RCA

Reference CCS Architecture

An initiative of the ERTMS users group and the EULYNX consortium

Concept: SCI-CMD

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1 Preamble

1.1 Release Information

Basic document information:

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1.3 Disclaimer

No disclaimer defined.

1.4 Purpose

See chapter 'Introduction'.

2 Version history

Version	Date	Author	Description
1.0	2022-09-30	Frank Schiffmann	First published version for RCA BL1 R0

3 Introduction

3.1 Purpose

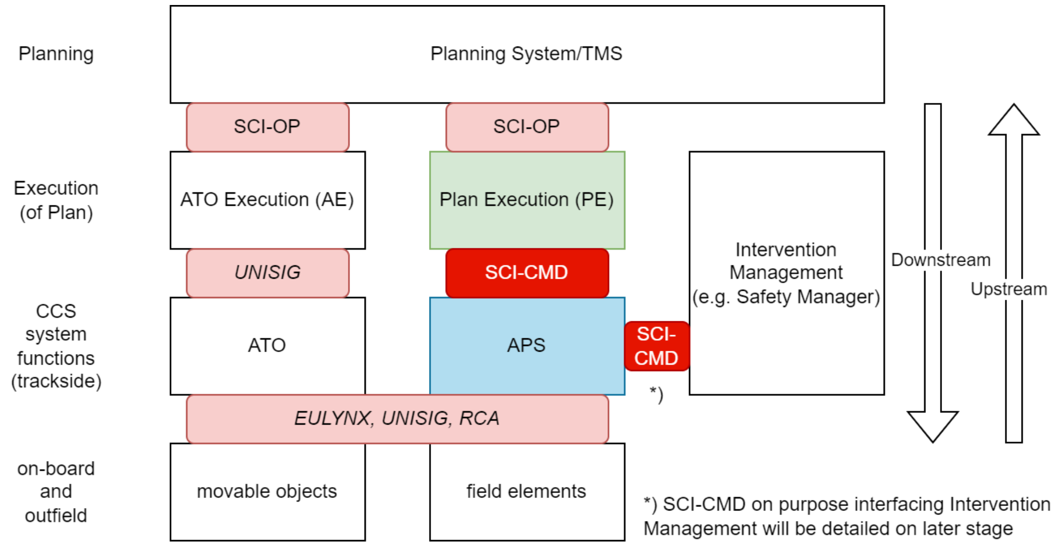
The Standard Communication Interface Command (SCI-CMD) interfaces the RCA subsystems Plan Execution (PE) and Advanced Protection System (APS) for exchange of commands and required states derived from the operational plan of the (national) Centralised Traffic Management Systems (named as Planning System - PAS - in RCA) and the current information present in the APS. It is under the responsibility of RCA concerning development including the coverage of safety targets. In APS the building block Safety Logic (SL) is the curent interface partner, considering the architecture of RCA and its abstraction levels.

The SCI-CMD will be developed as a bi-directional interface up to a FFFIS in the future. At this early stage it is a draft summary with potential data flows as downstream (PE >> SL) and upstream (SL >> PE) based on current definitions in RCA.

The SCI-CMD is foreseen for exchange of *Operational Data*.

In addition, this interface can be used for other interfacing partners like subsystems for Intervention Management (incident handling) too. In general the interface will consider requests, commands and status exchange.

As a wider system view the SCI-CMD is embedded between the parts of PE and the APS as the major implementation use case. PE derives the operational plan from the Planning System transmitted via SCI-OP. PE forms the needed request on downstream to APS. In addition the upstream from APS to PE via SCI-CMD considers any needed information for the operating state. In addition to this part, the function for Automatic Train Operation (ATO) is present with the transformation of the operational plan transmitted via SCI-OP into specific data objects on the interfaces based on Interface definitions handled by UNISIG.



Based on the architecture and the system approach, the data objects implemented in SCI-CMD for down- and upstream have a relation to the definition in SCI-OP.

The definition of interfaces and the architetural development follows some design principles defined in the documents describing the overall system and the specific system behaviour in the various parts and layer of the architecture of RCA including the interfaces to other parts of the rail system. A general principle used is the *Abstraction*. The abstraction and aggregation of data between real-world objects and their representation leads to design descision respected by this interface specification too.

This document explains therefore also the interplay between the different documents of the RCA baseline set as well the interconnection between the elements exchanged in down- and upstream as a description of the main working principles.

