Specifications for Interoperability
UNIFE	Union des Industries Ferroviaires Européennes

1.8.2 Relevant Terms and Definitions

Term	Definition
Automatic Train Operation	Automatic Train Operation is technology for automating the operation of trains. The degree of the automation is shown by the Grade of Automation (GoA). GoA0: train operating on-sight, no automation GoA1: train operating manual, train driver controls starting, stopping, passenger service functions as opening and closing doors and handling emergency. Train protection systems like ETCS L1 in place. GoA2: train operating semi-automatic. Starting and stopping automated using advanced train protection systems like ETCS L2 or 3, driver operates passenger service functions and handles emergencies GoA3: driverless train operation. Starting and stopping automated, service staff operates passenger service functions and handles emergencies GoA4: unattended train operation. All operations are fully automated without any on-train staff
Cyber Resilience Act	CRA - Cyber Resilience Act
ERTMS/ATO Trackside	ERTMS/ATO Trackside (ATO-TS) is the ERTMS/ATO trackside subsystem. ERTMS/ATO provides a set of non-safety functions related to speed control, accurate stopping, door opening and closing, and other functions traditionally assigned to a driver, while the safety of operation is still ensured by ETCS with regards to the speed and distance limits and also by other safe systems.
EULYNX System	The EULYNX System is a signalling system with a standard reference architecture with all subsystems and their interfaces as well as principal design paradigms, defined by the EULYNX System Definition.
European Trackside Protection System	The Trackside Protection System is the core system of Traffic CS, implementing the safety critical functions. The Trackside Protection System controls all Trackside Assets Control and Supervision (TACS) connected to ETPS, for example points, level crossings, and manages Movement Permissions for trains, whilst maintaining the safety of the railway.
Geometric Safety Logic	Geometric Safety Logic is a generic safety logic implementation independent from the specific where the paths reserved for train movements

Term	Definition
	can start and end at any geometric location on the railway track. This is in contrast to a more traditional route-based signaling system, where the paths reserved for train movements start and end at fixed, pre-determined locations (e.g. route origin and destination).
Plan Execution System	<p>The Plan Execution System is a subsystem of Traffic CS which is responsible for:</p> <ul style="list-style-type: none">• processing the Operational Plans provided by the TMS, which are based on the Operating State of the railway within the Area of Control and• providing the Operating State within the Area of Control received from Trackside Protection System towards the TMS.


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Term	Definition
SERA Enablers	<p>The development of the SERA Target functionality is a long-term process. In this process standalone functional units so-called "SERA Enablers" are developed belonging to the SERA Target system. Individual SERA Enablers might be suitable for early rollout in legacy projects, which still use national specifications and legacy systems. Therefore, SERA Enablers are standalone subsystems having standardized interfaces, which are specified, developed, tested and approved according to the needs of the SERA Target. If needed, adapters can be used to integrate them in legacy systems (part of migration strategy). Currently identified SERA Enablers are:</p> <ul style="list-style-type: none"> • Object controllers with SP Standard interfaces (partially based on EULYNX) • PES and ETPS with SP Standard interfaces (i.e. SCI process interfaces and service interfaces SDI, SMI and SSI) • Central services with SP Standard interfaces (i.e. service interfaces SDI, SMI and SSI), which provide supporting functions for operation of SERA systems: configuration, maintenance and digital register-infrastructure, security, communication. • TMS with SP Standard interfaces (i.e. SCI-OP process interface and service interfaces SDI, SMI and SSI) • FRMCS for radio communication, replacing GSM-R • Safe train integrity and train length information of rolling stock, enabling safe traffic control for mixed traffic • ATO-TS (for ATO GoA1/2) with SP Standard interfaces (i.e. SCI process interfaces and service interfaces SDI, SMI and SSI), based on harmonized operation concept and related rules
SERA Phase	<p>The SERA Phase is a deployment phase, which starts when the SERA Target - comprising all SERA Enablers (refer to SERA Enablers list in Glossary) - is ready (i.e. tested and approved) for implementation (rollout) in projects. The key SERA Enabler will be the moving block with the DTCC safety principle (either implemented with GSL or CBTC based solutions) based on the harmonized operation concept and related rule set.</p> <p>In this context the trackside infrastructure is equipped for moving block (allowing TDD reduction) enabling degraded modes and mixed</p>

Term	Definition
	<p>fleet operation (i.e. parallel movement of equipped and non-equipped trains with or w/o safe train length and integrity).</p> <p>Core elements for rollout of the SERA Target are the subsystems ETPS and PES (ATO-TS optional) plus the related process interfaces SCI between them and to the adjacent systems like:</p> <ul style="list-style-type: none"> • TMS • Operators Workplace • Object Controllers. <p>Additionally, also adjacent auxiliary systems and related interfaces SDI, SMI, SSI plus related tools (e.g. for engineering, testing, simulation) must be available as well. For example, these auxiliary systems are:</p> <ul style="list-style-type: none"> • Central services, which provide supporting functions for operation of the core systems: configuration, maintenance and digital register-infrastructure, security, communication.
SERA Pre-Phase	<p>The SERA Pre-Phase is a deployment phase, which starts when the first SERA Enablers (belonging to the SERA Target; see SERA Enablers list in Glossary) are ready for implementation (rollout) in projects, where legacy subsystems can be replaced already by equivalent SERA Subsystems. Such projects still use national specifications and legacy systems. This approach forms a significant part of the overall migration strategy towards SERA. As a sample this might comprise the early introduction of certain SERA Enablers like object controllers having SP Standard interfaces (based on EULYNX) in combination with legacy system components (supporting legacy L2/FB/FVB principles; optional ATO GoA2).</p> <p>This allows early benefitting - during the long-term SERA Development process - from their advantages (e.g. performance increase and cost reduction) and ensures protection of investment. The gradual rollout of those SERA Enablers is part of the migration path towards the later SERA Phase and its target system. SERA Enablers in this pre-phase must be functional</p>


Term	Definition
	units of reasonable size and standalone testable and approved - e.g. like an SERA ready object controller unit. Related migration use cases and concepts are specified in separate SP Documents.
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)
Standard Communication Interface	The standardised EULYNX interface for process data information.
Standard Diagnostic Interface	The standardised EULYNX interface for diagnostics to enable communication with the service functions Diagnostics collector and Time synchronisation.
Standard Maintenance Interface	The standardised EULYNX interface for maintenance to enable communication with the service function Loading procedure.
Standard Security Interface	The standardised EULYNX interface for security to enable communication with the service functions for security.
Standardisation and TSI Input Plan	The Europe's Rail (EU-Rail) Standardisation and TSI Input Plan (STIP) is a collection of all outputs from EU-Rail (Innovation and System Pillar) which contribute to the goal of harmonisation of the railway system. The harmonisation topics are categorised in technical domains and described by the foreseen harmonisation channel (TSI, EN standards, SP document), the time horizon as well as dependencies with existing regulations, standards, and R&I activities.
Traffic Management System	Ensemble of applications providing permanent control across the network, automatically sets routes for trains and logs train movements as well as detects and maybe solves potential conflicts.
Standard Communications Interface – Operational Plan	Standard Communications Interface – Operational Plan

2 Signaling System related Rollout Strategy

SPT2TRAFFIC-11664 - Some general recommendations for current rollouts and upcoming contracts are given in [2.1](#). Potential candidates meeting these recommendations for a SERA pre-phase integration are listed in [2.2](#) after which the criteria for evaluating these SERA Candidates are presented in [2.3](#), as a basis for the in-depth criteria-based evaluation in [3](#). [ Open]


2.1 General recommendations

SPT2TRAFFIC-11807 - General recommendations for current rollouts and upcoming contracts are given as follows:

#	Top requirement	Explanation	Reference
I	Apply for signalling deployments based on ETCS L2 without lineside signals (only the use of harmonised shunting signals can still be necessary)	The main requirement for the recommendations for current rollouts is that these contribute to full radio-based CCS (ERTMS L2 only) combined with (as far as possible) European harmonised operational, engineering and safety rules.	 SPT2TRAFFIC-11604 - SERA Target
II	Follow the specific recommendations elaborated in this deliverable	Follow the recommendations regarding the potential SERA Candidates evaluated in this deliverable of the CCS Trackside Migration Group within the Traffic CS domain.	3 - Criteria-based evaluation

[ Open]


2.2 List of potential SERA Candidates

SPT2TRAFFIC-12201 - Based on discussions in the System Pillar and especially in the CCS Trackside Migration Group, the following SERA Candidates have been chosen for further analysis whether these could be integrated in current rollouts and upcoming contracts within the SERA Pre-phase. In a later stage this list can be extended based on new inputs. [ Open]


SPT2TRAFFIC-8783 - List of potential candidates


#	Name	Description	Section
1	SCI-OP Interface	The interface between TMS and CCS, referred to as "Standard Communication Interface Operational Plan (SCI-OP)", located at the system boundary of Traffic CS and connects TMS with the ATO-Trackside (ATO-TS) and the Plan Execution System (PES). As such, it serves to ensure the flow of data between systems.	3.1
2	CCS/TMS Data Model	The CCS/TMS Data Model is the harmonised language applied in the System Pillar, that defines a common data language used across all relevant CCS interfaces, including CCS-TMS.	3.2
3	Cybersecurity	This consists of the complete set of EU-Rail Cybersecurity Specifications for railway CCS applications (and most likely for other railway applications), fully based on industry standards.	3.3

#	Name	Description	Section
	Requirements		
4	Object Controllers SCI	The standardised EULYNX interfaces SCI for process data information between IXL and Trackside Assets Object Controllers within legacy EULYNX System architecture (i.e. as such part of the SERA Pre-phase) and within future SERA System architecture.	3.4.1
5	Object Controllers SDI	The standardised EULYNX interfaces of Trackside Assets Object Controllers within legacy EULYNX System architecture (i.e. as such part of the SERA Pre-phase): - for diagnostics (SDI) to enable communication with the service functions Diagnostics collector (part of MDM) and within future SERA System architecture.	3.4.2
6	Object Controllers SMI	The standardised EULYNX interfaces of Trackside Assets Object Controllers within legacy EULYNX System architecture (i.e. as such part of the SERA Pre-phase): - for maintenance (SMI) to enable communication with the service function loading procedure (part of MDM).	3.4.3
7	Traffic CS SDI/SMI	The Transversal CCS (TCCS) domain handles the Diagnostic and Configuration functions for the SERA Architecture. For this, the necessary functional scope will be adjusted and transferred by TCCS into SDI/SMI SP Standard interfaces, to be used by all SP Subsystems in a harmonised way (e.g., ATO-TS, ETPS and PES). Where possible TCCS will make use of SDI/SMI Content in existing EULYNX Specifications for transfer into SDI/SMI SP Standard interface specifications according to SERA Needs.	3.5
8	Computing Environment Specifications	These are interface specifications for a generic computing Environment and architecture applicable both for trackside and onboard applications.	3.6



[ Open]



2.3 Evaluation criteria catalogue


SPT2TRAFFIC-12202 - The potential candidates are evaluated by the criteria listed below. [ Open]

SPT2TRAFFIC-13830 - In general, keep in mind that a comparison between "do it now" and "do it later", including all "pro's" and "con's", including the criteria listed below, are to be assessed in each individual migration strategy development. [ Open]

SPT2TRAFFIC-11667 - Evaluation criteria catalogue

Description of the feature/interface/ component	Sources/input documents	Applicability of the feature/ interface/component
<ul style="list-style-type: none"> • What is it about? What is the core functionality? Which technologies are used? • How does it fit in the CCS, especially in the Traffic CS scope? • Do assumptions need to be made regarding the further evaluation process? • <i>Pre-work from SC 2.3:</i>  D2 Feature high level description 	<ul style="list-style-type: none"> • On which information is this evaluation based on? • Can references to other documents be listed here? • Is there a reference in the STIP? 	<ul style="list-style-type: none"> • Applicability means the fact or quality of being relevant, appropriate, or suitable for a certain situation or range of situations • what is the possible scope? how often can the feature/interface be used?
Maturity of the feature/interface/ component	Time for product developments	Efforts for maintenance of specifications
<ul style="list-style-type: none"> • Is the feature/interface still under development in System Pillar or elsewhere? • Are there significant changes foreseen in the next months/ years? • Is there a mature specification available? ("mature" in terms of specificity, feasibility, risk assessment, stakeholder agreement, compliance and standards, documentation, testability, integration etc.) • Is the feature already used? Is the feature already tested? Are prototypes or pilots available? • <i>Pre-work from SC2.3:</i>  SPT2MIG-3328 - D2 Feature high level description , parts on maturity • <i>Pre-work from Traffic CS System Concept: Interface Evaluation</i> 	<ul style="list-style-type: none"> • Time between mature specifications and market ready products 	<ul style="list-style-type: none"> • Maintenance of products and specifications • Availability of a long/ sustained term organisation (surpassing the project phase)
Dependencies to other features/ interfaces/components	SERA conformity	

