EU-RAIL SYSTEM PILLAR

Shared Cybersecurity Services Specification

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Shared Cybersecurity Services Specification

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Maintenance

After release, this document immediately enters the maintenance phase. Maintenance includes error corrections and general improvement of the document. Please send your change requests to the following email address: cybersecurity.review@ertms.be

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2 Preamble

2.1 Scope, Purpose and Intended Audience

, SP-SEC-Serv-2.1-1 - This specification defines the Standard Security Interfaces (SSI) to the Shared Cybersecurity Services (SCS) and recommends the interfaces from SCS to the Enterprise Cybersecurity Services (ECS) for the following services:

- **STS** - Secure Time Synchronisation
- **PKI** - Public Key Infrastructure
- **IAM** - Identity and Access Management
- **NAC** - Network Access Control
- **LOG** - Security Logging
- **UAS** - User Authentication Server
- **BKP** - Backup and Restore
- **MNT** - Security Maintenance
- **DNS** - Domain Name System

Note 1: "interface" in the context of this specification is used as a network-bound logical or virtual interface, implemented by software **[**SPPRAMSS-1498 **]**

, SP-SEC-Serv-2.1-2 - A Shared Cybersecurity Service provides common security functions used by Secure Components. **[**SPPRAMSS-8220 **]**

, SP-SEC-Serv-2.1-3 - The Shared Cybersecurity Services are used via the interfaces described in this document by Secure Components. The interfaces can support interoperability in the European rail domain. **[**SPPRAMSS-1497 **]**

, SP-SEC-Serv-2.1-4 - The interfaces described in this document are specified so that temporal unavailability (e.g. a few hours to days) has no direct impact on rail operation. **[**SPPRAMSS-7176 **]**

, SP-SEC-Serv-2.1-5 - For a definition of key terms, see Taxonomy and References. **[**SPPRAMSS-10317 **]**

, SP-SEC-Serv-2.1-6 - The currently referenced concepts include the currently necessary prerequisites for PQC in the rail domain. Further specification rely on the ongoing specification in the world of cryptography and will be included beginning in 2030 according to the timeline of these activities. **[**SPPRAMSS-18015 **]**

, SP-SEC-Serv-2.1-7 - The documents defining the use of standard security interfaces (e.g. TSI CCS, TSI ENE, TSI TELEM, etc.) specify the applicable requirements of this document by referring to the relevant chapters. **[**SPPRAMSS-18310 **]**

, SP-SEC-Serv-2.1-8 - This document is intended for authors of documents that reference SSIs in the rail domain (e.g. Subset specifications), as well as product developers, cybersecurity experts, system designers, and system architects. **[**SPPRAMSS-18309 **]**

2.2 Document Usage

, SP-SEC-Serv-2.2-1 - This specification uses identifiers starting with "SP-SEC-Serv". **[**SPPRAMSS-14106 **]**

, SP-SEC-Serv-2.2-2 - Icon types used in this document are defined in SP-SEC-Tax. **[**SPPRAMSS-13858 **]**

, SP-SEC-Serv-2.2-3 - In this document, requirements are specified from Chapter 4 onwards. **[**SPPRAMSS-18021 **]**

, SP-SEC-Serv-2.2-4 - For a definition of the words "shall", "should" and "may" used in this specification, refer to SP-SEC-Serv-2.3-2 - [ISO/IEC Directives, Part 2] . **[**SPPRAMSS-18561 **]**

2.3 References

, SP-SEC-Serv-2.3-1 - This chapter contains all references of this document. For a complete list including external references see SP-SEC-Tax Chapter 2 **[**SPPRAMSS-13828 **]**

[ISO/IEC Directives, Part 2]
Principles and rules for the structure and drafting of ISO and IEC documents

[IANA PENs]
Private Enterprise Numbers (PENs)

[IANA SMI PKIX EKU]
SMI Security for PKIX Extended Key Purpose

[OIDC 1.0]
OpenID Connect Core 1.0

[IEEE 802.1X-2020]
IEEE Standard for Local and Metropolitan Area Networks--Port-Based Network Access Control

[RFC 1952]
GZIP file format specification version 4.3

[RFC 2865]
Remote Authentication Dial In User Service (RADIUS)

[RFC 4086]
Randomness Requirements for Security

[RFC 4511]
Lightweight Directory Access Protocol (LDAP): The Protocol

[RFC 5280]
Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile

[RFC 5424]
The Syslog Protocol

[RFC 5425]
Transport Layer Security (TLS) Transport Mapping for Syslog

[RFC 5905]
Network Time Protocol Version 4: Protocol and Algorithms Specification

[RFC 7636]
Proof Key for Code Exchange by OAuth Public Clients

[RFC 7643]
System for Cross-domain Identity Management: Core Schema

[RFC 7644]
System for Cross-domain Identity Management: Protocol

[RFC 7858]
Specification for DNS over Transport Layer Security (TLS)

[RFC 8176]
Authentication Method Reference Values

[RFC 8446]
The Transport Layer Security (TLS) Protocol Version 1.3.

[RFC 8915]
Network Time Security for the Network Time Protocol

[RFC 8310]
Usage Profiles for DNS over TLS and DNS over DTLS

[RFC 9112]
HTTP/1.1

[RFC9113]
HTTP/2

[RFC 9150]
TLS 1.3 Authentication and Integrity-Only Cipher Suites

[RFC 9190]
EAP-TLS 1.3: Using the Extensible Authentication Protocol with TLS 1.3

[RFC 9364]
DNS Security Extensions (DNSSEC)

[RFC 9481]
Certificate Management Protocol (CMP) Algorithms

[RFC 9483]
Lightweight Certificate Management Protocol (CMP) Profile

[RFC 9662]
Updates to the Cipher Suites in Secure Syslog

[RFC 9809]
X.509 Certificate Extended Key Usage (EKU) for Automation

[SP-SEC-CommSpec]
Europe's Rail System Pillar Cybersecurity Domain - Secure Communication Specification, v1.1

[SP-SEC-Tax]
Europe's Rail System Pillar Cybersecurity Domain - Taxonomy and References, v1.1

[OPC UA-10000-6]
OPC 10000-6 (Release 1.05.07): UA Part 6: Mappings

2.4 Terms and Definitions

Secure Component
An implementation, as part of an automation control system, which comprises one or more host devices, embedded devices, network devices or software applications on host devices. A secure component realizes subsystem functions, implements security capabilities, consists of a physical encasing, computing capabilities and network communication, and interfaces to Shared Cybersecurity Services.
Examples of CCS secure components are object controller, trackside cabinet, IXL rack, ATO-OB, OBU, ATO-TS, IXL/RBC combination, shared cybersecurity services, security proxy for legacy devices, …)
Examples of components which are not meeting the definition of a Secure Component are components with no network communication, e.g. directly connected sensors or displays. [SPPRAMSS-1447]

Shared Cybersecurity Services
The Shared Cybersecurity Services are defined as a collection of central security functions which also implement the Standard Security Interfaces (SSIs). These interfaces are accessible for all Secure Components in the automation solution. The realization of the Shared Cybersecurity Services (SCS) are considered as Secure Components as well.

The interfaces from Secure Components to Shared Cybersecurity Service are identified by SSI-<service name>.

The Shared Cybersecurity Services implementations are identified by SCS-<service name>.
[SPPRAMSS-1446 **]**

Enterprise Cybersecurity Services
A collection of enterprise security interface (ESI) implementations of central security and IT communication functions in a back-office environment.
Examples are Security Incident and Event Management System (SIEM), Intrusion Detection System, PKI Certificate Authority, Corporate Directory, Asset Management. These services are typically accessible for the automation network via controlled communication paths (e.g. DMZ). The interfaces of the Shared Cybersecurity Services to the Enterprise Cybersecurity Services are identified by ESI-<service name>.
Note 1: Enterprise Cybersecurity Services are typically third-party components not dedicated to the rail environment. Therefore the realization of the Enterprise Cybersecurity Services may use other security requirements than the Secure Component Specification. Recommended security specifications are ISO 27033, ISO 27034, NIST 800-53 Rev 5, and/or IEC 62443-4-2/COR1:2022.
Note 2: Enterprise Cybersecurity Services and Shared Cybersecurity Services are separated by the IT/OT border (e.g. by a DMZ).
[SPPRAMSS-6720 **]**

2.5 Abbreviation list

All abbreviation are listed in [SP-SEC-Tax] document.

3 Introduction

The scope and boundary of this specification of the application of the Shared Cybersecurity Services are shown in the following high-level Cybersecurity architecture.

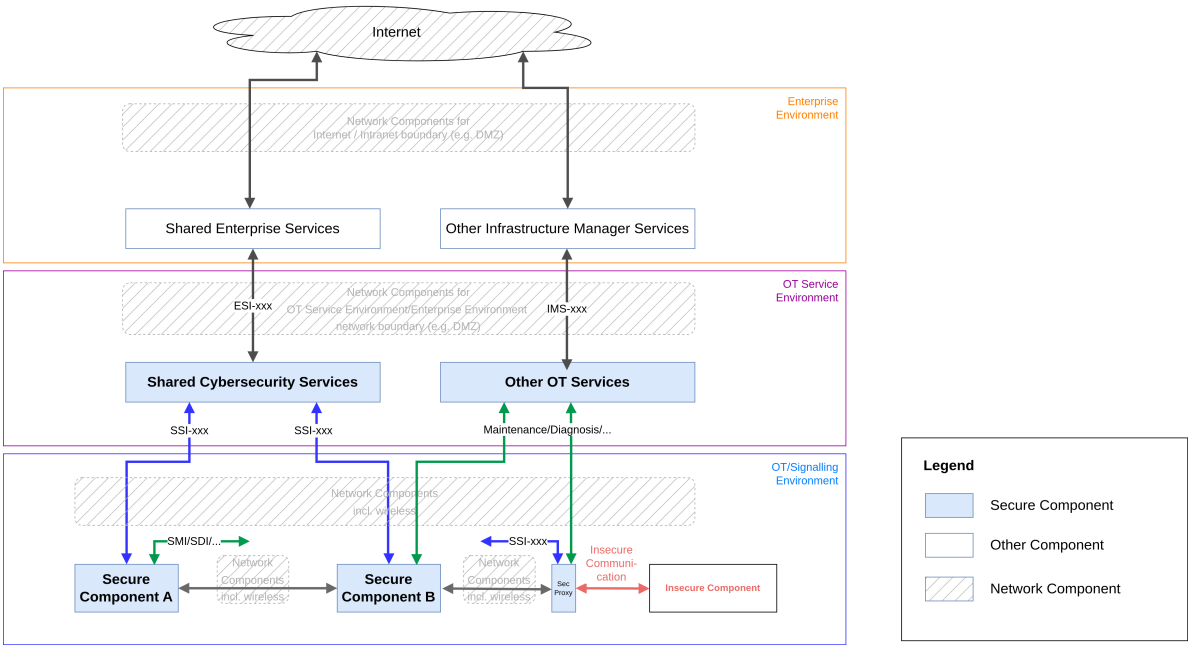


Figure 1: High-level cybersecurity architecture

, SP-SEC-Serv-3-2 - The following figure shows an example of hierarchy and interfaces (arrows) of shared services between each other, as well the association to external services. The figure includes:

- the Shared Cybersecurity Services (SCS) which offer mandatory Standard Security Interfaces (SSI) to Secure Components (usage of SSI between the SCS is not mandatory, but recommended)
- the Enterprise Cybersecurity Services (ECS), which offer recommended Enterprise Security Interfaces (ESI) to SCS
- external services on a national level used by the ECS

SSI are for the OT (operational technology) environment, the ESI are between the OT and IT environment, therefore crossing a trust boundary. Similarly, interfaces between ECS and national services also cross a trust boundary from IT environment to Internet services.

The following figure depicts a schematic view. A real-world implementation would incorporate a more complex federated structure (e.g. multiple deployments of the same services in different domains such as rail automation, electrification, stations, freight, etc). Additionally, a more complex hierarchy involving

multiple levels (e.g. on-board / trackside deployments) is possible (see Figure 3).

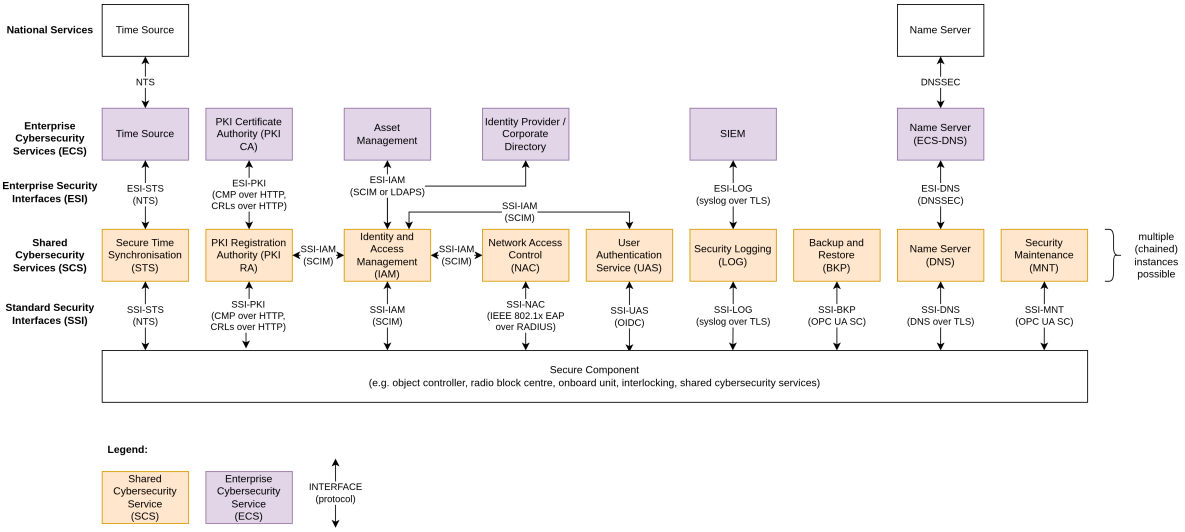


Figure 2 Example overview of the Shared Cybersecurity Services and their Interfaces

Note: A SIEM can be dedicated to a specific domain (e.g. rail automation). Network-based firewalls, IPS and IDS are not depicted on the figure, since these systems are not required to achieve interoperability. However, such systems complement a security architecture. **[**SPPRAMSS-4670 **]**

, SP-SEC-Serv-3-3 - The Shared Cybersecurity Services (SCS) serve as an abstraction layer between the OT/signalling environment and the enterprise environment. As the enterprise environment uses IT back-office technology which is subject to more frequent changes than the automation environment, a key purpose of the SCS is to shield the automation environment from changes in the enterprise environment. It is envisioned to keep the interfaces (SSI) between Secure Components and SCS stable, even when ECS technology and interfaces from ECS to SCS change. This is in line with federated enterprise architectures. Regression testing and impact analysis are good practices to be applied when ECS and ESI changes. **[**SPPRAMSS-16313 **]**

, SP-SEC-Serv-3-4 - The following table gives an overview of the Shared Cybersecurity Services described in this document. Furthermore, the table indicates if the implementation of each interface is mandatory for Secure Components.

Table 1 Overview of Shared Cybersecurity Services

Chapter - Shared Cybersecurity Service	**Interface(s)** SSI = standard security interface ESI = enterprise security interface	**Mandatory**	**Description**
5 - STS: Secure Time Synchronisation	SSI-STS ESI-STS	yes	service for secure time synchronisation to Secure Components, particularly important to validate certificates
6 - PKI: Public Key Infrastructure	SSI-PKI ESI-PKI	yes	service for distributing certificates and their revocation status to Secure Components, crucial for all secure communication

Chapter - Shared Cybersecurity Service	Interface(s) SSI = standard security interface ESI = enterprise security interface	Mandatory	Description
7 - IAM: Identity and Access Management	SSI-IAM ESI-IAM	only for use cases defined in chapter 7	service for managing digital identities (of components and users) **Comment:** Used among other for OPC-UA based services. Refer to list in chapter 7.
8 - NAC: Network Access Control	SSI-NAC	yes	service for identifying, authenticating, and authorizing network access of Secure Components
9 - LOG: Security Logging	SSI-LOG ESI-LOG	yes	service for collecting log messages from Secure Components and relaying log messages (e.g. to another relay or SIEM)
10 - UAS: User Authentication Service	SSI-UAS	for human users and token based authorization	service for managing roles for authorisation and user authentication
11 - BKP: Backup and Restore	SSI-BKP	for devices with state	service for creating and restoring backups to/from Secure Components **Comment:** SSI-BKP is not needed when there is nothing to back up (e.g. on devices without state with fixed configuration)
12 - MNT: Security Maintenance	SSI-MNT	yes (*)	interface for security-related maintenance functions
13 - DNS: Domain Name System	SSI-DNS ESI-DNS	only when DNS is used	service for name resolution to map domain names to IP addresses. **Comment**: SSI-DNS is not needed when DNS is not used

(*) onboard protocols are currently under specification, see SP-SEC-Serv-3-5 **[**SPPRAMSS-5254**]**

, SP-SEC-Serv-3-5 - For the following Shared Cybersecurity Services, an on-board deployment is recommended:

- **STS** - Secure Time Synchronisation
- **IAM** - Identity and Access Management
- **UAS** - User Authentication Service
- **NAC** - Network Access Control
- **LOG** - Security Logging
- **DNS** - Domain Name System

A subset of these services requires communication to trackside Shared Cybersecurity Services. This communication might be intermittent. Therefore mechanisms like caching or federation is recommended.

The following Cybersecurity Services are not needed for regular operation and therefore are optional for

an on-board deployment:

- **PKI RA** - Public Key Infrastructure Registration Authority
- **BKP** - Backup and Restore

The standardisation of an onboard SSI-MNT interface is currently ongoing. Therefore on-board components are not required to implement the SSI-MNT interface.

The train to ground communication via Mobile Communication Gateway (MCG) and Ground Communication Gateway (GCG) is defined in IEC 61375-2-6:2018. An IP-based communication channel is currently under specification by IEC and its release is expected in 2029. The communication for SSI-NTS, SSI-IAM, SSI-LOG, SSI-DNS, SSI-PKI interfaces is expected to be transparently routed between train and infrastructure operated by the railway undertaking owning the train.

The following figure shows an example architecture using these assumptions.