3.2 References

Id	Document
RCA.Doc. 14	RCA Terms and Abstract Concepts
RCA.Doc. 31	Concept Standard Communication Interface Operational Plan (SCI-OP)
RCA.Doc. 47	Concept Plan Execution
RCA.Doc. 51	APS Concept
RCA.Doc. 61	APS Concept Operating state
RCA.Doc. 62	APS Concept Route setting and route protection
RCA.Doc. 63	APS Concept Movement Permission
RCA.Doc. 67	APS Concept Movable Object
RCA.Doc. 75	Position paper Comparison and matching proposal of APS-SM (RCA) and IPM-ERM (DBS)
RCA.Doc. 79	Postion Paper Level Crossings

4 Viewpoint interface between operational and signalling level, current solutions

4.1 Problem description

4.1.1 High level functionality

The interface under consideration is an interface between operational and signalling level in Command-Control and Signalling (CCS) applications. It follows the required functionalities on both parts involved. Data concerning operational request for securing of train movements in downstream and the feedback on the current operational state in upstream are the main issues.

4.1.2 Current solution

Besides the target solution, signalling application covers one or more interfaces between the specific operational level e.g. in Traffic Management System (TMS) and the signalling level covered by various types of interlocking. Additional functions like automatic route setting are covered by the interfaces as-well. In the most applications several interfaces work in parallel and a clear split between operational and signalling level is not present, due to a mixture of operational and safety functions in the various applications. A reason for this fact is the stepwise adding of further systems towards existing systems with no clear architecture from the early start of system design. This is a general issue of developed systems in the past with a single view on the new application and not on the impact of the full railway system. The most commen current solution are specific from system manufactors formed according the needs of the various Infrastructure Managers.

Nearby these propriate solutions defined by several manufactures an interface is defined within EULYNX - the Standard Communication Interface Command & Control (SCI-CC). This interface is foreseen for the exchange between operational and signalling level.

But the SCI-CC is designed under the current system premisses and working principales of interlocking and not strictly designed on variants of CCS architectures. There was no full functional defintion in EULYNX present. This is made by each Infrastructure Manager leading to different generic applications in the field.

4.1.3 Problems with current solution

Current solution of interfaces as SCI-CC (includung predecessors) and their functions follow fixed coded **principles** concerning the real world objects instead of using abstraction principles. Therefore is a strong need of effort in case of changes. The missing abstraction principle leads to change process also in kind of minor changes in application. This is not a problem derived from interface itself, but from the missing overall architectural approach enable easy changes.

In addition, the interfaces and the functions are specified with missing overall approach as a historical stepwise increment. Thus it is more a summary of suboptimal solutions instead of a basket of choices based on a modular architecture. This is also valid for current EULYNX activities in signalling domain for interlocking and interfacing national Traffic Management Systems (TMSs) based on a wide varity of national implementation and interpretation of operation.

Any solution is IM- or country-specific and not easy exchangable or upgradeable. The market and as well the capacities of the industry are limited.

Fundamental reason can be found in the problem of missing overall standardisation in general in the rail sector. Other standards like ETCS are at some points hard coded to national needs, based on the not standardised environement of introduction and less commitment to real fundamental changes. Interfaces between train control standard, interlocking (not unified from function) and TMS are not well defined in all cases. Many implementation coveres specific workaround leading to a wide chain of different inhomogen applications.

5 Business targets, objectives and system requirements in RCA

5.1 Business targets and objectives

/RCA.Doc.53/ introduces specific objectives as detailing of the overall business targets of RCA. These are already coverd in /RCA.Doc.47/ and /RCA.Doc.51/ by system requirements as a definition of a minimal need to be considered on system development phase for PE and APS. Interfaces are specificly mentioned in both concepts. Thus no tracing against the objectives is needed for SCI-CMD.

5.2 System requirements

/RCA.Doc.47/ and /RCA.Doc.51/ introduces already system requirements to be covered by PE and APS in general. In chapter **Appendix - tracing of system requirements** the tracing is shown.

6 Solution details

6.1 Relation to other concepts

Functional concepts are given in:

- /RCA.Doc.47/ for PE
- /RCA.Doc.51/ for APS

In addition /RCA.Doc.31/ covers the SCI-OP and uses as major in- and output definition forming an operational purposes for all underlaying parts in RCA like the subsystem PE, APS with its subsystems and ATO.

Based on the functional concepts, detailed concept will stepwise published per domain like PE and APS with a specific detailed view on specific aspects like handling a Movement Permission. For APS the following detailed concepts are available and serve as input for the definition of the present SCI-CMD:

<table>
<tr><th>Id</th><th>Purpose</th><th>Main input</th></tr>
<tr><td>RCA.Doc.61</td><td>Definition of Operating state</td><td>• infrastructure elements (Field Elements) representation by abstract objects, e.g. point represented by the abstract object DPS
• Movable Objects, e.g. trackbound MOB as representation of a train
• Control objects, e.g. MP</td></tr>
<tr><td>RCA.Doc.62</td><td rowspan="3">Description of functionality and operational usage</td><td>• set Field Element, focus on DPS with abstraction 'point'
• Flank Protection</td></tr>
<tr><td>RCA.Doc.63</td><td>• Movement Permission</td></tr>
<tr><td>RCA.Doc.67</td><td>• Movable Object</td></tr>
<tr><td>RCA.Doc.79</td><td>Position paper</td><td>• Level Crossing</td></tr>
</table>

Within these documents the links to data exchange objects and the specific content are given.