<ul style="list-style-type: none"> • Does the feature depend on features currently under discussion and development (e.g., safety logic, cybersecurity requirements)? • is the feature standalone (independent constituent) and described as a whole or are other conditions to be fulfilled to enable reusability? • <i>Pre-work from SC 2.3:</i>  D1_CCS Features Indivisible for deployment (Status "D", "R" etc.) 	<ul style="list-style-type: none"> • Are the features already part of SERA/part of the System Pillar Reference Architecture? • Are the features SERA enablers? • Are the features SERA compatible/is the forward compatibility ensured? • Are scenarios for migrating to SERA available and evaluated? Are adapters needed/required? • In how far are the features harmonised across Europe? 	
Benefits of the feature/interface/ component	Efforts of the feature integration	Risks of an early integration
<ul style="list-style-type: none"> • Reference to System Pillar CBOs ( SPT1RS-140 - Common Business Objectives): <ul style="list-style-type: none"> ◦ Meeting evolving customer performance ◦ Improved performance and capacity ◦ Reduced costs ◦ More sustainable or resilient transport ◦ Harmonised approach to evolution and greater adaptability ◦ Reinforced role for rail in European transport and mobility ◦ Improved EU rail supply industry competitiveness 	<ul style="list-style-type: none"> • Change of operational/ organizational procedures / Changes of regulatory framework / Capacity, resources needed for development & implementation / Impact on authorization • Reasonable adaption efforts 	<ul style="list-style-type: none"> • Any "too early usage" of SP Standard specs (e.g. draft versions) in the SERA Pre-phase (tendering, projects) implies the risk that still necessary interface changes (due to iterations in the development) will not be backward compatible.
Pro arguments regarding an early integration (SERA pre-phase)	Con arguments regarding an early integration (SERA pre-phase)	Final recommendations
<ul style="list-style-type: none"> • Summary of the most important aspects of the evaluation • What are pro's and con's? Are general recommendations possible? What is recommended from ERJU's point of view? 		

 Open]

3 Criteria-based evaluation

SPT2TRAFFIC-11600 - In 2.2 the list of potential candidates for deployment in current rollouts is presented, consisting of the following features, models and/or requirements:

3.1 - SCI-OP Interface


3.2 - CCS/TMS Data Model

3.3 - Cybersecurity Requirements

3.4 - Object Controllers SCI, SDI and SMI

3.5 - Traffic CS SDI/SMI



3.6 - Computing Environment Specifications

In 2.3 the evaluation criteria for assessing these candidates are indicated, as a basis for the following detailed assessments. [ Open]

3.1 SCI-OP Interface


SPT2TRAFFIC-11266 -

SCI-OP Interface	
Criteria	Evaluation
Description of the feature/ interface/component <ul style="list-style-type: none"> • What is it about? What is the core functionality? Which technologies are used? • How does it fit in the CCS, especially in the Traffic CS scope? • Do assumptions need to be made regarding the further evaluation process? 	<ul style="list-style-type: none"> • The interface between TMS and CCS, namely “Standard Communication Interface Operational Plan (SCI-OP)” is located at the system boundary of CCS and connects TMS with the CCS ATO Trainside (ATO-TS) and Plan Execution System (PES) . As such, it serves to ensure the flow of data between systems while not needing to know their internal logic. • ATO Trainside System (ATO-TS) re-elaborates the Operational Plan received from TMS building a journey profile which is then sent to ATO-On Board (ATO-OB) system. On the other hand, ATO-TS receives status reports and updated train information from ATO-OB, filters what is useful and forwards to TMS. Plan Execution System (PES) also receives the Operational Plan from TMS and executes it, performing the traditional Central Traffic Control functions. Specifically, it is PES which acts as a front-end towards TMS and connects to ETPS. On the other side, PES receives updates from ETPS and sends trains and infrastructures status changes to TMS, which uses these information to perform its functions. • The SCI-OP interface is currently considered by TMS to rely on the Integration Layer communication platform, specified and defined by previous Shift2Rail initiative and TMS/CCS data model defined by Transversal SP Domain. It takes advantage from the studies and achievements already performed and which led to a common shared architecture at EU level. It is to be noted that other alternatives are not excluded at present SP work phase, should they bring additional advantages. However, the demonstrators to be planned and implemented as part of IP Wave2 will rely on the results and the implementations achieved nowadays. The communication model is based on a Publish-Subscribe-Principle to distribute data from one system to other involving system(s). Thereby, the leading distributing system acts as a producer and sends the data to a message broker. The message broker will dispatch the data to all subscribing systems, based on a routing key. The Integration Layer implementation will be further assessed by Traffic CS during its ongoing SP activities. • From the available input information it is understood that the main assumption to be made is the finalisation within Traffic CS domain

SCI-OP Interface	
	<p>of the detailed functional requirements and thus exact data messages that will be implemented.. As an example in document Concept Interface TMS CCS it is stated : "7.1.4.2 Warning Device This attribute is subject to change, depending on the final decision whether Warning Devices shall be integrated in CCS." The implementation or not of such devices is not considered complex and does not block the use of the interface however, the lack of detailed functional requirements within Traffic CS is an obvious consideration at present. Moreover, the final interface content depend on the overall SP logical architecture and joined domains decisions e.g. Operational Process Harmonisation.</p> <ul style="list-style-type: none"> • Another assumption that is made is that interface information will not affect directly safety and thus it should not bring complex implications to the safety core functionalities of ETPS, however this assumption needs to be proved upon release of detailed functional requirements of Traffic CS.
<p>Sources/input documents taken into account for the description and the evaluation</p> <ul style="list-style-type: none"> • On which information is this evaluation based on? • Can references to other documents be listed here? • Is there a reference in the STIP? 	<ul style="list-style-type: none"> • The main reference document is Interface Specification_TMS_CCS  T3-Interface Specification TMSCCS . This document is based on document Concept SCI-OP RCA (document id: RCA.Doc.31) by RCA Group and largely follows that description. • There is one STIP reference to SCI-OP interface as follows : "P_1 8 - Function distribution and Interface between TMS/TCS - Consistent splitting of the features of a Supervision system between the two systems (CMS/TMS and TCS) which implement the former and finalization of the specification of the interface between TMS and TCS, based on SCI-OP."  STIP_V1
<p>Applicability of the feature/ interface/component</p> <ul style="list-style-type: none"> • Applicability means the fact or quality of being relevant, appropriate, or suitable for a certain situation or range of situations? • what is the possible scope? how often can the feature/interface be used? 	<ul style="list-style-type: none"> • The applicability of this interface relates to the connectivity of PES – TMS and ATO-TS - TMS respectively.
<p>Maturity of the feature/ interface/component</p> <ul style="list-style-type: none"> • Is the feature/ interfaces still under development in System Pillar or elsewhere? • Are there significant changes foreseen in the next months/ years? 	<ul style="list-style-type: none"> • The interface is under development in System Pillar and from Traffic CS perspective there are currently expected minor modifications at present due to future release of detailed subsystem specifications . Moreover, Train capability report is to be further elaborated, currently few adaptations deemed necessary, most important is that static or semi-static data are considered as optional in the related messages. Data model rework is a topic that is to be addressed, however it is in good state and structure is concrete, while code itself maybe modified.

SCI-OP Interface	
<ul style="list-style-type: none"> • Is there a mature specification available? ("mature" in terms of specificity, feasibility, risk assessment, stakeholder agreement, compliance and standards, documentation, testability, integration etc.) • Is the feature already used? Is the feature already tested? Are prototypes or pilots available? 	<p>Furthermore, train messages can be also subject to modification with no visible issues so far.</p> <ul style="list-style-type: none"> • Several main interface modifications referenced above are aimed to be carried out in this remit with the exception of GoA3/4, trackworker safety system, DAC related automation commands. Exact interface content and specifications with detailed requirements are essential for that scope. Moreover, decisions of other SP domains , like Operational Harmonisation, can influence the interface content. • The interface SCI-OP including data model was already introduced by Innovation Pillar in Wave 1 (Moving block demonstrator) and it is currently foreseen for Wave 2 demonstrator in 2026. However, from Traffic CS perspective, the interface specification is currently planned for 2027. • Some interface content is or will be applied in some ongoing European projects (e.g. train capability report incorporated in Stuttgart, SCI-OP ATO part intended for use in Hamburg). Note that such implementations do not bind the final interface form and content in SP, however they are positive signs for future global acceptance and use by Railway Authorities.
Time for product developments <ul style="list-style-type: none"> • Time needed for developing market-ready products based on a mature and agreed specification 	<ul style="list-style-type: none"> • Time for development is not known yet. Once detailed Traffic specifications released and stabilized by 2027, data model content as well as any other SP domain input ,such as Operational harmonisation, that may influence SCI-OP, is finalised , each supplier need to identify and analyse the impacts in product development. . At this moment, it is challenging to provide a development forecast as it largely depends on the product timelines of the suppliers for the new SERA specifications. It is to be noted however, that the content of this interface is up to now considered as non safety relevant ,which simplifies the needed effort.
Efforts for maintenance of specifications <ul style="list-style-type: none"> • Maintenance of products and specifications • Availability of a long/ sustained term organisation (surpassing the project phase) 	<ul style="list-style-type: none"> • Continuous effort that needs to be quantified and it is subject of detailed SP system concept. Note, that once initial development is carried out, further interface modifications are considered easier for implementation.
Dependencies to other features/interfaces/ components <ul style="list-style-type: none"> • Does the feature depend on features currently under discussion and development (e.g., safety logic, 	<ul style="list-style-type: none"> • For what concern Safety, the development of SCI-OP components typically has minimal safety requirements i.e., only assure the operational plan is fit for purpose to operate the railway. SCI-OP is intended as a non-safety-relevant interface and is not intended to assume any responsibility for safety as per to EN 50126-1 or EN 50128. No safety targets are expected for SCI-OP and hence no risk minimizing measures are envisaged for it, unless otherwise

SCI-OP Interface	
<p>cybersecurity requirements)?</p> <ul style="list-style-type: none"> • is the feature standalone (independent constituent) and described as a whole or are other conditions to be fulfilled to enable reusability? 	<p>requested in the future by other SP domains such as Operational Harmonisation.</p> <ul style="list-style-type: none"> • The main dependability relates the release of detailed specifications of Traffic CS (specifications for PES, ETPS and ATO-TS), while on TMS side the information exchanged is considered rather mature. • Another dependability is the finalisation of CCS/TMS data model as well as any other potential modification due to other SP Domains decisions, e.g. Operational Harmonisation. • It is assumed, that SCI-OP is independent of the to be developed safety logic of ETPS
<p>SERA conformity</p> <ul style="list-style-type: none"> • Are the features already part of SERA/ part of the System Pillar Reference Architecture? • Are the features SERA enablers? • Are the features SERA compatible/is the forward compatibility ensured? • Are scenarios for migrating to SERA available and evaluated? Are adapters needed/ required? • In how far are the features harmonised across Europe? 	<ul style="list-style-type: none"> • The SCI-OP interface is considered the choice to connect TMS and CCS, therefore a stable reference for the System Pillar Reference Architecture. • For what concern ATO-TS - TMS interface part , it is considered SERA enabler, provided that ATO data content and specifications finished on time. • The SCI-OP interface is considered as a feature SERA compatible and the forward compatibility is aimed accordingly. • No migration scenarios are prepared so far, while the use of adapters is subject of national TMS systems. For now it is largely considered that national legacy systems will need adapters. Note, that in case of legacy system that does not have a TMS, e.g. static schedules, the use of adapter is always valid and therefore it is considered that national legacy systems independent of whether TMS present or not will need adapters.
<p>Benefits of the feature/ interface/component</p> <ul style="list-style-type: none"> • Reference to System Pillar CBOs: <ul style="list-style-type: none"> ◦ Meeting evolving customer performance ◦ Improved performance and capacity ◦ Reduced costs ◦ More sustainable or resilient transport ◦ Harmonised approach to evolution and greater adaptability 	<ul style="list-style-type: none"> • ATO-TS implementation result to application of journey and segment profile, there is therefore visible benefit to improved performance and capacity and a more sustainable transport, while it also reinforces the role for rail in European transport and mobility. When this interface is the project choice in SERA pre-phase it will satisfy the above mentioned ATO related benefits while when SERA phase take place it will result to less involved subsystems modifications, thus easier migration and less costs. Moreover, when PES/ETPS are also incorporated, it will further enhance the revenue service capacity and performance. • Even if not Traffic CS task to declare so, it is evident that SCI-OP implementation will provide enhanced capabilities to TMS to optimize traffic in real time and with high level of granularity.