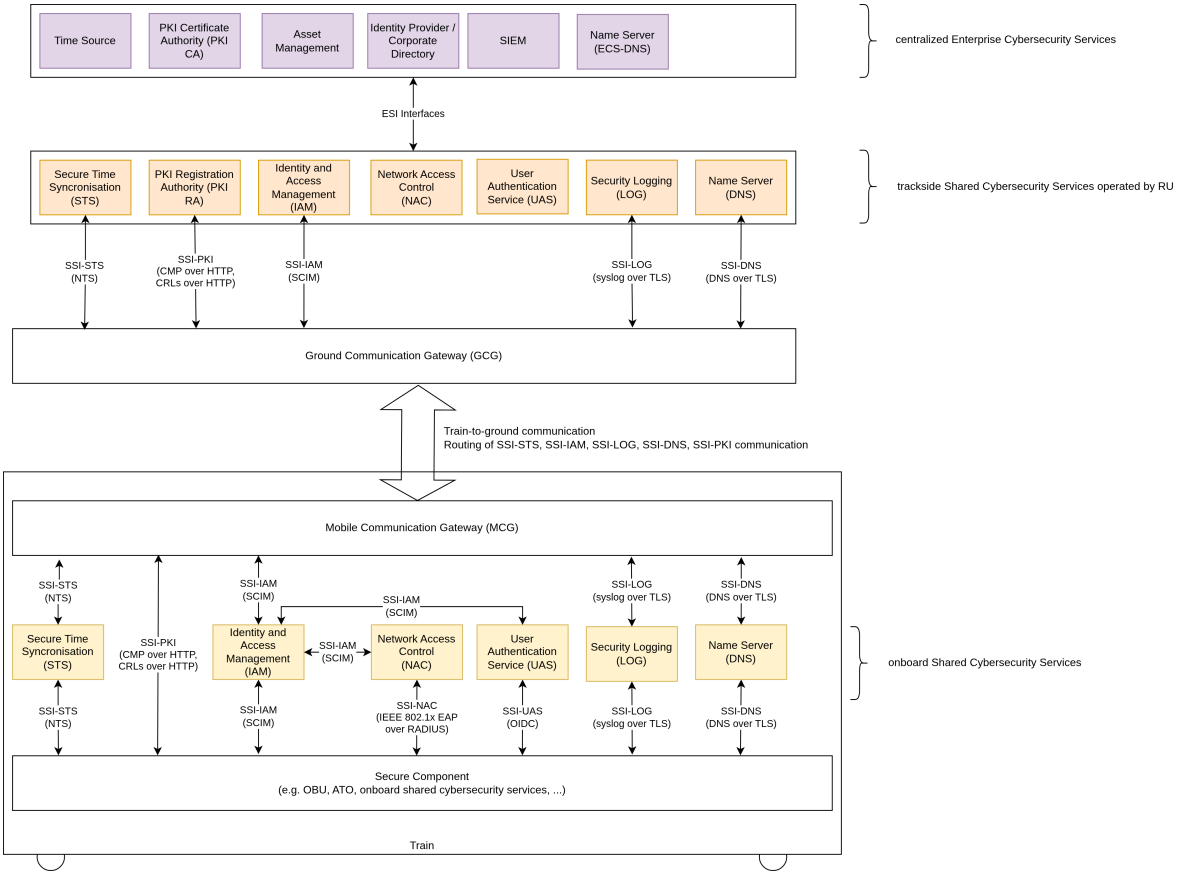


Figure 3 Example architecture of on-board and trackside Shared Cybersecurity Services

Each on-board SCS synchronises with its corresponding trackside SCS. Exceptions to this are on-board NAC and on-board UAS, which both interface with the on-board IAM. The on-board IAM synchronises with the trackside IAM.

For this deployment to work, the availability of roaming in an IP-based mobile network (e.g. FRMCS or 5G) between infrastructure managers (IMs) and railway undertakings (RUs) is assumed, as shown in the following figure.

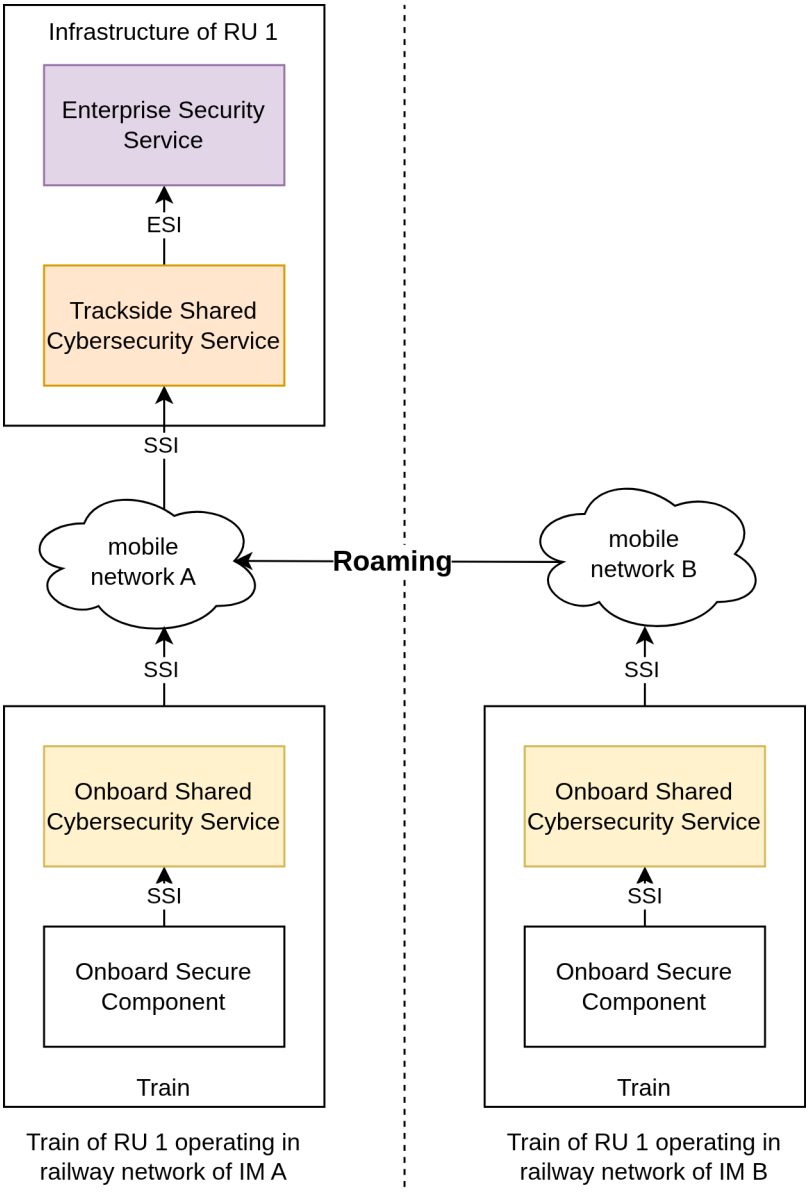


Figure 4 Example of roaming between networks to reach trackside Shared Cybersecurity Services of RU 1

[SPPRAMSS-9699]

4 Generic Requirements

, SP-SEC-Serv-4-1 - All implementations of Shared Cybersecurity Services are considered Secure Components.

Note: Implementations of the Enterprise Cybersecurity Services are assumed to be built according to comparable standards, e.g. ISO 27033, ISO 27034, NIST 800-53 Rev 5, and/or IEC 62443-4-2/COR1:2022. [SPPRAMSS-3692]

, SP-SEC-Serv-4-2 - If an SCS interfaces another SCS, the SCS shall use the SSI specified in the following table:

Table 2 Interfaces between SCS

interfaced SCS	used by other SCS	SSI to be used
STS	all	SSI-STS
PKI	all	SSI-PKI
IAM	NAC, PKI, UAS, BKP	SSI-IAM
NAC	none	none
LOG	all	SSI-LOG
UAS	IAM, BKP, MNT	SSI-UAS
BKP	IAM	SSI-IAM
MNT	all	SSI-MNT
DNS	all	SSI-DNS

[SPPRAMSS-18600**]**

, SP-SEC-Serv-4-3 - The SSI interfaces do not require any network prioritization over voice or safety communication. There is no distinction of service prioritization among the SSI. QoS class selection is implementation-specific. **[**SPPRAMSS-10041**]**

, SP-SEC-Serv-4-4 - The Standard Security Interfaces (SSI) shall use the protocols listed in the following table:

Table 3 Protocols mandatory for SSI

Interface SSI = standard security interface	**Protocols**	**References**
SSI-STS	NTS	SP-SEC-Serv-2.3-21 - [RFC 8915]
SSI-PKI	CMP over HTTP, CRLs over HTTP	SP-SEC-Serv-2.3-11 - [RFC 5280] SP-SEC-Serv-2.3-29 - [RFC 9483]
SSI-IAM	SCIM 2.0	SP-SEC-Serv-2.3-16 - [RFC 7643] SP-SEC-Serv-2.3-17 - [RFC 7644]
SSI-NAC	IEEE 802.1X EAP over RADIUS	SP-SEC-Serv-2.3-6 - [IEEE 802.1X-2020] SP-SEC-Serv-2.3-26 - [RFC 9190] SP-SEC-Serv-2.3-8 - [RFC 2865]
SSI-LOG	syslog over TLS	SP-SEC-Serv-2.3-13 - [RFC 5425] SP-SEC-Serv-2.3-30 - [RFC 9662]
SSI-UAS	OIDC	SP-SEC-Serv-2.3-5 - [OIDC 1.0]
SSI-BKP	OPC UA HTTP	SP-SEC-Serv-2.3-34 - [OPC UA-10000-6] SP-SEC-Serv-2.3-23 - [RFC 9112]
SSI-MNT	OPC UA	SP-SEC-Serv-2.3-34 - [OPC UA-10000-6]
SSI-DNS	DNS over TLS	SP-SEC-Serv-2.3-18 - [RFC 7858]

[SPPRAMSS-11178**]**

, SP-SEC-Serv-4-5 - The recommended protocols for the Enterprise Security Interfaces (ESI) are listed in the following table:

Table 4 Protocols recommended for ESI

Interface ESI = enterprise security interface	**Protocols**	**References**
ESI-STS	NTS	SP-SEC-Serv-2.3-21 - [RFC 8915]
ESI-PKI	CMP over HTTP, CRLs over HTTP	SP-SEC-Serv-2.3-11 - [RFC 5280] SP-SEC-Serv-2.3-29 - [RFC 9483]
ESI-IAM	SCIM 2.0 via HTTP over TLS (default) or LDAPS with TLS	SP-SEC-Serv-2.3-17 - [RFC 7644] SP-SEC-Serv-2.3-10 - [RFC 4511]
ESI-LOG	syslog over TLS	SP-SEC-Serv-2.3-13 - [RFC 5425] SP-SEC-Serv-2.3-30 - [RFC 9662]
ESI-DNS	DNSSEC	SP-SEC-Serv-2.3-27 - [RFC 9364]

[SPPRAMSS-11983 **]**

, SP-SEC-Serv-4-6 - Separate deployment of the SCS and ECS by network segmentation (e.g. a DMZ) is recommended. **[**SPPRAMSS-16014 **]**

, SP-SEC-Serv-4-7 - Interfaces using TLS, OPC UA or HTTP defined in this document shall implement the requirements defined in Secure Communication Specification. For SSI-UAS, SP-SEC-Comm-3.1-3 does not apply for web browser-based authentication flows. **[**SPPRAMSS-18560 **]**

5 STS: Secure Time Synchronisation

, SP-SEC-Serv-5-1 - The SCS-STS is an important Shared Cybersecurity Service, which is used to distribute common time base, for example for the following services described in this document:

- SCS-PKI: for certificate creation and validation
- SCS-IAM: for accurate, comparable timestamps for events
- SCS-LOG: for accurate, comparable timestamps for log messages
- SCS-BKP: for accurate, comparable timestamps for backup archives
- SCS-UAS: for accurate, comparable timestamps for tokens

[SPPRAMSS-3828 **]**

5.1 NTS Architectural Overview

, SP-SEC-Serv-5.1-1 - The following figure shows an example of hierarchy of NTS servers.

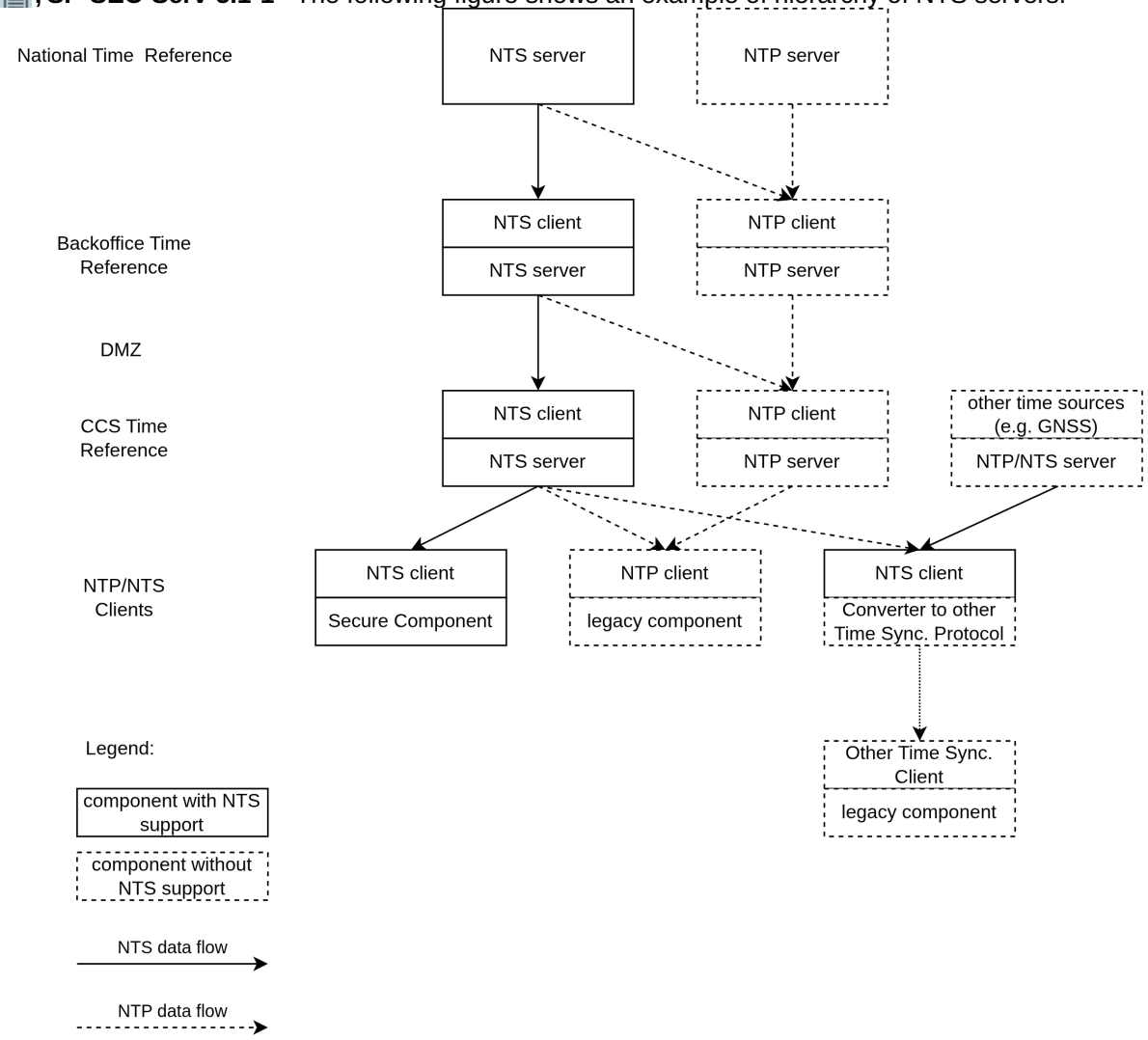


Figure 5 Example of hierarchy of NTS servers

[SPPRAMSS-3702]

5.2 Server Requirements

, SP-SEC-Serv-5.2-1 - For resiliency, the operation of multiple time servers is recommended. [SPPRAMSS-3820]

, SP-SEC-Serv-5.2-2 - The SCS-STS shall use Network Time Security (NTS) as specified in SP-SEC-Serv-2.3-21 - [RFC 8915].
Note: This means, that at least TLS version 1.3 is used. [SPPRAMSS-9965]

, SP-SEC-Serv-5.2-3 - The SCS-STS shall use the fixed network ports defined in SP-SEC-Serv-2.3-21 - [RFC 8915].
Note: This means that NTPv4 Port Negotiation is not used. [SPPRAMSS-3716]

, SP-SEC-Serv-5.2-4 - The SCS-STS shall use an Operator Non-Safety Communication Certificate (ONCC) as server certificate as defined in 6.2.2 - Operator Certificates. **[**SPPRAMSS-5264 **]**

, SP-SEC-Serv-5.2-5 - The SCS-STS shall only accept NTS-KE requests from authenticated clients. **[**SPPRAMSS-5266 **]**

5.3 Client Requirements

, SP-SEC-Serv-5.3-1 - The SSI-STS client shall use NTS as specified in SP-SEC-Serv-2.3-21 - [RFC 8915] .
Note: This means, that at least TLS version 1.3 is used. **[**SPPRAMSS-3701 **]**

, SP-SEC-Serv-5.3-2 - The SSI-STS client shall use an Operator Non-Safety Communication Certificate (ONCC) as defined in 6.2.2 - Operator Certificates for client authentication. **[**SPPRAMSS-5265 **]**

, SP-SEC-Serv-5.3-3 - During commissioning, the SSI-STS client shall use NTP as specified in SP-SEC-Serv-2.3-14 - [RFC 5905] .
Note: this removes the circular dependency when requesting the first operator certificates. **[**SPPRAMSS-13367 **]**

5.4 Backwards Compatibility to NTP

NTS is backwards compatible to NTP. That means an NTP client can synchronize with an NTS server (the NTS extension / signature appendix is ignored by NTP implementations). However, if the signatures of the time sync messages are not evaluated (in case of an NTP client), the client is vulnerable to man-in-the-middle attacks (no server authentication or message integrity protection).

6 PKI: Public Key Infrastructure

, SP-SEC-Serv-6-1 - A Public Key Infrastructure (PKI) is a set of processes, policies, and technology for associating asymmetric cryptographic keys with the entity to whom those keys were issued. It is a standardized method used for authentication and encryption to confirm the identity of communicating parties as well as validate information being shared. **[**SPPRAMSS-3690 **]**

, SP-SEC-Serv-6-2 - The following Figure shows interfaces and protocols used between the PKI and PKI clients. The PKI clients establish a TLS connection using the certificates distributed by the PKI.