In addition, to named functionalties in the detailed concepts where exchange objects for are SCI-CMD are given and their usage is explained, placeholders for exchange objects for further potential functions are introduced. There is no full parent functionality in the documents concerning these placeholders and no full specific definition of the data content yet present and possible. The idea of the placeholder is to express the potential wide picture. These placeholders are marked accordingly.

Due to the fact that the detailed concepts do not cover all potential/relevant system functions in APS, the current description in the following chapters is not complete. For example functions for blocking a DPS enabling maintenance works at a point are not yet given.

6.2 Domain objects and exchange objectes

Domain objects of APS are defined in /RCA.Doc.61/. From system context the objects of the operational plan and the operating state for interface towards a TMS are mentioned in /RCA.Doc.31/.

For enabling a cross-reference the domain objects in APS are traced against the objects in /RCA.Doc.31/. The following table is expanded by a reference to the already covered exchange objects (messages) in down- and upstream in the current definition of the SCI-CMD.

Domain object APS		**SCI-OP reference**		**SCI-CMD coverage**		**Remark**
Category	**Name**	**Operational Plan (Downstream)**	**Operating State (Upstream)**	**Downstream**	**Upstream**	
Infrastructure Objects	Drive Protection Section	Operational Plan Execution Request	Field Element State	yes	yes	this is the drivability information
	Drive Protection Section Group	Operational Plan Execution Request	Field Element State	yes	yes	this is the availability information
Movable Object	Non-Trackbound Movable Object (nMOB)	no	no	no	no	no handling is yet given, stakeholder need of presenting information in PE or PAS, e,g. for securing overlook of construction workers in the field, must be checked on later stage
	Trackbound Movable Object (tMOB)	- *)	Track Allocation	see uMOB and rMOB	see uMOB and rMOB	
	Unresolved Trackbound Movable Object (uMOB)	- *)	Track Allocation	no	yes	
	Resolved Trackbound Movable Object (rMOB)	- *)	Track Allocation Train Unit Report	no	yes	
Control Objects	Movement Permission (MP)	Operational Plan Execution Request	Track Allocation	yes	yes	

Domain object APS		SCI-OP reference		SCI-CMD coverage		Remark
Category	Name	Operational Plan (Downstream)	Operating State (Upstream)	Downstream	Upstream	
	Usage Restriction Area (URA)	Operational Plan Execution Request	Operational Restriction Area	no	no	
	Warning Area (WA)	Operational Plan Execution Request	Operational Warning Measure Area	no	no	

**) the handling of manual change of objects e.g. release in case of degraded situations is not yet given in SCI-OP.*

The downstream and upsteram is detailed per direction in the next sections.

6.3 Downstream

The following table compromises the downstrem in SCI-CMD. In case the specific message is already mentioned, a link towards the concept is given. If there is already a functional exchange described, the From (as source) and the To (as receiver) of the information is explicitly given. This principal applies for the upstream in the next chapter too.

Messages						
Name	Description	From	To	Parameter:Type	Concept	Remark
DpsBlockAgainstDeactivation	Request the block against automatic deactivation of a DPS within a DPS group.	PE	SL	• DpsGroupId:UUID • DpsId:UUID	RCA.Doc.79	only used in terms of Level Crossing at the moment
DpsReleaseBlockAgainstDeactivation	Request the release of block against automatic deactivation of a DPS within a DPS group.	PE	SL	• DpsGroupId:UUID • DpsId:UUID	RCA.Doc.79	only used in terms of Level Crossing at the moment

Messages						
Name	**Description**	**From**	**To**	**Parameter:Type**	**Concept**	**Remark**

DpsGroupRequest	Request the setting of a single field element by its abstraction to a *DPS group*. It is needed to supply the states of all *drive protection sections* within the group with their requested state.	PE	SL	• DpsGroupId:UUID
				• set of pairs
				    • DpsId:UUID
				    • DpsDrivability:DpsDrivabilityType
					RCA.Doc.62	

MPRequest	Request an inital Movement Permission.	PE	SL	• rMobId:UUID • MpRequestId:UUID • MPExtent:LinearContigousTrackArea • RiskBuffer:LinearContigousTrackArea • vOperationalProfile:SpeedProfile • safetyResponsibilityProfile • MovementMode:MovementModeClassProfile • RiskPath:ContigousTrackArea (0..n)	RCA.Doc.63	