SCI-OP Interface	
<ul style="list-style-type: none"> ◦ Reinforced role for rail in European transport and mobility ◦ Improved EU rail supply industry competitiveness 	
Efforts of the feature integration <ul style="list-style-type: none"> • Change of operational/ organizational procedures / Changes of regulatory framework / Capacity, resources needed for development & implementation / Impact on authorization • Reasonable adaption efforts 	<ul style="list-style-type: none"> • For what concern the operational/organizational procedures it is the railway authorities that need to assess in detail the impact, however it is presumed that those procedures will be generally simplified. • For what concern development and implementation, those are not considered extremely extended provided that there is a stable interface and data content.
Risks of an early integration <ul style="list-style-type: none"> • Any "too early usage" of SP Standard specs (e.g. draft versions) in the SERA Pre-phase (tendering, projects) implies the risk that still necessary interface changes (due to iterations in the development) will not be backward compatible. 	<ul style="list-style-type: none"> • Early integration in SERA pre-phase is at present questionable. Data model is considered mature but not finalised yet and on TMS side functional content is deemed satisfactory. However, on Traffic CS side modifications to the exchanged data are possible due to existing lack of detailed subsystem specifications. The technical specifications in question are aimed for 2027. • Other SP domain decisions, like Operational Harmonisation, can influence the final interface content. • Further data content that maybe deemed essential by national rules that are beyond SP scope is an additional risk. To minimise it, detailed specifications and global agreement by railway authorities is essential. • If SCI-OP is only used for ATO-TS, TMS has to manage at the same time two different interfaces: SCI-OP for ATO-TS and a legacy interface to CC/IXL/RBC
PRO arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • The SP document T3- Interface Specification_TMS_CCS  T3-Interface Specification TMS_CCS is a further development of the document Concept SCI-OP RCA by RCA Group and largely follows that description. Therefore, a detailed work outcome has been reached prior to System Pillar. Within System Pillar framework a significant elaboration of the interface was performed and furthermore the data model ,which was based to Shift2 Rail and RCA inputs, was aligned to TMS/CCS data model of the Transversal domain. • Some interface content is or will be applied in some ongoing European projects (e.g. train capability report incorporated in Stuttgart, SCI-OP ATO part intended for use in Hamburg). Note





SCI-OP Interface	
	<p>that such implementations do not bind the final interface form and content in SP, however they are positive signs for future global acceptance and use by Railway Authorities.</p> <ul style="list-style-type: none"> • The SCI-OP interface is to be considered in view of ATO and/or PES/ETPS upcoming implementation. Yet even if ETPS is not yet mature for implementation in SERA pre-phase, the ATO-TS standalone incorporation in view of ETCS L2 concept justifies the selection of the interface in question. • From a general standpoint early implementation of the SCI-OP interface will enable a smoother future implementation of SERA subsystems. • The SCI-OP interface is to be applied under different migration scenarios and use cases. Indicatively :SCI-OP shall support the use of CC systems and associated interlockings via adapters (to be investigated in upcoming deliverable D3). • SCI-OP shall support ATO grades of automation. Moreover, it will support Connected Driver Advisory Systems (C-DAS) with the potential use of adapters. • The SCI-OP interface relies on the Integration Layer communication platform, proposed by previous Shift2Rail initiative, and associated data model. This is the most logical choice which takes advantage from the studies and achievements already performed and which led to a common shared architecture at EU level. The communication model is based on a Publish-Subscribe-Principle to distribute data from one system to other involving system(s). • The development of SCI-OP components typically has minimal safety requirements i.e., only assure the operational plan is fit for purpose to operate the railway. SCI-OP is intended as a non-safety-relevant interface and is not intended to assume any responsibility for safety as per EN 50126-1 or EN 50128. No safety targets are expected for SCI-OP and hence, no risk minimizing measures are envisaged for it.
CONTRA arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • As per today SCI-OP content has not been finalised. The main risk from Traffic CS perspective for early implementation is that detailed technical specifications and corresponding interfaces are currently foreseen to be completed in 2027. If those specifications and interfaces are not concluded on time, then early implementation of the interface in question suggests further modifications and implications to the interfaced subsystems with visible time and cost effects. • Other SP domain decisions, like Operational Harmonisation, can influence the final interface content.
Final recommendations	<ul style="list-style-type: none"> • The interface is at present not complete as it needs further elaboration from Traffic CS perspective with respect to expected detailed functional requirements set -up of PES-ETPS part that are to be concluded in 2027. Early integration in SERA pre-phase is at present questionable, seems more likely for the ATO-TS part but not ensured yet. Data model is considered mature enough but not yet final while on TMS side functional content is deemed satisfactory. Furthermore, other SP Domains decisions ,e.g. Operational Harmonisation may also have impact that today is not visible. • In accordance with ATO-TS, PES, ETPS expected functional modifications the interface structure is subject of further update

SCI-OP Interface	
	<p>from TMS to ATO-TS & from TMS to PES and vice versa. Therefore, the governance and organisation of the SCI-OP specification should be maintained in the long term.</p> <ul style="list-style-type: none"> • Provided that the above mentioned pending activities are concluded it is recommended the use of this interface in the pre-SERA phase in order to prepare a smooth transition and migration when SERA takes place. A possible partial SCI-OP application could be the ATO-TS part, as it is independent from PES/ETPS application. Note, that today this interface implementation is targeted towards the end of pre-SERA phase, i.e. 2030.

[ Open]

3.2 CCS/TMS Data Model

SPT2TRAFFIC-11269 -


CCS/TMS Data Model	
Criteria	Evaluation
Description of the feature/ interface/component <ul style="list-style-type: none"> • What is it about? What is the core functionality? Which technologies are used? • How does it fit in the CCS, especially in the Traffic CS scope? • Do assumptions need to be made regarding the further evaluation process? 	<ul style="list-style-type: none"> • The CCS/TMS Data Model is the harmonised language applied in the System Pillar, that defines a common data language used across all relevant CCS interfaces, including CCS-TMS. • The Data Model v1.0 is ready to be used in the context of the System Pillar (Including TrafficCS). There is until now no formal agreement regarding the domain objects from TrafficCS. • The Data model is currently being used in the Innovation Pillar FP2 (in the WP44 Moving Block demonstrator, WP27 Digital Register), FP1 (WP27). • In FP2 Motion it is expected that the output of the IP going to the SP, so the SP will update the data model. • In FP1 WP10, the Data model from SP was analysed and not adopted for several reasons (primarily because there was not stable version of the SP model available). Therefore, for the current demonstrators, they are using their own data models. In January 2025, the Deliverable D10.2 "Definition of Data Elements" was released, which includes the different data models used in the proposed demonstrators.
Sources/input documents taken into account for the description and the evaluation <ul style="list-style-type: none"> • On which information is this evaluation based on? • Can references to other documents be listed here? • Is there a reference in the STIP? 	<ul style="list-style-type: none"> •  Information CCS/TMS Data Model •  TCCS SD1 - D3.5 Functional Specification • SPT2TS/TCCS SD1 - Data Model/TCCS SD1 - Data Model_00_Guide : 725622 • SPT2TS/TCCS SD1 - Data Model/TCCS SD1 - Introduction to Data Model : 725622 •  TCCS SD1 - CCS/TMS Data Model •  ERJU FA2 D27.1 – Set of requirements on the Digital Register in R2DATO • STIP reference is the item "STIP_11: Data Model." The Channel specified is a "SP document" and it is planned for 2026.

CCS/TMS Data Model	
Applicability of the feature/ interface/component <ul style="list-style-type: none"> • Applicability means the fact or quality of being relevant, appropriate, or suitable for a certain situation or range of situations? • what is the possible scope? how often can the feature/interface be used? 	<ul style="list-style-type: none"> • The CCS/TMS Data Model will be used for the ETPS/PES/ATO-TS TrafficCS components, and for related interfaces (e.g. TMS..) • At this moment, it has been identified that the Data Model is being used in following domains/documents: <ul style="list-style-type: none"> ◦ TMS-CMS domain. <i>SPT3CMS/30 Deliverables/Concept_Interface_TMS_CCS : 725622</i>
Maturity of the feature/interface/ component <ul style="list-style-type: none"> • Is the feature/interfaces still under development in System Pillar or elsewhere? • Are there significant changes foreseen in the next months/years? • Is there a mature specification available? ("mature" in terms of specificity, feasibility, risk assessment, stakeholder agreement, compliance and standards, documentation, testability, integration etc.) • Is the feature already used? Is the feature already tested? Are prototypes or pilots available? 	<ul style="list-style-type: none"> • Even the data model is considered highly developed with the scope of System Pillar, it is considered not mature since it needs further testing. There are ongoing demonstrators on going that lack the full context of the system. For the data model to be considered mature, it needs to be integrated with all the systems. • Additionally, regarding the specification, PES, ETPS and ATO-TS are still under design phase, which could impact in the version of the data model. • The Data Model v1.0 is ready to be used in the context of the System Pillar. Among the defined data, the topology and infrastructure Data are considered the most stable (with fewer expected changes) • The SP Data Model is building on the Rail Topo Model (RTM). To maximise the chance of forward compatibility the use of a mature data model also building on RTM (e.g. railML or Rail System Model) could be a valuable migration step.
Time for product developments <ul style="list-style-type: none"> • Time needed for developing market-ready products based on a mature and agreed specification 	<ul style="list-style-type: none"> • Once a given a mature and agreed specification of the Data Model is released, each supplier need to identify and analyse the impacts in each product development. Although the Data Model has been design using standard language, it supposes a complete definition of the system modelling. At this moment, it is challenging to provide a development forecast as it largely depends on the product timelines of the suppliers, the new SERA components and interface specifications, as well as the evolving demands of the customers.
Efforts for maintenance of specifications <ul style="list-style-type: none"> • Maintenance of products and specifications • Availability of a long/sustained term organisation (surpassing the project phase) 	<ul style="list-style-type: none"> • In the context of System Pillar, the data model will be updated in Transversal Domain. According to the STIP, the Data Model must be build up in several increments by maintaining backwards compatibility and working closely together with all the domains. • In the long term, it is crucial to establish clear governance and organisation of the Data Model specification and maintenance

CCS/TMS Data Model	
	activities. This remains an open point and should be addressed in the future.
Dependencies to other features/interfaces/components <ul style="list-style-type: none"> • Does the feature depend on features currently under discussion and development (e.g., safety logic, cybersecurity requirements)? • is the feature standalone (independent constituent) and described as a whole or are other conditions to be fulfilled to enable reusability? 	<ul style="list-style-type: none"> • We could only recommend the data model to be used in exchange component, but not for internal ones. E.g. interface with the digital register would required to use the data as expected by the definition of the digital register.
SERA conformity <ul style="list-style-type: none"> • Are the features already part of SERA/part of the System Pillar Reference Architecture? • Are the features SERA enablers? • Are the features SERA compatible/is the forward compatibility ensured? • Are scenarios for migrating to SERA available and evaluated? Are adapters needed/required? • In how far are the features harmonised across Europe? 	<ul style="list-style-type: none"> • The Data Model is part of the standardisation topics, since it will be used in the Digital Register and in the definition of the interfaces (e.g. SCI-OP), which are included in the system releases for harmonised specifications and standards (either in TSI or as SP standard) (Ref. Document and Release Plan - System milestones) • The Data Model has been analysed for the SCI-OP interface, in one specific migration scenario (replacement of the RBC+IXL with the future PES+ETPS).
Benefits of the feature/interface/component <ul style="list-style-type: none"> • Reference to System Pillar CBOs: <ul style="list-style-type: none"> ◦ Meeting evolving customer performance ◦ Improved performance and capacity ◦ Reduced costs ◦ More sustainable or resilient transport ◦ Harmonised approach to evolution and greater adaptability 	<ul style="list-style-type: none"> • The use of this data model in new products or demonstrators are very beneficial for improvement of the different objects defined towards the definition of the SERA architecture. • The use of common language for every system will be very beneficial since it will reduce engineering and integration efforts.