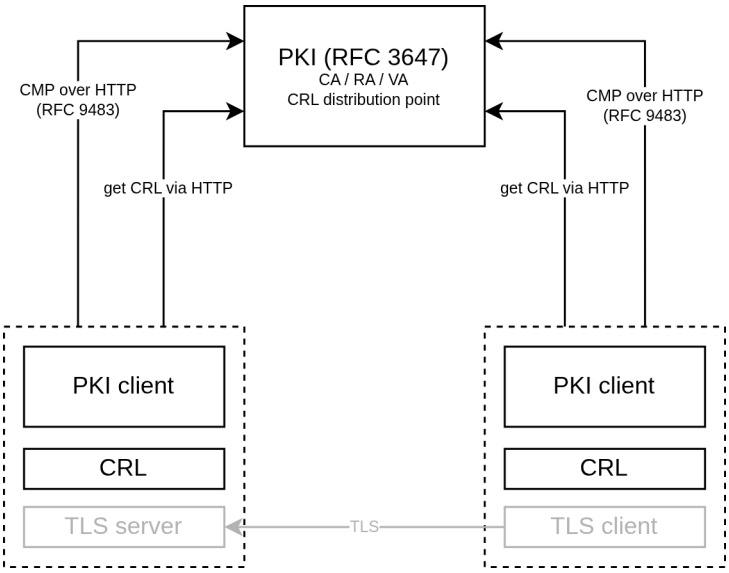


Figure 6 Interface between PKI and PKI clients

[SPPRAMSS-3393**]**

6.1 Use Cases

6.1.1 Use Case: Commissioning

📄**, SP-SEC-Serv-6.1.1-1 -** During the commissioning process of new component to an installation, the PKI client authenticates itself to the Registration Authority (RA) with a Manufacturer Device Certificate (MDC, see 6.2.1 - Manufacturer Certificates) to request the Operator Device Certificate (ODC, see 6.2.2 - Operator Certificates) according to Sections 4.1.1 and 5.2.1 of SP-SEC-Serv-2.3-29 - [RFC 9483]. With the ODC, further operator certificates can be obtained according to Sections 4.1.2 and 5.2. of SP-SEC-Serv-2.3-29 - [RFC 9483]. **[**SPPRAMSS-5086**]**

6.1.2 Use Case: Obtaining additional Operator Certificates

📄**, SP-SEC-Serv-6.1.2-1 -** The following Figure shows the dependencies of certificates. The Certificate Management Protocol (CMP as defined in SP-SEC-Serv-2.3-29 - [RFC 9483]) is used to request further certificates. Thereby, the previous certificate is used to authenticate the device before requesting following certificates. This is to ensure (a) device identity binding using the Manufacturer Device Certificate (MDC), (b) proof-of-possession of the key, (c) integrity and freshness of all enrollment messages. Since the Manufacturer Device Certificate (MDC) is installed during manufacturing, the device always has the possibility to request the other certificates.

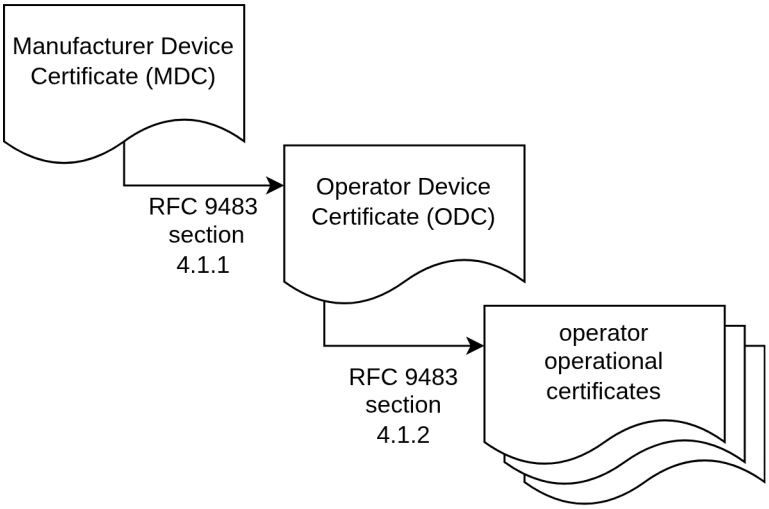


Figure 7 Dependencies of Certificates with References to CMP RFC

[SPPRAMSS-5845**]**

6.1.3 Use Case: Updating Operator Certificates

📄**, SP-SEC-Serv-6.1.3-1 -** Operator Certificates can be updated before their validity ends according to SP-SEC-Serv-2.3-29 - [RFC 9483] section 4.1.3. **[**SPPRAMSS-10182**]**

6.1.4 Use Case: Revoking Operator Certificates

, SP-SEC-Serv-6.1.4-1 - Operator Certificates can be revoked according to SP-SEC-Serv-2.3-29 - [RFC 9483] section 5.3.2. **[**SPPRAMSS-10183 **]**

6.2 Certificates

, SP-SEC-Serv-6.2-1 - All certificates in the PKI hierarchy shall be based on Elliptic Curve Cryptography (ECC).
Note: In future version of this document, the cryptographic primitives for the PKI will be extended to support additional primitives, e.g. for post quantum cryptography (PQC). **[**SPPRAMSS-10177 **]**

, SP-SEC-Serv-6.2-2 - The certificate profiles (see 14.1 - Certificate Profiles) use the following Object Identifiers (OIDs) defined in SP-SEC-Serv-2.3-31 - [RFC 9809] in the Extended Key Usage (EKU) field.

Table 5 OIDs used in certificate profiles

Object Identifier (OID) Name and Value	Description
`id-kp-configSigning 1.3.6.1.5.5.7.3.41`	Used in critical Extended Key Usage field of Manufacturer Configuration Signer Certificate (MCSC) and Operator Configuration Signer Certificate (OCSC) to denote the use of the certificate for verifying signatures of general-purpose configuration files.
`id-kp-trustAnchorConfigSigning 1.3.6.1.5.5.7.3.42`	Used in critical Extended Key Usage field of Manufacturer Trust Anchor Signer Certificate (MTASC) and Operator Trust Anchor Signer Certificate (OTASC) to denote the use of the certificate for verifying signatures of trust anchor configuration files. Trust anchor configuration files are used to add or remove trust anchors to the trust store of a Secure Device.
`id-kp-updatePackageSigning 1.3.6.1.5.5.7.3.43`	Used in critical Extended Key Usage field of Manufacturer Update Signer Certificate (MUSC) to denote the use of the certificate for verifying signatures of secure software or firmware update packages.
`id-kp-safetyCommunication 1.3.6.1.5.5.7.3.44`	Used in critical Extended Key Usage field of Operator Safety Communication Certificate (OSCC) to denote the use for authenticating a communication peer for safety-critical communication.

Note: The EKU OIDs are registered in SP-SEC-Serv-2.3-4 - [IANA SMI PKIX EKU] **[**SPPRAMSS-7128 **]**

6.2.1 Manufacturer Certificates

, SP-SEC-Serv-6.2.1-1 - The following Figure shows an example of a PKI hierarchy for railway manufacturers. All certificates are based on Elliptic Curve Cryptography (ECC). While this section includes requirements for the leaf certificates (MDC, MCSC, MTASC, MUSC), the exact numbers and characteristics of root and issuing CAs can be defined by the manufacturer.
Note: trust anchors are usually associated with a root CA, but this is not a requirement

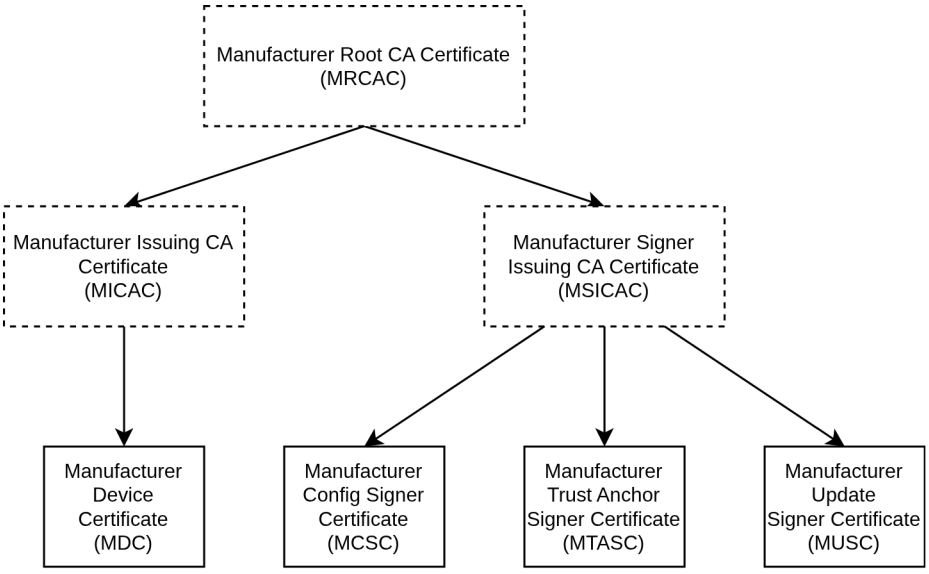


Figure 8 Example of a Manufacturer PKI Hierarchy. Certificates with solid lines are defined by certificate profiles.
[SPPRAMSS-5650 **]**

, SP-SEC-Serv-6.2.1-2 - The following table lists the certificates issued by the manufacturer and their use case.

Table 6 Overview of manufacturer leaf certificates and their usage.

Certificate Name	Certificate Tag	Use Case	Usual Occurrence
Manufacturer Device Certificate	MDC	The MDC uniquely identify every device in the scope of the manufacturer.	one MDC per device
Manufacturer Config Signer Certificate	MCSC	The MCSC is used by the manufacturer to sign configuration files.	one MCSC per manufacturer
Manufacturer Trust Anchor Signer Certificate	MTASC	The MTASC is used by the manufacturer to add operator trust anchors to a device.	one MTASC per manufacturer
Manufacturer Update Signer Certificate	MUSC	The MUSC is used by the manufacturer to sign SW/FW update files.	one MUSC per manufacturer

[SPPRAMSS-7675 **]**

, SP-SEC-Serv-6.2.1-3 - The Manufacturer Device Certificate (MDC) shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.1-1. **[**SPPRAMSS-7645 **]**

, SP-SEC-Serv-6.2.1-4 - The Manufacturer Config Signer Certificate (MCSC) shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.1-2. **[**SPPRAMSS-7356 **]**

, SP-SEC-Serv-6.2.1-5 - The Manufacturer Trust Anchor Signer Certificate (MTASC) shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.1-3.
[SPPRAMSS-7404 **]**

, SP-SEC-Serv-6.2.1-6 - The Manufacturer Update Signer Certificate (MUSC) shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.1-4. **[**SPPRAMSS-7405 **]**

, SP-SEC-Serv-6.2.1-7 - The Manufacturer CA certificates shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.3-1 - Table # CA Certificate profile.

Note: this only applies to root, intermediate and issuing CA certificates, not to leaf certificates **[**SPPRAMSS-16109 **]**

, SP-SEC-Serv-6.2.1-8 - Signatures created with the Manufacturer Configuration Signer Certificate (MCSC), Manufacturer Trust Anchor Signer Certificate (MTASC), Manufacturer Update Signer Certificate (MUSC) shall use the signature algorithm ecdsa-with-SHA512. **[**SPPRAMSS-16314 **]**

6.2.2 Operator Certificates

, SP-SEC-Serv-6.2.2-1 - The following Figure shows an example of a PKI hierarchy for railway operators. All certificates are based on Elliptic Curve Cryptography (ECC). While this section includes requirements for the leaf certificates (ODC, ONCC, OSCC, OUC, OCSC, OTASC), the exact numbers and characteristics of root and issuing CAs can be defined by the operator.

Note: trust anchors are usually associated with a root CA, but this is not a requirement

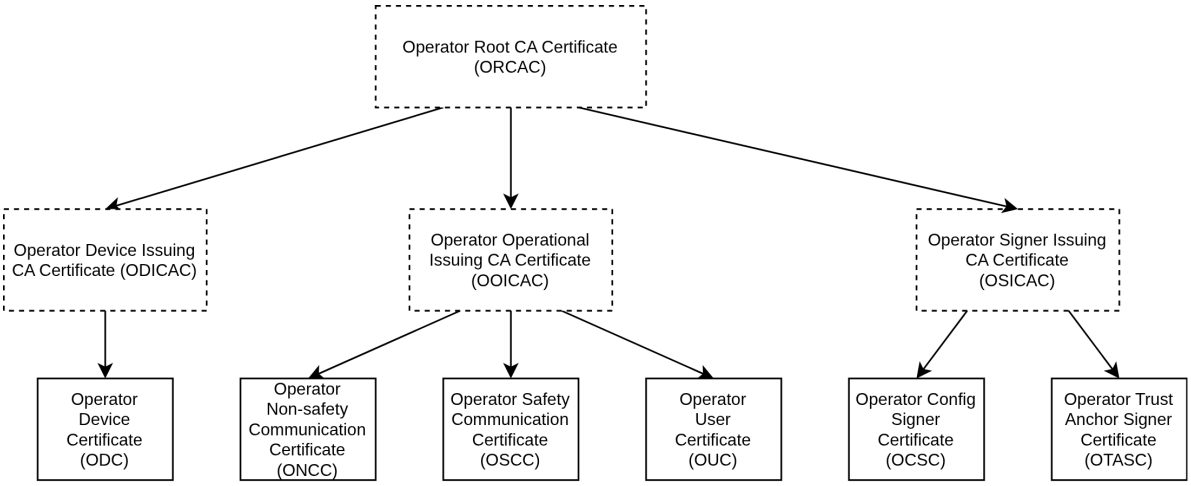


Figure 8 Example of an Operator PKI Hierarchy. Certificates with solid lines are defined by certificate profiles.

[SPPRAMSS-5126 **]**

, SP-SEC-Serv-6.2.2-2 - The following table lists the leaf certificates issued by the operator and their use case.

Table 7 Overview of operator leaf certificates and their usage.

Certificate Name	Certificate Tag	Use Case	Usual Occurrence
Operator Device Certificate	ODC	The ODC uniquely identify every device within the scope of the operator.	one ODC per device
Operator Non-safety Communication Certificate	ONCC	ONCCs are used to protect non-safety communication.	one or multiple ONCCs per software process realising non-safety communication
Operator Safety Communication Certificate	OSCC	OSCCs are used to protect safety communication.	one or multiple OSCCs per software process realising safety communication
Operator User Certificate	OUC	OUCs are used by human users or software processes, e.g. for authentication and authorisation.	zero to multiple OUCs per human user/software process
Operator Config Signer Certificate	OCSC	The OCSC is used by the operator to sign configuration files.	one OCSC per operator
Operator Trust Anchor Signer Certificate	OTASC	The OTASC is used by the operator to add operator trust anchors to a device. These certificates can be owned by the same operator or a different one.	one OTASC per operator

[SPPRAMSS-7676 **]**

, SP-SEC-Serv-6.2.2-3 - The Operator Device Certificate (ODC) shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.2-1. **[**SPPRAMSS-8001 **]**

, SP-SEC-Serv-6.2.2-4 - The Operator Non-Safety Communication Certificate (ONCC) shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.2-2. **[**SPPRAMSS-5129 **]**

, SP-SEC-Serv-6.2.2-5 - The Operator Safety Communication Certificate (OSCC) shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.2-3. **[**SPPRAMSS-5131 **]**

, SP-SEC-Serv-6.2.2-6 - The Operator User Certificate (OUC) shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.2-4. **[**SPPRAMSS-5123 **]**

, SP-SEC-Serv-6.2.2-7 - The Operator Configuration Signer Certificate (OCSC) shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.2-5. **[**SPPRAMSS-5270 **]**

, SP-SEC-Serv-6.2.2-8 - The Operator Trust Anchor Signer Certificate (OTASC) shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.2-6 **[**SPPRAMSS-9943 **]**

, SP-SEC-Serv-6.2.2-9 - The Operator CA certificates shall fulfill the certificate profile defined in SP-SEC-Serv-14.1.3-1 - Table # CA Certificate profile.

Note: this only applies to root, intermediate and issuing CA certificates, not to leaf certificates **[**SPPRAMSS-16110 **]**

, SP-SEC-Serv-6.2.2-10 - Signatures created with the Operator Configuration Signer Certificate (OCSC), and Operator Trust Anchor Signer Certificate (OTASC) shall use the signature algorithm ecdsa-with-SHA512. **[**SPPRAMSS-16348 **]**

6.3 PKI CA/RA requirements

, SP-SEC-Serv-6.3-1 - The PKI CA mentioned in this chapter is the CA installed in the operator's environment, not the manufacturer CA. **[**SPPRAMSS-11962 **]**

, SP-SEC-Serv-6.3-2 - The SSI-PKI shall issue X.509 v3 certificates as defined in SP-SEC-Serv-2.3-11 - [RFC 5280]. **[**SPPRAMSS-6744 **]**

, SP-SEC-Serv-6.3-3 - The SSI-PKI shall issue certificates according to the certificate profiles defined in 14.1 - Certificate Profiles. **[**SPPRAMSS-6745 **]**

, SP-SEC-Serv-6.3-4 - The PKI RA/CA shall provide the capability to issue and rekey certificates using the CMP protocol version 2 via HTTP according to the Lightweight CMP Profile (LCMPP) as defined in SP-SEC-Serv-2.3-29 - [RFC 9483].
[SPPRAMSS-4062 **]**

, SP-SEC-Serv-6.3-5 - The PKI RA/CA shall support the following CMP messages: Initialization Request (ir), Certification Request (cr), Key Update Request (kur), Certificate Confirmation (certConf) and their associated responses (ip, cp, kup, pkiConf, error).
Note: These CMP messages represent a subset of the messages defined in SP-SEC-Serv-2.3-29 - [RFC 9483].
[SPPRAMSS-4064 **]**

, SP-SEC-Serv-6.3-6 - The PKI RA/CA shall validate the content and signature-based message protection of every received CMP request according to Section 3.5 in SP-SEC-Serv-2.3-29 - [RFC 9483] before accepting it. **[**SPPRAMSS-6604 **]**

, SP-SEC-Serv-6.3-7 - The PKI RA/CA shall send a pkiConf message at the reception of the certConf message.
Note: this means that implicitConfirm is not used. **[**SPPRAMSS-4142 **]**

, SP-SEC-Serv-6.3-8 - The PKI RA/CA shall provide the following CMP endpoints according to Section 6.1 of SP-SEC-Serv-2.3-29 - [RFC 9483] for enrolling new certificates matching the certificate profiles chapter 6.3.2.

Table 8 CMP endpoints for enrolling new certificates

CMP Endpoint URL	Issued Certificate Types	Endpoint Protection
`/.well-known/cmp/p/ODC/initialization`	ODC	CMP requests: message protection with MDC CMP responses: message protection with issuing CA key
`/.well-known/cmp/p/ONCC/certification`	ONCC	CMP message protection with ODC CMP responses: message protection with issuing CA key
`/.well-known/cmp/p/OSCC/certification`	OSCC	CMP message protection with ODC CMP responses: message protection with issuing CA key

[SPPRAMSS-5167 **]**

, SP-SEC-Serv-6.3-9 - The PKI RA/CA shall provide the following CMP endpoints with the listed endpoint protection according to Section 6.1 of SP-SEC-Serv-2.3-29 - [RFC 9483] for rekeying existing certificates via Key Update Request (kup).

