



EULYNX Initiative



Europe's Rail Joint Undertaking

Interface definition SCI

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ID	Type	Requirement
Eu.SCI.6	Head	1 Introduction
Eu.SCI.7	Head	1.1 Release information
Eu.SCI.8	Info	[Eu.Doc.92] Interface definition SCI CENELEC Phase: 5 Version: 4.3 (1.A) Approval date: 02.06.2025
Eu.SCI.9	Info	Version history
Eu.SCI.245	Info	version number: 4.0 (0.A) date: 17.05.2022 author: Nico Hurman, package 4 working group review: CCB changes: EUAR-508, EUAR-526, EUAR-530
Eu.SCI.248	Info	version number: 4.1 (0.A) date: 31.03.2023 author: Nico Hurman review: changes: EUAR-545, EUAR-564, EUAR-571, EUAR-575
Eu.SCI.253	Info	version number: 4.1 (1.A) date: 10.05.2023 author: Nico Hurman review: cluster changes: EUAR-589
Eu.SCI.255	Info	version number: 4.2 (0.A) date: 27.06.2023 author: Nico Hurman review: TACS Mirror Group changes: EUAR-594, EUAR-610, EUAR-612, EUAR-613

ID	Type	Requirement
Eu.SCI.256	Info	version number: 4.2 (1.A) date: 29.04.2024 author: Nico Huurman review: changes: EUAR-681, EUAR-716
Eu.SCI.258	Info	version number: 4.3 (0.A) date: 19.06.2024 author: Nico Huurman review: TACS Mirror Group changes: EUAR-697, EUAR-740, EUAR-746, EUAR-751
Eu.SCI.259	Info	version number: 4.3 (1.A) date: 20.06.2025 author: Nico Huurman review: TACS Mirror Group changes: EUAR-766, EUAR-791, EUAR-802
Eu.SCI.11	Head	1.2 Impressum
Eu.SCI.12	Info	Publishers: Europe's Rail Joint Undertaking https://rail-research.europa.eu EULYNX Initiative https://eulynx.eu/
Eu.SCI.13	Info	Responsible for this document: EU-Rail System Pillar Trackside Assets Control and Supervision domain
Eu.SCI.14	Info	This document is drafted by and belongs to EU Rail. EU Rail encourages the distribution and re-use of this document, the technical specifications and the information it contains. EU Rail holds several intellectual property rights, such as copyright and trade mark rights, which need to be considered when this document is used. EU Rail authorizes you to re-publish, re-use, copy and store this document without changing it, provided that you indicate its source and include the following mention [EU Rail trade mark, title of the document, year of publication, version of document]. EU Rail makes no representation or warranty as to the accuracy or completeness of the information contained within these documents. EU Rail shall have no liability to any party as a result of the use of the information contained herein. EU Rail will have no liability whatsoever for any

ID	Type	Requirement
		indirect or consequential loss or damage, and any such liability is expressly excluded. You may study, research, implement, adapt, improve and otherwise use the information, the content and the models in this document for your own purposes. If you decide to publish or disclose any adapted, modified or improved version of this document, any amended implementation or derivative work, then you must indicate that you have modified this document, with a reference to the document name and the terms of use of this document. You may not use EU Rail's trade marks or name in any way that may state or suggest, directly or indirectly, that EU Rail is the author of your adaptations. EU Rail cannot be held responsible for your product, even if you have used this document and its content. It is your responsibility to verify the quality, completeness and the accuracy of the information you use, for your own purposes.
Eu.SCI.15	Head	1.3 Purpose
Eu.SCI.16	Info	This document defines the protocol stack of the standardised interface for safe communication between the Subsystem - Electronic Interlocking and EULYNX field element subsystems or adjacent systems (SCI-XX).
Eu.SCI.17	Info	This interface is designated as SCI-XX, where XX refers to the system type of the communication partner.
Eu.SCI.87	Info	This document contains the general requirements for transport, redundancy, safety and retransmission, and application layer specified for SCI-XX.
Eu.SCI.18	Info	This document is intended for the following users: <ul style="list-style-type: none"> • safety authorities • infrastructure managers • safety assessors • signalling system suppliers • validators
Eu.SCI.254	Info	This document is applicable for both the EU-Rail System Pillar target architecture and the EULYNX architecture. The document is delivered as a single specification fitting both the System Pillar documentation sets and the EULYNX documentation sets. EU-Rail System Pillar is the technical authority for this document.
Eu.SCI.19	Head	1.4 Applicable standards and regulations
Eu.SCI.90	Info	The applicable standards and regulations used in EULYNX are listed in the EULYNX Reference Document List [Eu.Doc.12].
Eu.SCI.20	Info	The references listed in the EULYNX Reference Document List [Eu.Doc.12] shall be considered where they are indicated as being applicable to SCI in the "Applies to" column of the EULYNX Reference Document List [Eu.Doc.12].
Eu.SCI.21	Head	1.5 Applicable documents
Eu.SCI.22	Info	The current versions of documents used as input or related to this document are listed in the EULYNX Documentation Plan [Eu.Doc.11]. The relationships between the documents are displayed in the Appendix A1 Documentation plan and structure [Eu.Doc.11_A1].