CCS/TMS Data Model	
<ul style="list-style-type: none"> ◦ Reinforced role for rail in European transport and mobility ◦ Improved EU rail supply industry competitiveness 	
Efforts of the feature integration <ul style="list-style-type: none"> • Change of operational/ organizational procedures / Changes of regulatory framework / Capacity, resources needed for development & implementation / Impact on authorization • Reasonable adaption efforts 	<ul style="list-style-type: none"> • The integration (or implementation) efforts will depend on each specific case: <ul style="list-style-type: none"> ◦ If it is a new product, it will probably require less effort, as all the development already done on this data model can be used as a basis. Additionally, future modifications to this data model would be applied directly to the implemented model. ◦ On the other hand, when it comes to an existing product, an impact analysis should be made. The current data needs to be translated to the future data model, either through the development of an adaptor or, in the worst case a product redesign, which would entail a significant effort.
Risks of an early integration <ul style="list-style-type: none"> • Any "too early usage" of SP Standard specs (e.g. draft versions) in the SERA Pre-phase (tendering, projects) implies the risk that still necessary interface changes (due to iterations in the development) will not be backward compatible. 	<ul style="list-style-type: none"> • The risk of implementation depends on the current situation. For new developments, consider this data model could be beneficial, not only because it can be applied for new implementations but also as an additional method of testing it. However, for current system updates, the risk of migrating to this data model is high, since implementing something new that could change in the future poses a substantial risk. • Even it is deemed not mature enough, the data model could be used for new product development, with the risk that it might change in the future. Nevertheless, since the change is a certainty, it is needed to consider it from the beginning.
PRO arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • Once the data model or an interface related are released as part of a System Milestones (in accordance with the the architecture roadmap that outlines the various releases towards the SERA architecture), it will be ready to be used. • Nevertheless, using this data model at an early stage will facilitate the learning curve, considering the changes are likely to occur.




CCS/TMS Data Model	
CONTRA arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • Functionalities of subsystem components not fully defined. • Lack of test using the data model in a full context. • Using an intermediate state for a data model that still depends on components under definition would not be very beneficial comparing to use models that are already being used in the product. • The CCS / TMS data model will be tailored to data the ETPS, PES and TMS need. Today's national legacy systems might require data which will be not part of this data model.
Final recommendations	<ul style="list-style-type: none"> • The definition of the current Data Model provides a very important foundation to work on. However, it is necessary to have a definition of the functionalities of the subcomponents, as well as the operational use cases, to prove that the defined data is necessary and to ensure that no data is missing or redundant. This will assure consistency and compatibility across all relevant interfaces. • Here are some recommendations: <ol style="list-style-type: none"> 1. Monitor the design phases of PES and ETPS closely and ensure that updates to the Data Model are aligned with these developments. 2. Continue integrating the Data Model with ongoing demonstrators, ensure comprehensive testing and focus on integrating with all systems. 3. Evaluate using the Data Model for new product development. 4. Evaluate how the consistency of data evolution will be maintained. 5. Focus on the benefits of using the Data Model in new products or demonstrators to improve the definition of objects towards the SERA architecture.

[ Open]

3.3 Cybersecurity Requirements

SPT2TRAFFIC-11268 -

Cybersecurity Requirements	
Criteria	Evaluation
Description of the feature/ interface/component <ul style="list-style-type: none"> • What is it about? What is the core functionality? Which technologies are used? • How does it fit in the CCS, especially in the Traffic CS scope? • Do assumptions need to be made regarding the further evaluation process? 	<p>Approach:</p> <p>(Cyber)security is a horizontal capability, that has to be built into every component and system. The expression "secure component" is used to address every component and system. Security is NOT provided by additional hardware but by integrated capabilities. This follows state of the art security from industry and industry standards (Security by design, end-to-end security, defense in depth)</p> <ul style="list-style-type: none"> • 3 Technical and 1 procedural requirements specification

Cybersecurity Requirements	
	<ul style="list-style-type: none"> • Secure Component Specification -> Requirements of Security Capabilities for each component • Secure Communication Specification -> Interface Specification to protect end-to-end communication to be applied to each interface referenced, e.g. (SCI-xx, SMI-xx, SDI-xx, ..) <p>Shared Cybersecurity Specification -> Interface specification for the security related standard interfaces (SSI) that need to be applied by every secure component.</p> <p>By applying these cybersecurity standards interoperability can be achieved for these capabilities.</p>
Sources/input documents taken into account for the description and the evaluation <ul style="list-style-type: none"> • On which information is this evaluation based on? • Can references to other documents be listed here? • Is there a reference in the STIP? 	<p>The following inputs where used / referenced:</p> <ul style="list-style-type: none"> • Standards: IEC 62443, TS 50701, draft IEC 63452, • Directives/Regulations: Cyber Resilience Act, Cyber Security Act, NIS 2 Directive • Initiatives: EULYNX, ERTMS Security Core Group, Rail Security Expert Group, Shift2Rail, OCORA • Reference STIP:  SPT2TRAFFIC-11363 - Related STIP documents cybersecurity: • EU-Rail Cybersecurity Specifications V1.0 references: <ul style="list-style-type: none"> ◦ Factsheet Security ◦ Cybersecurity Specifications V1.0 ◦ Explanatory note
Applicability of feature/interface/ component <ul style="list-style-type: none"> • Applicability means the fact or quality of being relevant, appropriate, or suitable for a certain situation or range of situations? • what is the possible scope? how often can the feature/ interface be used? 	<p>The applicability of the EU-Rail Cybersecurity Specifications to devices, is referenced in the Security Architecture Document:</p> <p> SPPRAMSS-2227 - Security Architecture</p>
Maturity of the feature/interface/ component <ul style="list-style-type: none"> • Is the feature/interfaces still under development in System Pillar or elsewhere? • Are there significant changes foreseen in the next months/years? 	<ul style="list-style-type: none"> • Mature and complete EU-Rail Cybersecurity Specifications, having 3 review rounds inside and outside (UNIFE, CER, etc.) System Pillar. This includes all mentioned security interfaces as depicted in:  SPPRAMSS-4670 - This scheme shows an exemplary hierarchy and interfaces (arrows) of shared servi... • All requirements are based on available technology, knowledge and capabilities in industry. The requirement

Cybersecurity Requirements	
<ul style="list-style-type: none"> • Is there a mature specification available? ("mature" in terms of specificity, feasibility, risk assessment, stakeholder agreement, compliance and standards, documentation, testability, integration etc.) • Is the feature already used? Is the feature already tested? Are prototypes or pilots available? 	<p>specification chose solutions to reduce variety, support directives, standard and regulation compliance and safe on costs</p> <ul style="list-style-type: none"> • No railway specific technical requirements • Security functional test cases to be provided in 2025 (work group started already) • Improvement may occur through feedback from practical implementation
<p>Time for product developments</p> <ul style="list-style-type: none"> • Time needed for developing market-ready products based on a mature and agreed specification 	<ul style="list-style-type: none"> • No new technology needs to be developed, only choice of technical standards that are available in the market; All described cybersecurity services are available/offered on the market • These services need to be integrated in the safety environment, hence some integration time to be anticipated for. • The requirement specifications are only meant for "new" products. New usually means "for every product that is to be approved 2 years after publishing the specifications". The effort for the integration depends on the supplier's strategy: <ul style="list-style-type: none"> ◦ (large) extra effort if existing products shall be modified (not recommended, contradicting industry best practice and security by design) ◦ Easy when integrated into new design to integrate in new products (e.g. SCI-OP interfaces) ◦ having alignment SPSEC on CCS SD1 Data Model already in place ◦ for CE it is anticipated that a full alignment for future systems is needed, but certainly possible. • Easy implementation for TrafficCS systems, as they are all "new" products/interfaces.
<p>Efforts for maintenance of specifications</p> <ul style="list-style-type: none"> • Maintenance of products and specifications • Availability of a long/sustained term organisation (surpassing the project phase) 	<ul style="list-style-type: none"> • April 2025 full v1.0 available to the sector, see V1.0 EU-Rail Cybersecurity Specifications • Maintenance of EU-Rail Cybersecurity Specifications does not require much effort; integration of changes will be accompanied by integration best practices and test cases (reducing the overall effort). • Regular update based on changes in security threat landscape, vulnerabilities, etc. • The specification foresees the required flexibility to react on these adaption without changes on the system design.


Cybersecurity Requirements	
<p>Dependencies to other features/ interfaces/components</p> <ul style="list-style-type: none"> • Does the feature depend on features currently under discussion and development (e.g., safety logic, cybersecurity requirements)? • is the feature standalone (independent constituent) and described as a whole or are other conditions to be fulfilled to enable reusability? 	<ul style="list-style-type: none"> • All of the security specifications, and associated procedures, need to be applied en bloc as they influence each other. • Secure Program Spec needs to be followed so the Railways are prepared to manage the secure products • Suppliers AND Railways need to comply to allow secure operation • Dependency on SMI as follows: <ul style="list-style-type: none"> ◦ No separate update functionality is planned for security ◦ If SMI will not be defined as standard, individual solutions for software updates for safety, security and other updates will be “invented” -> this would drive complexity at railway side to manage different technical and procedural approaches from different suppliers ◦ <u>Information:</u> There is no dependency of SDI on SMI ◦ <u>Information:</u> Security related diagnostic and maintenance could also become part of a separate Security OPC UA information model. This needs to be decided by Transversal OPC UA experts managing the OPC UA information models and documented somewhere (e.g. via a separate Security OPC UA information model)
<p>SERA conformity</p> <ul style="list-style-type: none"> • Are the features already part of SERA/part of the System Pillar Reference Architecture? • Are the features SERA enablers? • Are the features SERA compatible/is the forward compatibility ensured? • Are scenarios for migrating to SERA available and evaluated? Are adapters needed/required? • In how far are the features harmonised across Europe? 	<ul style="list-style-type: none"> • Cybersecurity is a horizontal requirement. • Cybersecurity only works efficient (level of security, costs, life-cycle management, ...) if integrated in the system design phase. • The earlier the requirements are fixed, published and required, the earlier all suppliers can align and follow the standard requirements. • One common objective in security is key for efficient security. Deviation will lead to incompatibility, security vulnerabilities and frustration for suppliers and railways <ul style="list-style-type: none"> ◦ Requiring the security specifications now will: <ul style="list-style-type: none"> ▪ allow comparable products from different suppliers ▪ establish compatibility between the different sub-systems shown in the architecture

Cybersecurity Requirements	
	create common understanding of the fulfilment of EU regulations what reduces the likelihood of failing compliance to EU regulation what may have major impact on sales and operation
Benefits of the feature/interface/ component <ul style="list-style-type: none"> • Reference to System Pillar CBOs: <ul style="list-style-type: none"> ◦ Meeting evolving customer performance ◦ Improved performance and capacity ◦ Reduced costs ◦ More sustainable or resilient transport ◦ Harmonised approach to evolution and greater adaptability ◦ Reinforced role for rail in European transport and mobility ◦ Improved EU rail supply industry competitiveness 	Main benefit expected: early integration reduces needed future fixes/adaptations/changes of expanding cybersec deployment deviations due to prolonged harmonised requirements absence.
Efforts of the feature integration <ul style="list-style-type: none"> • Change of operational/ organizational procedures / Changes of regulatory framework / Capacity, ressources needed for development & implementation / Impact on authorization • Reasonable adaption efforts 	<ul style="list-style-type: none"> • Alignment of development at suppliers' side to the requirements BUT CRA, NIS 2, IEC 63452, Product Liability Directive, etc. require these capabilities anyway. So, the ERJU System Pillar Security Requirements allow a common approach to fulfil the regulatory requirements • Alignment of process at Railway's and Suppliers' side to the requirements BUT NIS 2, IEC 63452, etc. require these capabilities anyway. So, the ERJU System Pillar Security Requirements allow a common approach to fulfil the regulatory requirements
Risks of an early integration <ul style="list-style-type: none"> • Any "too early usage" of SP Standard specs (e.g. draft versions) in the SERA Pre-phase (tendering, projects) 	<ul style="list-style-type: none"> • minor risk of adaptations at later stage

Cybersecurity Requirements	
implies the risk that still necessary interface changes (due to iterations in the development) will not be backward compatible.	
PRO arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • Cybersecurity can only be efficiently realized when integrated into the development processes. • The earlier the requirements are requested / mandatory, the more products/systems/components can integrate them by design • A later request of security will lead to a) high costs for mitigation measures, b) reduced level of security while threats and connectivity are rising, c) non-compliance to EU regulations. <p>Hence, Early integration allows cost-efficient security realisation and “automatic” compliance to EU regulations.</p>
CONTRA arguments regarding an early integration (SERA pre-phase)	No contra arguments yet defined
Final recommendations	<ul style="list-style-type: none"> • It is highly recommended to apply the EU-Rail Security Specifications as published 04/2025 for every new system/component development and tender. • Early adoption of these specifications will fulfil the European and into national law transposed NIS-2 (European Common Level Cybersecurity) and CRA (Cyber Resilience Act) already to be fulfilled by EU law.

