OCORA

Open CCS On-board Reference Architecture

Security Concept

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Management Summary

Industrial systems are affected by an increased threat environment regarding security. Due to an increased threat situation in Europe and the resulting governmental and international requirements, security is becoming more important. The technical workstream TWS06 dedicated to Cyber Security addresses this topic in OCORA and will provide detailed requirements for secure CCS on-board systems. The Security Concept paves the way for the future work of TWS06. It addresses security considerations for the railway domains and defines general security principles. Furthermore, it defines and splits up the systems in the scope of OCORA regarding security. Based on a definition of the threat landscape and attacker types, general security requirements are defined which summarize the results of initial assessments of the workstream. Initial assumptions on the implementation of security service provide an additional insight into the future requirements specifications.

Revision history

Version	Change Description	Initial	Date of change
1.0	Official version for Release R2	RPo MSc SSt	08.06.2022
2.0	Official version for Release R3	SSt	08.12.2022

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References

Reader's note: please be aware that the numbers in square brackets, e.g. [1], as per the list of referenced documents below, is used throughout this document to indicate the references to external documents. Wherever a reference to a TSI-CCS SUBSET is used, the SUBSET is referenced directly (e.g., SUBSET-026). OCORA always reference to the latest available official version of the SUBSET, unless indicated differently.

[1] OCORA-BWS01-010 – Release Notes

[2] OCORA-BWS01-020 – Glossary

[3] OCORA-BWS01-030 – Question and Answers

[4] OCORA-BWS01-040 – Feedback Form

[5] OCORA-BWS03-010 – Introduction to OCORA

[6] OCORA-BWS04-010 – Problem Statements

[7] OCORA-TWS01-030 – System Architecture

[8] OCORA-TWS01-035 – CCS On-Board (CCS-OB) – Architecture

[9] OCORA-TWS10-010 – CENELEC Phase 1 – Concept

[10] EULYNX, EUG, RCA, OCORA Security Guideline, Version 2, June 2022

[11] X2Rail-3 – Deliverable D8.2-3c – Protection Profile - OnBoard components, Version 4, 2021-01-28

[12] EN 50126-1:2017-10 – Railway Applications – The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 1: Generic RAMS Process

[13] TS 50701:2022 – Railway application - Cybersecurity

[14] IEC 62443-2-1: 2010-11, "Industrial communication networks – Network and system security – Part 2-1: Establishing an industrial automation and control system security program", International Electrotechnical Commission (IEC), Edition 1.0, November 2009.

[15] IEC 62443-2-4: 2017-08, "Security for industrial automation and control systems – Part 2-4: Security program requirements for IACS service providers", International Electrotechnical Commission (IEC), Edition 1.1, August 2017.

[16] IEC 62443-3-2: 2020-06, "Security for industrial automation and control systems – Part 3-2: Security risk assessment for system design", International Electrotechnical Commission (IEC), Edition 1.0, June 2020.

[17] IEC 62443-4-1: 2018-01, "Security for industrial automation and control systems – Part 4-1: Secure product development lifecycle requirements" International Electrotechnical Commission (IEC), Edition 1.0, January 2018.

[18] Eu.Doc.15 – EULYNX Security Concept

1 Introduction

1.1 Purpose of the document

The purpose of this document is to deliver the content and framework to complete Phase 2 based on TS 50701 [13] and its link to the CENELEC Process V-model. The document shall lay the basis for the next phase, phase 3, the risk and threat analysis. Thus, the main targets are:

1. Definition of generally applicable assumption and definitions
2. Definition of the System under Consideration
3. Protection Requirements Analysis based on the existing system definition and architecture of OCORA
4. Feedback to OCORA system architecture workstream to improve system definition and architecture based on the findings in the protection requirements analysis
5. High level requirements definition to the building blocks defined in the architecture

This document is addressed to experts in the CCS domain dedicated to architecture, network, safety functions and security functions and to any other person, interested in the OCORA concepts for on-board CCS. The reader is invited to provide feedback to the OCORA collaboration and can, therefore, engage in shaping OCORA. Feedback to this document and to any other OCORA documentation can be given by using the feedback form [4].

If you are a railway undertaking, you may find useful information to compile tenders for OCORA compliant CCS building blocks, for tendering complete on-board CCS system, or also for on-board CCS replacements for functional upgrades or for life-cycle reasons.

If you are an organization interested in developing on-board CCS building blocks according to the OCORA standard, information provided in this document can be used as input for your development.

1.2 Applicability of the document

The document is currently considered informative but may become a standard at a later stage for OCORA compliant on-board CCS solutions. Subsequent releases of this document will be developed based on a modular and iterative approach, evolving within the progress of the OCORA collaboration.

1.3 Context of the document

This document is published as part of an OCORA release, together with the documents listed in the release notes [1]. Before reading this document, it is recommended to read the Release Notes [1]. If you are interested in the context and the motivation that drives OCORA we recommend to read the Introduction to OCORA [5], and the Problem Statements [6]. The reader should also be aware of the Glossary [2] and the Question and Answers [3].

2 OCORA Security Concept Background

2.1 Introduction

In reference to the relevant standards EN 50126 [12], TS 50701 [13], IEC 62443 [14] as well as the EULYNX/RCA/OCORA guideline for cyber security [10]. The following introduction to the overall security process and its references will be provided. This will ensure future proof of the overall security concept for the evolving connectivity between infrastructure and rail vehicles.

The EN 50126 understands “security” as resilience of the railway system to vandalism, malevolence, and intentionally harmful human behaviours. As the standard does not introduce a dedicated topic “security”, as it does with “safety” or “reliability, availability and maintainability”, it is acceptable by the EN 50126 [12], to apply the security engineering processes proven in other industries, e.g., IEC 62443 [14].

The standard TS 50701 [13], defines the prerequisites to start the security process. These are:

- Railway operator’s security program is established
- Manufacturer’s and integrator’s secure development process is established
- Legal and regulatory framework is identified

It further documents the interaction of safety and security. As a result, the detailed steps of a security engineering process are shown in the following V-model. The security engineering process will provide relevant artefacts to the phases of the V-model matching the required level of detail for each phase. This results in artefacts, e.g., in the cyber security case and are gaining granularity during the later EN 50126 [12] phases (see Figure 1).

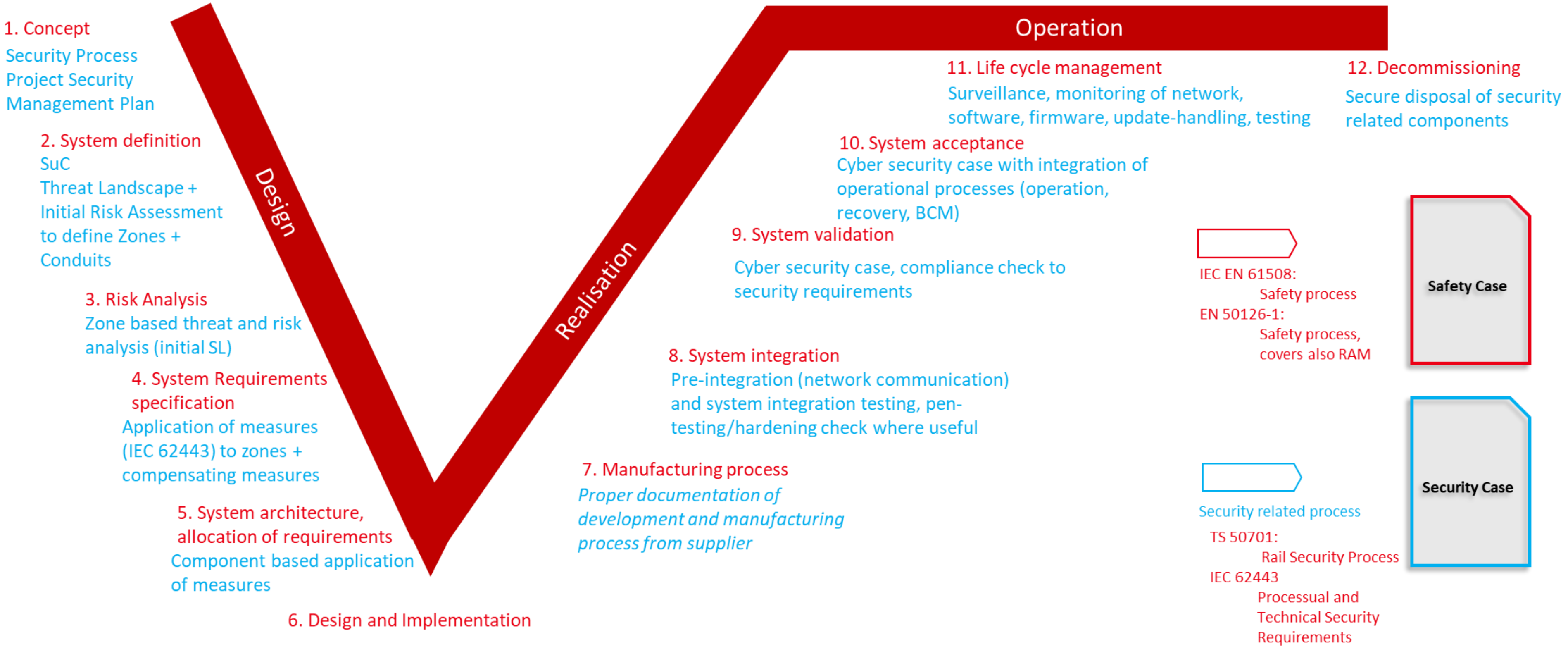


Figure 1: Reference EN 50126 and TS 50701

The security engineering process will cover the System under Consideration (SuC), its interfaces, and relations to surrounding systems. These systems may be in similar technology or maturity level as the SuC. It is also possible that interfaces to already established, maybe outdate, and so-called legacy systems need to be considered.

Both, the decoupling of security solution development and the vehicle/infrastructure specific situation of surrounding (incl. legacy) systems lead to the conclusion, that the system integrator must be aware of its key role. The Integrator must coordinate and manage during the development process (phase 1 to 10, see Figure 1).
During life cycle phase 11 (operation), the operating organization must take over this role. For example, in a life-cycle manager role or in an operation management organization leading change, configuration, or maintenance processes.

Security solutions shall not be subject to safety assessment in contrast to railway solutions, which are developed according to EN 50126 [12]. Therefore, the process of security engineering can be passed through separately. However, synchronization is necessary to ensure the coordinated transfer of input and output. Each phase of an EN 50126 [12] project has an equivalent in the V-model.

All security documents are classified to the V-model and one or more corresponding applications (EULYNX, RCA, OCORA).

Document Identifier	Title	Status	CENELEC	EULYNX	RCA	OCORA
OCORA-TWS06-010	Project Security Management Plan	R2 released	1			x
-	Security Guideline	R2 released	2-5	x	x	x
OCORA-TWS06-030	OCORA Security Concept	R3 released	2	x		
OCORA-TWS06-040	OCORA Security: Threats and Risks Analysis	Future release	3	x		
OCORA-TWS06-050	OCORA Security Specification	Future release	4,5	x	x	
Eu.Doc.115	Security parameter specification	BL 4 released	4,5	x	x	x
Eu.Doc.117	SSI Standard Security Interface	BL 4 released	4,5	x	x	x

Table 1: Reference Security Documentation

2.2 Security and safety considerations for Railway Operations

The OCORA security documents are based on following assumptions on areas of conflict in safety and security which result in the overall concept as “resolution of conflicts.”