ID	Type	Requirement
Eu.SCI.23	Head	1.6 Appendices
Eu.SCI.24	Info	<i>- intentionally left blank -</i>
Eu.SCI.25	Head	1.7 Terms and abbreviations
Eu.SCI.26	Info	The terms and abbreviations are listed in the EULYNX Glossary [Eu.Doc.9].
Eu.SCI.27	Head	1.8 Variability management
Eu.SCI.28	Info	This document describes harmonised requirements. Variability management is not applicable. The specific applicability of requirements is captured in individual interface specifications.
Eu.SCI.29	Head	1.9 Definition of object types
Eu.SCI.30	Info	The following definition for object types is applied in this document:
Eu.SCI.31	Info	<ul style="list-style-type: none"> • "Req" - This denotes a mandatory requirement.
Eu.SCI.32	Info	<ul style="list-style-type: none"> • "Info" - This denotes additional information to help understand the specification. These objects do not specify any additional requirements.
Eu.SCI.33	Info	<ul style="list-style-type: none"> • "Head" - This denotes chapter headings.
Eu.SCI.34	Head	2 Interface definition SCI-XX
Eu.SCI.35	Info	SCI-XX is an interface based on telegrams and consists of a protocol stack according to Figure 1. In this document, requirements for transport, redundancy, safety and retransmission, and application layer (see yellow marked layers in Figure 1 below) are specified.

ID	Type	Requirement															
Eu.SCI.145	Info	<p>Figure 1: SCI-XX protocol stack (yellow layers)</p> <p>Variant 1 Variant 2</p> <table border="1"> <tr> <td>PDI</td> <td>PDI</td> <td>Application layer</td> </tr> <tr> <td>RaSTA</td> <td>RaSTA</td> <td>Safety/Retransmission and Redundancy layer</td> </tr> <tr> <td>UDP</td> <td>TLS over TCP</td> <td>Transport layer</td> </tr> <tr> <td>IP</td> <td>IP</td> <td>Network layer</td> </tr> <tr> <td>Ethernet</td> <td>Ethernet</td> <td>Data link and Physical layer</td> </tr> </table>	PDI	PDI	Application layer	RaSTA	RaSTA	Safety/Retransmission and Redundancy layer	UDP	TLS over TCP	Transport layer	IP	IP	Network layer	Ethernet	Ethernet	Data link and Physical layer
PDI	PDI	Application layer															
RaSTA	RaSTA	Safety/Retransmission and Redundancy layer															
UDP	TLS over TCP	Transport layer															
IP	IP	Network layer															
Ethernet	Ethernet	Data link and Physical layer															
Eu.SCI.37	Info	The SCI-XX interface application layer shall be designated as SCI-XX.PDI (PDI Process Data Interface protocol). It defines the telegrams to be exchanged between communication partners.															
Eu.SCI.38	Req	The safety, retransmission and redundancy layer (safe communication according to [EN 50159]) in SCI-XX shall be realised with the RaSTA protocol [RaSTA].															
Eu.SCI.39	Req	The transport layer in SCI-XX shall be realised as two variants. Both variants shall be supported.															
Eu.SCI.147	Req	In variant 1, the transport layer shall be realised with [UDP].															
Eu.SCI.148	Req	In variant 2, the transport layer shall be realised with [TLS] over [TCP]. Note: There is no variant using [TCP] without [TLS].															
Eu.SCI.149	Info	Which of the two variants is used in a concrete application is defined by configuration.															
Eu.SCI.40	Info	The lower layers (physical layer, data link layer and network layer) are defined by the Point of Service - Signalling, as defined in [Eu.Doc.100].															
Eu.SCI.41	Head	3 Protocol layers															
Eu.SCI.42	Head	3.1 SCI-XX Process Data Interface protocol															