Messages						
Name	Description	From	To	Parameter:Type	Concept	Remark
MPExtendRequest	Request an extension of a already present Movement Permission.	PE	SL	• MpId:UUID • MPExtent:LinearContigousTrackArea • RiskBuffer:LinearContigousTrackArea • vOperationalProfile:SpeedProfile • safetyResponsibilityProfile • MovementMode:MovementModeClassProfile • RiskPath:ContigousTrackArea (0..n)	RCA.Doc.63	the request for the extend must name the MpId for indentification
UraCreateRequest				• *UraId* • *UraExtent: TrackArea* • *Q_Demand: 0* • *UraType: to be defined, e. g. TemporarySpeedRestriction* • *UraContent: according to UraType, e. g. V_Max=80*		placeholder only
UraRemoveRequest				• *UraId*		placeholder only

Messages						
Name	Description	From	To	Parameter:Type	Concept	Remark
UraCreateDemand				• *UraId* • *UraExtent: TrackArea* • *Q_Demand: 0* • *UraType: to be defined , e. g. TemporarySpeedRestriction* • *UraContent: according to UraType, e. g. V_Max=80*		placeholder only

In general, the SCI-CMD will be used, by a sequencial approach on specific data exchange for requests in downstream. This means in case a request is sent, no similiar request for the same objects will be sent, before a feedback in upstream is sent to requesting subsystem. This principle must be considered in system development of the interfaced systems besides specific exceptions.

6.4 Upstream

Messages						
Name	Description	From	To	Parameter:Type	Concept	Remark

DpsDeactivationState	Reports the state of active or deactive function block against automatic deactivation of (a) DPS within a DPS group.	SL	PE	• DpsGroupId:UUID
				• set of several
				    • DpsId:UUID
				    • BlockDeactivationState:Function
					RCA.Doc.79	only used in terms of Level Crossing at the moment

Messages						
Name	**Description**	**From**	**To**	**Parameter:Type**	**Concept**	**Remark**

DpsGroupUpdatedEvent	Reports the state changes of the *drive protection sections* in a a *DPS group* and the state of the *DPS group itself*. It is an asynchronous message which is either related to a previous DpsGroupRequest or any other event that changed the drivability of a *DPS group* (e.g. trailed point).	SL	PE	• DpsGroupId:UUID
				• DpsGroupState:DpsGroupStateType
				• set of pairs
				    • DpsId:UUID
				    • DpsDrivability:DpsDrivabilityType
					RCA.Doc. 62	in terms of Level Crossing term "pairs" shall be assumed as "several" 1..n

DpsGroupOfftimeExpiration	Notification on expiration of the set offtime of a DPS group.	SL	PE	• DpsGroupId:UUID	RCA.Doc. 79	only used in terms of Level Crossing at the moment

Messages						
Name	**Description**	**From**	**To**	**Parameter:Type**	**Concept**	**Remark**
DpsRequestRejectedEvent	Sent if the authorisation to change the DPS drivability cannot be granted.	SL	PE	• *Depending on DPSGroupRequest RejectCode:* DpsId:UUID *or* DpsGroupId:UUID • reason:DPSGroupRequestRejectCode	RCA.Doc.62	

MPCreateEvent	Reports the Movement Permission after succesful granting in terms of inital granting.	SL	PE	• rMobId:UUID
				• MpRequestId:UUID
				• Movement Permission
				  • MpId:UUID
				  • MPExtent:LinearContigousTrackArea
				  • RiskBufferExtent:LinearContigousTrackArea
				  • vOperationalProfile:SpeedProfile
				  • safetyResponsibilityProfile
				    • MovementMode:MovementModeClassProfile
					RCA.Doc.63	

MPRequestRejectEvent	Reports the rejection of a Movement Permission Request with the relevant Reject Code for enabling an operational desicion.	SL	PE	• MpRequestId:UUID • reason:MPRequestRejectCode	RCA.Doc.63	

Messages						
Name	**Description**	**From**	**To**	**Parameter:Type**	**Concept**	**Remark**

MPUpdatedEvent	Reports the Movement Permission after succesful extension of a already granted Movement Permission.	SL	PE	• rMobId:UUID
				• Movement Permission
				    • MpId:UUID
				    • MPExtent:LinearContigousTrackArea
				    • RiskBufferExtent:LinearContigousTrackArea
				    • vOperationalProfile:SpeedProfile
				    • safetyResponsibilityProfile
				        • MovementMode:MovementModeClassProfile
					RCA.Doc.63	

MPRemovalEvent	Reports the Removal of a Movement Permission including the reason.	SL	PE	• rMobId:UUID • MpId:UUID • reason:RemovalCodeMP	RCA.Doc.63	