2.2.1 Areas of conflict

	Safety	Security
Trust vs. Zero trust	Unconditional trust within the whole system. The system was designed and tested/certified by a competent body. All aspects considered correctly. If the operator follows the requirements (technical, processual, controls), nothing bad can happen. Everyone is acting as requested!	Miss-trust / Zero trust / no trust No trust until a defined level of trust is established for a certain time. There are people intentionally not following the requirements (e.g., to ease their work or to attack).
Fail Safe & Secure	The system never should harm itself or the environment. In case of doubt or failure it enters automatically into a "safe state." It is based on Safety Integrity Levels provided by established standards.	If a security control fails, it should maintain a state of deny access. Design security mechanisms so that a failure will follow the same execution path as disallowing the operation. Prevent unauthorized access in case of errors, failures, exceptions, system degradation, or compromise. Primary goal is ensuring system's integrity.
Monitoring & Logging	Detecting errors/failures is time critical as safety might be affected. There are only technical failures and considered wrongdoings. All safety-relevant failures are detected, a timely reaction is performed, or initiated, by the system itself or by the superior system.	Systems are monitored to detect failures with respect to operational levels (availability and integrity). The log data might indicate an attack or other security problems.
Defence in Depth	There are no attackers. The whole system is in a controlled environment. Intentional wrongdoings are excluded.	There are attackers, from outside and inside. Every (sub-) system must establish the security controls on several layers to protect against outside and inside attacks (including lateral attacks).
Simplicity over Complexity	Safety relevant systems are designed only for that very task, only contain the minimum required to implement the defined safety functionality.	Security systems must be tailored to the task as these systems/libraries include many options. The systems are highly complex and as a result faulty. The tailoring should be done as early as possible and as good as possible in every phase. . This tailoring also changes over time due to changing threat landscape.
Assume failure and compromise	Failure states are detected in a timely manner. Compromising a system is impossible due to requirements and controls.	It is very likely that an attack is not detected in a timely manner. Compromising a system is possible all the time. Both could potentially be detected years later.
Open Design	Highly integrated, proprietary/closed designed systems. 100% control of the system and its design reduces the risk in the approval process. The supplier guaranties the safety functionality and spare parts for decades.	Open standards and designs are preferred. Close or proprietary protocols and interfaces are per se considered insecure, as no independent testing can take place.

	Safety	Security
Maintainability / Availability / Updates	There is no need for updates if everything was considered correctly, and the test procedures were not faulty. The system is operated in a deterministic environment, hence there are no unconsidered coincidences. Every change requires a new certification/homologation.	As attack vectors change over time, updates are required. Newly detected security vulnerabilities must be mitigated. Both requires to updating system and protective concepts. This is the only way to ensure system/information integrity.

Table 2: Areas of conflict (derived from [18])

"Fail secure" or "fail safe" affects availability negatively. For a safety system, system integrity is key and is the basis for all assessments and certifications. A "fail open" action can therefore never be accepted for safety or safety-related systems or functionality. Depending on architecture and technical implementation, a "fail open" is only acceptable, if system integrity for safety is not affected and ensured by design of the system.

2.2.2 Resolution of conflicts

As the areas of conflict cannot be eliminated in general, the analysis of all RAMSS aspects must be done together. The method of “separation of concerns” can be followed if interactions/conflicts are identified and solved. Defining them as out-of-scope is not an option.

Security must start with the information used end-to-end, e.g., this is the top-level control loop if a System-Theoretic Process Analysis (STPA) method is applied and following the information flow defined by the processes. These processes involve business delivery processes and operational technology control loops.

As security affects safety and RAM aspects, a security protection profile must include all RAMS aspects, hence there is only one protection profile.

2.2.3 Threat definition

In OCORA, coordinated with EULYNX, EuG and RCA, the term “threat” is used to denote a negative impact to the assure ability of the OCORA solution. This is not to be confused with the use of “threat” in the security domain. Therefore, in this document we refer to both Assurance Threats and Security Threats.
If not otherwise stated, the term “threat” in this document refers to a Security Threat.

2.2.4 System definition

The SuC provides the architecture overview including sub-systems, interfaces, and the system boundaries. It also describes the responsibilities within the system boundaries. The architecture defines the communication network, security zones and conduits. It also includes the generic system functions and takes the security aspects, as well as the safety aspects into account to fulfil the regulatory requirements and limit initial risks.

Basis for the system definition is a structural analysis of the system to identify all components that are included in the communication regarding the train functions. Furthermore, all access points to the system (physical or logical) need to be identified. The system definition is part of the security concept.

2.2.5 Threat analysis

The threat analysis provides an overview on the possible threats for the System under consideration.

2.2.6 Risk analysis

The separate risk analysis document performs the zone and conduit-based risk assessment including a detailed threat analysis, hazard log, and mitigation controls.

The identification of the current risks, threats, hazards, and vulnerabilities will lead to an initial security level documentation. Within the risk evaluation also mitigation measures will be considered.

2.2.7 Initial Use Case Specification

The use cases specification includes predictable use cases that need to be performed to allow the security incident detection through the connected Security Information and Event Management (SIEM). This is needed to derive the requirements for each component and to ensure that the relevant information is available. The use case specification will not include exact definition of the use case implementation or correlation process. This is performed by the SIEM security specialists later with the onboarding process.

2.2.8 System requirement specification

In this chapter we will perform a SuC-specific refinement of system requirements. Including definition of organizational and physical requirements and security-related application conditions. Here we describe how the requirements should be implemented/applied, to be compliant with the security and safety standards.

2.2.9 Security Life Cycle Management

The Life Cycle Management delivers the relevant processes to ensure the system security over the lifetime through patch and test process definition. The relevant capabilities are foreseen in the requirement specification already.

2.2.10 System architecture, allocation of requirements

Allocates the security requirements to the (sub-)systems, components, and interfaces.

2.3 Security Principles

The security principles used in this concept are listed in the following chapters and are based on IEC 62443-4-1[17].

2.3.1 Secure by Design

Make security part of requirements and lifecycle definition, and not an afterthought

Rationale
Protect a system against attacks by considering security requirements as part of its overall requirements.

- Experience has shown it is both costly and difficult to implement security measures after a system has been developed
- Avoid unnecessary development efforts by considering security requirements early on
- As security interferes with safety (e.g., timings, fail behaviour) they must be a holistic approach

Implications

- Understand the resulting security requirements in the engineering, design, implementation, and disposal of the system
- Make use of strong keys (as strong as operational useable - this is a moving scale in time and available computing power)
- Security should treat the root cause of a problem, not its symptom. Security incidents should be avoided by design.

2.3.2 Defence in Depth

Avoid reliance on a single type of security control

Rationale
Implementing security on multiple layers is better than relying on a single defence layer. If one security control fails or is bypassed, an additional layer can help preventing the attack.

- Identify and secure the weakest links first
- Use multiple security layers to increases effort for an attacker to compromise a system or application

Implications

- Create a security architecture that documents the different layers of protection
- Balance defence in depth against simplicity and business needs
- Each deeper security layer should not trust the previous layers
- Compartmentalize the system by defining security boundaries for information flows
- Prepare for the worst possible compromise scenario

2.3.3 Secure by Default

Use secure default options to limit inherent security vulnerabilities

Rationale
System or application configurations should favour security over not being secure. The default setting for a security control should be to deny access to a resource and require a configuration to specifically grant access. When the system goes into an error or exception state, these states must favour security over not being secure.

Implication

- Security should not require extensive configuration to work and should just work reliably were implemented
- Establish secure defaults when system starts or goes in error or exception states
- Providing least privilege or making only necessary services and features available
- Use integrity protection and encryption by default for both data at rest and in transit. Encryption can be omitted if confidentiality protection is not required.

2.3.4 Simplicity over Complexity

Complexity is the worst enemy of security

Rationale
Complexity in systems leads to increased human confusion, errors, vulnerabilities, automation failures, and difficulty of recovering from an issue. Favour simple and consistent architectures, designs, and implementations. Avoid unnecessary complexity. The more complex the system, the more likely it may possess exploitable flaws

Implication

- Simplicity should be a key objective in design of systems and security
- DRY - do not repeat yourself
- Reduce the variety and types of hardware and software types and versions
- Designing systems that use the least hardware and software resources possible
- Favour convention over configuration

- Do not implement unnecessary security mechanisms
- Complexity makes vulnerabilities harder for developers and testers to uncover. Each feature, function, and interaction are a potential threat vector
- Complexity makes vulnerabilities harder to fix once we find them
- Loosely coupled, low complexity. Create process chains (security zones) with as much independence from other security zones as possible.

Notes

- Do not over-simplify
- Balance reduced complexity against diversity required to achieve resiliency and reduced single-point-of-failures

2.3.5 Assume Failure & Compromise

Complex distributed systems lead to unpredictability and cascading failures

Rationale
We build and operate highly coupled and interactively complex systems. Even when all the individual components of complex system are functioning properly, the interactions between those components can cause unpredictable outcomes and vulnerabilities. Rare or surprising combinations of events, vulnerabilities, and creative user interactions make such systems difficult to predict. Prediction, complete testing, and modelling of all states is not possible in such systems, we therefore must assume and account for failures and compromise.

Implications

- Our systems are too complex to anticipate all potential interactions or vulnerabilities
- Assume that critical parts of the infrastructure can be compromised during the life cycle of the components and systems
- Embrace principles of resilient engineering and testing - facilitate real and repeated tests to uncover systemic weaknesses
- Design system for automated testability
- Establish continued and comprehensive monitoring of vital parameters to determine system health and security
- Security shall actively manage over the IACS and product life cycle

2.3.6 Fail Safe and Secure

Failures should lead to a safe and secure state. Risk does not hurt - the impact does

Rationale
If a security control fails, it should maintain a state of deny access. Design security mechanisms so that a failure will follow the same execution path as disallowing the operation. Prevent unauthorized access in case of errors, failures, exceptions, system degradation, or compromise.

Implication

- Design to minimize the impact of component or control failures or compromise
- Confidentiality and integrity assurance top availability assurance
- Security methods like isAuthorized(), isAuthenticated(), and validate() should all return false if there is an exception during processing

- Assume system failure & compromise in design decisions

Examples

- Dead man's switch is automatically operated if the human operator becomes incapacitated
- Traffic light controllers use a Conflict Monitor Unit to detect faults or conflicting signals and switch an intersection to an all-flashing error signal, rather than displaying potentially dangerous conflicting signals.

2.3.7 Zero Trust

Assume everything to be insecure until a level of trust is established

Rationale
The historic concept of trust that is based on a perimeter separating the inside from the outside does no longer hold in today's rapidly changing environment. Assuming no trust is a security model that more effectively adapts to the complexity of the modern environment, embraces the mobile workforce, and protects people, devices, apps, and data wherever they are located.

Implication

- Trust is not granted until the user, system, or component can be authenticated and authorized first
- Verify anything and everything trying to connect to its systems before granting access
- Workforce: Authenticate users and continuously monitor and govern their access and privileges
- Workloads: Enforce controls across the entire application stack, especially connections between containers or hypervisors in the public cloud
- Data: Secure and manage data, categorize, and develop data classification schema, and encrypt data at rest and in transit
- Supply Chain: Question and assess the integrity and security of suppliers and the delivered products, systems, and services

2.3.8 Least Privilege

Only grant the minimal set of permissions that are necessary for a required/given operation/action - and no more

Rational
Systems and users should operate while invoking as few privileges as possible. Granting permissions beyond the scope of the necessary rights of an action can allow a user or system to obtain or change information in unwanted ways. This principle limits the damage that can result from an attack, accident, or error. It also reduces the number of potential interactions among privileged systems to the minimum for correct operation, so that unintentional, unwanted, or improper uses of privilege are less likely to occur.

Implication

- Minimize the system elements to be trusted
- This principle restricts how privileges are granted and revoked, and time out

2.3.9 Usability & Management

Balance of security and usability - make secure behaviours easy instead of complex

Rationale
Make it easy to do the right thing, make it difficult to do the wrong thing, and make it almost impossible to do

the catastrophic thing. Security controls should not obstruct users in performing their work and should not be difficult to manage. User interface must be easy to use, so that users routinely and automatically apply the mechanisms correctly. Relates to the paradigm of Least Astonishment in UI design and Simplicity Principles

Implications

- A component or system should be designed to behave in a manner consistent with how users of that component are likely to expect it to behave
- Design security interfaces and functions for ease of use, so that users routinely and automatically apply the protection mechanisms correctly

Note

- If security gets in the way, sensible, well-meaning, dedicated people develop hacks and workarounds that defeat the security

2.3.10 Design for Automation

Design for Automation to control complexity

Rationale
Manual security tasks are inefficient, expensive, and prone to inconsistencies and human error. It is no longer possible to deploy, operate, and secure complex applications and infrastructures without automation. Security, agility, scalability, and control are a direct function of automation in today's complex and rapidly changing technology and threat environment.