[ Open]

3.4 Object Controllers SCI, SDI and SMI

SPT2TRAFFIC-14881 - Note: The currently available specifications for various Object Controller (OC) interfaces SCI, SDI and SMI have different levels of compatibility to the future SERA Architecture. The differences are described in the following. [ Open]

SPT2TRAFFIC-14880 - SCI Process interfaces to OC's

From SERA point of view the existing EULYNX SCI interface specifications – e.g. being part of BL4R4 – have reached a high level of maturity and are considered as stable. During System Pillar conceptional and architectural work these interfaces have been confirmed for future connectivity between ETPS and OC's.

[ Open]

SPT2TRAFFIC-15404 - SDI Diagnostic interfaces to OC's

From SERA point of view the existing EULYNX SDI interface specifications – e.g. being part of BL4R4 – have reached a high level of maturity and are considered as stable. These interfaces are applicable for future diagnostic functions of the System Pillar Object Controllers.

[ Open]

SPT2TRAFFIC-14879 - SMI Maintenance interfaces to OC's

Current Specifications: From SERA point of view the existing EULYNX SMI interface specifications **(based on SMIv2)** – e.g. being part of BL4R4 - have a low compatibility level in terms of SERA applicability. They are strongly related to the legacy system architecture with the core systems like MDM and OC's. These specifications do not include all legacy systems like interlocking, RBC and are not aligned with the needs of the SERA System architecture.

New Specifications: From SERA point of view the new SP Standard SMI interface specification **(draft, based on SMIv3)** – currently prepared by Transversal - will reach high compatibility to the SERA System architecture needs.

As such this specification will meet the requirements from the CBO's, for maintenance for all SP Subsystems - including OC's and the core systems PES/ETPS and ATO-TS - in a harmonized way.

[ Open]

SPT2TRAFFIC-14882 - Detailed overview of the variabilities and commonalities


A more detailed overview of the variabilities and commonalities of the interface types - SCI, SDI and SMI - from the different perspectives (SERA Phase vs Legacy/SERA Pre-phase) is given in the following table:

[ Open]

SPT2TRAFFIC-15424 -


Interface types	View on the existing interface specs (e.g. BL4R4)	
	From SERA perspective (towards SP Standard interface, SERA Phase)	From legacy perspective (i.e. also covering SERA Pre-phase)
SCI for Object Controllers	<ul style="list-style-type: none"> • High compatibility, maturity and stability of existing SCI interface specification content (e.g. BL4R4), also for SERA purposes. • Nevertheless, further harmonisation and clean-up of specifications may be proposed • The ongoing specification of the ETPS functionality might lead to minor modifications/extensions of the current SCI functionality 	<ul style="list-style-type: none"> • High compatibility, maturity and stability of existing SCI EULYNX interface functionality for the legacy EULYNX system architecture. • Nevertheless, further harmonisation resulting from SERA work may be also beneficial in the SERA pre-phase, e.g. to simplify migration.

View on the existing interface specs (e.g. BL4R4)		
SDI for Object Controllers	<ul style="list-style-type: none"> High compatibility, maturity and stability of existing SDI interface specification content (e.g. BL4R4), also for SERA purposes. 	<ul style="list-style-type: none"> High compatibility, maturity and stability of existing SDI EULYNX interface functionality for the legacy EULYNX system architecture.
SMI for Object Controllers	<ul style="list-style-type: none"> Low compatibility of existing SMI interface specifications (e.g. being part of EULYNX BL4R4) in terms of the respective SERA subsystem functionality and CBOs. Transversal, as the owner of the Central Services in SERA, will specify SP Standard interfaces of type SMI for all the SP Subsystems in a harmonized way. This specification work will be done and aligned with the respective interface partners (i.e. other SP Domains). The SP Standard interfaces of type SMI (e.g. SMIv3) will be specified new, top-down, according to the SP Subsystem requirements and the CBOs, and will therefore not be backwards compatible 	<ul style="list-style-type: none"> The functional scope of an SMIv2 is limited mainly to a file upload mechanism managed by an MDM Nevertheless, further harmonisation resulting from SERA work may be also beneficial in the SERA pre-phase, e.g. to simplify migration. The application of the current SMIv2 has disadvantages caused by: <ol style="list-style-type: none"> Interlocking needs to be updated if a field element gets a safety related update Field elements must be taken out of operation for not safety related updates like cybersecurity updates The current TACS toolchain has a lot of manual processes that are error prone and need a lot of time - e.g. the creation of the OPC UA models and attribute lists.

[ Open]

3.4.1 Object Controllers SCI

SPT2TRAFFIC-15425 - SCI is representing the family of process data interface specifications (e.g. being part of EULYNX BL4R4) and also functional requirements for Object Controllers. Those enable the control and monitoring of trackside assets (e.g., points, train detection systems, level crossings via SCI-P, SCI-TDS and SCI-LC respectively) by the interlocking according to the connectivity principles of the EULYNX System architecture.

[ Open]

SPT2TRAFFIC-11267 -

Object Controllers SCI	
Criteria	Evaluation
Description of the feature/interface/ component <ul style="list-style-type: none"> What is it about? What is the core functionality? Which technologies are used? 	<ul style="list-style-type: none"> The existing EULYNX SCI interfaces are forming the standardised interface for exchange of process data information between interlocking and Object Controllers in the legacy EULYNX System architecture.

Object Controllers SCI	
<ul style="list-style-type: none"> • How does it fit in the CCS, especially in the Traffic CS scope? • Do assumptions need to be made regarding the further evaluation process? 	<ul style="list-style-type: none"> • As communication technology Ethernet (copper, SFP, wireless), UDP or TCP(TLS) and RaSTA are used it is intended to use SCI Interface functionality as well between ETPS and object controllers in the SERA Architecture.
<p>Sources/input documents taken into account for the description and the evaluation</p> <ul style="list-style-type: none"> • On which information is this evaluation based on? • Can references to other documents be listed here? • Is there a reference in the STIP? 	<ul style="list-style-type: none"> • EULYNX Baseline Set 4 Release 4 • STIP_85, _86, _87, _88, _89 SCI
<p>Applicability of the feature/interface/component</p> <ul style="list-style-type: none"> • Applicability means the fact or quality of being relevant, appropriate, or suitable for a certain situation or range of situations? • What is the possible scope? how often can the feature/interface be used? 	<ul style="list-style-type: none"> • The existing SCI can be used in a SERA Pre-phase as part of the EULYNX architecture for connection of interlockings with object controllers.
<p>Maturity of the feature/interface/component</p> <ul style="list-style-type: none"> • Is the feature/interfaces still under development in System Pillar or elsewhere? • Are there significant changes foreseen in the next months/years? • Is there a mature specification available? ("mature" in terms of specificity, feasibility, risk assessment, stakeholder agreement, compliance and standards, documentation, testability, integration etc.) • Is the feature already used? Is the feature already tested? Are prototypes or pilots available? 	<ul style="list-style-type: none"> • High compatibility, maturity and stability of existing SCI EULYNX interface functionality for the legacy EULYNX system architecture. • Nevertheless, further harmonisation and clean-up of specifications may be proposed, also for the legacy EULYNX system. This preparation work would simplify the migration for connecting to future ETPS.
<p>Time for product developments</p> <ul style="list-style-type: none"> • Time needed for developing market-ready products based on a mature and agreed specification 	<ul style="list-style-type: none"> • Several products based on BL 4 specifications are already commissioned in projects based on the legacy EULYNX System architecture, others are planned.
<p>Efforts for maintenance of specifications</p> <ul style="list-style-type: none"> • Efforts for maintaining/evolving specifications • Availability of a long/sustained term organisation (surpassing the project phase) 	<ul style="list-style-type: none"> • Existing SCI interface specification content (e.g. BL4R4) should be kept stable and backward compatible in future releases • The governance for updating existing EULYNX specifications in the System Pillar follows the System Pillar process.

Object Controllers SCI	
Dependencies to other features/interfaces/components <ul style="list-style-type: none"> • Does the feature depend on features currently under discussion and development (e.g., safety logic, cybersecurity requirements)? • is the feature standalone (independent constituent) and described as a whole or are other conditions to be fulfilled to enable reusability? 	<ul style="list-style-type: none"> • The cyber security documentation is developed in Europe's rail • Functionality in ETPS (not yet fully available in 09/2025) • Functionality in the harmonised operational rules (not yet available in 09/2025)
SERA conformity <ul style="list-style-type: none"> • Are the features already part of SERA/part of the System Pillar Reference Architecture? • Are the features SERA enablers? • Are the features SERA compatible/is the forward compatibility ensured? • Are scenarios for migrating to SERA available and evaluated? Are adapters needed/required? • In how far are the features harmonised across Europe? 	<ul style="list-style-type: none"> • The ongoing specification of the ETPS functionality might lead to minor modifications/extensions of the current SCI
Benefits of the feature/interface/component <ul style="list-style-type: none"> • Reference to System Pillar CBOs: <ul style="list-style-type: none"> ◦ Meeting evolving customer performance ◦ Improved performance and capacity ◦ Reduced costs ◦ More sustainable or resilient transport ◦ Harmonised approach to evolution and greater adaptability ◦ Reinforced role for rail in European transport and mobility ◦ Improved EU rail supply industry competitiveness 	<ul style="list-style-type: none"> • Harmonised approach to evolution and greater adaptability • An important enabler to simplify the migration towards a SERA Architecture compliant system
Efforts of the feature integration <ul style="list-style-type: none"> • Change of operational/organizational procedures / Changes of regulatory framework / Capacity, resources needed for development & implementation / Impact on authorization • Reasonable adaption efforts 	<ul style="list-style-type: none"> • Development of interlocking capable of using these interfaces SCI + adapt functionality accordingly • Object controllers capable of using these interfaces SCI + adapt functionality accordingly

Object Controllers SCI	
Risks of an early integration <ul style="list-style-type: none"> Any "too early usage" of SP Standard specs (e.g. draft versions) in the SERA Pre-phase (tendering, projects) implies the risk that still necessary interface changes (due to iterations in the development) will not be backward compatible. 	<ul style="list-style-type: none"> Current SCI features (e.g., functional packages) not agreed during SP harmonisation will not be supported anymore for usage with future SP systems like ETPS
PRO arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> The reuse of OC's equipped with existing EULYNX SCI interfaces in the SERA Architecture is intended for protecting investments, as far as harmonised interface features are used only
CONTRA arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> See Risks (mentioned above)
Final recommendations	<ul style="list-style-type: none"> It is recommended to use EULYNX SCI It is a must to use Baseline 4 Release 4 of the EULYNX specifications, because they are considered as stable

[🔗 Open]

3.4.2 Object Controllers SDI

SPT2TRAFFIC-15421 - Here described **Trackside Assets SDI** (being part of the group of diagnosis interfaces SDI) are representing the family of diagnostic interface specifications (e.g. being part of EULYNX BL4R4) for Objects Controllers in the EULYNX System architecture. Those interfaces enable the diagnosis of the Objects Controllers and connected trackside assets (e.g., points, train detection systems, level crossings; SDI-P, SDI-TDS, SDI-LC) according to the needs of the EULYNX System architecture. The central component for diagnosis in the EULYNX System architecture forms the Maintenance and Data Management (MDM) system.

[🔗 Open]

SPT2TRAFFIC-14884 -

Object Controllers SDI	
Criteria	Evaluation
Description of the feature/interface/component <ul style="list-style-type: none"> What is it about? What is the core functionality? Which technologies are used? How does it fit in the CCS, especially in the Traffic CS scope? Do assumptions need to be made regarding the further evaluation process? 	<ul style="list-style-type: none"> The existing EULYNX SDI interfaces are forming standardised interfaces between Maintenance and Data Management (MDM) and Object Controllers in the legacy EULYNX System architecture. EULYNX SDI is the standardised EULYNX interface for diagnostics to enable communication with the service functions Diagnostics collector (part of MDM).