ID	Type	Requirement
Eu.SCI.43	Req	The application layer uses the Process Data Interface protocol for communication between the Subsystem - Electronic Interlocking and EULYNX field element subsystem or adjacent systems as defined in the interface specification of the respective SCI-XX.
Eu.SCI.44	Req	After a disconnection (in the lower layers of the protocol stack), Subsystem - Electronic Interlocking and EULYNX field element subsystem or adjacent system shall attempt to re-establish communication within the time $T_{\max} \leq X \leq T_{\max} + 20\%$.
Eu.SCI.249	Head	3.1.1 Variable and byte order
Eu.SCI.250	Req	The encoding of telegrams defined for the Process Data Interface protocol shall respect the order of content variables as defined in the respective interface specification, starting with transmission of byte 00 and counting upwards.
Eu.SCI.257	Req	All data shall be transmitted in the little-endian format. Excluded from this rule are the data types string and byte array.
Eu.SCI.45	Head	3.2 RaSTA
Eu.SCI.46	Req	<p>For the application of the generic RaSTA protocol with SCI-XX, the following parameters shall be applied. For specific implementation projects, different values may be defined by national specifications.</p> <p>RaSTA consists of the Safety/Retransmission and Redundancy layers, the configuration parameters for each layer are defined separately.</p> <p>Note: These parameters have been derived from existing small scale implementations. They have to be proven by further operational experience on larger scales. Deviating values can be used for specific interfaces.</p> <p>Note: In future phases of the System Pillar, national specifications will be replaced by harmonised specifications.</p>
Eu.SCI.223	Info	For variant 1 of SCI-XX (UDP), there is 1 RaSTA configuration.
Eu.SCI.224	Info	<p>For variant 2 of SCI-XX (TLS/TCP), there are 3 RaSTA configuration profiles.</p> <ul style="list-style-type: none"> a. Reduced heartbeat profile b. Fast timeout profile c. Backwards compatibility profile
Eu.SCI.225	Req	Profile c. (backwards compatibility) shall be supported.
Eu.SCI.226	Info	Support for profiles a. (reduced heartbeat) and b. (fast timeout) is optional.
Eu.SCI.150	Info	Which of the three profiles is used in a concrete application is defined by configuration.
Eu.SCI.146	Head	3.2.1 RaSTA configuration for UDP
Eu.SCI.247	Info	<p>It is assumed that RaSTA parameters are related to T_{\max} according to the following formula:</p> $T_{\max} > 3 \cdot T_h + 2 \cdot (T_a + T_b) + T_{\text{seq}}$ <p>plus sufficient margin. (T_a and T_b are transmission times)</p>

ID	Type	Requirement
Eu.SCI.47	Head	3.2.1.1 Safety/Retransmission layer configuration
Eu.SCI.48	Head	3.2.1.1.1 T_{max}
Eu.SCI.49	Info	T _{max} is the maximum accepted age of a message.
Eu.SCI.50	Req	T _{max} = 1800 ms
Eu.SCI.51	Head	3.2.1.1.2 T_h
Eu.SCI.52	Info	T _h is the heartbeat interval.
Eu.SCI.53	Req	T _h = 300 ms
Eu.SCI.54	Head	3.2.1.1.3 Safety Code
Eu.SCI.56	Req	SafetyCode = option 2 (lower half of MD4) The initialisation value for MD4 is project specific.
Eu.SCI.57	Head	3.2.1.1.4 N_{sendmax}
Eu.SCI.58	Info	A communication partner shall not send more than N _{sendmax} messages without an acknowledgement received (ReceiveBufferSize). This value is exchanged among communication partners during initialisation and can be interpreted as receive buffer minimum size.
Eu.SCI.59	Req	N _{sendmax} = 20
Eu.SCI.60	Head	3.2.1.1.5 MWA
Eu.SCI.61	Info	A communication partner shall send an acknowledgement after receiving MWA messages (AcknowledgeWindow). MWA < N _{sendmax}
Eu.SCI.62	Req	MWA = 10
Eu.SCI.63	Head	3.2.1.1.6 N_{maxPaket}
Eu.SCI.64	Info	N _{maxPaket} determines, how many user messages may be combined to a single Safety/Retransmission layer packet.
Eu.SCI.65	Req	N _{maxPaket} = 1
Eu.SCI.66	Head	3.2.1.1.7 N_{diagWindow}
Eu.SCI.67	Info	N _{diagWindow} defines the channel quality measurement window.