Implications

- Automation reduces complexity and ensures consistency
- Reduces the talent gap by freeing scarce expertise form mundane tasks
- Automated testing

2.3.11 Open Design

The security of a mechanism should not depend on the secrecy of the details of its design or implementation

Rationale
Assume outsiders and attackers will have access to source code (also for closed source software), system design and network topologies. Assume sensitive information regarding security measurements are leaked or sold. Encourage proactive reporting of security issues or vulnerabilities and act on such reports.

Implications

- Never store secrets in code, documentation, or configurations
- Open security design promotes faster improvement cycles
- Security measurements should be open and transparent

Examples

- Shannon's Maxim: The enemy knows the system

3 System definition

The system definition covers the definition of the system under consideration and an initial threat analysis to allow building zones and conduits.

Currently no final OCORA System Definition is available. The CENELEC phase 1 document and the OCORA System Architecture are the only sources for defining the system.

Therefore, the system definition, which defines the base for the security considerations is built by the following documents and assumptions made during the activities:

- OCORA-TWS01-030 – System Architecture [7]
- OCORA-TWS01-035 – CCS On-Board (CCS-OB) – Architecture [8]
- OCORA-TWS10-010 – CENELEC Phase 1 – Concept [9]

The assumptions made during the considerations and assessments need to be revisited after the final OCORA System Architecture becomes available. All the assumptions need to be well documented and evaluated if they are still valid in a later phase of OCORA. Eventually the status of an assumption varies, so a tailored process needs to be defined to manage this issue.

3.1 System under Consideration (SuC)

The definition of the OCORA system is a task performed by TWS01 System Architecture [7] from an architectural point of view. The following figures presents the SuC used in TWS06 Security. It is based on the system architecture of Release R2.Figure 2 show the physical components and networks which are used during the transition to future OCORA systems.

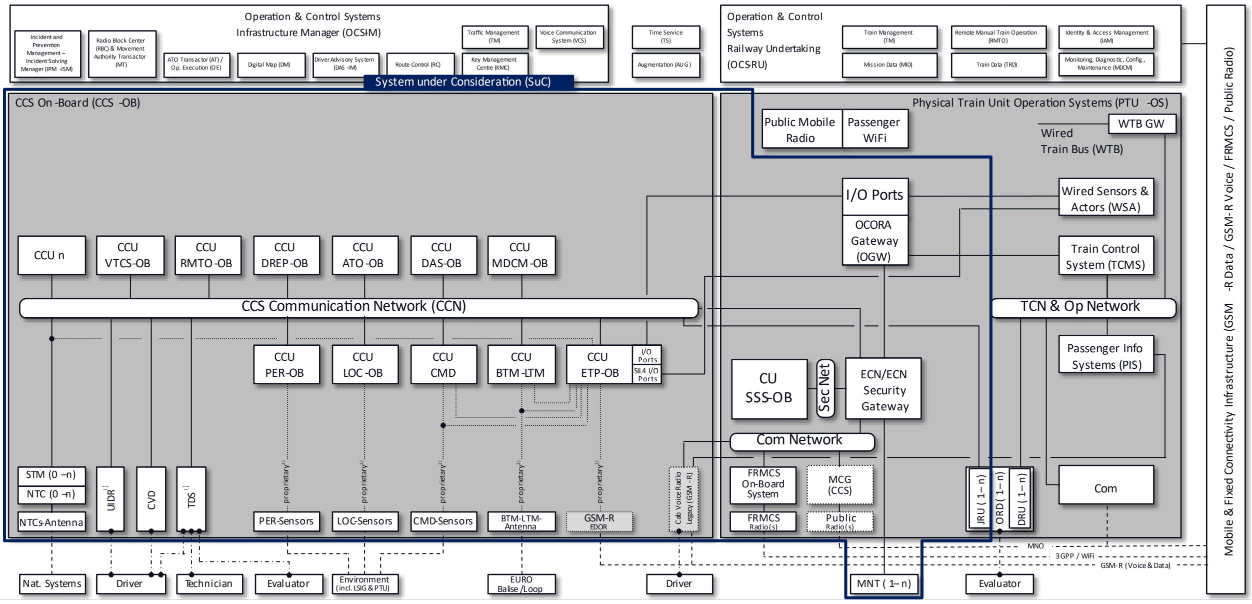

Operation & Control Systems
Infrastructure Manager (OCSIM)
Incident and Prevention Management – Incident Solving Manager (IPM -ISM)
Radio Block Center (RBC) & Movement Authority Transactor (MT)
ATO Transactor (AT) / Op. Execution (OE)
Digital Map (DM)
Driver Advisory System (DAS -IM)
Route Control (RC)
Traffic Management (TM)
Key Management Centre (KMC)
Voice Communication System (VCS)
Time Service (TS)
Augmentation (AUG)
Operation & Control Systems
Railway Undertaking (OCS-RU)
Train Management (TM)
Mission Data (MID)
Remote Manual Train Operation (RMTO)
Train Data (TRD)
Identity & Access Management (IAM)
Monitoring, Diagnostic, Config., Maintenance (MDCM)
System under Consideration (SuC)
CCS On -Board (CCS -OB)
CCU n
CCU VTCS-OB
CCU RMTO -OB
CCU DREP -OB
CCU ATO -OB
CCU DAS-OB
CCU MDCM -OB
CCS Communication Network (CCN)
CCU PER-OB
CCU LOC -OB
CCU CMD
CCU BTM -LTM
CCU ETP-OB
I/O Ports
SIL4 I/O Ports
STM (0 –n)
NTC (0 –n)
NTCs-Antenna
UIDR 1)
CVD
TDS 1)
proprietary 2)
PER-Sensors
LOC-Sensors
CMD-Sensors
BTM-LTM-Antenna
GSM-R EDOR
Cab Voice Radio Legacy (GSM - R)
Nat. Systems
Driver
Technician
Evaluator
Environment (incl. LSIG & PTU)
EURO Balise /Loop
Driver
Physical Train Unit Operation Systems (PTU -OS)
Public Mobile Radio
Passenger WiFi
WTB GW
Wired Train Bus (WTB)
I/O Ports
OCORA Gateway (OGW)
Wired Sensors & Actors (WSA)
Train Control System (TCMS)
TCN & Op Network
Passenger Info Systems (PIS)
CU SSS-OB
Sec Net
ECN/ECN Security Gateway
Com Network
FRMCS On-Board System
FRMCS Radio(s)
MCG (CCS)
Public Radio(s)
JRU (1– n)
ORD (1– n)
DRU (1– n)
Com
MNO
3GPP / WiFi
GSM-R (Voice & Data)
MNT (1– n)
Evaluator
Mobile & Fixed Connectivity Infrastructure (GSM -R Data / GSM-R Voice / FRMCS / Public Radio)

Figure 2: System under Consideration – Physical Architecture - Transition View

The logical components and external connections are shown in the logical architecture in Figure 3.

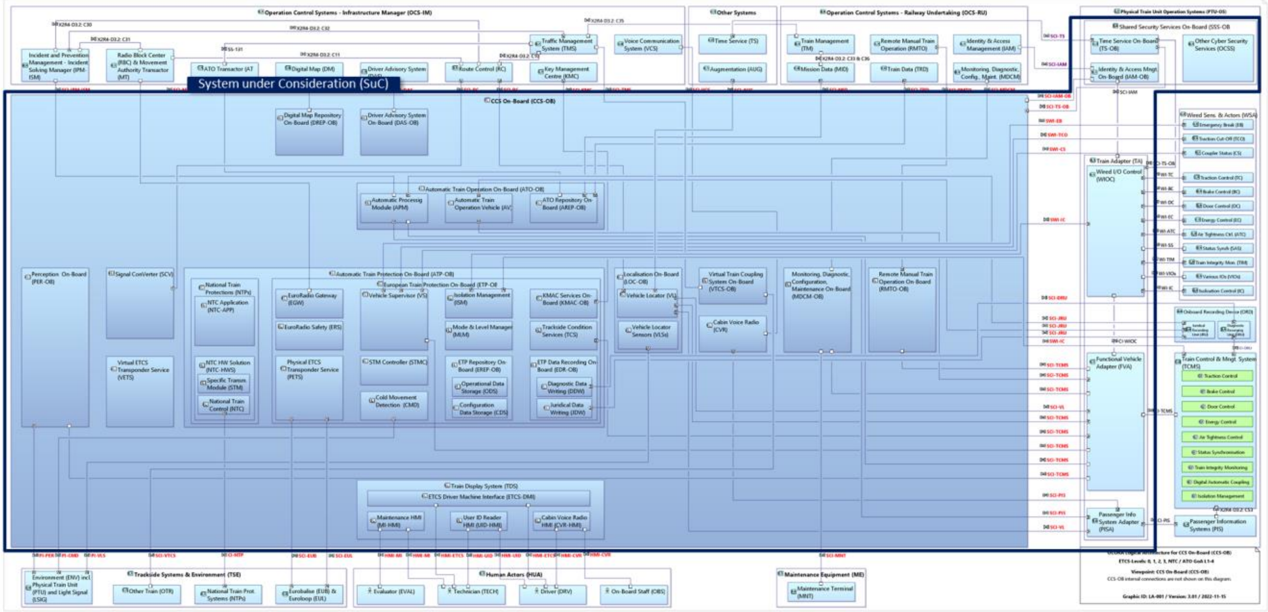

System under Consideration (SuC)
Operation Control Systems - Infrastructure Manager (OCS-IM)
Other Systems
Operation Control Systems - Railway Undertaking (OCS-RU)
Physical Train Unit Operation Systems (PTU-OS)
CCS On-Board (CCS-OB)
Trackside Systems & Environment (TSE)
Human Actors (HUA)
Maintenance Equipment (ME)

Figure 3: System under Consideration - Logical Architecture - Components view

The composition of logical components to building blocks is shown in the following figure.

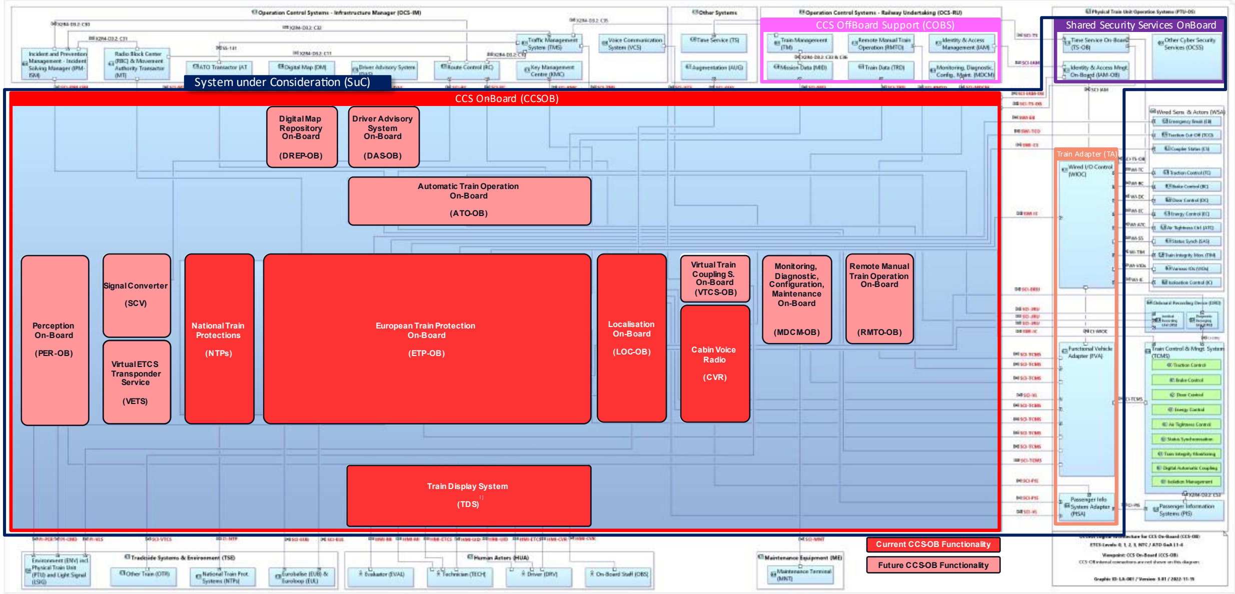

System under Consideration (SuC)
CCS OffBoard Support (COBS)
Shared Security Services OnBoard
CCS OnBoard (CCSOB)
Digital Map Repository On-Board (DREP-OB)
Driver Advisory System On-Board (DASOB)
Automatic Train Operation On-Board (ATO-OB)
Perception On-Board (PER-OB)
Signal Converter (SCV)
Virtual ETCS Transponder Service (VETS)
National Train Protections (NTPs)
European Train Protection On-Board (ETP-OB)
Localisation On-Board (LOC-OB)
Virtual Train Coupling S. On-Board (VTCS-OB)
Cabin Voice Radio (CVR)
Monitoring, Diagnostic, Configuration, Maintenance On-Board (MDCM-OB)
Remote Manual Train Operation On-Board (RMTO-OB)
Train Display System (TDS)
Train Adapter (TA)
Current CCSOB Functionality
Future CCSOB Functionality

Figure 4: System under Consideration - Logical Architecture - Building Block View

The basis of the SuC definition is the OCORA logical architecture and the physical transition view from the OCORA System Architecture [7]. Please note that the architecture view of R2 used in this concept was altered for R3. However, only minor changes (mainly naming) have been made for R3.