Table 9 CMP endpoints for rekeying existing certificates

CMP Endpoint URL	Issued Certificate Types	Endpoint Protection
`/.well-known/cmp/p/ODC/keyupdate`	ODC	CMP requests: message protection with ODC CMP responses: message protection with issuing CA key
`/.well-known/cmp/p/ONCC/keyupdate`	ONCC	CMP requests: message protection with ONCC CMP responses: message protection with issuing CA key
`/.well-known/cmp/p/OSCC/keyupdate`	OSCC	CMP requests: message protection with OSCC CMP responses: message protection with issuing CA key

[SPPRAMSS-5168 **]**

, SP-SEC-Serv-6.3-10 - The PKI RA shall only process authenticated and authorized CMP requests. **[**SPPRAMSS-5223 **]**

, SP-SEC-Serv-6.3-11 - The PKI RA/CA shall support the following protection algorithms for creating signatures to protect its CMP responses: ecdsa-with-SHA256, ecdsa-with-SHA512 according to Section 3.2 of SP-SEC-Serv-2.3-28 - [RFC 9481].
Note: SP-SEC-Serv-6.3-8 and SP-SEC-Serv-6.3-9 define which key to use for every CMP endpoint. **[**SPPRAMSS-7494 **]**

, SP-SEC-Serv-6.3-12 - The PKI RA/CA shall reject CMP protection algorithms not defined in this specification. **[**SPPRAMSS-15419 **]**

, SP-SEC-Serv-6.3-13 - The PKI RA shall only forward CMP initialization requests to PKI CA if signed by an MDC which associated asset exists in the SCS-IAM and the asset's state is "COMMISSIONING". **[**SPPRAMSS-15437 **]**

, SP-SEC-Serv-6.3-14 - The PKI RA shall only forward CMP certification requests to PKI CA if signed by an ODC which associated asset exists in the SCS-IAM and the asset's state is "ACTIVE". **[**SPPRAMSS-15435 **]**

, SP-SEC-Serv-6.3-15 - If the PKI RA is not forwarding a initialization request due to an SCS-IAM status mismatch, the PKI RA shall respond with an initialization response containing the PKIStatus "rejection". **[**SPPRAMSS-15436 **]**

, SP-SEC-Serv-6.3-16 - If the PKI RA is not forwarding a certification request due to an SCS-IAM status mismatch, the PKI RA shall respond with a certification response containing the PKIStatus "rejection". **[**SPPRAMSS-15434 **]**

, SP-SEC-Serv-6.3-17 - The PKI RA/CA shall provide CRLs compliant to SP-SEC-Serv-2.3-11 - [RFC 5280] via HTTP.
Note: Secure CRL download via HTTP over TLS is not necessary, because CRLs are signed by the respective CA.
[SPPRAMSS-4063 **]**

, SP-SEC-Serv-6.3-18 - The PKI CA shall set the CRL nextUpdate field to a date no earlier than six weeks after the CRL creation date.
Note: the date in the nextUpdate field should take availability of the system into account. **[**SPPRAMSS-7629 **]**

, SP-SEC-Serv-6.3-19 - The PKI RA/CA shall update the CRL every 24h. **[**SPPRAMSS-18762 **]**

6.4 PKI Client Requirements

, SP-SEC-Serv-6.4-1 - The SSI-PKI client shall provide the capability to request and rekey certificates using the CMP protocol version 2 via HTTP according to the Lightweight CMP Profile (LCMPP) SP-SEC-Serv-2.3-29 - [RFC 9483].
Note: Confidentiality protection is not needed because only public data is transferred. Since CMP includes integrity protection, an insecure transport protocol (HTTP in this case) can be used. **[**SPPRAMSS-4070 **]**

, SP-SEC-Serv-6.4-2 - When rekeying a certificate, the SSI-PKI client shall use the private key associated with the certificate to sign the CMP Key Update Request message (kup) and certConf (see SP-SEC-Serv-2.3-29 - [RFC 9483] Section 4.1.3). **[**SPPRAMSS-7177 **]**

, SP-SEC-Serv-6.4-3 - The SSI-PKI client shall support the following CMP messages: Initialization request (ir), Certification Request (cr), Key Update Request (kur), Certificate Confirmation (certConf) and their associated responses (ip, cp, kup, pkiConf, error) as defined in SP-SEC-Serv-2.3-29 - [RFC 9483] . **[**SPPRAMSS-4068 **]**

, SP-SEC-Serv-6.4-4 - The SSI-PKI client shall request and rekey certificates needed for operation. **[**SPPRAMSS-4069 **]**

, SP-SEC-Serv-6.4-5 - The SSI-PKI client shall download CRLs via HTTP and process CRLs as defined in SP-SEC-Serv-2.3-11 - [RFC 5280] using a URL defined in the CRL Distribution Point (CDP) extension, which can be overwritten by a URL defined in the client's configuration. **[**SPPRAMSS-4067 **]**

, SP-SEC-Serv-6.4-6 - The PKI client shall support the following protection algorithms for creating signatures to protect and validating CMP message protection: ecdsa-with-SHA256, ecdsa-with-SHA512 according to Section 3.2 of SP-SEC-Serv-2.3-28 - [RFC 9481].
Note: SP-SEC-Serv-6.3-8 and SP-SEC-Serv-6.3-9 define which key to use for every CMP endpoint.
[SPPRAMSS-7495 **]**

7 IAM: Identity and Access Management

, SP-SEC-Serv-7-1 - Examples of clients needing SSI-IAM information include:

- SCS-PKI RA;
- SCS-NAC;
- OPC-UA based services SCS-MNT for trackside applications, SCS-BKP;
- services requiring permission lookup;
- SSI-UAS, where IAM information is required for token or permission decisions.

The following use cases are provided by SSI-IAM:

- asset existence and status lookup;
- certificate inventory query and update;
- verification of asset state for certificate issuance;
- verification of asset state for network access control;
- retrieval of entitlements or permissions for human users or technical users;
- synchronization of asset and user information with enterprise identity provider / corporate directory and asset management systems through ESI-IAM.

[SPPRAMSS-18682 **]**

, SP-SEC-Serv-7-2 - The SCS-IAM structures the assets based on their functional/technical identifier and their manufacturer serial number.

Table 10 Identifiers used in SCS-IAM

Identifier	Description	Attribute Name in Asset Schema of SSI-IAM	Content in Certificate Field
functional/ technical identifier	identifies the function realised by physical device (e.g. an object controller at a specific location); does not change when physical hardware is replaced	CN	CN in Subject of ODC
manufacturer serial number	unique per physical device per manufacturer	serialNumber + manufacturerDN	serialNumber in Subject of MDC + DN of the manufacturer trust anchor certificate

[SPPRAMSS-18617 **]**

, SP-SEC-Serv-7-3 - The SSI-IAM is a machine-to-machine interface for managing and querying digital identities (human users, software processes or devices), assets, certificates and permissions. The IAM acts as a single source of truth for identities, assets, certificates and permissions used by Secure Components, Shared Cybersecurity Services and OT shared services. When an interface uses SSI-UAS for both authentication and authorization (typically under the form of token), SSI-IAM interface is not needed by the client. **[**SPPRAMSS-4974 **]**

, SP-SEC-Serv-7-4 - Asset data of the SCS-IAM is synchronised via ESI-IAM with an asset management system. **[**SPPRAMSS-11439 **]**

, **SP-SEC-Serv-7-5 -** User data of the SCS-IAM is synchronised via ESI-IAM with a corporate directory. **[**SPPRAMSS-18655 **]**

, **SP-SEC-Serv-7-6 -** The OPC UA permissions for SSI are defined in Chapter 4 of the SP-SEC-Serv-2.3-32 - [SP-SEC-CommSpec]. **[**SPPRAMSS-9806 **]**

, **SP-SEC-Serv-7-7 -** The SSI-IAM interface is used to query and manage assets and human users. The interface is involved in multiple use cases such as the verification of initial certificate requests, certificate storage, and network authentication.
[SPPRAMSS-7970 **]**

, **SP-SEC-Serv-7-8 -** The SCS-IAM shall accept SCIM 2.0 requests via REST using HTTP over TLS according to SP-SEC-Serv-2.3-17 - [RFC 7644].
[SPPRAMSS-5803 **]**

, **SP-SEC-Serv-7-9 -** The SCS-IAM shall use an Operator Non-safety Communication Certificate (ONCC). **[**SPPRAMSS-5811 **]**

, **SP-SEC-Serv-7-10 -** The SSI-IAM client shall use an Operator Non-safety Communication Certificate (ONCC). **[**SPPRAMSS-15506 **]**

, **SP-SEC-Serv-7-11 -** The SCS-IAM shall send SCIM 2.0 JSON-formatted responses as defined in SP-SEC-Serv-2.3-17 - [RFC 7644]. **[**SPPRAMSS-5802 **]**

, **SP-SEC-Serv-7-12 -** The SCS-IAM shall send SCIM 2.0 responses following the Core Schema defined in SP-SEC-Serv-2.3-16 - [RFC 7643] **[**SPPRAMSS-10351 **]**

, **SP-SEC-Serv-7-13 -** The SCS-IAM shall provide the capability to use filtering on the SCIM endpoints as defined in SP-SEC-Serv-2.3-17 - [RFC 7644].
Note: The filtering function is provided for all attributes available in the schemas using expressions as defined in SP-SEC-Serv-2.3-17 - [RFC 7644] section 3.4.2.2. **[**SPPRAMSS-18619 **]**

, **SP-SEC-Serv-7-14 -** The SCS-IAM client shall be able to query data from the SCS-IAM including filtering as defined in SP-SEC-Serv-2.3-17 - [RFC 7644]. **[**SPPRAMSS-18618 **]**

7.1 Asset Inventory

, **SP-SEC-Serv-7.1-1 -** The SSI-IAM server shall provide access to its asset inventory via SCIM 2.0 under the endpoint `/v2/Assets`. **[**SPPRAMSS-9814 **]**

, **SP-SEC-Serv-7.1-2 -** The SSI-IAM server shall enforce the following permissions for its asset inventory:

Permission Name	Description
`eu.rail.security.iam.asset-info`	This permission allows to check if a given asset (defined by serial number and manufacturerDN) exists in the asset database (see SP-SEC-Serv-7.1-4)
`eu.rail.security.iam.update-assets-certificates`	This permission allows to modify the certificates (add, delete, update operations) of a given asset (see SP-SEC-Serv-7.1-12)

[SPPRAMSS-11371]

, SP-SEC-Serv-7.1-3 - The SSI-IAM server shall distinguish the following asset types by assigning the following permissions:

Asset Type	Permissions
PKI RA	`eu.rail.security.iam.asset-info` `eu.rail.security.iam.update-assets-certificates`
All authenticated components	`eu.rail.security.iam.asset-info`

Note: mapping these permissions to roles, which match to component types is allowed
[SPPRAMSS-9807]

, SP-SEC-Serv-7.1-4 - The Assets endpoint is used by the following components and interfaces to retrieve asset information from SSI-IAM:

- SCS-PKI RA / SCS-NAC request asset information using one of the following filters:
  - MDC serialNumber and manufacturerDN
  - ODC serialNumber
- OPC UA components (e.g. SSI-BKP client, SSI-MNT client, maintenance/diagnostic client) request asset information using one of the following filters:
  - ONCC serialNumber

Note: an MDC-based request has the following form:

```
GET /v2/Assets?filter=(serialNumber eq "[serial number]") and (manufacturerDN eq "[manufacturer-specific DN]") HTTP/1.1
Host: [SSI-IAM instance address]
User-Agent: [SSI-IAM REST Client identifier]
Accept: application/scim+json
```

[SPPRAMSS-5805]

, SP-SEC-Serv-7.1-5 - If the SCS-IAM receives a request for a known asset by serial number, the SSI-IAM server shall check if an asset with the requested serial number exists in the IAM's database and Subject DN of the manufacturer certificate matches the Subject DN of the trust anchor certificate stored in the IAM. [SPPRAMSS-6708]

, SP-SEC-Serv-7.1-6 - If the SCS-IAM receives a request for a known asset by CN, the SSI-IAM server shall check if an asset with the requested CN exists in the IAM's database. [SPPRAMSS-13066]

, SP-SEC-Serv-7.1-7 - The SCS-IAM shall implement the schema `urn:ietf:params:scim:eu-rail:2.0:Asset` defined by the following JSON object:

```
{
 "id": "urn:ietf:params:scim:eu-rail:2.0:Asset",
 "name": "Asset",
 "description": "Asset Schema",
 "attributes": [
  {
   "name": "serialNumber",
   "type": "string",
   "multiValued": false,
   "required": true,
   "caseExact": true,
```

```
  "mutability": "immutable",
  "returned": "default",
  "uniqueness": "none",
  "description": "serial number of the asset provided in the MDC"
 },
 {
  "name": "CN",
  "type": "string",
  "multiValued": false,
  "required": false,
  "caseExact": true,
  "mutability": "readWrite",
  "returned": "default",
  "uniqueness": "server",
  "description": "Common Name of the asset as part of the ODC"
 },
 {
  "name": "manufacturerDN",
  "type": "string",
  "multiValued": false,
  "required": true,
  "caseExact": true,
  "mutability": "immutable",
  "returned": "default",
  "uniqueness": "none",
  "description": "Distinguished Name of the trust anchor certificate corresponding to the MDC"
 },
 {
  "name": "status",
  "type": "string",
  "multiValued": false,
  "required": true,
  "caseExact": true,
  "mutability": "readWrite",
  "returned": "always",
  "uniqueness": "none",
  "canonicalValues": ["CREATED","ACTIVE","INACTIVE","COMMISSIONING","DECOMMISSIONED"],
  "description": "state of the asset"
 },
 {
  "name" : "entitlements",
  "type" : "complex",
  "multiValued" : true,
  "description" : "A list of permissions for the User that represent a thing the User has.",
  "required" : false,
 "subAttributes" : [
```

```
    {
     "name" : "value",
      "type" : "string",
      "multiValued" : false,
      "description" : "The value of a permission.",
      "required" : true,
      "caseExact" : false,
      "mutability" : "readWrite",
      "returned" : "default",
      "uniqueness" : "none"
    },
    "mutability" : "readWrite",
    "returned" : "default"
  },
 {
    "name": "certificates",
    "type": "complex",
    "subattributes": [
    {
      "name": "type",
      "type": "string",
      "multiValued": false,
      "required": true,
      "caseExact": true,
      "mutability": "immutable",
      "returned": "default",
      "uniqueness": "none",
      "canonicalValues": ["ODC","ONCC","OSCC","OUC","OCSC","OTASC"],
      "description": "Certificate Profile Tag"
    },
    {
      "name": "serialNumber",
      "type": "integer",
      "multiValued": false,
      "required": true,
      "caseExact": true,
      "mutability": "immutable",
      "returned": "default",
      "uniqueness": "none",
      "description": "serial number of the certificate according to RFC 5280 4.1.2.2"
    },
    {
      "name": "CN",
     "type": "string",
      "multiValued": false,
      "required": true,
```

```
      "caseExact": true,
     "mutability": "immutable",
      "returned": "default",
      "uniqueness": "none",
      "description": "common name of the certificate"
    },
    {
      "name": "value",
      "type": "string",
      "multiValued": false,
      "required": true,
      "caseExact": false,
      "mutability": "immutable",
      "returned": "default",
      "uniqueness": "none",
      "description": "base64-encoded DER string of the X.509 certificate (without BEGIN
CERTIFICATE/END CERTIFICATE)"
    }
  ],
 "multiValued": true,
  "required": true,
  "caseExact": true,
  "mutability": "readWrite",
  "returned": "default",
  "uniqueness": "none",
  "description": "Certificates issued for the asset"
  }
  ]
}
```

Note: additional attributes are allowed **[**SPPRAMSS-15429**]**

, SP-SEC-Serv-7.1-8 - If the SCS-IAM has a record of the requested asset, the SSI-IAM server shall return a SCIM response with the schema `urn:ietf:params:scim:api:messages:2.0:ListResponse`, containing `Resources` of the schema `urn:ietf:params:scim:eu-rail:2.0:Asset` (see SP-SEC-Serv-7.1-7), which includes the `serialNumber` or `CN` attribute as asset identifier.

Note 1: a response with `serialNumber` attribute has the following form:

```
HTTP/1.1 200 OK
Content-Type: application/scim+json
{
       "schemas":["urn:ietf:params:scim:api:messages:2.0:ListResponse"],
       "totalResults":1,
       "Resources": [
       {
              "id":"2819c223-7f76-453a-919d-413861904646",
              "schemas":["urn:ietf:params:scim:eu-rail:2.0:Asset"],
              "meta":{
                     "resourceType":"Asset",
```

```
                "created":"2011-08-01T18:29:49.793Z",
                "lastModified":"2011-08-01T18:29:49.793Z",
                "location":
                "https://example.com/v2/Assets/2819c223-7f76-453a-919d-13861904646",
                "version":"W\/\"f250dd84f0671c3\""
            },
            "serialNumber":"<asset identifier>",
            "manufacturerDN":"<DN of manufacturer>",
            "status":"<asset status>",
            "entitlements": "<asset permissions>",
            "certificates": " "<asset certificates>"
        ],

  }
  ]
}
```

Note 2: a response with CN attribute has the following form:

```
HTTP/1.1 200 OK
Content-Type: application/scim+json
{
      "schemas":["urn:ietf:params:scim:api:messages:2.0:ListResponse"],
      "totalResults":1,
      "Resources": [
      {
            "id":"2819c223-7f76-453a-919d-413861904646",
            "schemas":["urn:ietf:params:scim:eu-rail:2.0:Asset"],
            "meta":{
                  "resourceType":"Asset",
                  "created":"2011-08-01T18:29:49.793Z",
                  "lastModified":"2011-08-01T18:29:49.793Z",
                  "location":
                  "https://example.com/v2/Assets/2819c223-7f76-453a-919d-13861904646",
                  "version":"W\/\"f250dd84f0671c3\""
            },
            "CN":"<asset identifier>",
            "status":"<asset status>",
            "entitlements": "<asset permissions>",
            "certificates": " "<asset certificates>"
        ],

  }
  ]
}
```

Note 3: additional attributes are allowed **[**SPPRAMSS-9842 **]**

, SP-SEC-Serv-7.1-9 - The SCS-IAM shall support the following states for assets: CREATED**,** ACTIVE, INACTIVE, COMMISSIONING, DECOMMISSIONED. **[**SPPRAMSS-15431 **]**

, SP-SEC-Serv-7.1-10 - The SCS-IAM shall support the state changes for assets as depicted in the following figure:

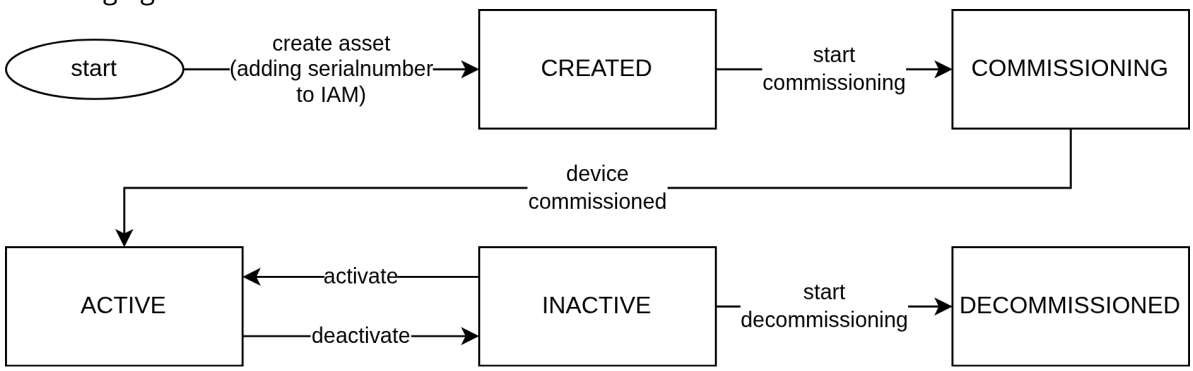


Figure 9 asset state transitions for SCS-IAM

[SPPRAMSS-15430]

, SP-SEC-Serv-7.1-11 - If the SCS-IAM has no record of the requested asset, the SCS-IAM shall return a SCIM response with the schema `urn:ietf:params:scim:api:messages:2.0:ListResponse`, containing `totalResults` set to 0 and an empty `Resources` list.