Object Controllers SDI	
	<ul style="list-style-type: none"> As communication technology Ethernet (copper, SFP, wireless), OPC UA (cybersec) are used.
Sources/input documents taken into account for the description and the evaluation <ul style="list-style-type: none"> On which information is this evaluation based on? Can references to other documents be listed here? Is there a reference in the STIP? 	<ul style="list-style-type: none"> EULYNX Baseline Set 4 Release 4 (STIP_90-_100) about diagnostics interfaces
Applicability of the feature/interface/component <ul style="list-style-type: none"> Applicability means the fact or quality of being relevant, appropriate, or suitable for a certain situation or range of situations? what is the possible scope? how often can the feature/interface be used? 	<ul style="list-style-type: none"> The existing EULYNX SDI forms an interface solution, that can be used both in the legacy EULYNX System architecture (between MDM and OC's), i.e. in the SERA Pre-phase, and in the future SERA phase
Maturity of the feature/interface/component <ul style="list-style-type: none"> Is the feature/interfaces still under development in System Pillar or elsewhere? Are there significant changes foreseen in the next months/years? Is there a mature specification available? ("mature" in terms of specificity, feasibility, risk assessment, stakeholder agreement, compliance and standards, documentation, testability, integration etc.) Is the feature already used? Is the feature already tested? Are prototypes or pilots available? 	<ul style="list-style-type: none"> High compatibility, maturity and stability of existing SDI interface specification content (e.g. BL4R4), also for SERA purposes.
Time for product developments <ul style="list-style-type: none"> Time needed for developing market-ready products based on a mature and agreed specification 	<ul style="list-style-type: none"> Several products based on BL 4 specifications are already commissioned in projects based on the legacy EULYNX System architecture, others are planned.
Efforts for maintenance of specifications <ul style="list-style-type: none"> Efforts for maintaining/evolving specifications Availability of a long/sustained term organisation (surpassing the project phase) 	<ul style="list-style-type: none"> Existing SDI interface specification content (e.g. BL4R4) should be kept stable and backward compatible in future releases
Dependencies to other features/interfaces/components <ul style="list-style-type: none"> Does the feature depend on features currently under discussion and development (e.g., safety logic, cybersecurity requirements)? 	<ul style="list-style-type: none"> The cyber security documentation is developed in Europe's rail

Object Controllers SDI	
<ul style="list-style-type: none"> • is the feature standalone (independent constituent) and described as a whole or are other conditions to be fulfilled to enable reusability? 	
SERA conformity <ul style="list-style-type: none"> • Are the features already part of SERA/part of the System Pillar Reference Architecture? • Are the features SERA enablers? • Are the features SERA compatible/is the forward compatibility ensured? • Are scenarios for migrating to SERA available and evaluated? Are adapters needed/required? • In how far are the features harmonised across Europe? 	<ul style="list-style-type: none"> • SDI interface specification is already part of SERA
Benefits of the feature/interface/component <ul style="list-style-type: none"> • Reference to System Pillar CBOs: <ul style="list-style-type: none"> ◦ Meeting evolving customer performance ◦ Improved performance and capacity ◦ Reduced costs ◦ More sustainable or resilient transport ◦ Harmonised approach to evolution and greater adaptability ◦ Reinforced role for rail in European transport and mobility ◦ Improved EU rail supply industry competitiveness 	<ul style="list-style-type: none"> • Harmonised approach to evolution and greater adaptability • An important enabler to simplify the migration towards a SERA Architecture compliant system
Efforts of the feature integration <ul style="list-style-type: none"> • Change of operational/organizational procedures / Changes of regulatory framework / Capacity, resources needed for development & implementation / Impact on authorization • Reasonable adaption efforts 	<ul style="list-style-type: none"> • Development of Object controllers capable of using these interfaces OC + adapt functionality accordingly
Risks of an early integration <ul style="list-style-type: none"> • Any "too early usage" of SP Standard specs (e.g. draft versions) in the SERA Pre-phase (tendering, projects) implies the risk that still necessary interface changes (due to iterations in the development) will not be backward compatible. 	<ul style="list-style-type: none"> • There might be further updates necessary after feedback from first implementations
PRO arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • The reuse of OC's equipped with existing EULYNX SDI interfaces in the SERA Architecture is intended for protecting investments

Object Controllers SDI	
CONTRA arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • See Risks (mentioned above)
Final recommendations	<ul style="list-style-type: none"> • It is recommended to use EULYNX SDI • It is a must to use Baseline 4 Release 4 of the EULYNX specifications, because they are considered as stable

[ Open]

3.4.3 Object Controllers SMI

SPT2TRAFFIC-15422 - Here described Trackside Assets SMI (being part of the group of maintenance interfaces SMI) are representing the family of maintenance interface specifications (e.g. being part of EULYNX BL4R4) for Objects Controllers in the EULYNX System architecture. Those interfaces enable the maintenance (incl. SW Upload for OC's) of the Objects Controllers and connected trackside assets (e.g., points, train detection systems, level crossings) according to the needs of the EULYNX System architecture. The central component for maintenance in the EULYNX System architecture forms the Maintenance and Data Management (MDM) system.


[ Open]

SPT2TRAFFIC-15414 -


Object Controllers SMI	
Criteria	Evaluation
Description of the feature/interface/component <ul style="list-style-type: none"> • What is it about? What is the core functionality? Which technologies are used? • How does it fit in the CCS, especially in the Traffic CS scope? • Do assumptions need to be made regarding the further evaluation process? 	<ul style="list-style-type: none"> • The existing EULYNX SMI interfaces are forming standardised interfaces between Maintenance and Data Management (MDM) and Object Controllers in the legacy EULYNX System architecture. • EULYNX SMI (current version SMIv2) is the standardised EULYNX interface for maintenance to enable communication with the service function Loading procedure (part of MDM). • As communication technology Ethernet (copper, SFP, wireless), OPC UA (cybersec) are used.
Sources/input documents taken into account for the description and the evaluation <ul style="list-style-type: none"> • On which information is this evaluation based on? • Can references to other documents be listed here? • Is there a reference in the STIP? 	<ul style="list-style-type: none"> • EULYNX Baseline Set 4 Release 4 • (STIP_90-_100) about diagnostics interfaces

Object Controllers SMI	
<p>Applicability of the feature/interface/ component</p> <ul style="list-style-type: none"> • Applicability means the fact or quality of being relevant, appropriate, or suitable for a certain situation or range of situations? • what is the possible scope? how often can the feature/ interface be used? 	<ul style="list-style-type: none"> • The existing EULYNX SMI forms an interface solution, that can be used in the legacy EULYNX System architecture only (between MDM and OC's), i.e. in the SERA Pre-phase • Be aware, for the SERA Architecture new SMI SP Standard interface specifications are prepared by TCCS (see SPT2TRAFFIC-12260 - Traffic CS SDI/SMI) meeting the significantly extended functional needs for maintenance (e.g. configuration management) of all SP Subsystems in a harmonized way • Therefore, only parts of existing SMI content are incorporated in the SMI SP Standard interface specifications, like: <ul style="list-style-type: none"> ▪ SMI: extended functionality with configuration management (version SMIv3) enables future (remote) updates in the SERA Architecture. • An early use of OC's having legacy EULYNX SMI interfaces would be beneficial, if these OC's are upgradeable to the future SMI SP Standard interface functionality (see SPT2TRAFFIC-12260 - Traffic CS SDI/SMI)
<p>Maturity of the feature/interface/ component</p> <ul style="list-style-type: none"> • Is the feature/interfaces still under development in System Pillar or elsewhere? • Are there significant changes foreseen in the next months/ years? • Is there a mature specification available? ("mature" in terms of specificity, feasibility, risk assessment, stakeholder agreement, compliance and standards, documentation, testability, integration etc.) • Is the feature already used? Is the feature already tested? Are prototypes or pilots available? 	<ul style="list-style-type: none"> • The existing EULYNX SMI interface specifications have partially low compatibility to the SERA Architecture and the related SP Subsystems like the OC's and Central Services (e.g. Configuration Management) • Therefore, new SMI SP Standard interface specifications are prepared by TCCS (see SPT2TRAFFIC-12260 - Traffic CS SDI/SMI)
<p>Time for product developments</p> <ul style="list-style-type: none"> • Time needed for developing market-ready products based on a mature and agreed specification 	<ul style="list-style-type: none"> • Criterion is only of limited application, because: <ul style="list-style-type: none"> ◦ Specification of SERA compliant SMI SP Standard interface is done by TCCS (see SPT2TRAFFIC-12260 - Traffic CS SDI/SMI) ◦ Benefit of early usage of OC's with EULYNX SMI depends on their upgradeability to the future SMI SP Standard interface


Object Controllers SMI	
Efforts for maintenance of specifications <ul style="list-style-type: none"> • Efforts for maintaining/evolving specifications • Availability of a long/sustained term organisation (surpassing the project phase) 	<ul style="list-style-type: none"> • Criterion is only of limited application: see statement above
Dependencies to other features/ interfaces/components <ul style="list-style-type: none"> • Does the feature depend on features currently under discussion and development (e.g., safety logic, cybersecurity requirements)? • is the feature standalone (independent constituent) and described as a whole or are other conditions to be fulfilled to enable reusability? 	<ul style="list-style-type: none"> • Criterion is only of limited application: see statement above
SERA conformity <ul style="list-style-type: none"> • Are the features already part of SERA/part of the System Pillar Reference Architecture? • Are the features SERA enablers? • Are the features SERA compatible/is the forward compatibility ensured? • Are scenarios for migrating to SERA available and evaluated? Are adapters needed/required? • In how far are the features harmonised across Europe? 	<ul style="list-style-type: none"> • Criterion is only of limited application: see statement above
Benefits of the feature/interface/ component <ul style="list-style-type: none"> • Reference to System Pillar CBOs: <ul style="list-style-type: none"> ◦ Meeting evolving customer performance ◦ Improved performance and capacity ◦ Reduced costs ◦ More sustainable or resilient transport ◦ Harmonised approach to evolution and greater adaptability 	<ul style="list-style-type: none"> • Criterion is only of limited application: see statement above

Object Controllers SMI	
<ul style="list-style-type: none"> ◦ Reinforced role for rail in European transport and mobility ◦ Improved EU rail supply industry competitiveness 	
Efforts of the feature integration <ul style="list-style-type: none"> • Change of operational/ organizational procedures / Changes of regulatory framework / Capacity, ressources needed for development & implementation / Impact on authorization • Reasonable adaption efforts 	<ul style="list-style-type: none"> • Criterion is only of limited application: see statement above
Risks of an early integration <ul style="list-style-type: none"> • Any "too early usage" of SP Standard specs (e.g. draft versions) in the SERA Pre-phase (tendering, projects) implies the risk that still necessary interface changes (due to iterations in the development) will not be backward compatible. 	<ul style="list-style-type: none"> • Criterion is only of limited application: see statement above
PRO arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • Criterion is only of limited application: see statement above
CONTRA arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • Criterion is only of limited application: see statement above
Final recommendations	<ul style="list-style-type: none"> • It might be beneficial to use EULYNX SMI for object controllers - in projects which are setup according to the EULYNX System architecture in the SERA pre-phase -until SMI SP Standard interface specifications (prepared by Transversal) are available • Reason: parts of existing SMI content are incorporated in the SMI SP Standard interface specifications (see  SPT2TRAFFIC-12260 - Traffic CS SDI/SMI), which means: <ul style="list-style-type: none"> ▪ SMI: extended functionality with configuration management (version SMIv3) enables future (remote) updates in the SERA Architecture.

Object Controllers SMI	
	<ul style="list-style-type: none"> • Nevertheless, benefit of early usage of OC's with EULYNX SMI depends on their upgradeability to the future SMI SP Standard interface, leading to protection of investment • EULYNX SMIv2 is an option to allow later an update to the SP standard interface

[ Open]

3.5 Traffic CS SDI/SMI

SPT2TRAFFIC-15423 - Here described SDI and SMI are **representing the family of new diagnostic and maintenance interfaces in the SERA System architecture**. These interfaces belong to the SP Standard interface set and enable the diagnosis and maintenance of **SP Subsystems (e.g., Traffic CS systems as ETPS, PES, ATO-TS)**. The central services for diagnosis and maintenance and also the SDI/SMI functionality for all SP Subsystems are specified in a harmonised way by the Transversal CCS domain. [ Open]


SPT2TRAFFIC-12261 -

Transversal CCS SDI/SMI	
Criteria	Evaluation
Description of the feature/ interface/component <ul style="list-style-type: none"> • What is it about? What is the core functionality? Which technologies are used? • How does it fit in the CCS, especially in the Traffic CS scope? • Do assumptions need to be made regarding the further evaluation process? 	<ul style="list-style-type: none"> • For the trackside, the EULYNX standards facilitate the collection of diagnostics and monitoring data from field elements through standardised interfaces (SDI-XX), feeding into the maintenance and data management system (MDM). Future efforts -in the scope of TCCS domain- will expand this to other track-side CCS components such as ETPS, PES and ATO-TS, in collaboration with relevant domains. • The EULYNX SMI interface is about transferring configuration Items to trackside field elements. In the EULYNX concept the safety is ensured by the interlocking via the SCI interface. Transversal will develop this concept further. The concept is applicable for configuration updates of Object Controllers, ETPS, ATO-TS, PES etc. • Technologies used ethernet, OPC UA (cybersec).
Sources/input documents taken into account for the description and the evaluation <ul style="list-style-type: none"> • On which information is this evaluation based on? • Can references to other documents be listed here? • Is there a reference in the STIP? 	<ul style="list-style-type: none"> • Transversal documentation: System Requirements Specification TCCS - Part 3 System Interface Description TCCS - System Interface SMI (v3) System Requirements Specification TCCS - System Interface SMI (v2) to SMI (v3) Change Request System Interface Description TCCS - System Interface REPO System Requirements Specification TCCS - Part 2 Note! This documents is up for review in September 2025. Is recommended by TCCS to be used after internal SP Release. • Europe's Rail/ EULYNX Baseline Set 4 Release 4 (STIP_90-_100) about diagnostics interfaces