From security perspective it is essential to take the whole train into consideration to create comprehensive security measures to protect the operational relevant systems against attacks. Therefore, the system under consideration is covering not only CCS On-Board (CCS-OB) but also the Train Adapter, ECN/ECN-Security Gateway and dedicated communication and security components.

Also, all possible train compositions and vehicle types must be considered during the security related considerations, analyses and measure management, because of the different implementations.

The TCMS components, WSA (wired sensors and actors) and PIS components are outside the SuC and are not considered by TWS06.

The interfaces to the WSA are highly proprietary, therefore TA and WIOC needs to be developed for each train fleet by the specific vendor.

Only the interfaces specified by OCORA are considered.

3.2 Threat Landscape

The threat landscape is relevant for the risk and threat analysis (phase 3) and thus part of the Security Guidelines [10].

3.3 Attacker type definition

The attacker types will be defined, and the exclusion of attackers will be assessed in subsequent phases of OCORA.

4 Security Requirements

4.1 Protection Requirements Analysis

The basis for building zones and conduits is an initial definition of level of needed security based on possible threats and security goals (protection needs). Therefore, the logical architecture is analysed with an assessment of protection requirements (APR).

The APR uses the following criteria to analyse the protection requirement per interface. These criteria cover all protection targets relevant for the OCORA domain:

1. Confidentiality
2. Integrity
3. Availability
4. Non-Repudiation
5. Authenticity (only Human-Machine interface)

The criteria are classified based on the following levels:

- Low
- Middle
- High
- Very High

Per interface and criteria one level is defined. The definitions of these levels are available to the OCORA members. The maximum level per component for each of the five criteria is documented. The made assumption are explained in the Appendix A of this document.

To ensure consistency in the analysis of the protection requirements and the use of levels a risk matrix is used that allows to comprehensively analyse possible impacts.

The protection requirements per building block [7] are displayed in the following Table 3. The building block definition used for this assessment is shown in Figure 4.

Building Block	Confidentiality	Integrity	Availability	Non-Repudiation	Authenticity (only Human-Machine-Interaction)
ATO-OB	Not relevant	Very High	High	Middle	Low
External	Very High	Very High	High	Middle	Very High
ETP-OB	Not relevant	Very High	High	Middle	Not relevant
CVR	Not relevant	Very High	Low	Middle	Not relevant
TDS	Not relevant	Very High	Middle	Middle	Very High
DAS-OB	Not relevant	Low	Low	Low	Not relevant
DREP-OB	Not relevant	Very High	High	Middle	Not relevant
TA	Not relevant	Very High	High	Middle	Not relevant
SSS-OB	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
MDCM-OB	Very High	Very High	Low	Middle	Very High
NTPs	Not relevant	Very High	High	Middle	Not relevant
PER-OB	Not relevant	Very High	Low	Middle	Not relevant
RMTO-OB	Not relevant	Very High	High	Middle	Not relevant
SCV	Not relevant	Very High	Low	Middle	Not relevant

VETS	Not relevant	Very High	Low	Middle	Not relevant
LOC-OB	Not relevant	Very High	High	Middle	Not relevant
VTCS-OB	Not relevant	Very High	High	Middle	Not relevant

Table 3: Protection Requirements per Building Block

The detailed requirements per logical component and interface are displayed in the protection requirements analysis in Appendix A.

4.2 Architectural Impact Analysis and Requirements

4.2.1 Requirements Matrix

The development of a system architecture is an iterative process. Further, OCORA foresees different integration phases to allow improving existing vehicles, those that are going to be delivered in near future based on older requirement set-ups and future systems that meet the OCORA target set-up.

To support the iteration and migration process, the impact of different solutions to the security analysis and protection needs shall be flexible adoptable without analysing each possible variant. That is why a requirements definition was made that allows to understand the impact of architectural decision to the security requirements.

The matrix (Figure 5) represents the principle of the full requirements set-up in Appendix A. Figure 5 is a shortened excerpt of the full matrix. It shall be used the following way:

Preconditions:

- There is a given architecture. In this case, it is the OCORA logical architecture with the building blocks
- A protection requirements analysis was performed before, following the principle of chapter 4.1.

How to interpret the result and what to expect:

The matrix shows how the requirements change if an interface with a certain protection requirement moves from internal interface (connecting components inside one component via a physical protected network) to an external (connecting components via open/unprotected networks) interface and further distinguishes between the type of external connection. Therefore, the matrix comprehensively shows what consequences architectural decisions have.

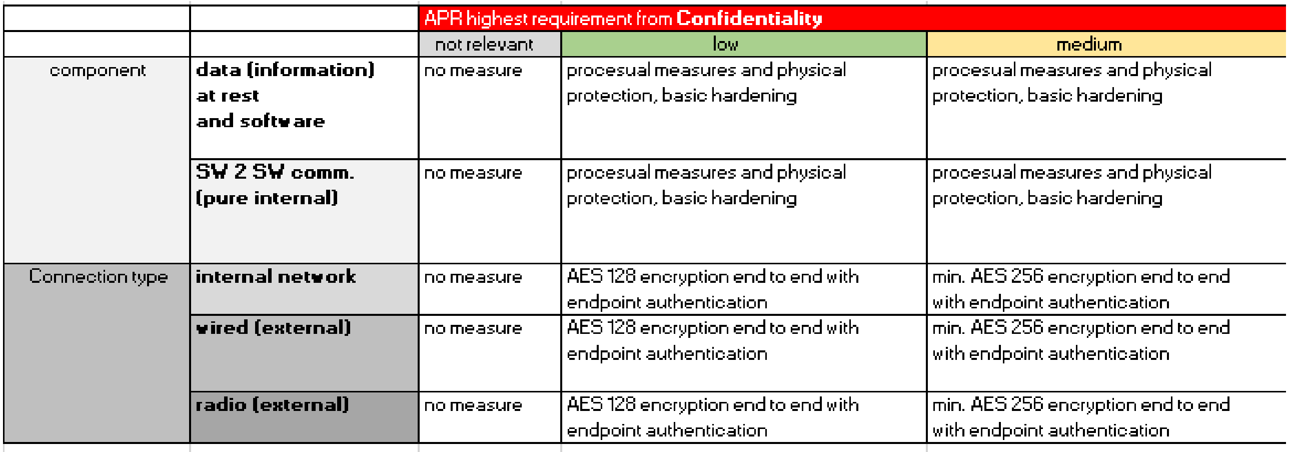
The matrix does not represent a full set of security requirements per component or system, but only concentrates on the main differences.

This matrix shall support a carefully chosen architecture that allows to meet the following requirements:

- Efficient (financial)
- Efficient operation
- Manageable over the life cycle
- Minimise OT-security risks

How to read the matrix:

1. The interface is classified to the greyish categories, e.g., external, wired connection
2. The relevant protection requirement is chosen, e.g., Confidentiality
3. The protection level is identified from the APR, e.g., medium
4. The meeting point of the column of the protection level (e.g., medium) and the connection category (e.g., external wired) displays the requirement differentiation criteria (e.g., AES 256 encryption and endpoint authentication)



		APR highest requirement from **Confidentiality**		
		not relevant	low	medium
component	**data (information) at rest and software**	no measure	procesual measures and physical protection, basic hardening	procesual measures and physical protection, basic hardening
	SW 2 SW comm. (pure internal)	no measure	procesual measures and physical protection, basic hardening	procesual measures and physical protection, basic hardening
Connection type	**internal network**	no measure	AES 128 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication
	wired (external)	no measure	AES 128 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication
	radio (external)	no measure	AES 128 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication

Figure 5: Protection Requirements architectural dependency

In Appendix A the full matrix is available covering all protection requirements and level of protection from the APR in chapter 4.1.

4.2.2 Understanding the requirements

The requirements from chapter 4.2.1 are, as described, only those requirements that differentiate between different architectural decisions. The full set of requirements will be derived from the threat and risk analysis in phase 3. The full set of requirements to the building blocks, based on the APR and phase 2 is presented in this document.

Following context is given to every of these differential requirements, to allow to use it properly for architectural design or component/system development.

The requirements are grouped. So e.g., "encryption end to end with endpoint authentication" is only explained once, the difference of AES 128, AES 256 is assumed to be comprehensive to the reader. Table 4 gives more context for some of the requirements to understand the impact of the distinction.

Requirement	Additional comment
Encryption end to end with endpoint authentication	Here AES encryption methods (symmetric) are defined. It is assumed that the key exchange process is asymmetric.
The developer must consider security with respect of implementing SL-T and expected attacker category.	This implies that the organization of the developer knows the relevant processes and works in well-defined processes according to IEC 62443-4-1 [17], IEC 62443-2-4 [15] and IEC 62443-2-1 [14] (depending on the organization)
Monitoring/detection of malware (SIEM) with central logging	It is assumed that security monitoring and intrusion detection is implemented onboard. Further it is assumed that events are event driven sent to the land side in a back-end SOC to be treated within an incident response process. In addition, security logging information shall be available constantly on the SOC (back-end) side to allow a continuous overview of the threat landscape.
Protect component availability low	The definition of low, middle, high, very high is to be defined by the operator. An assumption was made in the protection requirements analysis.
Two radio networks with own core or high availability one-network-design; with automated detection of availability load handling and "switching" between networks; or combination radio and wired networks	Very high availability requirements via a radio connection are assumed nearly impossible as radio connection can be easily and remotely interrupted, e.g., through jamming.
Multi-network, multi-source, multi-operator (not	

service provider, operator!) with automated detection of availability load handling and "switching" between networks + cabled network or "wire breakage proof" required (process resilience to connection interruption)	
Username, no or weak password; roles for authorization	Authenticity in the protection requirements is only analysed for human-machine interface. This is because authenticity in machine-2-machine communication is state of the art and independently from the network design required by IEC 62443.

Table 4: Requirements supportive description

4.2.3 Architectural feedback and improvement

Based on the System Requirements of the IEC 62443 the architecture of OCORA was assessed. The SRs will be selected and assigned as mitigating measures in the risk assessments in one of the subsequent phases. To prepare this process and to identify possible conflicts of system requirements and the current OCORA architecture as early as possible, a conflict check has been performed. This conflict check takes all SRs relevant for SL 3 into account. The result can be used in two different ways:

- Input to the architecture

  Some conflicts with the SRs have already been resolved by the architecture workstream. Thus, some aspects of the OCORA security are aligned as early as possible.

- Mitigating measures for the risk assessment

  The upcoming risk assessment will take SRs into account and use them as mitigating measures. During the assessments, the identified applicability can directly be used, which helps to improve the risk values and evaluation of mitigating measures.