Note: such a response has the following form:

```
HTTP/1.1 200 OK
Content-Type: application/scim+json
{
      "schemas":["urn:ietf:params:scim:api:messages:2.0:ListResponse"],
      "totalResults":0,
      "Resources": [
    ]
}
```

[SPPRAMSS-6709]

, SP-SEC-Serv-7.1-12 - The server implementing SSI-PKI shall support the ability to add issued certificates to an existing asset resource in the SSI-IAM service by sending a SCIM request with the schema `urn:ietf:params:scim:api:messages:2.0:PatchOp` and add the following values to the request:

- certificate type (according to 6.3 - PKI CA/RA requirements) as "type"
- certificate status "issued" or "revoked" as "status"
- certificate's Common Name as "cn"
- certificate content as base64-encoded in DER format as "value"

Note 1: such a request has the following form:

```
PATCH /v2/Assets/<asset identifier> HTTP/1.1
Host: <SSI-IAM instance address>
User-Agent: <IAM REST Client identifier>
Accept: application/scim+json
Content-Type: application/scim+json
{
      "schemas":["urn:ietf:params:scim:api:messages:2.0:PatchOp"],
      "operations":[{
            "op":"add",
            "value":{
```

```
                "certificates":[
                {
                      "type":"<certificate type>",
                      "status":"<certificate status>",
                      "cn": "<CN of certificate>",
                      "value":"<certificate>"
                }]
          }
    }]

}
```

Note 2: additional attributes are allowed [SPPRAMSS-6710]

, **SP-SEC-Serv-7.1-13 -** If the SSI-IAM successfully added the supplied certificate to the assets resource, the SSI-IAM shall return a SCIM response with the schema `urn:ietf:params:scim:api:messages:2.0:ListResponse` as defined in SP-SEC-Serv-7.1-8 [SPPRAMSS-6715]

, **SP-SEC-Serv-7.1-14 -** If the SCS-IAM successfully added a supplied ODC with status "issued" and if the corresponding asset is in status "COMMISSIONING", the SCS-IAM shall set the status of the corresponding asset to "ACTIVE". [SPPRAMSS-15511]

7.2 User Inventory

, **SP-SEC-Serv-7.2-1 -** The SSI-IAM shall provide access to its user inventory via SCIM under the endpoint `/v2/Users`. [SPPRAMSS-9815]

, **SP-SEC-Serv-7.2-2 -** The SSI-IAM shall enforce the following permissions for its user inventory:

Permission Name	Description
`eu.rail.security.iam.read-permissions`	This permission allows to retrieve all permissions for a single user specified by their email address (see SP-SEC-Serv-7.2-4)

[SPPRAMSS-11372]

, **SP-SEC-Serv-7.2-3 -** The SSI-IAM shall assign the following permissions:

Asset Type	Permissions
all component types	`eu.rail.security.iam.read-permissions`

Note: mapping these permissions to roles, which match to component types, is allowed
[SPPRAMSS-11373]

, **SP-SEC-Serv-7.2-4 -** The Users endpoint is used by the following components and interfaces to retrieve user information from SSI-IAM:

- SCS-UAS requests user information using the following filter:
  - User E-Mail with attribute emails

Note: such a request has the following form:

```
GET /v2/Users?filter=emails.value eq "[user email]"&attributes=emails.value,entitlements cn HTTP/
1.1
```

```
Host: [SSI-IAM instance address]
User-Agent: [SSI-IAM REST Client identifier]
Accept: application/scim+json
```
[SPPRAMSS-9817**]**

, SP-SEC-Serv-7.2-5 - If the SSI-IAM can provide the requested user permissions, the SSI-IAM server shall return a SCIM response with the schema `urn:ietf:params:scim:api:messages:2.0:ListResponse`, containing `Resources` of the schema `urn:ietf:params:scim:core:2.0:User`, which includes the users email addresses as values in the "emails" resource and the users permissions as values in the "entitlements" resource.

Note 1: such a response has the following form:

```
HTTP/1.1 200 OK
Content-Type: application/scim+json
{
      "schemas":["urn:ietf:params:scim:api:messages:2.0:ListResponse"],
      "totalResults":1,
      "Resources": [
      {
            "id":"2819c223-7f76-453a-919d-413861904646",
            "schemas":["urn:ietf:params:scim:core:2.0:User"],
            "externalId":"jbloggs",
            "meta":{
                  "resourceType":"User",
                  "created":"2011-08-01T18:29:49.793Z",
                  "lastModified":"2011-08-01T18:29:49.793Z",
                  "location":
                  "https://example.com/v2/Users/2819c223-7f76-453a-919d-13861904646",
                  "version":"W\/\"f250dd84f0671c3\""
            },
            "emails":[
                {"value":"joe.bloggs@example.com"}
            ],
            "entitlements": [
               {"value": "eu.rail.sdi.diagnostic-read"},
               {"value": "eu.rail.ssi.security-read"}
            ]
        ],
  }
  ]
}
```

Note 2: additional attributes are allowed **[**SPPRAMSS-9818**]**

8 NAC: Network Access Control

, SP-SEC-Serv-8-1 - The purpose of the SSI Network Access Control (SSI-NAC) interface is to prevent unauthorized access to the network. The SCS-NAC shall identify, authenticate, and authorize the entity attempting to access the network. IEEE 802.1X is used as basis for the Network Access Control solution.

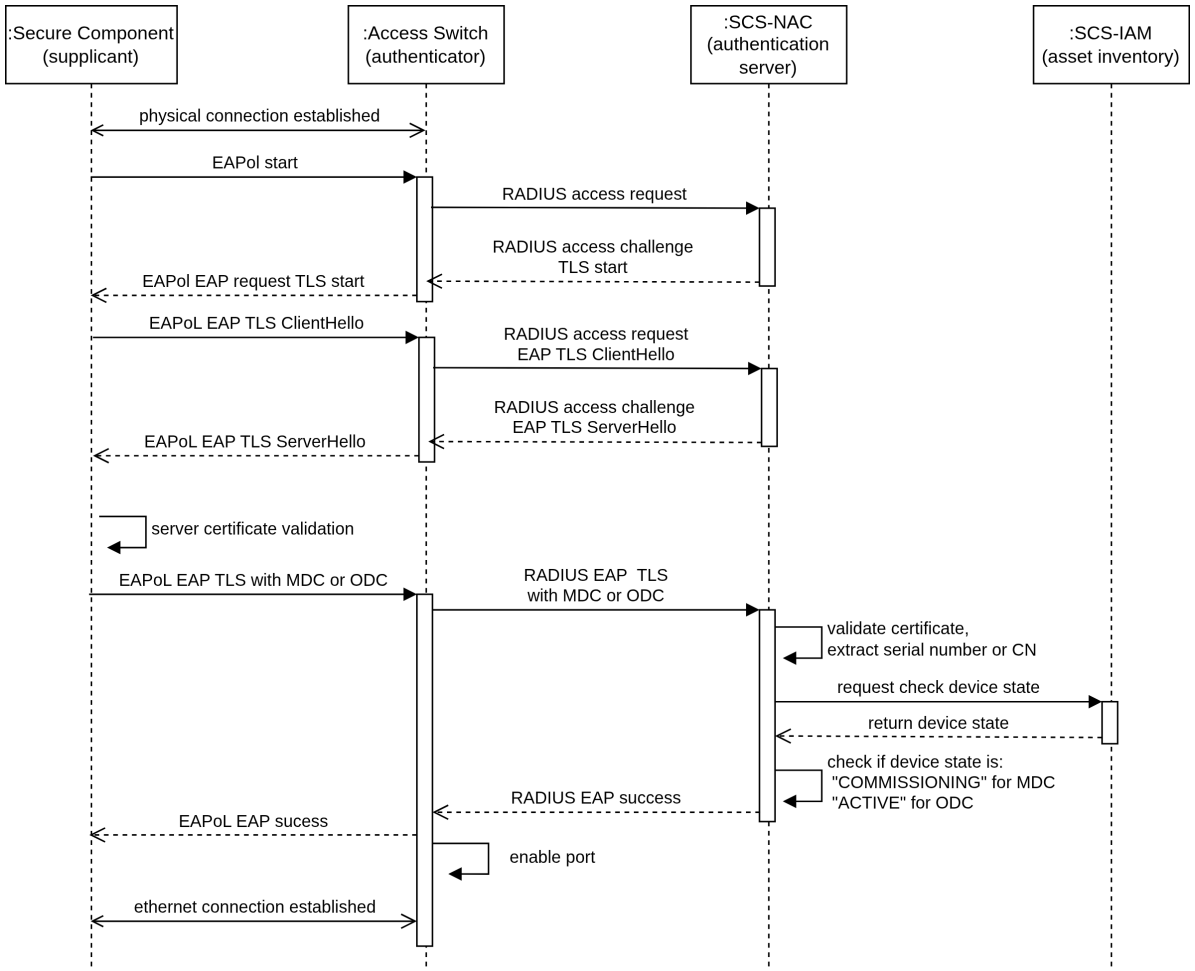


Figure 11 Network authentication sequence diagram **[**SPPRAMSS-4814 **]**

, SP-SEC-Serv-8-2 - The SSI-NAC interface shall realize network authentication using SP-SEC-Serv-2.3-6 - [IEEE 802.1X-2020]. **[**SPPRAMSS-10039 **]**

, SP-SEC-Serv-8-3 - The SSI-NAC interface shall realize the EAP-TLS protocol as described in SP-SEC-Serv-2.3-26 - [RFC 9190]. **[**SPPRAMSS-4817 **]**

, SP-SEC-Serv-8-4 - The SSI-NAC interface shall realize the RADIUS protocol as described in SP-SEC-Serv-2.3-8 - [RFC 2865]. **[**SPPRAMSS-4862 **]**

, SP-SEC-Serv-8-5 - The SCS-NAC shall reply to RADIUS requests using an ONCC to authenticate itself towards the 802.1X supplicant. **[**SPPRAMSS-4897 **]**

, SP-SEC-Serv-8-6 - The SCS-NAC shall extract the serial number of the MDC of the requesting 802.1X supplicant (see SP-SEC-Serv-14.1.1-1). **[**SPPRAMSS-4945 **]**

, SP-SEC-Serv-8-7 - The SCS-NAC shall extract the CN of the ONCC of the requesting 802.1X supplicant (see SP-SEC-Serv-14.1.2-1). **[**SPPRAMSS-13065 **]**

, SP-SEC-Serv-8-8 - The SCS-NAC shall use the SSI-IAM interface to check if the requesting 802.1X supplicant is authorized to access the network in the SCS-IAM. **[**SPPRAMSS-4944 **]**

, SP-SEC-Serv-8-9 - The SCS-NAC shall allow network access to a 802.1X supplicant, if the 802.1X supplicant is authorized based on its MDC and the asset exists in the SCS-IAM and its state is "COMMISSIONING". **[**SPPRAMSS-15433 **]**

, SP-SEC-Serv-8-10 - The SCS-NAC shall allow network access to a 802.1X supplicant, if the 802.1X supplicant is authorized based on the ODC and the asset exists in the SCS-IAM and its state is "ACTIVE". **[**SPPRAMSS-15432 **]**

, SP-SEC-Serv-8-11 - If the 802.1X supplicant is authorised to access the network, the SCS-NAC shall reply with a RADIUS EAP success to the RADIUS authenticator. **[**SPPRAMSS-4946 **]**

, SP-SEC-Serv-8-12 - If the 802.1X supplicant is not authorised to access the network, the SCS-NAC shall reply with a RADIUS EAP failure to the RADIUS authenticator. **[**SPPRAMSS-4947 **]**

, SP-SEC-Serv-8-13 - If the 802.1X supplicant does not have all information for certificate validation, the 802.1X supplicant may skip the validation of the server certificate provided by the SCS-NAC. **[**SPPRAMSS-18434 **]**

, SP-SEC-Serv-8-14 - The 802.1X supplicant shall use the Operator Device Certificate (ODC) as specified in SP-SEC-ServSpec Ch 13.1.2-1 - Operator Device Certificate for authentication towards the Network Authentication Server. **[**SPPRAMSS-18436 **]**

, SP-SEC-Serv-8-15 - If no Operator Device Certificate (ODC) is available, the 802.1X supplicant shall use the Manufacturer Device Certificate (MDC) as specified in SP-SEC-ServSpec Ch 13.1.1-1 - Manufacturer Device Certificate for authentication towards the Network Authentication Server.

Note: to ensure that the Network Authentication Server uses the Manufacturer Device Certificate (MDC) only in the cases where it is necessary (e.g. when a new device is plugged into the network which does not have an operator trust anchor certificate) **[**SPPRAMSS-18437 **]**

, SP-SEC-Serv-8-16 - The Network Component acting as a SCS-NAC Authenticator shall support IEEE 802.1x EAP TLS network authentication.

Note: IEEE 802.1x EAP TLS might also be required for trunk ports **[**SPPRAMSS-18622 **]**

, SP-SEC-Serv-8-17 - The Network Component acting as a SCS-NAC Authenticator shall support the RFC 2865 RADIUS protocol for network authentication. **[**SPPRAMSS-18621 **]**

9 LOG: Security Logging

, SP-SEC-Serv-9-1 - The Security Logging Interface enables the transmission of logs from devices via relays to a central service. Logs are used to detect attacks on the system to initiate mitigations. In contrast, Security Diagnostic contains the current state of the log originator, based on a diagnostics model. **[**SPPRAMSS-7975 **]**

, SP-SEC-Serv-9-2 - The Security Logging consists of syslog log originators (which creates log messages), one or more syslog relays (which forwards and potentially filters log messages) and syslog collectors (which analyse the logs).

[SPPRAMSS-4403 **]**

, SP-SEC-Serv-9-3 - The following Figure depicts an example for a logging architecture. The exact implementation is not defined in this document.

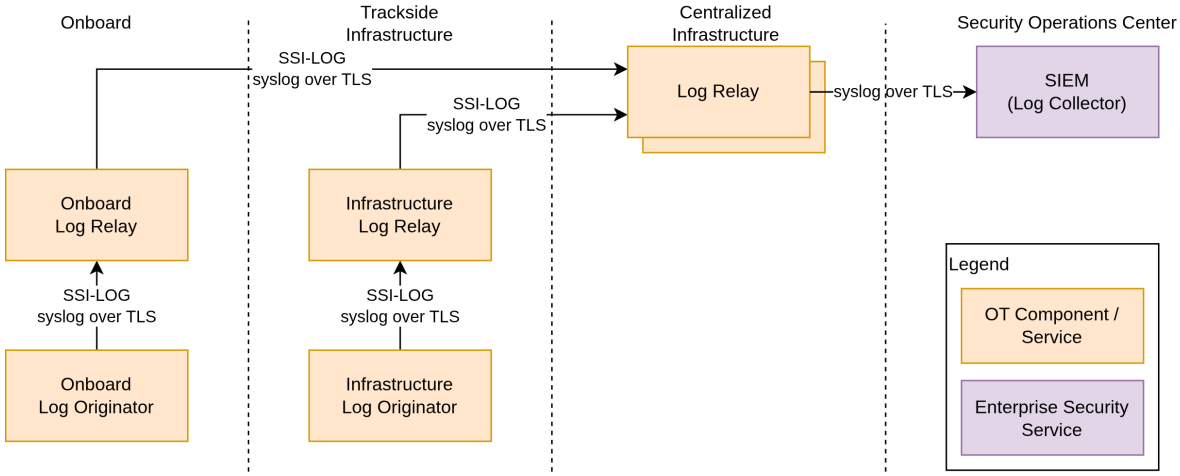


Figure 10 Example of architecture of the Log Services

[SPPRAMSS-4786]

, SP-SEC-Serv-9-4 - The Security Logging (LOG) of the Shared Cybersecurity Services is a syslog relay service which collects, potentially filters or correlates and forwards the log messages to upstream log relays or log collectors.
[SPPRAMSS-4402]

, SP-SEC-Serv-9-5 - The communication partners using the SSI-LOG (log originator, log relay, log collector) shall use syslog over TLS as defined in RFC SP-SEC-Serv-2.3-12 - [RFC 5424] and SP-SEC-Serv-2.3-13 - [RFC 5425] for sending and/or receiving security log messages.
[SPPRAMSS-4404]

, SP-SEC-Serv-9-6 - The communication partners using the SSI-LOG (log originator, log relay, log collector) shall use for each syslog-over-TLS connection an Operator Non-safety Communication Certificate (ONCC). [SPPRAMSS-4409]

9.1 Log Message Format

9.1.1 Structured Data Format

, SP-SEC-Serv-9.1.1-1 - Log messages shall conform to the syslog format as defined in SP-SEC-Serv-2.3-12 - [RFC 5424]. [SPPRAMSS-4795]

, SP-SEC-Serv-9.1.1-2 - If a log message is not created by third-party software, the log message shall conform to the structured data format defined in Chapter 6.3 of SP-SEC-Serv-2.3-12 - [RFC 5424].
Note: This means, that third-party software (e.g. open source software) does not need be adapted. [SPPRAMSS-7522]

, SP-SEC-Serv-9.1.1-3 - If a log message is not created by third-party software, the log message shall contain the SD-ID “SEC_LOG@” + vendor private enterprise number (see SP-SEC-Serv-2.3-3 - [IANA PENs]). [SPPRAMSS-4823]

, SP-SEC-Serv-9.1.1-4 - If a log message is not created by third-party software, the log message shall contain the following parameter names in the structured data field: user, credential, action, object, src, status, reason, and contentid.