Messages						
Name	**Description**	**From**	**To**	**Parameter:Type**	**Concept**	**Remark**

uMobCreatedEvent				• *uMob*
				  • *uMobID:UUID*
				  • *uMobDomainID:UUID*
				  • *uMobState:UState*
				  • *uMobExtent: ContiguousTrackArea*
						placeholder only
						takover of attributes of RCA.Doc. 67; no specific data exchange derived yet

uMobRemovedEvent				• *uMobId:UUID*		placeholder only takover of attributes of RCA.Doc. 67; no specific data exchange derived yet

Messages						
Name	**Description**	**From**	**To**	**Parameter:Type**	**Concept**	**Remark**

rMobCreatedEvent				• *rMOB*
				  • *rMobID:UUID*
				  • *rMobDomainID:UUID*
				  • *rMobState:RStates*
						placeholder only
						takover of attributes of RCA.Doc. 67; no specific data exchange derived yet

Messages						
Name	**Description**	**From**	**To**	**Parameter:Type**	**Concept**	**Remark**

rMobUpdatedEvent				• *rMOB*
				    • *rMobId:UUID*
				    • *rMobDomainID:UUID*
				    • *rMobState:RStates*
				    • *rMobExtent: ContiguousTrackArea*
				    • *rMobDirection:Direction*
				    • *rMobSpeed:Speed*
						placeholder only
						takover of attributes of RCA.Doc. 67; no specific data exchange derived yet
						rMobExtent could be needed in value == 0 too, this mut be enabled by the data model

Messages						
Name	**Description**	**From**	**To**	**Parameter:Type**	**Concept**	**Remark**
rMobRemovedEvent				• *rMobID:UUID*		placeholder only takover of attributes of RCA.Doc. 67; no specific data exchange derived yet

UraCreateDemandRejectEvent				• *UraId*
				• *RejectCode:*
				    • *URA_SYNTAX*
				    • *URA_ALREADY_EXISTS*
				    • *URA_TRACKAREA*
						placeholder only

UraCreateEvent				• *UraID:UUID* • *all data describing URA with UraID*		placeholder only

Messages						
Name	**Description**	**From**	**To**	**Parameter:Type**	**Concept**	**Remark**

UraCreateRequestRejectEvent				• *UraID:UUID*
				• *RejectCode:*
				    • *URA_SYNTAX*
				    • *URA_ALREADY_EXISTS*
				    • *URA_TRACKAREA*
				    • *URA_<SPECIFIC_CONFLICT>*
						placeholder only

UraRemoveEvent				• *UraID:UUID*		placeholder only

UraRemoveRequestReject				• *UraId*
				• *RejectCode:*
				    • *UNKNOWN_SENDER*
				    • *URA_SYNTAX*
				    • *URA_<SPECIFIC_CONFLICT>*
						placeholder only

6.5 Parameters

The explicite parameters including a structure of the needed Databits and additional parameters for describing headers and check data fields for Downstream and Upstream will be defined at later stage.

6.6 Data types

The data types including the possible values in Downstream and Upstream are listed in the following table:

Types			
Name	**Values and specific content**	**Concept**	**Remark**
ContigousTrackArea	specialised class of Track Area to group a number of Track Edge Sections, see /RCA.Doc.14/	RCA.Doc.63	
Direction	• UP: with topological orientation • DOWN: against topological orientation	RCA.Doc.63 RCA.Doc.67	
DpsDrivabilityType	• NONE: Safe drivabiliy is not given (discontinuity of track) • LIMITED: Driveable with limitations. • FEASIBILITY_CHECKED: Driveable without any limitation. • FULL: Driveable without any limitation.	RCA.Doc.62 RCA.Doc.79	LIMITED and FEASIBILITY_CHECKED only used in terms of Level Crossing at the moment, see RCA.Doc.79
DPSGroupStateType	• READY: This Group State indicates, that the switchable 'fieldElement' is undefined has a defined state and is functioning. • PROCESSING: This Group State indicates an ongoing processing of information, while the switchable 'fieldElement' is undefined does not reach the required state yet. Note: This Group State can be used, but there is no must. • DISTURBED: This Group State indicates any failure of the DPS Group. The full functionality is not given. Example: A point does not reach its requested end position after timeout (compare Timeout scenario below)	RCA.Doc.62 RCA.Doc.79	

Types			
Function	• ACTIVE: The associated functions is switched on • INACTIVE: The associated function is switched off	RCA.Doc. 62	only used in terms of Level Crossing at the moment
LinearContigousTrackArea	specialised class of Track Area to group an ordered and directional number of topologically connected Track Edge Sections, see /RCA.Doc.14/	RCA.Doc. 63	
MovementModeClassProfile	Linear profile of Classes (1..n): • FULL_SUPERVISION: Highest supervision type of Train Control System	RCA.Doc. 63	there are no different kinds of modes for different safety level defined yet