This IEC 62443-3-3 check is not published, but some changes have been included in the system architecture already due to collaboration of TWS06 Security and TWS01 Architecture. These changes include amongst others:

- Cabin Voice Radio

  The Cabin Voice Radio component is connected through the Security Gateway and has no direct connection to the CCN anymore.

- MT (Maintenance Terminal)

  The Maintenance Terminal will not have direct access to the CCN and is connected through the Security Gateway.

Furthermore inter alia following open topics have been identified and will be addressed in future releases:

- Identity and Access Management
- Account and Authorization Management
- Network Segregation
- DMI and User Authentication
- Software and Configuration Updates
- Isolation and Degraded Mode

4.2.4 Essential components

In accordance with TS 50701 essential functions shall be determined to allow focus on the systems and components with the highest protection needs for integrity, as they support most the safe process of the rail system. As OCORA has defined an architecture with logical components, this method is applied to these logical components.

The following table shows the essential components of the logical architecture in OCORA.

Component	Confidentiality	Integrity	Availability	Non-Repudiation	Authenticity (only Human-Machine-Interaction)
APM	Not relevant	Very High	High	Middle	Low
AV	Not relevant	Very High	High	Middle	Not relevant
CDS	Not relevant	Very High	High	Middle	Not relevant
CVR	Not relevant	Very High	Low	Middle	Not relevant
CVR-HMI	Not relevant	Very High	Low	Middle	Not relevant
DM	Not relevant	Very High	High	Middle	Not relevant
DREP-OB	Not relevant	Very High	High	Middle	Not relevant
ETCS-DMI	Not relevant	Very High	Middle	Middle	Not relevant
FVA	Not relevant	Very High	High	Middle	Not relevant
ISM	Not relevant	High	Low	Middle	Not relevant
MDCM	Very High	Very High	Low	Middle	Very High
MDCM-OB	Very High	Very High	Low	Middle	Very High
MI-HMI	Not relevant	Very High	Middle	Middle	Very High
MLM	Not relevant	Very High	High	Middle	Not relevant
MNT	Very High	Very High	Low	Middle	Very High
NTC-APP	Not relevant	Very High	High	Middle	Not relevant
PER-OB	Not relevant	Very High	Low	Middle	Not relevant
PETS	Not relevant	Very High	High	Middle	Not relevant
PISA	Not relevant	Very High	Low	Middle	Not relevant
RBC	Not relevant	Very High	Low	Middle	Not relevant
RMTO	Not relevant	Very High	High	Middle	Not relevant
RMTO-OB	Not relevant	Very High	High	Middle	Not relevant
SCV	Not relevant	Very High	Low	Middle	Not relevant
STM	Not relevant	Very High	Low	Middle	Not relevant
STMC	Not relevant	Very High	High	Middle	Not relevant
TECH	Not relevant	Very High	Low	Middle	Very High
VCS	Not relevant	Very High	Low	Middle	Not relevant
VETS	Not relevant	Very High	Low	Middle	Not relevant
VL	Not relevant	Very High	High	Middle	Not relevant
VS	Not relevant	Very High	High	Middle	Not relevant
VTCS-OB	Not relevant	Very High	High	Middle	Not relevant
WIOC	Not relevant	High	Low	Middle	Not relevant
WSA	Not relevant	Very High	Low	Middle	Not relevant
ETP-OB	Not relevant	Very High	Low	Middle	Not relevant

Table 5: Protection requirements of essential components

4.3 Zoning and Conduits

4.3.1 Process for building zones and conduits

The Protection Requirements analysis has analysed the kind of protection need per interface and/or component.

Based on the protection requirements building blocks are grouped into zones and conduits. The zoning process is briefly described with examples in TS 50701 [13] and IEC 62443-3-2 [16].

Zones in the context of IEC 62443 [16], TS 50701 [13], the Security Guideline [10] and thus this Security Concept always mean Security zones. These can be different from network zones.

For the partitioning of the SuC into zones and conduits the following main criteria of TS 50701 [13] have been involved:

1. Protection requirements in terms of Integrity, Availability and Confidentiality
2. Operational function
3. Physical or logical location
4. Safety aspect
5. Access requirements

The zoning is graphically displayed in the physical architecture.

The results of the protection requirements and the zoning show:

- the distribution of crucial functions in the architecture
- criticality of the protected functions

This allows a discussion in the sense of safety and security and the necessary approvals, safety, and security levels. The feedback should be used to improve the architecture to reduce the critical interfaces and components to a minimum.

Based on the zoning, in phase 3 (Threat and risk analysis) the SL-T shall be defined per zone.

The detailed protection requirements analysis focused on the CCS system only. Nevertheless, a full overview of the train is relevant to set the CCS system and its zoning concept into relation of the full train. Therefore, based on Shift2Rail X2Rail-3 High-level on-board security architecture [11] and the protection requirements analysis the zoning concept is split in a high-level zoning in chapter 4.3.2. and a detailed zoning concept (sub zones) in chapter 4.3.4.

4.3.2 High Level zoning concept for the train

Based on the different protection needs and fundamentals like commonly used vehicle architectures and zoning examples provided by the standards, the train system is split into the following main zones for the security analysis.

- Train Signalling and ATP zone (ETP-OB, LOC-OB, TDS, ATO etc.)
- Train Control and Command Zone (TCMS, Brakes, Doors etc.)
- Train Auxiliary Zone (HVAC, Lighting etc.)
- Train Comfort Zone (Passenger Information etc.)
- Train Public Services Zone (Passenger WiFi etc. if existing)
- Security Services Zone (Shared Security Services etc.)
- Communication Zone (connection to trackside)

The mapped functions per zone represent the most applicable to the specific zone and are examples, as the system definition in OCORA for the full train is not defined as complete, yet.

4.3.3 Detailed Zoning concept for the OCORA scope of the system under consideration

The zoning of the OCORA System under Consideration is mainly derived from a functional point of view considering criticality of assets and logical location as recommended in [16]. The zoning corresponds also to the X2Rail-3 High-level on-board security architecture [11] and the TS 50701 Railway physical architecture model. The OCORA zoning concept is shown in Figure 6.

4.3.4 Zoning concept of the system under consideration

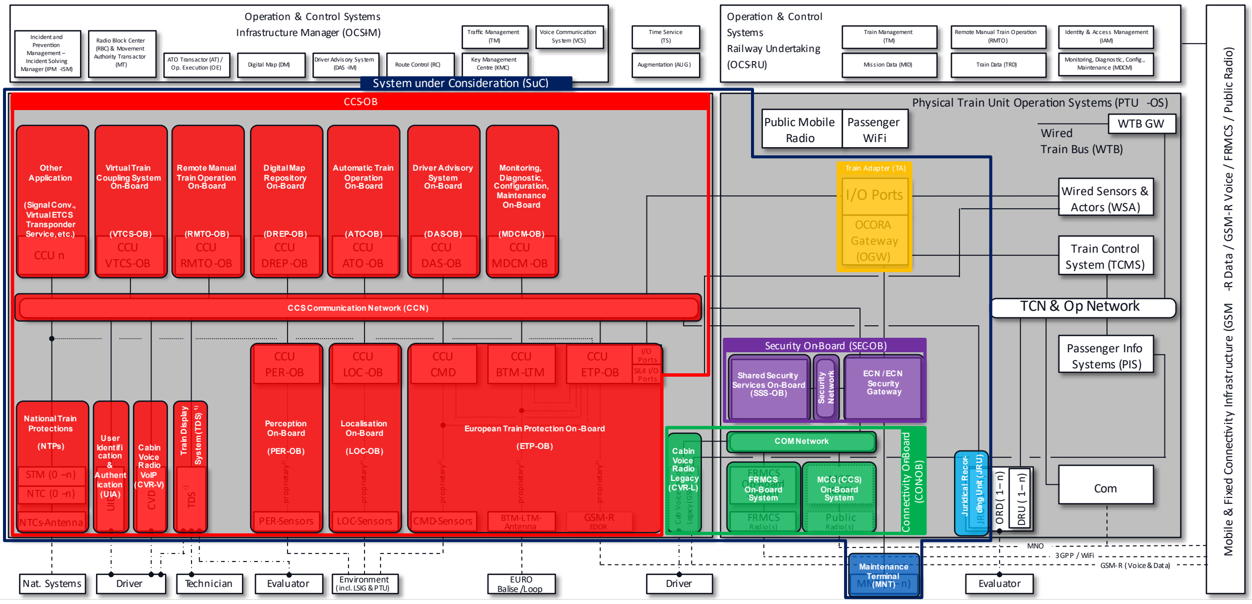

Operation & Control Systems
Infrastructure Manager (OCSIM)
Incident and Prevention Management – Incident Solving Manager (IPM -ISM)
Radio Block Center (RBC) & Movement Authority Transactor (MT)
ATO Transactor (AT) / Op. Execution (OE)
Digital Map (DM)
Driver Advisory System (DAS -IM)
Route Control (RC)
Traffic Management (TM)
Key Management Centre (KMC)
Voice Communication System (VCS)
Time Service (TS)
Augmentation (AUG)
Operation & Control Systems
Railway Undertaking (OCS-RU)
Train Management (TM)
Mission Data (MID)
Remote Manual Train Operation (RMTO)
Train Data (TRD)
Identity & Access Management (IAM)
Monitoring, Diagnostic, Config., Maintenance (MDCM)
System under Consideration (SuC)
CCS-OB
Other Application (Signal Conv., Virtual ETCS Transponder Service, etc.)
CCU n
Virtual Train Coupling System On-Board (VTCS-OB)
CCU VTCS-OB
Remote Manual Train Operation On-Board (RMTO-OB)
CCU RMTO-OB
Digital Map Repository On-Board (DREP-OB)
CCU DREP-OB
Automatic Train Operation On-Board (ATO-OB)
CCU ATO-OB
Driver Advisory System On-Board (DAS-OB)
CCU DAS-OB
Monitoring, Diagnostic, Configuration, Maintenance On-Board (MDCM-OB)
CCU MDCM-OB
CCS Communication Network (CCN)
CCU PER-OB
CCU LOC-OB
CCU CMD
CCU BTM-LTM
CCU ETP-OB
I/O Ports
SIL4 I/O Ports
National Train Protections (NTPs)
STM (0 –n)
NTC (0 –n)
NTCs-Antenna
User Identification & Authentication (UIA)
UID
Cabin Voice Radio VoIP (CVR-V)
CVD
Train Display System (TDS) 1)
TDS 1)
Perception On-Board (PER-OB)
PER-Sensors
Localisation On-Board (LOC-OB)
LOC-Sensors
European Train Protection On-Board (ETP-OB)
CMD-Sensors
BTM-LTM-Antenna
GSM-R EDOR
proprietary 2)
Cabin Voice Radio Legacy (CVR-L)
Cab Voice Legacy (GSM-R)
Physical Train Unit Operation Systems (PTU -OS)
Public Mobile Radio
Passenger WiFi
WTB GW
Wired Train Bus (WTB)
Train Adapter (TA)
I/O Ports
OCORA Gateway (OGW)
Wired Sensors & Actors (WSA)
Train Control System (TCMS)
TCN & Op Network
Passenger Info Systems (PIS)
Security On-Board (SEC-OB)
Shared Security Services On-Board (SSS-OB)
Security Network
ECN / ECN Security Gateway
COM Network
FRMCS On-Board System
FRMCS Radio(s)
MCG (CCS) On-Board System
Public Radio(s)
Connectivity On-Board (CONOB)
Juridical Recording Unit (JRU)
ORD (1 – n)
DRU (1 – n)
Com
Maintenance Terminal (MNT)
MNO
3GPP / WiFi
GSM-R (Voice & Data)
Mobile & Fixed Connectivity Infrastructure (GSM -R Data / GSM-R Voice / FRMCS / Public Radio)
Nat. Systems
Driver
Technician
Evaluator
Environment (incl. LSIG & PTU)
EURO Balise /Loop
Driver
Evaluator

Figure 6: Security Zoning Concept

The current security zoning concept is based on the transition view. Other versions of the OCORA architecture are currently not considered. The SuC is shown in Figure 6 and includes all the CCS and supporting components. The TCMS and external systems are excluded.