Table 11 Log Structured Data fields

Keyword (PARAM-NAME as defined in [RFC 5424])	**Description**	**Recommended values** (PARAM-VALUE as defined in [RFC 5424], additional values are allowed)	**Examples**
user	String representing the entity triggering the action, e.g., the user authenticating or causing the change to happen.	• Username/ID • Process-name:PID • Unknown – if the entity is not identified • None – if no user is associated with this action e.g., resource exhaustion	John_Doe1 (human user) 820xauth:34593 (SW process)
credential	String representing the type of credentials used to perform the associated action, e.g., the user authenticating or changing.	• X509cert – certificate-based authentication • SSHcert – certificate-based authentication (ssh only) • pwAuth – password-based authentication • IAMSSOtoken – Bearer token-based authentication • local – for local access without explicit authentication	X509cert SSHcert pwAuth IAMSSOtoken local
action	Human-readable free text in English describing, what happened.	Human-readable free text in English, however, starting with a keyword is recommended, which identifies the broad action type.	login access change monitor
object	String describing, what was affected by the performed action, e.g., a session created, malicious file opened, rasta connection disturbed, ...	• Component name/id • Account • File name • Data resource name • Process-name:PID	OPC.UA.Model.ModuleX John_Doe1 (human user) /etc/conf.xml sda3

Keyword (PARAM-NAME as defined in [RFC 5424])	Description	Recommended values (PARAM-VALUE as defined in [RFC 5424], additional values are allowed)	Examples
src	String representing the source of the event.	• IP address:Port number – for remotely triggered events • Process name:PID – local events • FQDN • Any technical identifier	10.10.1.20:1043 [fe80:1111::4444:0:0]:8888 webserver:4951 localhost **ETCS FQDN example:** Id8470f.ty01.etcs **EULYNX technical identifier example:** [country code][area designator][system type][code][tag][sequence no] DEHG2_XIO___37##0005
status	String description of the action status.	• Success • Failure • Unknown • Empty String (e.g., for availability events)	success failure unknown
reason	Human-readable free text in English demonstrating the reason and the way of action.	Human-readable free text in English	“invalid chain of trust: root XYZ not accepted”
contentid	String defining a unique message ID for translation purposes	A unique ID for this log message	SSI_IAM_OPC_UA_MSG_13

[SPPRAMSS-4807]

, SP-SEC-Serv-9.1.1-5 - A log message can optionally contain the following parameter names in the structured data field: serial

Keyword (PARAM-NAME as defined in [RFC 5424])	Description	Allowed values (PARAM-VALUE as defined in [RFC 5424], additional values are allowed)	Examples
serial	Manufacturer serial number of the device sending the log message	Free text	12345679-01

[SPPRAMSS-13915]

9.1.2 Syslog Header Definitions

, SP-SEC-Serv-9.1.2-1 - The following requirements are applicable for custom-made software. These requirements are not mandatory for third-party software.
Note: third-party software is software that is acquired for use without direct control over its design or development process. Custom-made software is software that is developed and maintained by an organization which has direct influence over its design and development process. **[**SPPRAMSS-9607 **]**

, SP-SEC-Serv-9.1.2-2 - The log originator shall set the facility of the syslog header to "4" (security/ authorization messages) as defined in SP-SEC-Serv-2.3-12 - [RFC 5424]. **[**SPPRAMSS-7976 **]**

, SP-SEC-Serv-9.1.2-3 - The log originator shall set the SEVERITY of the syslog header for debug messages for application developers to "7" (debug). **[**SPPRAMSS-4805 **]**

, SP-SEC-Serv-9.1.2-4 - The log originator shall set the SEVERITY of the syslog header for the audit log to "6" (info) in case of a successful event (e.g. successful authentication). **[**SPPRAMSS-4806 **]**

, SP-SEC-Serv-9.1.2-5 - The log originator shall set the SEVERITY of the syslog header for the audit log to "4" (warning) in case of an unsuccessful event (e.g. unsuccessful authentication). **[**SPPRAMSS-4804 **]**

, SP-SEC-Serv-9.1.2-6 - The log originator shall set the SEVERITY of the syslog header for all error conditions not requiring immediate action, but human attention to "3" (error). **[**SPPRAMSS-4810 **]**

, SP-SEC-Serv-9.1.2-7 - The log originator shall set the SEVERITY of the syslog header for all events requiring immediate action, likely by a human, to "1" (alert). **[**SPPRAMSS-4811 **]**

, SP-SEC-Serv-9.1.2-8 - The log originator shall log at least the following events:
a) access control;
b) request errors;
c) control system events;
d) backup and restore event;
e) configuration changes; and
f) audit log events (incl. administrative actions, input validation errors)
g) threats (attacks and probes)
h) resource events (system resources reaching a threshold)
i) availability (shutdown, failures, crashes). **[**SPPRAMSS-18620 **]**

, SP-SEC-Serv-9.1.2-9 - The following table gives examples for the use of severity levels:
Note: Debug messages are not included in this table because they are highly application-specific.

Table 11 Examples of syslog structured data

Log Type	6 – Info	4 – Warning	3 – Error	1 – alert
AAA (Authentication, Authorization, Access)	Successful authentication or authorization decisions Successful remote access, including from one application component to another in a distributed environment Significant system access, data access, and application component access	Failed authentication or authorization decisions Failed remote access attempts Failed re-authentication or session timeouts	Repetitive failed authentication resulted in a locked user account	
Change	Successful changes, e.g: System or application changes (especially privilege changes) Data changes (including creation and destruction) Application and component installation and changes Changes to PKI (certificate requests,	Unsuccessful changes first CRL update failure first failed certificate update	System changes could affect security and availability repeated CRL update failure (one month before expiration) repeated failed certificate update (one month before expiration)	System changes lead to a security and availability problems repeated CRL update failure (two weeks before expiration) Changes of security configuration Factory reset repeated failed certificate update (two weeks before expiration)

Log Type	6 – Info	4 – Warning	3 – Error	1 – alert
	certificate revocations)			
Threat		Attack attempts and probes (e.g. pings, nmap scans, connection attempts, to unused ports)	Attacks that have a high chance of being successful (e.g. malformed requests)	Attacks that are successful (e.g. unexpected states within application, failed runtime integrity checks / security configuration)
Resource	Statistical resource information	System reaching or falls below a first water mark value (warning level threshold)	System reaching a high water mark value, system operation might be endangered in some time System falls below high water mark value. Faults that can affect a system operation	System reaching capacity, system operation is endangered System recovers from capacity errors
Availability	Status messages o f hardware, systems, applications or components	Startup/shutdow n/restart of systems, applications or components	Failures of systems, applications or components Unavailability of a non-critical service such as	Crashes of systems, applications or components Unavailability of a critical service such as SCS-IAM,

Log Type	6 – Info	4 – Warning	3 – Error	1 – alert
			SCS-STS, SCS-PKI, SCS-BKP, SCS-MNT	SCS-NAC, SCS-LOG, SCS-UAS, SCS-DNS

[SPPRAMSS-4803]

, SP-SEC-Serv-9.1.2-10 - The timestamp of the syslog header contains the time when the log message was created on the originating system (syslog originator). [SPPRAMSS-4826]

, SP-SEC-Serv-9.1.2-11 - The log originator shall set the timestamp of the syslog header to the current time as defined in SP-SEC-Serv-2.3-12 - [RFC 5424] using UTC date/time format including milliseconds using TIME-SECFRAC.
Note: An Example for for such a timestamp is `2038-01-19T:03:14:08.000Z` [SPPRAMSS-4819]

, SP-SEC-Serv-9.1.2-12 - The log originator shall set the HOSTNAME to one of the following values: FQDN, static IP address, hostname, dynamic IP address or use-case specific identifier (e.g. etcs FQDN with board number as suffix).
Note: HOSTNAME contains an Identifier for the machine that sent the log message [SPPRAMSS-4831]

, SP-SEC-Serv-9.1.2-13 - The APP-NAME is a String containing the identification of the application that created the log message. [SPPRAMSS-4836]

, SP-SEC-Serv-9.1.2-14 - Process ID of the syslog daemon is automatically set by syslog implementation. [SPPRAMSS-4834]

, SP-SEC-Serv-9.1.2-15 - The log originator shall set the MSGID as defined in SP-SEC-Serv-2.3-12 - [RFC 5424] to one of the following values:

- AAA (Authentication, Authorization, Access)
- Change
- Threat
- Resource
- Availability
- Debug
- Other

[SPPRAMSS-4838]

, SP-SEC-Serv-9.1.2-16 - The msg part of the syslog message is optional if the structured data contains all necessary information. [SPPRAMSS-4844]

, SP-SEC-Serv-9.1.2-17 - If the msg part is used, the log originator shall use UNICODE with UTF-8 encoding. [SPPRAMSS-4843]

, SP-SEC-Serv-9.1.2-18 - If the msg part is used, the log originator shall not use Octet values below 32 (control character range). [SPPRAMSS-4846]

9.2 Log Message Examples

These examples showcase how log messages are structured:

- Authentication failure due to untrusted root certificate
  ```
  <syslog header>[SEC_LOG@32473 user="John_Doe1" credential=”X509cert” action=”login” object=”OPC.UA.Model.ModuleX” src=”10.10.1.20:1043” status=”failure” reason=”invalid chain of trust: root XYZ not trusted” contentid=”SSI_IAM_OPC_UA_MSG_13”]
  ```
- Process runtime integrity check failed
  ```
  <syslog header>[SEC_LOG@32473 user="runtime-integrity-daemon:5" credential=”local” action=”monitor” object=”/usr/bin/openssl” src=”localhost” status=”failure” reason=”Integrity check failed for binary /usr/bin/openssl” contentid=”SECCOMP_PROCESS_RUNTIME_INTEGRITY_MSG_1”]
  ```
- Log originator sending a certificate request
  ```
  <syslog header>[SEC_LOG@32473 user="certificate-maintainer:6" credential=”local” action=”change” object=”new operator device certificate” src=”localhost” status=”success” reason=”Send certificate request for new operator device certificate” contentid=”SECCOMP_CERT_MAINTAINER_MSG_3”]
  ```

10 UAS: User Authentication Service

, SP-SEC-Serv-10-1 - The User Authentication Service enables authentication of human users.
Note: User authentication on operating system level is not part of this standard. **[**SPPRAMSS-12404 **]**

, SP-SEC-Serv-10-2 - The following UAS Endpoints exist

- SCS-UAS (OpenID Connect - Authorisation Server / OpenID Provider)
- UAS Client (OpenID Connect - Client Application & User Agent)
- UAS Resource Server (OpenID Connect - Resource Server)

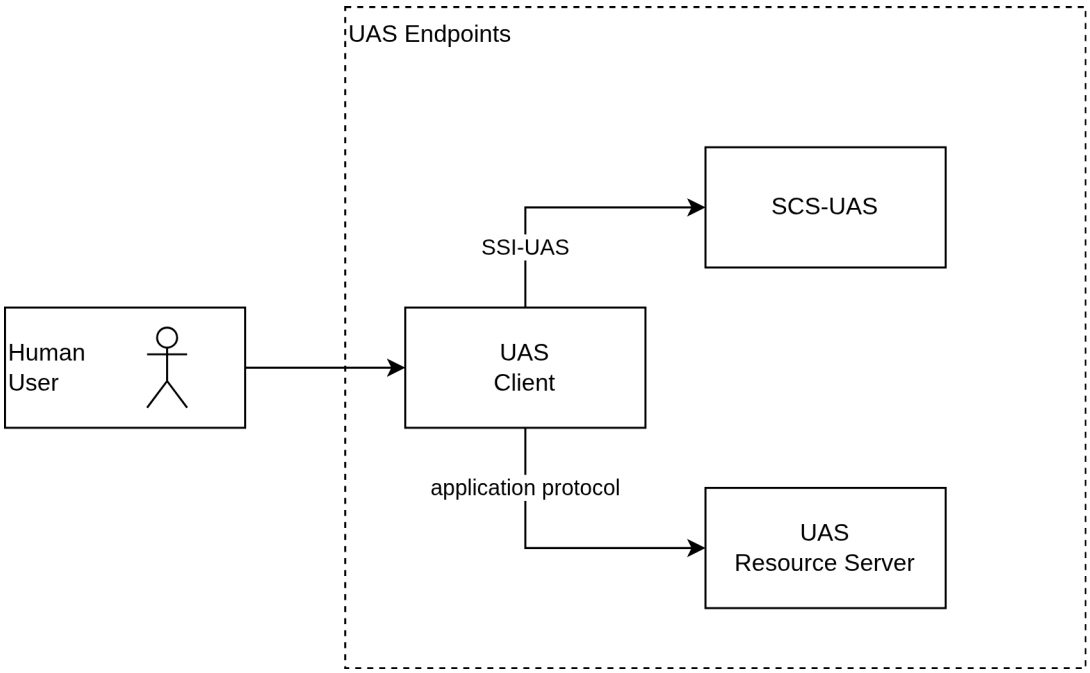


Figure 11 Endpoints of the User Authentication Service (UAS)

Note: UAS Client and Resource Server can be implemented in one or multiple devices. [SPPRAMSS-16449]

, SP-SEC-Serv-10-3 - The SCS-UAS shall support multi-factor authentication of human users. [SPPRAMSS-4675]

, SP-SEC-Serv-10-4 - The UAS Resource Server shall only accept requests from human users authenticated via SCS-UAS. [SPPRAMSS-16451]

, SP-SEC-Serv-10-5 - The UAS Resource Server shall only grant access to resources according to the token claims. [SPPRAMSS-16450]

, SP-SEC-Serv-10-6 - The SSI-UAS Endpoint shall implement single sign-on (SSO) based on OpenID Connect 1.0 (OIDC) as defined in SP-SEC-Serv-2.3-5 - [OIDC 1.0]. [SPPRAMSS-6055]

, SP-SEC-Serv-10-7 - The SSI-UAS Endpoint shall use the OAuth 2.0 Authorization Code Flow as defined in SP-SEC-Serv-2.3-5 - [OIDC 1.0] when authenticating human users.
Note 1: This means, that ID Tokens, Authorization Codes and Access Tokens need to be handled by the client. This functionality is supported by browsers and capable HTTP client implementations.
Note 2: The use of PKCE as defined in SP-SEC-Serv-2.3-15 - [RFC 7636] is recommended. [SPPRAMSS-6066]

, SP-SEC-Serv-10-8 - The SCS-UAS shall use an Operator Non-safety Communication Certificate (ONCC) for server authentication.
Note: SCS-UAS does not expect client authentication for the TLS connection [SPPRAMSS-15507]

, SP-SEC-Serv-10-9 - The SCS-UAS shall support authentication with X.509 client certificates complying to the Operator User Certificate (OUC) profile see SP-SEC-Serv-14.1.2-4. [SPPRAMSS-6575]

, SP-SEC-Serv-10-10 - The SCS-UAS shall support authentication with username/password with at least one additional factor (e.g. authenticator apps using TOTP (time-based one-time-password)). [SPPRAMSS-6574]

, SP-SEC-Serv-10-11 - The SCS-UAS should support passwordless authentication with at least one additional factor (e.g. passkeys with biometric factor). [SPPRAMSS-6576]

10.1 SSI-Tokens for Authentication and Authorisation

, SP-SEC-Serv-10.1-1 - The SCS-UAS shall include in Access Tokens at least the JWT claims defined as mandatory according to SP-SEC-Serv-10.1-3 - Table # JWT claims for Access Tokens and ID Tokens. [SPPRAMSS-6068]

, SP-SEC-Serv-10.1-2 - The SCS-UAS shall include in ID Tokens at least the JWT claims defined as mandatory according to SP-SEC-Serv-10.1-3 - JWT claims for Access Tokens and ID Tokens. [SPPRAMSS-6559]

, SP-SEC-Serv-10.1-3 -

Table 12 JWT claims for Access Tokens and ID Tokens

Claim	Description	Use in JWT access token	Use in JWT ID token
sub	Subject identifier of the user that requested the token.	mandatory	mandatory
iss	Issuer of the token.	mandatory	mandatory
aud	Identifier of the audience the token is intended for. Shall be set to the URL of the service to be accessed.	mandatory	mandatory
exp	Expiration time of the token. The lifetime should not be longer than the maximum session idle time at the service to be accessed (e.g. 30 minutes).	mandatory	mandatory
jti	JWT ID. Unique identifier of the token. Automatically generated by the OpenID Provider.	mandatory	mandatory
scope	Scope values for authorization. Shall only contain the permissions of the user.	mandatory	no
auth_time	Time of user authentication.	recommended	recommended
nonce	Value used to associate a Client session with an ID Token.	recommended	recommended
amr	Authentication Method Reference. Allowed values as defined in SP-SEC-Serv-2.3-19 - [RFC 8176] • sc (Smartcard) plus pin (Personal Identification Number) • mfa (Multi-factor authentication), for example pwd (Password) plus otp (One-time Password) • A combination of hwk (hardware key) and swk (software key) plus fpt (fingerprint) and face (facial recognition)	mandatory	mandatory
email	email address of the authenticated user.	mandatory	mandatory

[SPPRAMSS-6578 **]**

, SP-SEC-Serv-10.1-4 - The SCS-UAS shall set the expiration time of Access Tokens to a configurable maximum time.

Note: The maximum validity of the access token is set to be in line with the security policies of the Infrastructure Manager and the practical feasibility in daily operation. **[**SPPRAMSS-6671 **]**

, SP-SEC-Serv-10.1-5 - The SCS-UAS shall set the expiration time of ID Tokens to a configurable maximum time. **[**SPPRAMSS-16452 **]**

10.2 Token Validation

, SP-SEC-Serv-10.2-1 - The SSI-UAS Resource Server shall verify the signature of a token before accepting it. **[**SPPRAMSS-6563 **]**

, SP-SEC-Serv-10.2-2 - The SSI-UAS Resource Server shall verify that all mandatory token claims as defined in SP-SEC-Serv-10.1-3 - Table # JWT claims for Access Tokens and ID Tokens are included in the token. **[**SPPRAMSS-6580 **]**

, SP-SEC-Serv-10.2-3 - The SSI-UAS Resource Server shall verify the content of all included token claims **[**SPPRAMSS-6583 **]**

11 BKP: Backup and Restore

, SP-SEC-Serv-11-1 - Backups are intended for operational data that are relevant for operational availability (e.g. changes in databases), but are not part of the configuration. Most rail automation devices receive data required for operation from a central repository and do not need the interface SSI-BKP. **[**SPPRAMSS-9700 **]**

, SP-SEC-Serv-11-2 - Backup creation can be triggered either locally by the backup client or centrally by the SCS-BKP server as shown in Figure 14. The SCS-BKP server may be located trackside or on-board. The backup is uploaded to SCS-BKP via HTTPS POST to a URI. In case of remote trigger, this URI is defined in the input parameter of the `CreateBackup` OPC UA call. In case of local trigger, a preconfigured URI is used.