ID	Type	Requirement
Eu.SCI.68	Info	The value of $N_{diagWindow}$ shall be defined by national specifications. The recommended default value is $N_{diagWindow} = 5000$ Note: In future phases of the System Pillar, national specifications will be replaced by harmonised specifications.
Eu.SCI.69	Head	3.2.1.2 Redundancy layer configuration
Eu.SCI.70	Head	3.2.1.2.1 Amount of physical channels
Eu.SCI.71	Info	Amount of channels used for communication in transport layer. One channel means no redundancy.
Eu.SCI.72	Req	Amount of physical channels = 2
Eu.SCI.73	Head	3.2.1.2.2 Check code
Eu.SCI.75	Req	Check code = option a (no check code)
Eu.SCI.76	Head	3.2.1.2.3 Tseq
Eu.SCI.77	Info	T_{seq} defines the amount of time a message, received off the channels sequence, is stored (DeferTime).
Eu.SCI.78	Req	$T_{seq} = 100$ ms
Eu.SCI.79	Head	3.2.1.2.4 NDiagnose
Eu.SCI.80	Info	$N_{Diagnose}$ defines the Redundancy layers diagnostic message window.
Eu.SCI.151	Info	The value of $N_{diagnose}$ shall be defined by national specifications. The recommended default value is $N_{Diagnose} = 200$ Note: In future phases of the System Pillar, national specifications will be replaced by harmonised specifications.
Eu.SCI.82	Head	3.2.1.2.5 NdeferQueueSize
Eu.SCI.83	Info	$N_{deferQueueSize}$ defines the maximum number of entries in the deferQueue.
Eu.SCI.84	Req	$N_{deferQueueSize} = 4$
Eu.SCI.152	Head	3.2.2 RaSTA configuration for TLS over TCP

ID	Type	Requirement
Eu.SCI.240	Info	<p>It is assumed that RaSTA parameters are related to T_{\max} according to the following formula:</p> $T_{\max} \geq T_a + T_b + 2 \times T_h + T_{\text{tcpre}}$ <p> $T_a, T_b = T_{\text{cpu}} + T_n$ T_{cpu}: processing time T_n: network latency T_{tcpre}: Time of retransmission on TCP layer </p>
Eu.SCI.153	Head	3.2.2.1 Safety/Retransmission layer configuration
Eu.SCI.154	Head	3.2.2.1.1 T_{\max}
Eu.SCI.155	Info	A message shall be received within T_{\max} after sending (MaxChannelDelay).
Eu.SCI.156	Info	Reduced heartbeat profile: $T_{\max} = 1800$ ms
Eu.SCI.227	Info	Fast timeout profile: $T_{\max} = 1000$ ms
Eu.SCI.241	Info	Eu.SCI.227 assumes: $T_h = 300$ ms, network latency $T_n = 50$ ms, processing time $T_{\text{cpu}} = 100$ ms and $T_{\text{tcpre}} = 100$ ms
Eu.SCI.242	Info	The value in Eu.SCI.227 will be validated and might be updated in a future release. The aim is reducing T_{\max} . The effects on SMI, SDI and SSI will be considered.
Eu.SCI.228	Req	Backwards compatibility profile: $T_{\max} = 1800$ ms
Eu.SCI.157	Head	3.2.2.1.2 T_h
Eu.SCI.158	Info	T_h is the heartbeat interval.
Eu.SCI.159	Info	Reduced heartbeat profile: $T_h = 600$ ms
Eu.SCI.243	Info	Eu.SCI.159 assumes: $T_{\max} = 1800$ ms, network latency $T_n = 50$ ms, processing time $T_{\text{cpu}} = 100$ ms and $T_{\text{tcpre}} = 300$ ms
Eu.SCI.244	Info	The value in Eu.SCI.159 will be validated and might be updated in a future release. The aim is processing load by reducing the heartbeat frequency. The effects on SMI, SDI and SSI will be considered.
Eu.SCI.229	Info	Fast timeout profile: $T_h = 300$ ms
Eu.SCI.230	Req	Backwards compatibility profile: $T_h = 300$ ms
Eu.SCI.160	Head	3.2.2.1.3 Safety Code