Currently the following zones are defined:

- CCS (red)
- Train Adapter (orange)
- JRU (light blue)
- MNT (dark blue)
- SSS-OB and ECN/ECN Security Gateway (purple)
- Communication (green)

The zoning is shown above is based on the following assumption:

- Communication devices with connection to trackside are in an own zone
- Security Gateway is in the same zone as the connected CU SSS-OB

  (The functionality of the Security Gateway could be split up in multiple security components in a future architecture. Furthermore, more than one Security Gateway could be implemented.)
- The Train Adapter and the included Gateway is an own zone
- The maintenance terminal is an own zone as it is not part of the fix installations of the train

Depending on the implementation on the vehicles later, the building blocks of the CCS zone can be divided into separate sub-zones of the CCS zone, if they are physically located in different parts of the train and the connection between is not secured.

The connections between the zones can be seen as conduits. The Security Gateway represents the perimeter protection of the zones and is connected on the CU SSS-OB in one zone, as both fulfil security functionalities together.

In the current status of the OCORA project (phase 2) the logical connections/components, and the system architecture are not finally designed yet. Furthermore, the functional scope is not completely defined.

Due to these aspects, it is not possible to define a final security zoning concept. Only the preliminary zoning concept on a preliminary system under consideration can be defined.

5 Security Services and Supportive Services

5.1 Initial Assumption

It is assumed that, based on the threat and risk analysis (phase 3), the security services and supportive services will be required. Thus, they are presented as input in the Security Concept already to be considered in the further architectural development.

5.2 Security Services

The security services are standardized between EULYNX, EUG and OCORA and further coordinated with Shift2Rail X2Rail3.

Security services serve as central services over the life cycle. Standardization supports easy implementation and interoperability.

The specification of the security services is available in EU.Doc.117 (Security Services Interface) and EU.Doc.121 (Security Services Platform).

The services are:

- Time
- Back-up
- SIEM
- Security Logging
- PKI (Public Key Infrastructure)
- IAM (Identity and Access Management)

Further description and details are not given to ensure single source usage.

5.3 Supportive Services

Supportive services enable security services, safety services and maintenance over the life cycle.
The following supportive services shall be in place:

- Asset Inventory
- Software and Configuration Repository
- Diagnostic Logging

Their general interaction and connection are displayed in Figure 7. The supportive services are each described in more detail in the following chapters.

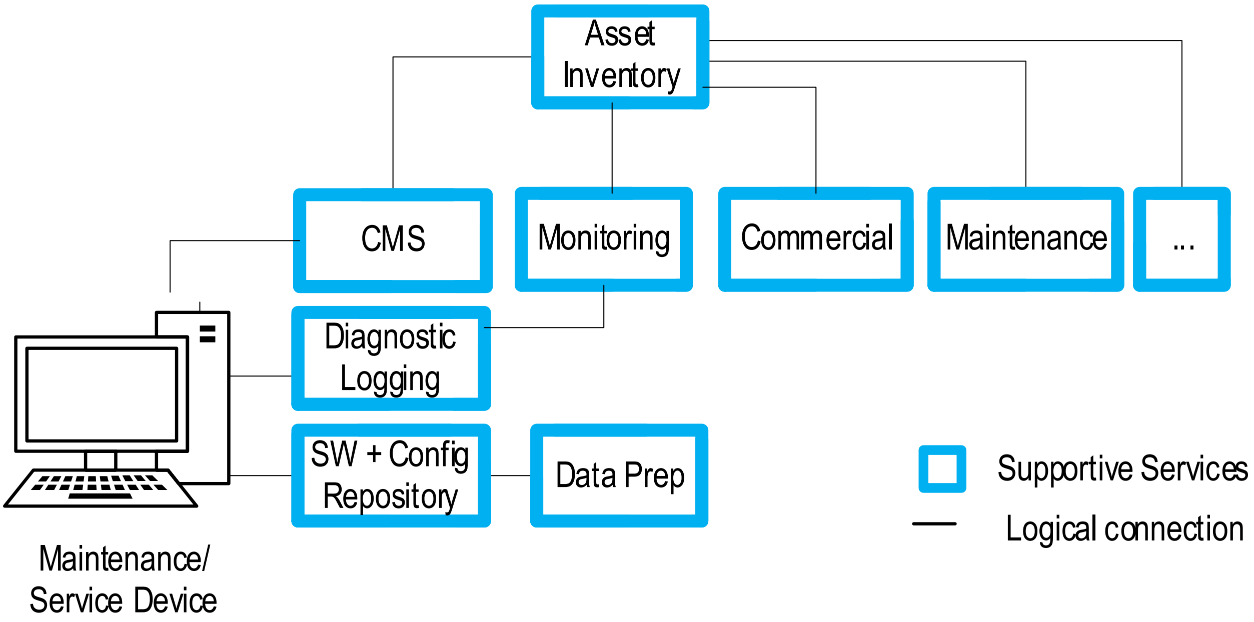


Figure 7: Supportive Services overview

5.3.1 Asset Management

The asset inventory is part of the asset management process. The asset management is used to track the lifecycle of all hardware and software assets. The assets managed include all assets relevant within the vehicle architecture and not only the security related assets. It tracks the data of assets beginning with the interface from the procurement management, ending with the decommissioning.

This service is a non-technical service using available technical systems of a Railway Undertaking and is interconnected with commercial processes, including supply chain and procurement processes.

The asset management contains amongst others:

- Asset Inventory,
- Configuration Management System (CMS),
- Maintenance aspects,
- Commercial aspects.

For use within OCORA, the CMS is relevant for the Software (configuration and software) management process. The CMS manages the software and configuration of the assets in the context of a desired overall state. This service is sometimes referred as Configuration Management Database (CMDB). It must provide a versioning system which records and provides the configuration used by the assets. The CMS does not store software or configurations. The software and configuration are stored in the SW+Config Repository.

The CMS orchestrates configuration updates using the SW+Config Repository service to deploy software files and configuration.

A maintenance and diagnostic device that has the right to update the onboard systems, shall support this task by performing a lookup for the software and configuration version defined in the CMS. Afterwards it is requesting the corresponding software and configuration from the SW+Config Repository. This software and configuration are then deployed to the asset. This service is a technical service interconnected to the life-cycle-management of the asset and the system, as well as with data preparation procedures. This service supports keeping the overall system in a certified state. The process is displayed in Figure 8.

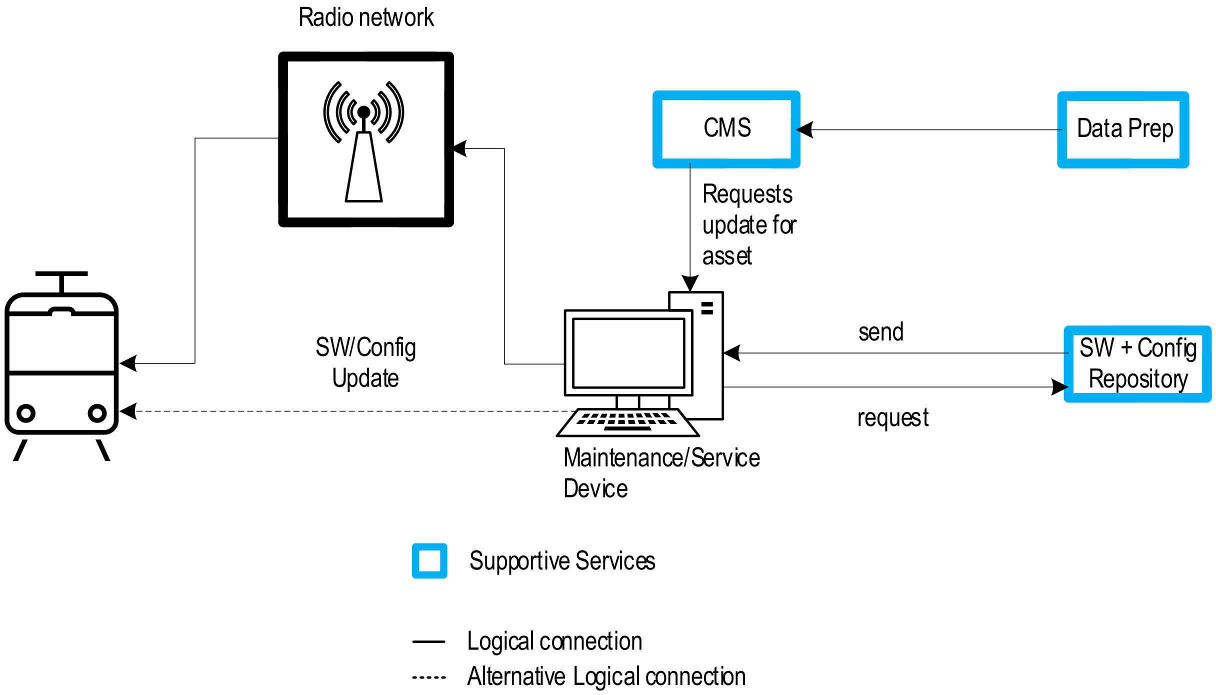


Figure 8: Supportive Services SW/Config Update

Asset inventory must include attributes to each asset giving indication on their position and function in the logical architecture (e.g., to be used for risk inheritance during risk management process) and physical architecture (e.g., to be used for updates, retrofit efforts)

The asset inventory shall provide the following connectivity and support interaction:

- Interacts with Life-Cycle Managers
- Interacts with maintenance personnel (maintenance, replacement)
- Interacts with build projects (import/create assets to be managed)
- Interacts with IAM (basic data for identity, decommissioning of asset)
- Supports maintenance activities
- Provides technical, commercial and supply chain data based on authentication and authorization based on IAM service
- documents physical (e.g., location) and high-level logical (e.g., EIL area) context of asset
- Provide Configuration Management System (CMS) orchestrating software and configuration changes ensuring compliance with safety regulation/certificates
- The Configuration Management System interacts with processes/systems supporting change
- The Configuration Management System interacts with the MDM

The Configuration Management System uses the Software & Configuration Repository service

5.3.2 Assumption on Maintenance

During the process of the review presented in Chapter 4.2.3 several assumptions on the maintenance and on-board security services were necessary. These services are currently not defined in the OCORA architecture or specifications. The assumptions provide a basis for the future work of upcoming releases. They do not represent any specified solution yet.

Figure 9 shows the distribution across the onboard and infrastructure side systems. The Shared Security Services On-Board (CU SSS-OB) are connected to the internal network and to the infrastructure via the ECN/ECN-Security Gateway. The SSS-Trackside (SSS-TS) are located at the infrastructure of the RU and connected to supporting (security) services like the OCS-RU and the SOC (yellow). Arrows in the figure indicate if the specific service is the main data source or if it is a mirror of a subset of the data (Destination).