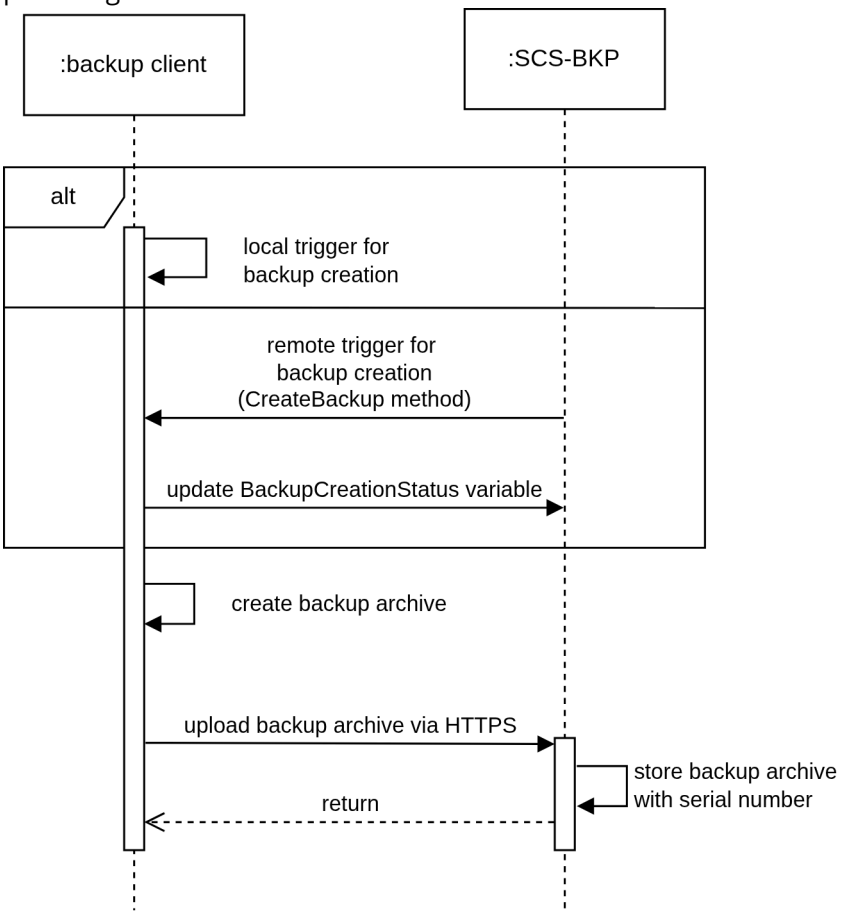


Figure 12 Backup Creation Sequence Diagram

The SCS-BKP triggers backup restoration on the backup client as shown in Figure 15. Following this

trigger, the backup client requests the backup archive to be restored from SCS-BKP.

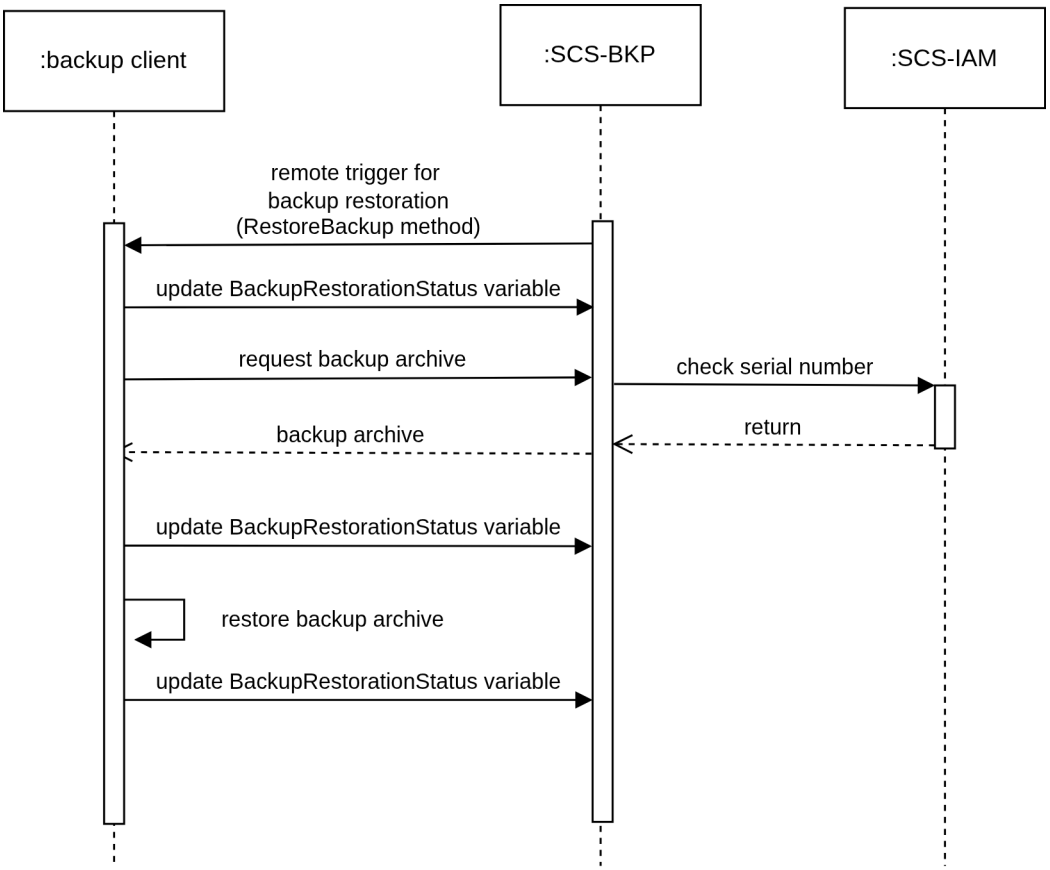


Figure 13 Backup Restoration Sequence Diagram

[SPPRAMSS-4483**]**

, SP-SEC-Serv-11-3 - The SCS-BKP shall act as OPC UA client compliant to requirements specified in SP-SEC-Comm chapter 4. **[**SPPRAMSS-18668**]**

, SP-SEC-Serv-11-4 - The backup client shall act as OPC UA server compliant to requirements specified in SP-SEC-Comm chapter 4. **[**SPPRAMSS-18669**]**

, SP-SEC-Serv-11-5 - The SCS-BKP shall act as HTTP server compliant to requirements specified in SP-SEC-Comm chapter 5. **[**SPPRAMSS-18671**]**

, SP-SEC-Serv-11-6 - The backup client shall act as HTTP client compliant to requirements specified in SP-SEC-Comm chapter 5. **[**SPPRAMSS-18670**]**

, SP-SEC-Serv-11-7 - A backup shall consist of one or multiple backup artifacts which contain the component-specific backup data packaged as a TAR archive and compressed using the GZIP format as defined in SP-SEC-Serv-2.3-7 - [RFC 1952] with the following filename pattern:`<YYYYMMDDThhmmssZ>_<serialNumber-from-ONCC-Subject>[_<fragment_id>].tar.gz`

Note: `<YYYYMMDDThhmmssZ>` is the timestamp of artifact creation. `<serialNumber-from-ONCC-Subject>` is the value of the serialNumber attribute contained in the Subject of the backup client's ONCC and identifies the asset to which the backup

belongs. [_<fragment-id>]is optional. If present, <fragment-id> identifies a fragment within the overall backup. [SPPRAMSS-4486]

, SP-SEC-Serv-11-8 - A backup shall be described in a metadata file with the following filename pattern <YYYYMMDDThhmmssZ>_<serialNumber-from-ONCC-Subject>.metadata.json which includes a fragments property listing all fragments in an array

Note1: a metadata file has the following form:

```
{
   "fragments": [ "20260401T000000Z_myComonentType_myApplicationId_fragment1.tar.gz",
"20260402T000000Z_myComonentType_myApplicationId_fragment2.tar.gz", ... ]
}
```

Note2: additional properties are allowed

Note3: this can be used by the backup server to enlist all fragments relevant for a specific backup [SPPRAMSS-18433]

, SP-SEC-Serv-11-9 - The SSI-BKP interface shall implement the following OPC UA methods:

Table 13 OPC UA methods for SSI-BKP

Method Name	Description	Input Arguments	Output Arguments	Permission Required to Execute Method
CreateBackup	Trigger backup creation from SCS-BKP	URL: prefix of the URL for upload of the backup humanReadableTag: user supplied tag that is inserted into the Metadata File for easier identification of the backup machineReadableTag: user supplied tag that is inserted into the Metadata File for easier identification of the backup encryptCert: optional certificate (and trust chain) in PEM format that will be used to derive a key for encryption of the Backup Archive. Note: usage of encryptCert will be detailed in the upcoming version of this specification	Success (use status variables for more info), Failure (status variables are irrelevant)	eu.rail.ssi.backup-create
RestoreBackup	Trigger restoration of backup from SCS-BKP	URL: URL for download of the backup metadata file	Success (use status variables for more info), Failure (status variables are irrelevant)	eu.rail.ssi.backup-restore

Note: these methods are provided by the OPC UA server running on the device which requires backup. [SPPRAMSS-4539]

, SP-SEC-Serv-11-10 - The SSI-BKP interface shall provide the the following OPC UA variables for report status information:

Table 14 OPC UA variables for SSI-BKP

Variable Name	Variable Type	Possible values	Description	Permission Required to Read Variable
BackupCreationStatus	String	100 - Idle 200 - Creating 201 - Failure during creation 500 - Uploading 501 - Failure during upload 900 - TransferCompleted -1 - unexpected error		eu.rail.ssi.backup-create
BackupRestorationStatus	String	100 - Idle 200 - Downloading 201 - Failure during download 500 - Restoring 501 - Failure during restoring 900 - TransferCompleted -1 - unexpected error		eu.rail.ssi.backup-restore

Note 1: these variables are provided by the OPC UA server running on the device which requires backup.
Note 2: more detailed failure states can be implemented using values not defined in this table. **[**SPPRAMSS-4541 **]**

, SP-SEC-Serv-11-11 - The SCS-BKP server and backup client shall verify the integrity of backup archives according to SP-SEC-Serv-2.3-7 - [RFC 1952]. **[**SPPRAMSS-18564 **]**

, SP-SEC-Serv-11-12 - If verification of the CRC contained in the GZIP archive fails, the SCS-BKP server and backup client shall reject the backup archive. **[**SPPRAMSS-18565 **]**

11.1 Server Requirements

, SP-SEC-Serv-11.1-1 - The SCS-BKP shall store, for each uploaded backup artifact, the serialNumber attribute contained in the Subject of the backup client's ONCC. Note: The serialNumber is a functional or technical identifier (e.g. ETCS-ID), which is persistent even if device hardware is exchanged. **[**SPPRAMSS-18678 **]**

, SP-SEC-Serv-11.1-2 - The SCS-BKP shall use an Operator Non-safety Communication Certificate (ONCC) for authenticating towards the backup client. **[**SPPRAMSS-18676 **]**

, SP-SEC-Serv-11.1-3 - The SCS-BKP shall determine via SSI-IAM whether the requesting backup client is authorized to restore the requested backup artifact. **[**SPPRAMSS-18677 **]**

, SP-SEC-Serv-11.1-4 - The SCS-BKP shall only provide a backup artifact to the requesting backup client if the backup client has been successfully authenticated and the backup client is authorized via SSI-IAM to restore the requested backup artifact. **[**SPPRAMSS-18674 **]**

, SP-SEC-Serv-11.1-5 - If the authentication or authorization of the backup client was unsuccessfull, the SCS-BKP shall respond with an HTTP 401 error. **[**SPPRAMSS-18675 **]**

, SP-SEC-Serv-11.1-6 - The SCS-BKP shall check that the serialNumber associated with the backup artifact matches the serialNumber in the Subject of the backup client's ONCC.
Note: Matching serialNumbers provide protection against accidental or unauthorized restoration of backups belonging to a different asset. **[**SPPRAMSS-18680 **]**

, SP-SEC-Serv-11.1-7 - If the serialNumber check fails, the SCS-BKP shall respond with an HTTP 403 error. **[**SPPRAMSS-18681 **]**

11.2 Client Requirements

, SP-SEC-Serv-11.2-1 - The backup client shall use an Operator Non-safety Communication Certificate (ONCC) for authenticating towards the SCS-BKP. **[**SPPRAMSS-18679 **]**

12 MNT: Security Maintenance

, SP-SEC-Serv-12-1 - The SSI-MNT interface is currently used for trackside applications, as defined in technical documents of TSIs. The definition of a standard MNT interface for onboard applications is still ongoing as part of Train-to-Ground communication standardisation. **[**SPPRAMSS-18683 **]**

, SP-SEC-Serv-12-2 - The SSI-MNT server shall act as OPC UA client compliant to requirements specified in Secure Communication Specification Chapter 4. **[**SPPRAMSS-12998 **]**

, SP-SEC-Serv-12-3 - The SSI-MNT client shall act as OPC UA server compliant to requirements specified in Secure Communication Specification Chapter 4. **[**SPPRAMSS-18656 **]**

, SP-SEC-Serv-12-4 - The SSI-MNT server shall use an Operator Non-safety Communication Certificate (ONCC).
[SPPRAMSS-15509 **]**

, SP-SEC-Serv-12-5 - The SSI-MNT client shall use an Operator Non-safety Communication Certificate (ONCC).
[SPPRAMSS-15508 **]**

, SP-SEC-Serv-12-6 - The SCS-MNT shall be capable of using diagnostic values and methods defined in this chapter. **[**SPPRAMSS-18567 **]**

, SP-SEC-Serv-12-7 - The SSI-MNT interface shall implement the following namespaces: `http://eu.rail/ssi/mnt/` with the single child node SSI-MNT. **[**SPPRAMSS-18570 **]**

, SP-SEC-Serv-12-8 - The SSI-MNT node shall contain the the following child nodes: `SecurityStatus`, `Truststore`, `Logging`, `ComponentConfiguration`, `ComponentLifecycleManagement`, `SecurityFunctionalityVerification`.
[SPPRAMSS-18568 **]**

, SP-SEC-Serv-12-9 - The SSI-MNT interface shall implement the following values with the assigned arguments, parent namespaces and permissions:

Table 15 SSI-MNT Values

Value	Data Type	Parent Node	History Flag	Permission Required to Read Value
`SecurityStatus`	boolean	SecurityStatus	enabled	eu.rail.ssi.security-read
`IntegrityCheckStatus`	boolean	SecurityStatus	enabled	eu.rail.ssi.security-read

[SPPRAMSS-18569**]**

, SP-SEC-Serv-12-10 - The SSI-MNT interface shall implement the following methods with assigned arguments, parameters, parent namespaces and permissions:

Table 16 SSI-MNT Methods

Method	Additional Output Arguments	Additional Input Arguments	Parent Node	Permission Required to Execute Method
`UpdateCRLs()`	errorCode: Int32 errorReason: String	None	Truststore	eu.rail.ssi.security-execute
`RenewCert()`	errorCode: Int32 errorReason: String	`String certificateSerialNumber, String issuerDN`	Truststore	eu.rail.ssi.security-execute
`GetComponentConfiguration()`	String errorCode: Int32 errorReason: String	None	ComponentConfiguration	eu.rail.ssi.security-read
`GetNetworkConfiguration()`	String errorCode: Int32 errorReason: String	None	ComponentConfiguration	eu.rail.ssi.security-read
`InitiateFactoryReset()`	errorCode: Int32 errorReason: String	None	ComponentLifecycleManagement	eu.rail.ssi.factory-reset

Method	Additional Output Arguments	Additional Input Arguments	Parent Node	Permission Required to Execute Method
`TestProcessIntegrityCheck()`	errorCode: Int32 errorReason: String	None	SecurityFunctionalityVerification	eu.rail.ssi.security-test
`TestHostFirewall()`	errorCode: Int32 errorCeason: String	`String destinationIPAddr, UInt16 destinationPort, String protocol`	SecurityFunctionalityVerification	eu.rail.ssi.security-test

Note1: The output arguments errorCode and errorReason are specific for every method and should not be confused with the standard OPC UA status codes
Note2: The TemporaryFileTransferType is defined in https://reference.opcfoundation.org/Core/Part20/v105/docs/4.4
[SPPRAMSS-18571**]**

, SP-SEC-Serv-12-11 - The SSI-MNT interface shall implement the following nodes of Type TemporaryFileTransferType with assigned methods, arguments, parent namespaces and permissions:

Table 17 SSI-MNT TemporaryFileTransferType nodes

Node	Method	Additional Input Arguments	Parent Node	Permission required to execute method
`InstalledCerts`	`GenerateFileForRead()`	None	Truststore	eu.rail.ssi.security-read
`InstalledTrustAnchors`	`GenerateFileForRead()`	None	Truststore	eu.rail.ssi.security-read
`InstalledCRLs`	`GenerateFileForRead()`	None	Truststore	eu.rail.ssi.security-read
`SecurityLog`	`GenerateFileForRead()`	startTime: DateTime endTime: DateTime	Logging	eu.rail.ssi.security-read

[SPPRAMSS-18572**]**

, SP-SEC-Serv-12-12 - All methods in SSI-MNT shall implement the following error codes:

Table 18 SSI-MNT Error Codes

Event	errorCode	errorReason
method executed successfully	0	[empty]
failure during method execution	1	execution error

[SPPRAMSS-18573]

12.1 Overall Security Status

, SP-SEC-Serv-12.1-1 - The SSI-MNT interface shall provide the diagnostic value SSI-MNT:SecurityStatus:SecurityStatus which represents the overall security status of the component.
Note: the value is TRUE when no security related issues (e.g. expired certificates, availability errors to SSI) are currently present, the value is FALSE when security issues are currently present. [SPPRAMSS-10127]

, SP-SEC-Serv-12.1-2 - The SSI-MNT interface shall provide the diagnostic value SSI-MNT:SecurityStatus:IntegrityCheckStatus (Boolean), which represents the status of the integrity checks.
Note: the value is TRUE when no integrity failures have been reported (e.g. process allowlist checks, signature checks for files) and FALSE when integrity errors have occurred since boot time. Details of errors is available from the security logs.
[SPPRAMSS-10126]

12.2 Certificate Maintenance

, SP-SEC-Serv-12.2-1 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:TrustStore:UpdateCRLs()`, which triggers the update of all installed CRLs. [SPPRAMSS-14139]

, SP-SEC-Serv-12.2-2 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:TrustStore:RenewCert()`, which triggers the renewal of the certificate given by the certificate serial number and Distinguished Name (DN) of the issuer.
Note: The default method for certificate renewal is done automatically via SSI-PKI interface. The diagnostic method covers edge cases when certificate renewal is necessary before certificate expiration. [SPPRAMSS-4381]

, SP-SEC-Serv-12.2-3 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:TrustStore:InstalledCerts:GenerateFileForRead()`, which creates a single tar archive with one pem file for every leaf certificate installed on the Secure Component including the full certificate chain. [SPPRAMSS-10138]

, SP-SEC-Serv-12.2-4 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:TrustStore:InstalledTrustAnchors:GenerateFileForRead()`, which creates a single tar archive with one pem file for every operator trust anchor certificate installed on the Secure Component.
[SPPRAMSS-10139]

, SP-SEC-Serv-12.2-5 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:TrustStore::InstalledCRLs:GenerateFileForRead()`, which creates a single tar archive containing one file with extension `.pem` in PEM format per known root CA and intermediate CA containing the CRL of that CA.

Note: the certificate chains needed to validate the CRLs can be retrieved via SSI-MNT:TrustStore:InstalledCerts:GenerateFileForRead() [SPPRAMSS-12393]

12.3 Log Maintenance

, SP-SEC-Serv-12.3-1 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:LoggingSecurityLog:GenerateFileForRead()`, which creates a single plain text file containing all log entries between the given start and end time.