ID	Type	Requirement
Eu.SCI.161	Req	SafetyCode = option 2 (lower half of MD4) The initialisation value for MD4 is project specific.
Eu.SCI.162	Head	3.2.2.1.4 Nsendmax
Eu.SCI.163	Info	A communication partner shall not send more than N_{sendmax} messages without an acknowledgement received (ReceiveBufferSize). This value is exchanged among communication partners during initialisation and can be interpreted as receive buffer minimum size.
Eu.SCI.164	Req	$N_{\text{sendmax}} = 20$
Eu.SCI.165	Head	3.2.2.1.5 MWA
Eu.SCI.166	Info	A communication partner shall send an acknowledgement after receiving MWA messages (AcknowledgeWindow). $MWA < N_{\text{sendmax}}$
Eu.SCI.167	Req	$MWA = 10$
Eu.SCI.168	Head	3.2.2.1.6 NmaxPaket
Eu.SCI.169	Info	N_{maxPaket} determines, how many user messages may be combined to a single Safety/Retransmission layer packet.
Eu.SCI.170	Req	$N_{\text{maxPaket}} = 1$
Eu.SCI.171	Head	3.2.2.1.7 NdiagWindow
Eu.SCI.172	Info	$N_{\text{diagWindow}}$ defines the channel quality measurement window.
Eu.SCI.173	Info	The value of NdiagWindow shall be defined by national specifications. The recommended default value is $N_{\text{diagWindow}} = 5000$ Note: In future phases of the System Pillar, national specifications will be replaced by harmonised specifications.
Eu.SCI.174	Head	3.2.2.2 Redundancy layer configuration
Eu.SCI.175	Head	3.2.2.2.1 Amount of physical channels
Eu.SCI.176	Info	Amount of channels used for communication in transport layer. One channel means no redundancy.
Eu.SCI.177	Req	Amount of physical channels = 2
Eu.SCI.178	Head	3.2.2.2.2 Check code
Eu.SCI.179	Req	Check code = option a (no check code)

ID	Type	Requirement
Eu.SCI.180	Head	3.2.2.2.3 Tseq
Eu.SCI.181	Info	T _{seq} defines the amount of time a message, received off the channels sequence, is stored (DeferTime).
Eu.SCI.182	Info	Reduced heartbeat profile: T _{seq} = 50 ms
Eu.SCI.231	Info	Fast timeout profile: T _{seq} = 50 ms
Eu.SCI.232	Req	Backwards compatibility profile: T _{seq} = 100 ms
Eu.SCI.183	Head	3.2.2.2.4 NDiagnose
Eu.SCI.184	Info	N _{Diagnose} defines the Redundancy layers diagnose message window.
Eu.SCI.185	Info	The value of N _{diagnose} shall be defined by national specifications. The recommended default value is N _{diagnose} = 200 Note: In future phases of the System Pillar, national specifications will be replaced by harmonised specifications.
Eu.SCI.186	Head	3.2.2.2.5 NdeferQueueSize
Eu.SCI.187	Info	N _{deferQueueSize} defines the maximum number of entries in the deferQueue.
Eu.SCI.188	Req	N _{deferQueueSize} = 4
Eu.SCI.85	Head	3.3 UDP
Eu.SCI.86	Info	- <i>intentionally left blank</i> -
Eu.SCI.189	Head	3.4 TLS over TCP
Eu.SCI.190	Req	The transport layer in variant 2 is a secure transport layer, consisting of two sub-layers. The security layer shall be realised with TLS. The transport layer shall be realised with TCP.
Eu.SCI.191	Head	3.4.1 TLS
Eu.SCI.192	Info	The parameters for the security layer are defined in [SP-SEC-CommSpec].
Eu.SCI.193	Head	3.4.2 TCP
Eu.SCI.233	Info	The values of certain TCP parameters depends on the RaSTA configuration profile.