Transversal CCS SDI/SMI	
Applicability of the feature/ interface/component <ul style="list-style-type: none"> • Applicability means the fact or quality of being relevant, appropriate, or suitable for a certain situation or range of situations? • what is the possible scope? how often can the feature/ interface be used? 	<ul style="list-style-type: none"> • SDI/SMI can be used in a SERA pre-phase architecture with Europe's Rail/EULYNX object controllers (see 3.4) <ul style="list-style-type: none"> - Diagnostic capabilities (SDI) are fully aligned with the EULYNX architecture system. - Configuration management (SMI) enables future (remote) updates. • For SERA specifications see sources/input documents.
Maturity of the feature/interface/ component <ul style="list-style-type: none"> • Is the feature/interfaces still under development in System Pillar or elsewhere? • Are there significant changes foreseen in the next months/ years? • Is there a mature specification available? ("mature" in terms of specificity, feasibility, risk assessment, stakeholder agreement, compliance and standards, documentation, testability, integration etc.) • Is the feature already used? Is the feature already tested? Are prototypes or pilots available? 	<ul style="list-style-type: none"> • Generic SDI diagnostic classes already specified and to be used by TACS subsystems. TCCS will add: <ul style="list-style-type: none"> - The toolchain - Generalization of metadata. • Generic SMIv2 specification available without subsystem specific contents - generic requirements applicable across all subsystems. TCCS will update the SMIv3 with: <ul style="list-style-type: none"> - applicable for all elements (not only field elements) - scalable to be applied with many elements - explicit with dependency management - no update chains - no deactivation for non-safety • SP has decided to use SDI/SMI in the full SERA context, adaptations that needs to be made is under development in the Transversal CCS domain.
Time for product developments <ul style="list-style-type: none"> • Time needed for developing market-ready products based on a mature and agreed specification 	<ul style="list-style-type: none"> • Specific object controllers products based on Europe's Rail/ EULYNX Baseline Set 4 Release 4 specifications are already commissioned. The new TCCS specifications are soon ready and can then be estimated.
Efforts for maintenance of specifications <ul style="list-style-type: none"> • Efforts for maintaining/ evolving specifications • Availability of a long/ sustained term organisation (surpassing the project phase) 	<ul style="list-style-type: none"> • The Transversal CCS domain provides the specifications. The governance of the specifications in the System Pillar follows the System Pillar process.
Dependencies to other features/ interfaces/components <ul style="list-style-type: none"> • Does the feature depend on features currently under discussion and development 	<ul style="list-style-type: none"> • CCS/TMS Data Model • TCCS SMIv3 is a necessary foundation for reliable, scalable and safe configuration management. • Also dependencies to operational processes defined in SERA. Cyber security also needs to be considered.

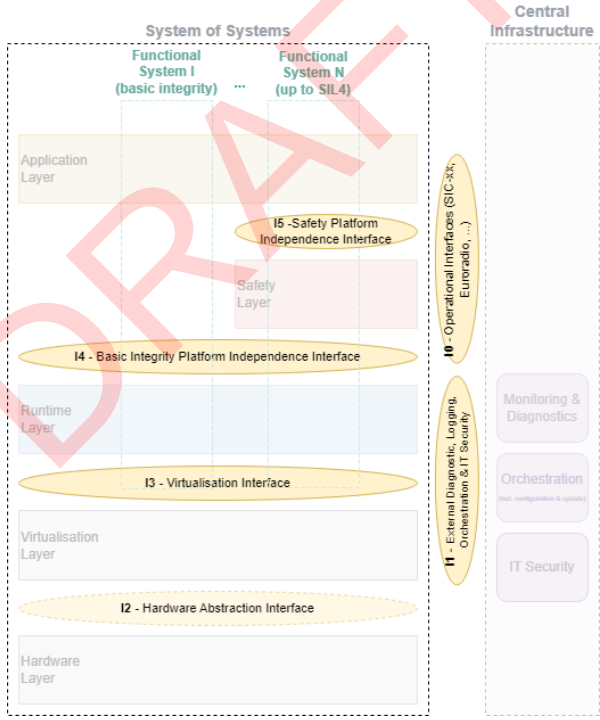




Transversal CCS SDI/SMI	
<p>(e.g., safety logic, cyber security requirements)?</p> <ul style="list-style-type: none"> • is the feature standalone (independent constituent) and described as a whole or are other conditions to be fulfilled to enable reusability? 	
<p>SERA conformity</p> <ul style="list-style-type: none"> • Are the features already part of SERA/part of the System Pillar Reference Architecture? • Are the features SERA enablers? • Are the features SERA compatible/is the forward compatibility ensured? • Are scenarios for migrating to SERA available and evaluated? Are adapters needed/required? • In how far are the features harmonised across Europe? 	<ul style="list-style-type: none"> • Scenario's for migrating to SERA have to be described. • The Transversal CCS (TCCS) domain handles the Diagnostic and Configuration for the SERA.
<p>Benefits of the feature/interface/ component</p> <ul style="list-style-type: none"> • Reference to System Pillar CBOs: <ul style="list-style-type: none"> ◦ Meeting evolving customer performance ◦ Improved performance and capacity ◦ Reduced costs ◦ More sustainable or resilient transport ◦ Harmonised approach to evolution and greater adaptability ◦ Reinforced role for rail in European transport and mobility ◦ Improved EU rail supply industry competitiveness 	<ul style="list-style-type: none"> • Harmonised approach to evolution and greater adaptability • An important enabler to simplify the migration towards a fully Target Architecture compliant system • SMIv3 supports broader system integration, standardization, and automation targets. • Cyber security dependencies on SDI/SMI: <ul style="list-style-type: none"> ▪ SMI interface shall be used for security related software and configuration updates ▪ No separate update functionality is planned for security ▪ If SMI will not be defined as standard, individual solutions for software updates for safety, security and other updates will be "invented" -> this would drive complexity at railway side to manage different technical and procedural approaches from different suppliers
<p>Efforts of the feature integration</p> <ul style="list-style-type: none"> • Change of operational/ organizational procedures / Changes of regulatory framework / Capacity, ressources needed for development & implementation / Impact on authorization 	<ul style="list-style-type: none"> • Transversal Diagnostic and Configuration capable of using these interfaces + adapt functionality accordingly.

Transversal CCS SDI/SMI	
<ul style="list-style-type: none"> • Reasonable adaption efforts 	
Risks of an early integration <ul style="list-style-type: none"> • Any "too early usage" of SP Standard specs (e.g. draft versions) in the SERA Pre-phase (tendering, projects) implies the risk that still necessary interface changes (due to iterations in the development) will not be backward compatible. 	<ul style="list-style-type: none"> • In the Europe's Rail/EULYNX specification the SDI/SMI interface between MDM and Object controllers is specified and can be used in SERA pre-phase if EULYNX objects controller will be used. • When it comes to the SERA specification it is under development and planned to be internally released in TCCS/SP. There can be delays but if not it can be used. The final release will not come until 2027.
PRO arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • To use a standardised service like Loading (Configuration) procedure can be a great advantage during migration phase depending on the frequency of updates. • The needed updates in TACS SDI/SMI is defined in TCCS and will be released internally SP in 09/2025. This can be used as a guide to make SERA pre-phase solutions. • The consequences for adding SDI/SMI, as for cyber security, will be big on the IM side. The sooner these changes are started the better. • SMI will enable remote update of software and configuration data.
CONTRA arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • A Maintenance and Data Management (MDM) is needed in some form. Most likely changes will come for SERA later. • The Transversal CCS (TCCS) domain handles the Diagnostic and Configuration for the SERA. They have updated the SMI/SDI and it is still not verified in real use. • Current SDI/SMI - see SPT2TRAFFIC-14877 and SPT2TRAFFIC-15415 - is developed for EULYNX object controllers.
Final recommendations	<ul style="list-style-type: none"> • SP has decided to use Transversal CCS domain's SDI/SMI in the full SERA context, adaptations that needs to be made are under development in the Transversal CCS domain. • It is recommended to make use of the Traffic CS SDI/SMI SP Standard interface specifications as soon as they are available, because they fit to the SERA Architecture. • the early rollout of these interfaces in the SERA Pre-phase would require as well the provision of the corresponding SERA conform central services for diagnosis, maintenance incl. configuration management • beside connection to OC's via SDI and SMI, these central services can be used in future for connectivity of all SERA subsystems via SDI/SMI (i.e. protection of investment)

[ Open]

3.6 Computing Environment Specifications

SPT2TRAFFIC-11592 -


Computing Environment Specifications	
Criteria	Evaluation
Description of the feature/ interface/component <ul style="list-style-type: none"> What is it about? What is the core functionality? Which technologies are used? How does it fit in the CCS, especially in the Traffic CS scope? Do assumptions need to be made regarding the further evaluation process? 	<ul style="list-style-type: none"> Specifications for a generic Computing Environment/Architecture both for trackside and onboard applications (independent of specific applications for IXL, RBC etc.) Modular architecture based on harmonised interfaces to be specified Foreseen interfaces I0-I5: <ul style="list-style-type: none"> I0: Operational Interfaces I1: Interface for External Diagnostic, Logging, Orchestration and IT Security Interface(s) I2: Hardware Abstraction Interface (not really an interface, but rather a compatibility list of allowed hardware) I3: Virtualization Interface I4: Basic Integrity Platform Independence Interface I5: Safety Platform Independence Interface  <p>System of Systems</p> <p>Functional System I (basic integrity) ... Functional System N (up to SIL4)</p> <p>Application Layer</p> <p>Runtime Layer</p> <p>Virtualisation Layer</p> <p>Hardware Layer</p> <p>I5 - Safety Platform Independence Interface</p> <p>I4 - Basic Integrity Platform Independence Interface</p> <p>I3 - Virtualisation Interface</p> <p>I2 - Hardware Abstraction Interface</p> <p>I0 - Operational Interfaces (SIC, etc.)</p> <p>I1 - External Diagnostic, Logging, Orchestration & IT Security</p> <p>Central Infrastructure</p> <p>Monitoring & Diagnostics</p> <p>Orchestration</p> <p>IT Security</p> <p> Glossary</p>
Sources/input documents taken into account for the description and the evaluation <ul style="list-style-type: none"> On which information is this evaluation based on? Can references to other documents be listed here? 	<ul style="list-style-type: none">  Recommendation on Interfaces to be standardised  Glossary  System Concept including operational analysis EU-Rail System Pillar Specific Contract (SC) 2.4 SC 2.3 D2 Feature high level description Computing Environment is part of the EU-rail STIP list V1.0 of april 2024.