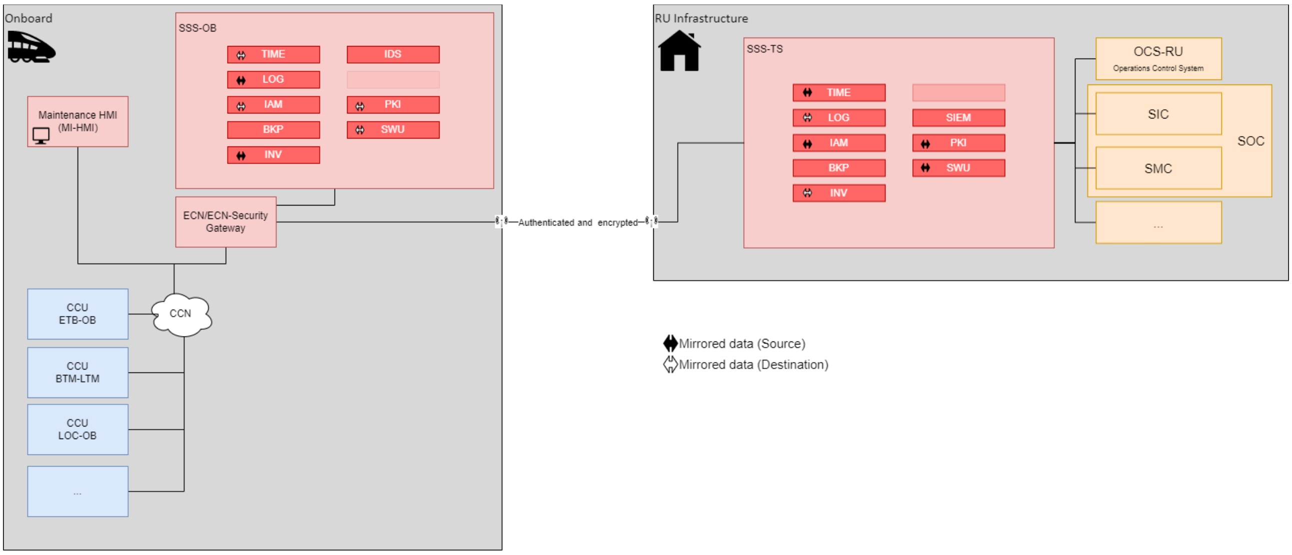


Figure 9: SSS-OB and SSS-TS

Following services are defined in the SSS-OB and SSS-TS:

- TIME: Time source syncing the local SSS-OB TIME to the SSS-TS TIME
- IDS: SSS-OB side Intrusion Detection System
- LOG: Logging service uploading the local SSS-OB data to the SSS-TS
- SIEM: Security Incident and Event Management on SSS-TS using the data provided by LOG (depending on the logs an on-board pre-treatment or prioriation of sending has to be analysed)
- IAM: Identity and Access Management provided by SSS-TS which is mirrored to the SSS-OB for local use.
- PKI: Public Key Infrastructure which is managed centrally in the SSS-TS. Parts of the PKI might be mirrored to the SSS-OB (e.g., CRLs)
- BKP: Local and infrastructure side backup. Local backup might contain e.g., logging information and previously used software and configuration files for rollback. Infrastructure side might include software and configuration files, logging data and other backups of other services.
- SWU: Software and configuration repository available at SSS-TS. Update files could be transferred to the SSS-OB SWU and saved locally until they are applied.
- INV: SSS-OB side inventory of all components as well as software/configuration versions which is transferred to the SSS-TS.

In Figure 10 the connection from the Maintenance Terminal (MNT) to the CCU(s) is shown. The figure describes how a software- or configuration change must be performed to ensure complete coverage of the requirement given by the applied standards.

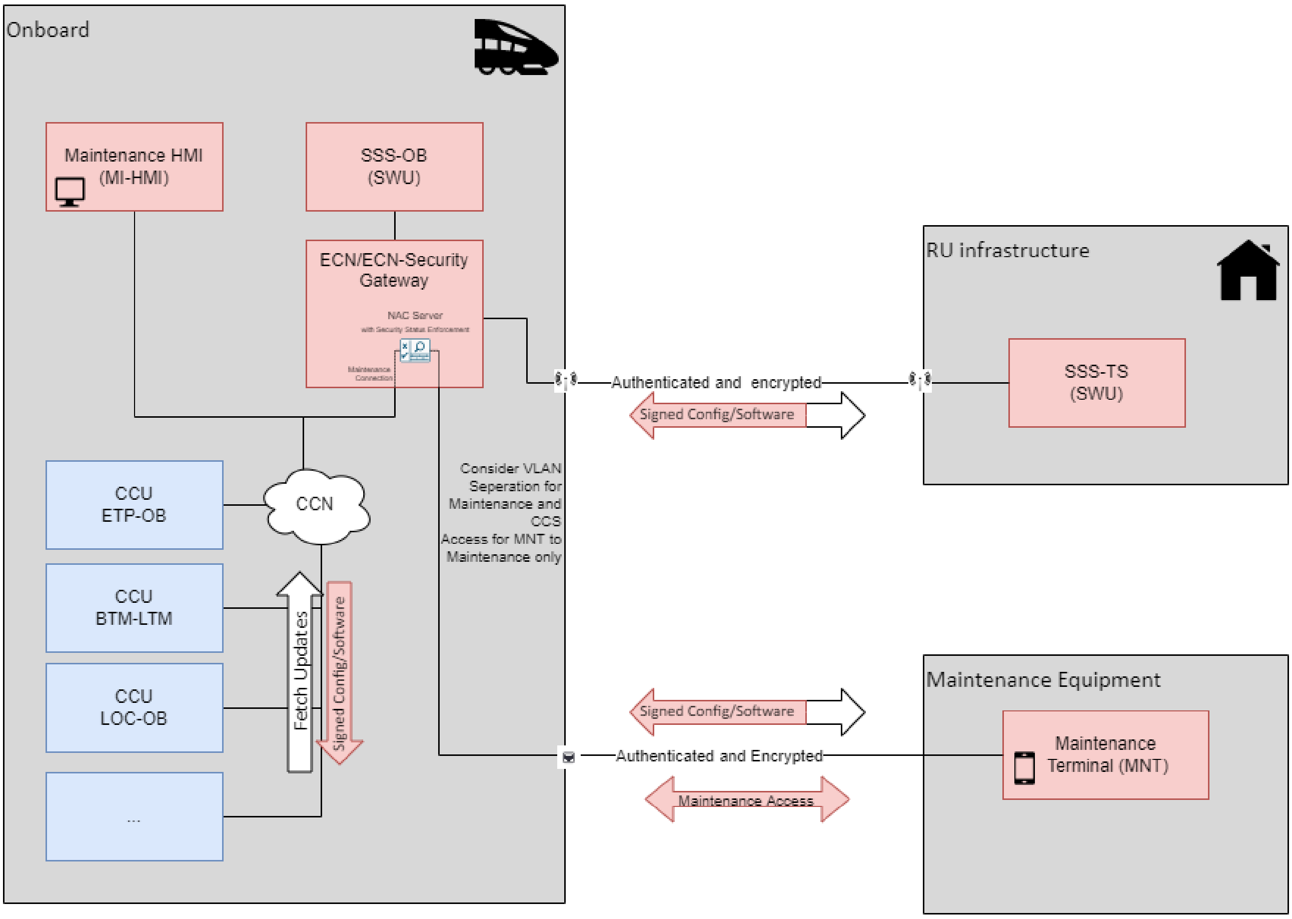


Figure 10: Assumptions on Maintenance

In the following the different update scenarios are described using the approach shown in the figure above.

Direct Maintenance Connection via Maintenance Terminal (MNT)

The MNT establishes a connection to a component (e.g., EVC) via the ECN-Security Gateway and using a separated VLAN. After successfully establishing a connection and reaching the destination component only signed (software or configuration) files are allowed to be transferred to the component.

Software and Configuration Update:

SSS-TS Update

The SSS-TS establishes a connection to the ECN-Security gateway. A direct connection from the SSS-TS to another component of the onboard system must be prohibited. Files are allowed to be transferred to the SSS-OB and the rollout of the change can be planed or executed.

MNT Update:

The MNT establishes a connection to the ECN-Security gateway. A direct connection from the MNT to another component of the onboard system must be prohibited. Files are allowed to be transferred to the SSS-OB and the rollout of the change can be planed or executed.

Appendix A Assessment of the Protection Requirements

Assumptions	Comment
Non repudation is set to middle if health damage is (very) high in other APR categories. It is set to middle as juridical consequences and nation wide reporting can be expected if the cause of an accident can not be identified.	
Availability is always connected to the evaluation of the assessed interface.	
Availability is set to low, if a non-availability is not linked to any safety critical reaction and only one train can be affected.	
Availability is set to high or very high, if a non-availability is linked to a safety critical reaction, e.g. the Emergency break.	
Availability is set to high, if a non-availability of one in one train is linked to a fleet fail.	

Assessment of the protection requirements

Interface ID	Interface Name	Component Group A	Component A	Component Group B	Component B / Personell	Building Block Connection	Direction	Confidentiality	Integrity	Availability	Non-Repudiation	Authenticity (only Human-Machine-Interaction)
1	SCI-VL	HMI-OB	ETCS-DMI	LOC-OB	VL	External	<-	Not relevant	Very High	Low	Middle	Not relevant
2	SCI-TCS	HMI-OB	ETCS-DMI	TCS	TCS	External	<-	Not relevant	Middle	Middle	Middle	Not relevant
3	SCI-ETCS-DMI	HMI-OB	ETCS-DMI	ATP-OB	STMC	External	<-	Not relevant	Low	Low	Low	Not relevant
4	SCI-ETCS-DMI	HMI-OB	ETCS-DMI	ATP-OB	MLM	External	<->	Not relevant	Very High	Low	Middle	Not relevant
5	SCI-ETCS-DMI	HMI-OB	ETCS-DMI	ATP-OB	VS	External	<->	Not relevant	Very High	Low	Middle	Not relevant
6	SCI-CVR	HMI-OB	CVR-HMI	CVR	CVR	External	<->	Not relevant	Very High	Low	Middle	Not relevant
7	-	HMI-OB	MI-HMI	Human	EVAL	External	<->	Not relevant	Low	Low	Low	
8	-	HMI-OB	MI-HMI	Human	TECH	External	<->	Not relevant	Very High	Low	Middle	Very High
9	-	HMI-OB	ETCS-DMI	Human	TECH	External	<->	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
10	-	HMI-OB	UID-HMI	Human	TECH	External	<->	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
11	-	HMI-OB	UID-HMI	Human	DRV	External	<->	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
12	-	HMI-OB	ETCS-DMI	Human	DRV	External	<->	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant

13	-	HMI-OB	CVR-HMI	Human	DRV	External	<->	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
14	-	HMI-OB	CVR-HMI	Human	OBS	External	<->	Not relevant	Middle	Low	Low	Not relevant
15	SCI-VL	LOC-OB	VL	TCS	TCS	External	->	Not relevant	Middle	Middle	Middle	Not relevant
16	HMI	LOC-OB	VL	TA	PISA	External	->	Not relevant	Low	Low	Low	Not relevant
17	-	LOC-OB	VL	TA	FVA	External	->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
18	SCI-AUG	LOC-OB	VL	AUG	AUG	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
19	SCI-RC	LOC-OB	VL	OCS-IM	RC	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
20	SCI-DREP	LOC-OB	VL	DREP-OB	DREP-OB	External	<-	Not relevant	Very High	High	Middle	Not relevant
21	SCI-VL	LOC-OB	VL	DAS-OB	DAS-OB	External	->	Not relevant	Low	Low	Low	Not relevant
22	SCI-VL	LOC-OB	VL	ATO-OB	AV	External	->	Not relevant	Middle	Low	Low	Not relevant
23	SCI-VL	LOC-OB	VL	ATO-OB	APM	External	->	Not relevant	Low	Low	Not relevant	Not relevant
24	SCI-VL	LOC-OB	VL	ATP-OB	MLM	External	->	Not relevant	Very High	High	Middle	Not relevant
25	SCI-VL	LOC-OB	VL	ATP-OB	VS	External	->	Not relevant	Very High	High	Middle	Not relevant
26	SCI-VL	LOC-OB	VL	ATP-OB	STMC	External	->	Not relevant	Very High	High	Middle	Not relevant
27	SCI-VL	LOC-OB	VL	ATP-OB	NTC-APP	External	->	Not relevant	Very High	High	Middle	Not relevant