Types			
DPSGroupRequestRejectCode	• UNKNOWN_DPS: The Drive Protection Section is unknown to APS, e.g. checked-out. • UNKNOWN_DPSGROUP: The Drive Protection Section Group is unknown to APS. • DPS_OCCUPIED: The Drive Protection Section is occupied and not switchable. • DPS_SECURING_RISKPATH: Any of the Drive Protection Sections in the drive protection section group is with the protecting element of a risk path and not switchable. • DPS_GROUP_DISTURBED: The Drive Protection Section Group is disturbed. • DPS_SYNTAX: The DpsGroupRequest is not conform to the syntax definition. • DPS_IN_MP_EXTENT: The DpsExtent of at least one DPS provided by the Topology, which has the same DpsGroup as the requested in the DpsGroupRequest overlaps any MpExtent. • DPS_IN_RISK_BUFFER: The Drive Protection Section Group is in conflict with any Risk Buffer. • DPS_NETWORK_FAILURE: Network issues from Point of view of APS-FOT • DPS_STATE_CONFLICT: The requested DPS states are in conflict to each other from point of view of APS-FOT (e.g. single point FULL/FULL).	RCA.Doc.62	

MPRequestRejectCode	used in concept already: • SYNTAX: The requested MP does have syntax faults. • INCONSISTENT_WITH_MOB: The requested MP does not correlated with the MOB mentioned. • INVALID_TOPOLOGY: The requested MP covers parts not given on current topological data. • PATH_OCCUPIED: Parts of the requested MP extent are occupied. • RISK_BUFFER_PATH_OCCUPIED: Parts of the requested Risk Buffer extent are occupied. • AS_OCCUPIED: Parts of the Allocation Sections in the requested MP are occupied. • EXTENT_CONFLICT: The requested MP extent is in conflict with another MP. • EXTENT_AS_CONFLICT: The requested MP extent is in conflict with Allocation Sectionss of another MP. • RISK_BUFFER_CONFLICT: The Risk Buffer of the requested MP is in conflict with another MP. • RISK_BUFFER_AS_CONFLICT: The Risk Buffer of the requested MP is in conflict with Allocation Sections of another MP. • RISK_BUFFER_TOO_SHORT: The Risk Buffer of the requested MP is too short. • SAFETY_RESPONSIBILITY_PROFILE_INVALID: The requested Safety Responsibility Profile does not match with the current conditions. • SPEED_PROFILE_VIOLATION: The requested Speed Profile does not match with the current conditions.	RCA.Doc.62 RCA.Doc.63	

Types			
MPRequestRejectCode	• RISK_PATH_OCCUPIED: Parts of the Risk Path in the requested MP are occupied. • RISK_PATH_CONFLICT: Risk Path of the requested MP is in conflict with another MP. • RISK_PATH_MISSING: Risk Path in requested MP are incomplete. • UNPROTECTED_RISKPATH: Risk Path of the requested MP does not got sufficient risk mitigiation measures for flank protection. • CHANGE_IN_EXTENSION: The present MP is not covered by the requested MP for extension. • RECALCULATE_IN_EXTENTION: The present MP of the requested MP extension differ in attributes. • UPGRADE_CONFLICT: The requested MP for upgrade an existing MP violates the safety conditions. • URA_SPEED_VIOLATION: The requested MP does not cover speed restrictions as temporarly active. • MOB_NOT_INTEGER: The search for a flank protection providing element terminated at the rear end of an MOB. However, the MOB is not integer. • PROHIBITION_ZONE_NOT_ACTIVE: The search for a flank protection providing element terminated at Prohibition Zone. However, the zone is not active. • SEARCH_LIMIT_REACHED: The search for a flank protection providing element did not terminate with the limits.	RCA.Doc.62 RCA.Doc.63	

Types			
MPRequestRejectCode	further placeholders are: • *DPS_DRIVABILITY_CONFLICT* • *MOB_SUITABILITY_FAILURE*	-	
RemovalCodeMP	• MP_REMOVAL_REQUESTED: The removal was requested by the operator. • MP_REMOVAL_FINISHED_MOVEMENT: The operational movement has been finished by the Train Driver or Automated Train Operation, indicated by a so-called End of Mission. • MP_REMOVAL_LEAVING_AOC: The movement was leaving the Area of Control (AoC).	RCA.Doc.63	