Computing Environment Specifications	
<ul style="list-style-type: none"> • Is there a reference in the STIP? 	
Applicability of the feature/ interface/component <ul style="list-style-type: none"> • Applicability means the fact or quality of being relevant, appropriate, or suitable for a certain situation or range of situations? • what is the possible scope? how often can the feature/interface be used? 	<ul style="list-style-type: none"> • Can be used for onboard and trackside CCS applications with IP-based communication (e.g., for the applications of PES and ETPS currently under development in Traffic CS)
Maturity of the feature/ interface/component <ul style="list-style-type: none"> • Is the feature/interfaces still under development in System Pillar or elsewhere? • Are there significant changes foreseen in the next months/years? • Is there a mature specification available? ("mature" in terms of specificity, feasibility, risk assessment, stakeholder agreement, compliance and standards, documentation, testability, integration etc.) • Is the feature already used? Is the feature already tested? Are prototypes or pilots available? 	<ul style="list-style-type: none"> • Current maturity to be considered as very low, as there are no specifications available (02/2025) • There is unanimous agreement on the need of standardizing I1, I2 and I3 interfaces within the SP Computing Environment domain, while the need for standardizing the application execution environments I4 and I5 is still under discussion (-> clear focus on standardizing I1, I2, I3). • Specification work for I1 (in cooperation with Transversal CCS) as well as I2 and I3 already started. First draft of specifications to be delivered by 08/2025 • SERA pre-phase integration (usability for current IXL and RBC) possible as soon as the first specifications for I1, I2, I3 are mature and validated (End of 2025/2026)
Time for product developments <ul style="list-style-type: none"> • Time needed for developing market-ready products based on a mature and agreed specification 	<ul style="list-style-type: none"> • First products are foreseen in 2026 or 2027 • The I2 and I3 specifications will mainly base on COTS solutions and therefore faster development time expected


Computing Environment Specifications	
Efforts for maintenance of specifications <ul style="list-style-type: none"> • Efforts for maintaining/evolving specifications 	<ul style="list-style-type: none"> • It is consensus to use COTS solutions, including hardware and virtualization, which opens doors to building specifications from other domains such as general data center IT platforms, automotive, and avionics. -> The decision to use COTS technology will reduce the maintenance effect as large industries maintain the specifications globally
Dependencies to other features/interfaces/components <ul style="list-style-type: none"> • Does the feature depend on features currently under discussion and development (e.g., safety logic, cyber security requirements)? • is the feature standalone (independent constituent) and described as a whole or are other conditions to be fulfilled to enable reusability? 	<ul style="list-style-type: none"> • I1 depends on the SMI/SDI interfaces and the CCS/TMS data model as well as the SSI interfaces and the Cyber security requirements
SERA conformity <ul style="list-style-type: none"> • Are the features already part of SERA/ part of the System Pillar Reference Architecture? • Are the features SERA enablers? • Are the features SERA compatible/is the forward compatibility ensured? • Are scenarios for migrating to SERA available and evaluated? Are adapters needed/ required? • In how far are the features harmonised across Europe? 	<ul style="list-style-type: none"> • An harmonised generic computing environment is part of the System Pillar Reference Architecture and SERA target • The use of the harmonised interfaces (I0-I5), especially for separating software, hardware, maintenance and diagnostics (I1, I2, I3) facilitate migrating to SERA • Computing platform could be used already for non-SERA applications
	<ul style="list-style-type: none"> • Simplify software installation, hardware configuration and life-cycle processes such as upgrades, updates, or replacement with different software products • Ensuring interoperability between different supplier products and exchangeability of hardware and software

Computing Environment Specifications	
Benefits of the feature/ interface/component <ul style="list-style-type: none"> • Reference to System Pillar CBOs: <ul style="list-style-type: none"> ◦ Meeting evolving customer performance ◦ Improved performance and capacity ◦ Reduced costs ◦ More sustainable or resilient transport ◦ Harmonised approach to evolution and greater adaptability ◦ Reinforced role for rail in European transport and mobility ◦ Improved EU rail supply industry competitiveness 	<ul style="list-style-type: none"> • Given possibility to run safe and non-safe applications from different suppliers next to each other, on the same commercially available general purpose hardware platform, and yet to fulfil all PRAMSS requirements (still to be proven) • Requirements for Computing Environment specifications related to the following CBO <ul style="list-style-type: none"> ◦ Automate lifecycle processes / Independent lifecycles ◦ Changeability and upgradeability ◦ Modularity ◦ Overall CAPEX/OPEX optimization ◦ Standardized architecture ◦ See full analysis here: User stories & Requirements
Efforts of the feature integration <ul style="list-style-type: none"> • Change of operational/ organizational procedures / Changes of regulatory framework / Capacity, ressources needed for development & implementation / Impact on authorization • Reasonable adaption efforts 	<ul style="list-style-type: none"> • There are efforts both on IM and supplier sides, but considered as acceptable in comparison to the expected benefits (see above).
Risks of an early integration <ul style="list-style-type: none"> • Any "too early usage" of SP Standard specs (e.g. draft versions) in the SERA Pre-phase (tendering, projects) implies the risk that still necessary interface changes (due to iterations in the development) will not be backward compatible. 	<ul style="list-style-type: none"> • No evaluation possible, as currently (02/2025) there is no specification available

Computing Environment Specifications	
PRO arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • Harmonised interfaces I1, I2, I3 facilitate migration to the SERA Target Architecture • Use of interface specification independent of other features/ interfaces still under development in SP
CONTRA arguments regarding an early integration (SERA pre-phase)	<ul style="list-style-type: none"> • Interfaces I1, I2, I3 need to be tested and validated • in general, It is a safety requirement for the design that a real time safety-related application will not be influenced by a parallel running application as far as safety, security and performance is concerned (e.g., realtime requirements need support of RTOS which can be implemented as part of virtualisation-I3).
Final recommendations	<ul style="list-style-type: none"> • The use of the Computing Environment specifications is already beneficial in the SERA pre-phase area as soon as mature and tested specifications are available • The specifications are independent of other probably longer taking developments in the System Pillar (e.g. could be used already before mature specifications of PES or ETPS are available) • The final recommendation on Computing Environment Specifications shall be postponed until specifications for the interfaces I1, I2 and I3 are available (probably end of 2025/beginning of 2026) • The current modular Traffic CS design and system architecture support a later deployment in the Computing Environment. Further impacts on the Traffic CS design - especially on application level - are currently not predictable

[ Open]

4 Conclusions & Summary

SPT2TRAFFIC-11679 - Based on the assessments above the following conclusions, with their summarized evaluations are presented as **Recommendations for current rollouts**. The status of each candidate regarding their possible usage in the SERA pre-phase is indicated by a traffic light in the rightmost column. The traffic light logic is explained at the beginning of this document in section [1.4-3](#).
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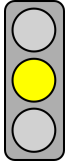
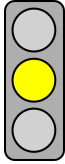
SPT2TRAFFIC-14973 - General recommendations

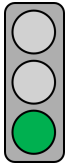
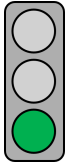
I	Apply for signalling deployments based on ETCS L2 without lineside signals (only the use of harmonised shunting signals can still be necessary)
II	Follow the specific recommendations elaborated in this deliverable

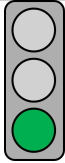
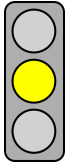
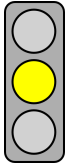
For more details, see [2.1 - General recommendations](#).

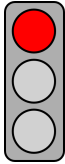
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SPT2TRAFFIC-13539 - Summarized **criteria-based evaluation of potential candidates** for deployment in current rollouts.

No	Name	Description	Final recommendations	Status
1	SCI-OP Interface	The interface between TMS and CCS, referred to as "Standard Communication Interface Operational Plan (SCI-OP)", located at the system boundary of Traffic CS CCS and connects TMS with the ATO-Trackside (ATO-TS) and the Plan Execution System (PES) As such, it serves to ensure the flow of data between systems.	<ul style="list-style-type: none"> The interface is at present not complete as it needs further elaboration from Traffic CS perspective with respect to expected detailed functional requirements set -up of PES-ETPS part that are to be concluded in 2027. Early integration in SERA pre-phase is at present questionable, seems more likely for the ATO-TS part but not ensured yet. Data model is considered mature enough but not yet final while on TMS side functional content is deemed satisfactory. Furthermore, other SP Domains decisions ,e.g. Operational Harmonisation may also have impact that today is not visible. In accordance with ATO-TS, PES, ETPS expected functional modifications the interface structure is subject of further update from TMS to ATO-TS & from TMS to PES and vice versa. Therefore, the governance and organisation of the SCI-OP specification should be maintained in the long term. Provided that the above mentioned pending activities are concluded it is recommended the use of this interface in the pre-SERA phase in order to prepare a smooth transition and migration when SERA takes place. A possible partial SCI-OP application could be the ATO-TS part, as it is independent from PES/ETPS application. Note, that today this interface implementation is targeted towards the end of pre-SERA phase, i.e. 2030. 	
2	CCS/TMS Data Model	The CCS/TMS Data Model is the harmonised language applied in the System Pillar, that defines a common data language used across all	<ul style="list-style-type: none"> The definition of the current Data Model provides a very important foundation to work on. However, it is necessary to have a definition of the functionalities of the subcomponents, as well as the operational use cases, to prove that the defined data is 	

No	Name	Description	Final recommendations	Status
		relevant CCS interfaces, including CCS-TMS.	<p>necessary and to ensure that no data is missing or redundant. This will assure consistency and compatibility across all relevant interfaces.</p> <ul style="list-style-type: none"> Here are some additional recommendations: <ul style="list-style-type: none"> Monitor the design phases of PES and ETPS closely and ensure that updates to the Data Model are aligned with these developments. Continue integrating the Data Model with ongoing demonstrators, ensure comprehensive testing and focus on integrating with all systems. Evaluate using the Data Model for new product development. Evaluate how the consistency of data evolution will be maintained. Focus on the benefits of using the Data Model in new products or demonstrators to improve the definition of objects towards the SERA architecture 	
3	Cybersecurity Requirements	Cybersecurity consists of a complete set of cybersecurity requirements for railway CCS applications (and beyond), fully based on industry standards.	<ul style="list-style-type: none"> It is highly recommended to apply the EU-Rail Security Specifications as published 04/2025 for every new system/component development and tender. Early adoption of these specifications will fulfil the European and into national law transposed NIS-2 (European Common Level Cybersecurity) and CRA (Cyber Resilience Act) already to be fulfilled by EU law. 	
4	Object Controllers SCI	The standardised EULYNX interfaces SCI for process data information between IXL and Trackside Assets Object Controllers within legacy EULYNX System architecture (i.e. as such part of the SERA Pre-phase) and within future SERA System architecture.	<ul style="list-style-type: none"> It is recommended to use EULYNX SCI It is a must to use Baseline 4 Release 4 of the EULYNX specifications, because they are considered as stable 	
5			<ul style="list-style-type: none"> It is recommended to use EULYNX SDI 	

No	Name	Description	Final recommendations	Status
	Object Controllers SDI	The standardised EULYNX interfaces of Tracksides Assets Object Controllers within legacy EULYNX System architecture (i.e. as such part of the SERA Pre-phase): - for diagnostics (SDI) to enable communication with the service functions Diagnostics collector (part of MDM) and within future SERA System architecture.	<ul style="list-style-type: none"> It is a must to use Baseline 4 Release 4 of the EULYNX specifications, because they are considered as stable 	
6	Object Controllers SMI	The standardised EULYNX interfaces of Tracksides Assets Object Controllers within legacy EULYNX System architecture (i.e. as such part of the SERA Pre-phase): - for maintenance (SMI) to enable communication with the service function loading procedure (part of MDM).	<ul style="list-style-type: none"> It might be beneficial to use EULYNX SMI for object controllers - in projects which are setup according to the EULYNX System architecture in the SERA pre-phase -until SMI SP Standard interface specifications (prepared by Transversal) are available Reason: parts of existing SMI content are incorporated in the SMI SP Standard interface specifications (see SPT2TRAFFIC-12260 - Traffic CS SDI/SMI), which means: <ul style="list-style-type: none"> SMI: extended functionality with configuration management (version SMIv3) enables future (remote) updates in the SERA Architecture. Nevertheless, benefit of early usage of OC's with EULYNX SMI depends on their upgradeability to the future SMI SP Standard interface, leading to protection of investment EULYNX SMIv2 is an option to allow later an update to the SP standard interface 	
7	Traffic CS SDI/ SMI	The Transversal CCS (TCCS) domain handles the Diagnostic and Configuration functions for the SERA Architecture. For this, the necessary functional scope will be	<ul style="list-style-type: none"> SP has decided to use Transversal SDI/SMI in the full SERA context, adaption that needs to be made is under development in the Transversal CCS domain. It is recommended to make use of the Traffic CS SDI/SMI SP Standard interface specifications as soon as they are available, because they fit to the SERA Architecture. the early rollout of these interfaces in the SERA Pre-phase would require as well the 	

No	Name	Description	Final recommendations	Status
		adjusted and transferred by TCCS into SDI/SMI SP Standard interfaces, to be used by all SP Subsystems in a harmonised way (e.g., ATO-TS, ETPS and PES). Where possible TCCS will make use of SDI/SMI Content in existing EULYNX Specifications for transfer into SDI/SMI SP Standard interface specifications according to SERA Needs.	<p>provision of the corresponding SERA conform central services for diagnosis, maintenance incl. configuration management</p> <ul style="list-style-type: none"> • beside connection to OC's via SDI and SMI, these central services can be used in future for connectivity of all SERA subsystems via SDI/SMI (i.e. protection of investment) 	
8	Computing Environment Specifications	Specifications for a generic Computing Environment/Architecture both for trackside and onboard applications (independent of specific applications for IXL, RBC etc.). Assuming having a modular architecture based on harmonised interfaces to be specified.	<ul style="list-style-type: none"> • The use of the Computing Environment specifications is already beneficial in the SERA pre-phase area as soon as mature and tested specifications are available • The specifications are independent of other probably longer taking developments in the System Pillar (e.g. could be used already before mature specifications of PES or ETPS are available) • The final recommendation on Computing Environment Specifications shall be postponed until specifications for the interfaces I1, I2 and I3 are available (probably end of 2025/beginning of 2026) • The current modular Traffic CS design and system architecture support a later deployment in the Computing Environment. Further impacts on the Traffic CS design - especially on application level - are currently not predictable. 	

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