Note: the log file should include a note, if log entries are younger than the startTime, e.g. due to log rotation [SPPRAMSS-10134]

12.4 Configuration Management

, SP-SEC-Serv-12.4-1 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:ComponentConfiguration:GetComponentConfiguration()`, which returns a JSON file including all configuration file names with the SHA-256 hash of the file content in the following form:

```
{
   "configuration":[
      {
         "filename":"configuration filename",
         "hash":"01ba4719c80b6fe911b091a7c05124b64eeece964e09c058ef8f9805da
      },
     ...
   ]
}
```

Note: this maintenance method can be used to detect changes in component configuration by comparing the result with previously stored configurations (or hashes). [SPPRAMSS-10141]

, SP-SEC-Serv-12.4-2 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:ComponentConfiguration:GetNetworkConfiguration()`, which returns a JSON file including all configuration file names with the SHA-256 hash of the file content in the following form:

```
{
   "configuration":[
      {
         "filename":"network configuration item",
         "hash":"01ba4719c80b6fe911b091a7c05124b64eeece964e09c058ef8f9805da
      },
     ...
   ]
}
```

Note: this maintenance method can be used to detect changes in network configuration by comparing the result with previously stored configurations (or hashes). [SPPRAMSS-3088]

12.5 Factory Reset

, SP-SEC-Serv-12.5-1 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:ComponentLifecycleManagement:InitiateFactoryReset()`, which deletes persistent data to reset the component to factory state.

Note 1: this method can be used as part of a decommissioning process

Note 2: this method does not delete the factory key material (e.g. the MDC together with its root certificate will stay on the devices).

Note 3: this methods provides the user with the ability to erase data which requires confidentiality protection from persistent memory.
[SPPRAMSS-6748 **]**

12.6 Security Function Verification

, SP-SEC-Serv-12.6-1 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:SecurityFunctionalityVerification:TestProcessIntegrityCheck()`, which tests the functionality of the process integrity check.

Note: a typical implementation is to have an executable file with no functionality not in part of the process integrity check (e.g. an allowlist). This executable is still integrity protected, e.g. by secure boot. The executable is executed by this maintenance method. This triggers the process integrity check and issues a log message, which can be used to verify the security functionality of process allowlisting, security logs, time synchronization and real-time clock (time is part of a log message). **[**SPPRAMSS-10142 **]**

, SP-SEC-Serv-12.6-2 - The SSI-MNT interface shall provide the maintenance method `SSI-MNT:SecurityFunctionalityVerification:TestHostFirewall()`, which tests the functionality of the host-based firewall.

Note: a typical implementation is to have a process try to open a connection when this maintenance method is called to the destination address, port and protocol (either UDP or TCP) and then terminates. In case the connection is blocked by the host-based firewall, a log message is issued. This can be used to verify the security functionality of the host-based firewall.
[SPPRAMSS-10143 **]**

13 DNS: Domain Name System

, SP-SEC-Serv-13-1 - This chapter contains security requirements for Domain Name System (DNS). These requirements are applicable when DNS is used. The architectural decisions regarding DNS are out of scope of the security domain. DNS consists of two interfaces:

- ESI-DNS: between DNS servers (transfer and validation of zone contents)
- SSI-DNS: between DNS client and DNS server (DNS lookups)

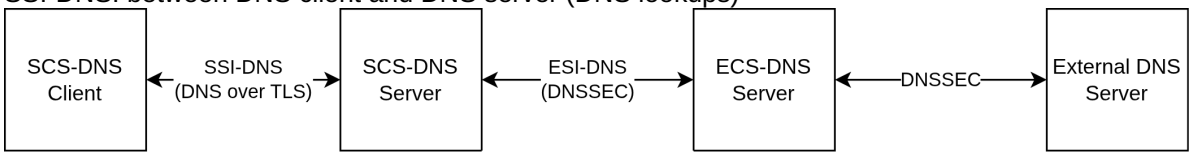


Figure 14 DNS Scope

DNS clients use DNS over TLS for DNS lookups. DNSSEC is not used by DNS clients.
Integrity of DNS records provided by ECS DNS servers or external DNS servers is ensured by using DNSSEC.
[SPPRAMSS-6652 **]**

, SP-SEC-Serv-13-2 - The SCS DNS server should validate the DNS records provided by the higher DNS server using DNSSEC as defined in SP-SEC-Serv-2.3-27 - [RFC 9364]. **[**SPPRAMSS-8157 **]**

, SP-SEC-Serv-13-3 - The SCS-DNS server shall use DNS over TLS as defined in SP-SEC-Serv-2.3-18 - [RFC 7858]. **[**SPPRAMSS-5690 **]**

, SP-SEC-Serv-13-4 - The SCS-DNS server shall use an Operator Non-Safety Communication Certificate (ONCC) as server certificate. **[**SPPRAMSS-5693 **]**

, SP-SEC-Serv-13-5 - The SCS-DNS client shall authenticate the SCS-DNS server as described in Chapter 8.1 in SP-SEC-Serv-2.3-22 - [RFC 8310] . **[**SPPRAMSS-12407 **]**

, SP-SEC-Serv-13-6 - DNS can be used to map CRL Distribution Points hosted by manufacturers to internal CRL Distribution Points hosted by operators. **[**SPPRAMSS-16306 **]**

14 Annex

14.1 Certificate Profiles

, SP-SEC-Serv-14.1-1 - The following rules describe when certification evaluation succeeds:

- Mandatory certificate fields: Certificate evaluation succeeds when all mandatory certificate fields are present and contain the specified content.
- Recommended, Optional and Allowed certificate fields: Certificate evaluation succeeds when recommended, optional or allowed fields either are not present or contain the specified content.

[SPPRAMSS-18623 **]**

14.1.1 Manufacturer Certificate Profiles

, SP-SEC-Serv-14.1.1-1 - MDC

Table 19 Manufacturer Device Certificate (MDC) profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA512	
Issuer	[Subject DN of issuing CA]	
Validity	[expected lifetime of the device after creation date]	recommended validity is at least 30 years

Field Name	Content	Comment
Subject	**mandatory:** CN=[product name] serialNumber=[manufacturer-unique device serial number] **recommended:** O=[manufacturer name] C=[manufacturer country]	Additional manufacturer-specific attributes are allowed.
Subject Public Key Info	[public key], secp521r1	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuers public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	**mandatory:** digitalSignature keyAgreement	Additional key usages are allowed to enable additional use cases.
Subject Alternative Name	[manufacturer-specific, e.g. OID structure]	Optional
Basic Constraints (critical)	**mandatory:** CA:FALSE	Required for all end-entity certificates; pathLenConstraint omitted
Certificate Policies	[manufacturer-defined policy information]	optional, if used, content shall comply to SP-SEC-Serv-2.3-11 - [RFC 5280]
CRL Distribution Points	**mandatory:** [manufacturer-specific cRLDistributionPoints]	

[SPPRAMSS-7641 **]**

, SP-SEC-Serv-14.1.1-2 - MCSC

Table 20 Manufacturer Config Signer Certificate (MCSC) profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA512	
Issuer	[Subject DN of issuing CA]	
Validity	[manufacturer-specific period]	recommended validity period is 1 year
Subject	**mandatory:** CN=[unique manufacturer-specific CN] **recommended:** OU=[manufacturer-specific organization] C=[manufacturer-specific country]	Additional manufacturer-specific attributes are allowed.
Subject Public Key Info	[public key], secp521r1	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuer public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	digitalSignature	
Extended Key Usage (critical)	id-kp-configSigning	OID: 1.3.6.1.5.5.7.3.41
Subject Alternative Name	[manufacturer-specific]	optional
Basic Constraints (critical)	**mandatory:** CA:FALSE	Required for all end-entity certificates; pathLenConstraint omitted
Certificate Policies	[manufacturer-defined policy information]	optional, if used, content shall comply to SP-SEC-Serv-2.3-11 - [RFC 5280]
CRL Distribution Points	**mandatory:** [manufacturer-specific cRLDistributionPoints]	

[SPPRAMSS-7642 **]**

, SP-SEC-Serv-14.1.1-3 - MTASC

Table 21 Manufacturer Trust Anchor Signer Certificate (MTASC) profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA512	
Issuer	[Subject DN of issuing CA]	
Validity	[manufacturer-specific period]	recommended validity period is 1 year
Subject	**mandatory:** CN=[unique manufacturer-specific CN] **recommended:** OU=[manufacturer-specific organization] C=[manufacturer-specific country]	Additional manufacturer-specific attributes are allowed.
Subject Public Key Info	[public key], secp521r1	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuer public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	digitalSignature	
Extended Key Usage (critical)	id-kp-trustAnchorConfigSigning	OID: 1.3.6.1.5.5.7.3.42
Subject Alternative Name	[manufacturer-specific]	optional
Basic Constraints (critical)	**mandatory:** CA:FALSE	Required for all end-entity certificates; pathLenConstraint omitted
Certificate Policies	[manufacturer-defined policy information]	optional, if used, content shall comply to SP-SEC-Serv-2.3-11 - [RFC 5280]
CRL Distribution Points	**mandatory:** [manufacturer-specific cRLDistributionPoints]	

[SPPRAMSS-7643 **]**

, SP-SEC-Serv-14.1.1-4 - MUSC

Table 22 Manufacturer Update Signer Certificate (MUSC) profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA512	
Issuer	[Subject DN of issuing CA]	
Validity	[manufacturer-specific period]	recommended validity period is 1 year
Subject	**mandatory:** CN=[unique manufacturer-specific CN] **recommended:** OU=[manufacturer-specific organization] C=[manufacturer-specific country]	Additional manufacturer-specific attributes are allowed.
Subject Public Key Info	[public key], secp521r1	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuer public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	digitalSignature	
Extended Key Usage (critical)	id-kp-updatePackageSigning	OID: 1.3.6.1.5.5.7.3.43
Subject Alternative Name	[manufacturer-specific]	optional
Basic Constraints (critical)	**mandatory:** CA:FALSE	Required for all end-entity certificates; pathLenConstraint omitted
Certificate Policies	[manufacturer-defined policy information]	optional, if used, content shall comply to SP-SEC-Serv-2.3-11 - [RFC 5280]
CRL Distribution Points	**mandatory:** [manufacturer-specific cRLDistributionPoints]	

[SPPRAMSS-7644 **]**

14.1.2 Operator Certificate Profiles

, SP-SEC-Serv-14.1.2-1 - ODC

Table 23 Operator Device Certificate (ODC) profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA512	
Issuer	[Subject DN of issuing CA]	
Validity	[operator-specific period]	maximum 5 years
Subject	**mandatory:** CN=[operator-specific device identifier] serialNumber=[device serial number] **recommended:** O=[operator-specific organization] C=[operator-specific country]	Operator-specific device identifier may include the EULYNX technical identifier Additional operator-specific attributes are allowed
Subject Public Key Info	[public key], secp521r1	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuer public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	**mandatory:** digitalSignature keyAgreement	Additional key usages are allowed to enable additional use cases.
Subject Alternative Name	[operator-specific, e.g. OID structure]	optional
Basic Constraints (critical)	**mandatory:** CA:FALSE	Required for all end-entity certificates; pathLenConstraint omitted
Certificate Policies	[operator-defined policy information]	optional, if used, content shall comply to SP-SEC-Serv-2.3-11 - [RFC 5280]
CRL Distribution Points	**mandatory:** [operator-specific cRLDistributionPoints]	distributionPoint contains URL to download CRLs within operator network

[SPPRAMSS-7648 **]**

, SP-SEC-Serv-14.1.2-2 - ONCC

Table 24 Operator Non-Safety Communication Certificate (ONCC) profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA256	
Issuer	[Subject DN of issuing CA]	
Validity	[operator-specific period]	maximum 2 years
Subject	**mandatory:** CN=[use-case specific process identifier] serialNumber=[use-case specific] **recommended:** O=[operator-specific organization] C=[operator-specific country] OU=[element abbreviation]	**ETCS use case:** CN shall be an FQDN as defined in [Subset-037-1]. serialNumber shall be the ETCS ID OU shall be the ETCS ID type defined in [Subset-037-1] **other use cases:** CN shall be unique, e.g. using the technical identifier defined in EULYNX EU.Doc.16.Req Eu.SAS.77 Additional operator-specific attributes are allowed.
Subject Public Key Info	[public key], secp256r1	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuer public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	**mandatory:** digitalSignature keyAgreement **mandatory for OPC UA:** nonRepudiation keyEncipherment dataEncipherment	Additional key usages are allowed to enable additional use cases.
Extended Key Usage	**optional:** serverAuth, clientAuth	serverAuth and/or clientAuth depending of the use case of the certificate
Subject Alternative Name	dNSName=[FQDN] iPAddress=[IP address] URI=[application URI]	either dNSName or iPAddress shall be used for OPC UA, URI shall be used additionally Example: urn:hostname:namespace:applicationName
Basic Constraints (critical)	**mandatory:** CA:FALSE	Required for all end-entity certificates; pathLenConstraint omitted

Field Name	Content	Comment
Certificate Policies	[operator-defined policy information]	optional, if used, content shall comply to SP-SEC-Serv-2.3-11 - [RFC 5280]
CRL Distribution Points	**mandatory:** [operator-specific cRLDistributionPoints]	distributionPoint contains URL to download CRLs within operator network

[SPPRAMSS-7649 **]**

, SP-SEC-Serv-14.1.2-3 - OSCC

Table 25 Operator Safety Communication Certificate (OSCC) profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA256	
Issuer	[Subject DN of issuing CA]	
Validity	[operator-specific period depending on purpose]	maximum 2 years. should be configurable based on operational environment.
Subject	**mandatory:** CN=[use-case specific process identifier] serialNumber=[device identifier] **recommended**: O=[operator-specific organization] C=[operator-specific country]	**ETCS use case:** CN shall be an FQDN as defined in [Subset-037-1]. serialNumber shall be the ETCS ID OU shall be the ETCS ID type defined in [Subset-037-1]. **EULYNX use case:** CN shall be unique, e.g. using the technical identifier defined in EULYNX EU.Doc.16.Req Eu.SAS.77 Additional operator-specific attributes are allowed.
Subject Public Key Info	[public key], secp256r1	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuer public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	digitalSignature keyAgreement	
Extended Key Usage	**mandatory:** id-kp-safetyCommunication **optional:** serverAuth clientAuth	OID: 1.3.6.1.5.5.7.3.44 serverAuth and/or clientAuth depending of the use case of the certificate
Subject Alternative Name	dNSName=[FQDN] iPAddress=[IP address]	either dNSName or iPAddress shall be used

Field Name	Content	Comment
Basic Constraints (critical)	**mandatory:** CA:FALSE	Required for all end-entity certificates; pathLenConstraint omitted
Certificate Policies	[operator-defined policy information]	optional, if used, content shall comply to SP-SEC-Serv-2.3-11 - [RFC 5280]
CRL Distribution Points	**mandatory:** [operator-specific cRLDistributionPoints]	distributionPoint contains URL to download CRLs within operator network

[SPPRAMSS-7650 **]**

, SP-SEC-Serv-14.1.2-4 - OUC

Table 26 Operator User Certificate (OUC) profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA256	
Issuer	[Subject DN of issuing CA]	
Validity	[operator-specific period depending on purpose]	maximum 1 year should be configurable based on operational environment.
Subject	**mandatory:** CN=[operator-specific identifier of human user / software process] **recommended for human users:** surname=[last name of user] givenName=[first name of user] **recommended for all certificates:** O=[operator name] C=[operator country]	human user identifier is usually an email address. Additional operator-specific attributes are allowed.
Subject Public Key Info	secp256r1, [public key]	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuer public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	[key usage depending on use case]	
Extended Key Usage	[extended key usage depending on use case]	
Subject Alternative Name	email=[email address of user]	email is an rfc822Name according to SP-SEC-Serv-2.3-11 - [RFC 5280] chapter 4.2.1.6
Basic Constraints (critical)	**mandatory:** CA:FALSE	Required for all end-entity certificates; pathLenConstraint omitted
Certificate Policies	[operator-defined policy information]	optional, if used, content shall comply to SP-SEC-Serv-2.3-11 - [RFC 5280]
CRL Distribution Points	**mandatory:** [operator-specific cRLDistributionPoints]	distributionPoint contains URL to download CRLs within operator network

[SPPRAMSS-7651]

, SP-SEC-Serv-14.1.2-5 - OCSC

Table 27 Operator Configuration Signer Certificate (OCSC) profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA512	
Issuer	[Subject DN of issuing CA]	
Validity	[operator-specific period depending on purpose]	recommended validity period is 2 years
Subject	**mandatory:** CN=[unique operator-specific CN] **recommended:** OU=[operator-specific organization] C=[operator-specific country]	Additional operator-specific attributes are allowed
Subject Public Key Info	[public key], secp521r1	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuer public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	digitalSignature	
Extended Key Usage (critical)	id-kp-configSigning	OID: 1.3.6.1.5.5.7.3.41
Subject Alternative Name	[operator-specific]	optional
Basic Constraints (critical)	**mandatory:** CA:FALSE	Required for all end-entity certificates; pathLenConstraint omitted
Certificate Policies	[operator-defined policy information]	optional, if used, content shall comply to SP-SEC-Serv-2.3-11 - [RFC 5280]
CRL Distribution Points	**mandatory:** [operator-specific cRLDistributionPoints]	

[SPPRAMSS-7653]

, SP-SEC-Serv-14.1.2-6 -

Table 28 Operator Trust Anchor Signer Certificate (OTASC) profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA512	
Issuer	[Subject DN of issuing CA]	
Validity	[operator-specific period]	recommended validity period is 1 year
Subject	**mandatory:** CN=[unique operator-specific CN] **recommended:** OU=[operator-specific organization] C=[operator-specific country]	Additional operator-specific attributes are allowed.
Subject Public Key Info	[public key], secp521r1	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuer public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	digitalSignature	
Extended Key Usage (critical)	id-kp-trustanchorConfigSigning	OID: 1.3.6.1.5.5.7.3.42
Subject Alternative Name	[operator-specific]	optional
Basic Constraints (critical)	**mandatory:** CA:FALSE	Required for all end-entity certificates; pathLenConstraint omitted
Certificate Policies	[operator-defined policy information]	optional, if used, content shall comply to SP-SEC-Serv-2.3-11 - [RFC 5280]
CRL Distribution Points	**mandatory:** [operator-specific cRLDistributionPoints]	

[SPPRAMSS-9942 **]**

14.1.3 CA Certificate Profiles

, SP-SEC-Serv-14.1.3-1 -
Table 30 CA Certificate profile

Field Name	Content	Comment
Version	0x2	X.509 v3
Serial Number	[integer]	
Signature Algorithm	ecdsa-with-SHA512	
Issuer	[Subject DN of issuing CA]	
Validity	[manufacturer/operator-specific period]	recommended validity period is 15 years for self-signed operator (root) CAs recommended validity period is 5 years for operator intermediate CAs
Subject	[manufacturer/operator-specific]	
Subject Public Key Info	[public key], secp521r1	
X.509 v3 Extensions		
Authority Key Identifier	[key identifier of issuer public key]	
Subject Key Identifier	[key identifier of own public key]	
Key Usage (critical)	keyCertSign cRLSign	Additional key usages are allowed to enable additional use cases.
Subject Alternative Name	[manufacturer/operator-specific]	optional
Certificate Policies	[manufacturer/operator-defined policy information]	optional
Basic Constraints (critical)	cA: true pathLenConstraint: [optional]	
CRL Distribution Points	[manufacturer/operator-specific distributionPoint]	optional for self-signed (root) CAs required for intermediate CAs

[SPPRAMSS-16108**]**