RState	• Identified: The unique identification of the corresponding real-world object is known to System RCA : System RCA. • Waiting for localisation: The session with the corresponding real-world object is established but it has not reported a valid and trustworthy position and can therefore not be safely located in the topology. • Waiting for readiness for Movement Permission: The corresponding real-world object is not yet ready to receive/ process an ETCS Movement Authority. • Ready for Movement Permission: The corresponding real-world object is localised, has sent train data and trackside has acknowledged this train data, i.e. the real-world object is ready to receive a Movement Permission. • Waiting for granting of a Movement Permission: The corresponding real-world object is ready to receive/process an ETCS Movement Authority but System RCA : System RCA has not yet granted a Movement Permission. • Waiting for Resolved Trackbound Movable Object to obey Movement Permission: A Movement Permission has been granted and the associated authorisation has been sent to the corresponding real-world object but the latter has not yet switched to a mode indicating that it obeys this authorisation. • Resolved Trackbound Movable Object obeys Movement Permission: The corresponding real-world object has reported a mode indicating to obey the granted authorisation. • Inactive: The corresponding real-world object has terminated the mission but the communication session still exists.	RCA.Doc.67	

Types			
Speed	value range: 0 ... 600 km/h	RCA.Doc.67	resolution: 5 km/h
SpeedProfile	Linear profile of speed (1..n) with: • value range: 0 ... 600 km/h	RCA.Doc.63	resolution: 5 km/h
UState	Not identified: The unique identification of the corresponding real-world object is not known to System RCA	RCA.Doc.67	states indication faulty situations not yet defined
UUID	None	RCA.Doc.62	

Note: The data type supports values out of ETCS capabilities (5 km/h resolution for speed values). However, as long as ETCS is used, the sender shall not use another resolution, otherwise the related request will fail.

6.7 RAMSS-related aspects

The interface SCI-CMD is placed between the (safe) signalling part APS and the operational part represented by PE. The interface and its further development must cover the RAMSS-related aspect from early beginning. RAMSS-related aspects include the coverage of safety and security goals, the enabling of achievement of RAM targets including performance and latency requirements. A further detailing of main required values will be made in a later step within a system concept according the CENELEC-development standard to by applied for RCA.

6.8 Configurability of behaviour

In general the SCI-CMD will not be a single version with a single data exchange. Different version following the evolution of PE, APS and its interfaced parts will be considered. This is implemented by specific data exchange fitting to a system version. Thus a system identifier is needed to be taken into consideration in system development. A X.Y-version handling shall be possible, to marke main baselines - not fully compatible with each other but also lower version been compliant in basic functionality. This principle is already known e.g. by ETCS in terms of system version 2.0 and 2.1 are compatible in basic functions but differing in optional parts. The exact handling must be detailed later.

In general each interface must be marked clear, enabling interface compatibility check at system integration and optional at runtime of the systems.

The exact behaviour per version will be configured by usage on both parts. This means the interfaces cover a set of possible down- and upstream information. If not all functions are implemented trackside in APS, there is no need to send the relevant requests by PE.

6.9 Migration

Migration in terms of RCA system must cover two fields of interest:

- the migration towards a RCA-compatible trackside application
- the migration of a RCA-compatible trackside application from one system version to a higher one

In respect of the first bullet point the role of SCI-CMD can be explained simply. In case of APS is installed, the data exchange towards the operational level must be done by SCI-CMD. Thus PE (or any other system that has fully implemented the SCI-CMD) must be present. For this migration purpose no specific changes on SCI-CMD and APS are required. PE can have additional functional parts, in case further installations on operational level are not yet migrated to a fully compliant solution.

In terms of the second bullet point an update of the SCI-CMD is needed if a higher system version of the RCA system requires a different interface behaviour. Thus each interface will have its own system version identifier for correct recognition of the capabilities. The handling of system version identifier is not new, because already part of the /TSI CCS/.

In case the specific trackside equipment changes, no changes in SCI-CMD are needed if these specific trackside equipment changes do not lead to new system functions. This means e.g. a migration from a TTD-oriented track occupancy abstraction towards a full train-orientated localisation does not need any changes. The first version of SCI-CMD will already cover this issue.

6.10 Open points

Nearby the given information on placeholders introduced some open points are highlited for understanding the current version. The following main items must be treated as open while reading:

- enlargement of interface to GoA4-related 'Safety Manager' according RCA architecture for handling commands instead of requests, see also /RCA.Doc.75/
- stepwise detailing of PE and APS leading to extension in the SCI-CMD, e.g. handling of Usage Restriction Areas and Warning Areas from inital scope
- feedback of specific ID of the element leading to a rejection of a request, e.g. the ID of the MOB not providing flank protection for a further movement
- real specification of the interface accoding a development standard covering the different layers needed too

7 Appendix

7.1 Tracing of objectives

The following table considers the objectives derived from /RCA.Doc.53/ refered to interface between PE and APS including a reference to the category of the system requirements traced in chapter **Tracing of system requirements** of this annex.