ID	Type	Requirement
Eu.SCI.194	Req	The following parameters shall be applied:
Eu.SCI.195	Head	3.4.2.1 Nagle Algorithm (tcp_nodelay)
Eu.SCI.196	Req	tcp_nodelay = true
Eu.SCI.197	Info	Explanation: The Nagle's algorithm is disabled to avoid buffering and combining multiple packets into one TCP-packet.
Eu.SCI.198	Head	3.4.2.2 TCP Fast Retransmit (tcp_quickack)
Eu.SCI.199	Req	tcp_quickack = on
Eu.SCI.200	Info	Explanation: To immediately acknowledge packets instead of waiting a bit to acknowledge multiple packets.
Eu.SCI.201	Head	3.4.2.3 Selective Acknowledge (tcp_sack)
Eu.SCI.202	Req	tcp_sack = enable
Eu.SCI.203	Info	Explanation: To reduce the number of retransmissions if multiple packets are lost.
Eu.SCI.207	Head	3.4.2.4 Linear timeouts (tcp_thin_linear_timeouts)
Eu.SCI.208	Req	tcp_thin_linear_timeouts = false
Eu.SCI.209	Info	Explanation: Usage of exponential backoff is useful but should be well controlled to avoid too large timeouts (controlled by proper RTO-values, see Eu.SCI.212).
Eu.SCI.210	Head	3.4.2.5 Buffers (tcp_cork)
Eu.SCI.211	Req	tcp_cork = off
Eu.SCI.246	Info	Explanation: tcp_cork parameter delays sending out partial frames.
Eu.SCI.212	Head	3.4.2.6 Retransmission timeout (tcp_rto_min, tcp_rto_max)
Eu.SCI.213	Info	Reduced heartbeat profile: tcp_rto_min = 50 ms
Eu.SCI.214	Info	Reduced heartbeat profile: Recommended value tcp_rto_max = 400 ms Note: The use of this value is optional, depending on the implementation.
Eu.SCI.215	Info	Reduced heartbeat profile: tcp_rto_init = 200 ms

ID	Type	Requirement
Eu.SCI.234	Info	Fast timeout profile: tcp_rto_min = 10 ms
Eu.SCI.235	Info	Fast timeout profile: Recommended value tcp_rto_max = 150 ms Note: The use of this value is optional, depending on the implementation.
Eu.SCI.236	Info	Fast timeout profile: tcp_rto_init = 200 ms
Eu.SCI.237	Req	Backwards compatibility profile: tcp_rto_min = 50 ms
Eu.SCI.238	Info	Backwards compatibility profile: Recommended value tcp_rto_max = 400 ms Note: The use of this value is optional, depending on the implementation.
Eu.SCI.239	Req	Backwards compatibility profile: tcp_rto_init = 200 ms
Eu.SCI.216	Info	Explanation: Retransmission Time Out (RTO) will dynamically adapt to the actual round-trip-time (network delay + processing time).
Eu.SCI.217	Head	3.4.2.7 RTT-accuracy (tcp_timestamp)
Eu.SCI.218	Req	tcp_timestamp = on
Eu.SCI.219	Info	Explanation: Use of TCP-timestamps according to RFC7323 for more accurate round-trip-time calculations.
Eu.SCI.220	Head	3.4.2.8 Number of retries (tcp_retries2)
Eu.SCI.221	Req	tcp_retries2 = 15
Eu.SCI.222	Info	Explanation: TCP-stack should keep trying to retransmit, in case of problems RaSTA will break the connection (the value 15 is the default for TCP). This value defines the time when TCP detects a connection loss based on effective Retransmission Time Out and is between tcp_retries2 * tcp_rto_min and tcp_retries2 * tcp_rto_max.