Objective	category for derived system requirements
A.P.M.@Consider open interfaces to integrate as much formats as possible	for APS: 'Standardised Interfaces' for PE: 'Standardisation, Automation, and Integration"
O-PE@Support clearly designed and robust interfaces for fully automated data exchange	'Standardisation, Automation, and Integration"
APS@The building blocks and their interfaces should have as little version dependency as possible	'Standardised Interfaces'
A.P.M.@Use interfaces with automatic adaptions and internal intelligence for interfacing different versions of building blocks without the need of upgrade existing building blocks based on change in interface	for APS: 'Automation' for PE: 'Standardisation, Automation, and Integration"
APS@Introduce generic capabilitiy-based interfaces O-PE@Introduce generic capabilitiy-based interfaces	for APS: 'Standardised Interfaces' for PE: 'Standardisation, Automation, and Integration"
APS@Develop and commission standard interfaces	'Standardised Interfaces'
APS@Support the AoC segment size of the interfaced Plan Exection	'Standardised Interfaces'
A.P.M.@Standardize all main CCS processes, functionalities and interfaces	for APS: 'Standardised Interfaces' for PE: 'Standardisation, Automation, and Integration"

Objective	category for derived system requirements
APS@Ensure functionality even in case of incomplete information due to limited functionality of interfaced components	'Standardised Interfaces'

7.2 Tracing of system requirements

The following table considers the system requirements derived in /RCA.Doc.47/ refered to interface between PE and APS and for /RCA.Doc.51/ in section "Standardised Interfaces" refering to the connection between PE and APS only.

Source	Category	System Requirement	Tracing of coverage
/RCA.Doc. 47/	Plan Execution	SubSys Plan Execution shall constantly monitor the current Operating State	Enabling of receiving information as upstream
		SubSys Plan Execution shall optimally trigger the requests to be sent to the SubSys Safety Logic via SCI-CMD to ensure the timely implementation of Operational Plans	Consideration of all relevant request in Downsream, not yet given due to limitation in focus
	Robustness	SubSys Plan Execution shall request Movement Permission with specific characteristics to cope with failures of Field Elements	not yet given due to limitation in focus
		SubSys Plan Execution shall request Movement Permission with specific characteristics to cope with degraded modes of field elements	not yet given due to limitation in focus
		SubSys Plan Execution shall request Movement Permission with specific characteristics to cope with temporary restrictions of the railway network	partly given by possibility of speed profile, not yet given for further restrictions due to limitation in focus
		SubSys Plan Execution shall request Movement Permission with specific characteristics to cope with Track Allocations of the railway network	not yet given due to limitation in focus
		SubSys Plan Execution shall request Movement Permission with specific characteristics to cope with failures of Physical Train Units	not yet given due to limitation in focus
		SubSys Plan Execution shall request Movement Permission with specific characteristics to cope with degraded modes of Physical Train Unit	not yet given due to limitation in focus
	Standardisation, Automation, and Integration	SubSys Plan Execution shall use standardised interfaces for communication with other (sub-)systems	covered by the definition of SCI-CMD

Source	Category	System Requirement	Tracing of coverage
		SubSys Plan Execution shall provide information on its interfaces in such a granularity and format that it is suitable for target systems consuming the information correctly and efficient	handled by stepwise definition of SCI-CMD involving all stakeholders
		SubSys Plan Execution shall provide generic capability-based interfaces	handled by stepwise definition of SCI-CMD involving all stakeholders issue of configurability in terms of clear version management
		SubSys Plan Execution shall support easy adaptable interface for avoiding manual data exchange efforts	issue of configurability
/RCA.Doc. 51/	Standardised Interfaces	All APS interfaces shall be defined with unambiguous semantics	covered by the definition of SCI-CMD
		All APS interfaces should be specified in an unambiguous, exact and testable way	covered by the definition of SCI-CMD
		APS shall provide information on its interfaces in such a granularity and format that it is suitable for target systems to consume the information correctly and efficiently	handled by stepwise definition of SCI-CMD involving all stakeholders
		Ensure clear layering for transport, marshalling and application model	issue of specification level, later
		APS shall be able to process information of varying quality on its interfaces	handled by abstraction principle and data aggregation, SCI-CMD forwards only the resulting information
		APS shall process localisation information from existing TTD systems	uMOB object
		APS shall not rely on the existence of localisation information from existing TTD systems to identify track occupancies	rMOB object
		All APS interfaces must provide multi version support	issue of configurability
		APS shall use a unified and generic representation of identified track occupancies, independent of the localisation technologies used	uMOB and rMOB object, extended by further nMOB in future

Source	Category	System Requirement	Tracing of coverage
		APS interface specification shall be detailed enough to enable a replacement of building blocks compliant to the same interface without further adaptations	covered by the definition of SCI-CMD, in addition an issue of configurability in terms of clear version management
		APS shall support the segmentation of MAP data from interfacing systems	issue of specification level, later AoC of APS == AoC of PE
	Automation	All APS interfaces must provide multi version support	
		APS shall support the automatic identification and recognition of different system configurations and versions during runtime	