28	SCI-VL	LOC-OB	VL	SCV	SCV	External	->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
29	SCI-CMD	LOC-OB	VL	MD-OB	CMD	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
30	SCI-VL	LOC-OB	VL	ETS	VETS	External	->	Not relevant	Very High	Low	Middle	Not relevant
31	SCI-PETS	LOC-OB	VL	ETS	PETS	External	<-	Not relevant	Very High	Low	Middle	Not relevant
32	-	LOC-OB	VLSs	ENV	ENV	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
33	SCI-TMC	ATP-OB	STMC	ATP-OB	NTC-APP	External	<->	Not relevant	Very High	Low	Middle	Not relevant
34	SCI-JMC	ATP-OB	DDW	PTU-OS	DRU	External	->	Not relevant	Middle	Middle	Middle	Not relevant
35	SCI-JMC	ATP-OB	JDW	PTU-OS	JRU	External	->	Not relevant	Middle	Middle	Middle	Not relevant
36	SCI-PETS	ATP-OB	NTC-APP	ETS	PETS	External	<-	Not relevant	Very High	Low	Middle	Not relevant
37	SCI-PETS	ATP-OB	STM	ETS	PETS	External	<-	Not relevant	Very High	Low	Middle	Not relevant
38	SCI-VETS	ATP-OB	NTC-APP	ETS	VETS	External	<-	Not relevant	Very High	Low	Middle	Not relevant
39	SCI-VETS	ATP-OB	STMC	ETS	VETS	External	<-	Not relevant	Very High	Low	Middle	Not relevant
40	SCI-VETS	ATP-OB	STM	ETS	VETS	External	<-	Not relevant	Very High	Low	Middle	Not relevant
41	SCI-VETS	ATP-OB	MLM	ETS	VETS	External	<-	Not relevant	Very High	Low	Middle	Not relevant
42	SCI-VETS	ATP-OB	VS	ETS	VETS	External	<-	Not relevant	Very High	Low	Middle	Not relevant

43	SCI-STMC	ATP-OB	STMC	ATP-OB	STM	External	<->	Not relevant	Very High	Low	Middle	Not relevant
44	-	ATP-OB	VS	TA	FVA	External	<->	Not relevant	Middle	Low	Low	Not relevant
45	SCI-VS	ATP-OB	VS	ATO-OB	AV	External	<-	Not relevant	Low	Low	Not relevant	Not relevant
46	-	ATP-OB	VS	PTU-OS	WSA	External	->	Not relevant	Very High	Low	Middle	Not relevant
47	-	ATP-OB	ISM	TA	WIOC	External	->	Not relevant	High	Low	Middle	Not relevant
48	-	ATP-OB	VS	OCS-IM	RBC	External	<->	Not relevant	Very High	Low	Middle	Not relevant
49	SCI-VS	ATP-OB	VS	ATO-OB	APM	External	<-	Not relevant	Very High	Low	Middle	Not relevant
50	SCI-NTC-APP	ATP-OB	NTC-APP	ATO-OB	AV	External	<-	Not relevant	Middle	Low	Low	Not relevant
51	SCI-STM	ATP-OB	STM	ATO-OB	AV	External	<-	Not relevant	Middle	Low	Low	Not relevant
52	-	ATP-OB	NTC	NTPs	NTPs	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
53	SCI-JRU	ATO-OB	AV	PTU-OS	JRU	External	->	Not relevant	Low	Low	Low	Not relevant
54	SCI-PER-OB	ATO-OB	APM	PER-OB	PER-OB	External	<-	Not relevant	Very High	Low	Middle	Not relevant
55	SCI-SCV	ATO-OB	AV	SCV	SCV	External	<-	Not relevant	Low	Low	Low	Not relevant

56	-	ATO-OB	AV	TA	FVA	External	<->	Not relevant	Low	Low	Low	Not relevant
57	SCI-DREP	ATO-OB	AV	DREP-OB	DREP-OB	External	<-	Not relevant	Low	Low	Low	Not relevant
58	-	ATO-OB	AREP-OB	OCS-IM	AT	External	<->	Not relevant	Low	Low	Low	Not relevant
59	-	DAS-OB	DAS-OB	OCS-IM	DAS	External	<->	Not relevant	Low	Low	Low	Not relevant
60	SCI-DREP	DREP-OB	DREP-OB	ETS	VETS	External	->	Not relevant	Very High	Low	Middle	Not relevant
61	SCI-DREP	DREP-OB	DREP-OB	SCV	SCV	External	->	Not relevant	Very High	Low	Middle	Not relevant
62	-	ATO-OB	APM	CCS-OB	DREP-OB	External	<-	Not relevant	Middle	Low	Low	Not relevant
63	-	ATO-OB	APM	OCS-IM	IPM-ISM	External	<->	Not relevant	Low	Low	Low	Low
64	-	PER-OB	PER-OB	TA	FVA	External	<->	Not relevant	Low	Low	Low	Not relevant
65	-	PER-OB	PER-OB	ENV	ENV	External	<-	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
66	SCI-SCV	SCV	SCV	ETS	VETS	External	->	Not relevant	Very High	Low	Middle	Not relevant
67	-	CVR	CVR	TA	PISA	External	<->	Not relevant	Very High	Low	Middle	Not relevant
68	-	TCS	TCS	TA	FVA	External	->	Not relevant	Middle	Middle	Middle	Not relevant
69	-	ETP-OB	ISM	TCMS	TCMS	External	->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
70	-	ETP-OB	ISM	TA	WIOC	External	->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed

71	-	SSS-OB	IAM-OB	OCS-RU	IAM	External	<->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
72	-	SSS-OB	TS-OB	OCS-IM	TS	External	<->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
73	-	MDCM-OB	MDCM-OB	OCS-RU	MDCM	External	<->	Very High	Very High	Low	Middle	Very High
74	-	LOC-OB	VL	TA	PISA	External	->	Not relevant	Low	Low	Low	Not relevant
75	-	ATP-OB	KMAC-OB	OCS-IM	KMC	External	->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
76	-	ATP-OB	CDS	ATO-OB	AV	External	->	Not relevant	Low	Low	Low	Not relevant
77	-	ATP-OB	CDS	ATO-OB	APM	External	->	Not relevant	Very High	Middle	Middle	Not relevant
78	-	ATP-OB	CDS	TDS	MI-HMI	External	<->	Not relevant	Very High	Middle	Middle	Not relevant
79	-	ATP-OB	CDS	TDS	ETCS-DMI	External	->	Not relevant	Low	Low	Low	Not relevant
80	-	ATP-OB	CDS	LOC-OB	VL	External	->	Not relevant	Very High	High	Middle	Not relevant
81	-	ATP-OB	ODS	ATO-OB	AV	External	->	Not relevant	Low	Low	Low	Not relevant
82	-	ATP-OB	ODS	ATO-OB	APM	External	->	Not relevant	Low	Low	Low	Not relevant
83	-	ATP-OB	ODS	TDS	ETCS-DMI	External	<->	Not relevant	Low	Low	Low	Not relevant
84	-	ATP-OB	ODS	LOC-OB	VL	External	->	Not relevant	Low	Low	Low	Not relevant
85	-	ATP-OB	CMD	LOC-OB	VL	External	->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed

86	-	ATP-OB	CMD	ENV	ENV	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
87	-	ATP-OB	PETS	LOC-OB	VL	External	->	Not relevant	Very High	High	Middle	Not relevant
88	-	ATP-OB	ETP-OB	MDCM-OB	MDCM-OB	External	<->	Not relevant	Very High	Low	Middle	Not relevant
89	-	ATP-OB	ETP-OB	SSS-OB	IAM-OB	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
90	-	ATP-OB	ETP-OB	SSS-OB	TS-OB	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
91	-	LOC-OB	VL	RMTO-OB	RMTO-OB	External	->	Not relevant	Very High	Low	Low	Not relevant
92	-	LOC-OB	VL	VTCS-OB	VTCS-OB	External	->	Not relevant	Very High	High	Middle	Not relevant
93	-	LOC-OB	LOC-OB	SSS-OB	TS-OB	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
94	-	LOC-OB	LOC-OB	SSS-OB	IAM-OB	External	<->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
95	-	LOC-OB	LOC-OB	MDCM-OB	MDCM-OB	External	<->	Not relevant	Very High	Low	Middle	Not relevant
96	-	TA	FVA	RMTO-OB	RMTO-OB	External	<->	Not relevant	Very High	High	Middle	Not relevant
97	-	TA	FVA	MDCM-OB	MDCM-OB	External	<->	Not relevant	Very High	Low	Middle	Not relevant
98	-	TA	FVA	LOC-OB	VL	External	->	Not relevant	Very High	High	Middle	Not relevant
99	-	TA	FVA	ATO-OB	APM	External	<->	Not relevant	Very High	High	Middle	Not relevant
100	-	ATP-OB	VS	ATO-OB	AV	External	->	Not relevant	Low	Low	Low	Not relevant

101	-	ATO-OB	AV	VTCS-OB	VTCS-OB	External	<-	Not relevant	Very High	High	Middle	Not relevant
102	-	ATO-OB	AREP-OB	OCS-RU	MID	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
103	-	ATO-OB	AREP-OB	OCS-RU	TRD	External	<-	Not relevant	Low	Low	Low	Not relevant
104	-	ATO-OB	APM	PTU-OS	JRU	External	->	Not relevant	Low	Low	Low	Not relevant
105	-	ATO-OB	APM	CCS-OB	SCV	External	<->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
106	-	ATO-OB	APM	TA	PISA	External	->	Not relevant	Low	Low	Low	Not relevant
107	-	SCV	SCV	External	RC	External	<-	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
108	-	DREP-OB	DREP-OB	External	DM	External	<->	Not relevant	Very High	High	Middle	Not relevant
109	-	VTCS-OB	VTCS-OB	External	TM	External	<->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
110	-	VTCS-OB	VTCS-OB	External	OT	External	<->	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
111	-	External	VCS	CVR	CVR	External	<->	Not relevant	Very High	Low	Middle	Not relevant
112	-	MDCM-OB	MDCM-OB	External	MNT	External	<->	Very High	Very High	Low	Middle	Very High
113	-	MDCM-OB	MDCM-OB	RMTO-OB	RMTO-OB	External	->	Not relevant	Very High	Low	Middle	Not relevant
114	-	External	RMTO	RMTO-OB	RMTO-OB	External	->	Not relevant	Very High	High	Middle	Not relevant

Definitions:	*privacy (e.g. EU DSGV) is a combination of Confidentiality (information cannot be read by anyone), Integrity (not changed) and Authenticity (the right person(s) have access) *The measures are not taken from the IEC 62443-3-3 and -4-2 since in this state of the CENELEC and security life cycle process to zones and conduits, and thus no SL level can be defined. *For juridical prosecution availability of data and non repudiation are in direct connection. *chapter availability focusses on the operational availability, what means that the relevant information or systems shall be "permanently" available to ensure operation. * encryption: encrypt then sign/mac; when combining integrity and confidentiality: sign payload then encrypt then sign/mac * encryption and signing: the respective endpoints or consumers are authenticated for being the correct encryption endpoint or the correct signer * authenticity in machine-machine situation is part of confidentiality and/or integrity as both endpoints must authenticate to the other

		APR highest requirement from **Confidentiality**				
		not relevant	low	medium	high	very high
component	**data (information) at rest and software**	no measure	processual measures and physical protection, basic hardening	processual measures and physical protection, basic hardening	encrypted data storage with min. AES 256, processual measures and physical protection, basic hardening	encrypted data storage with min. AES 256, processual measures and physical protection, basic hardening
	SW 2 SW comm. (pure internal)	no measure	processual measures and physical protection, basic hardening	processual measures and physical protection, basic hardening	the developer must consider security with respect of implementing SL-T and expected attacker category.	the developer must consider security with respect of implementing SL-T and expected attacker category.
Connection type	**internal network**	no measure	AES 128 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication
	wired (external)	no measure	AES 128 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication

	radio (external)	no measure	AES 128 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication	min. AES 256 encryption end to end with endpoint authentication

		APR highest requirement from **Integrity**				
		not relevant	low	medium	high	very high
component	**data (information) at rest and software**	no measure	processual measures and physical protection, basic hardening	processual measures and physical protection, basic hardening	signed data storage (e.g. SHA256, Curve25519), physical protection, basic hardening	signed data storage (e.g. SHA512, Curve25519), physical protection, basic hardening
	SW 2 SW comm. (pure internal)	no measure	processual measures and physical protection, basic hardening	processual measures and physical protection, basic hardening	signed data (e.g. SHA256, Curve25519), basic hardening	signed data (e.g. SHA512, Curve25519), basic hardening
Connection type	**internal network**	no measure	signed data (e.g. SHA256, Curve25519), basic hardening	signed data (e.g. SHA256, Curve25519), basic hardening	signed data (e.g. SHA256, Curve25519), basic hardening, monitoring/detection of malware (SIEM) with central logging	strong signed data (e.g. SHA512, Curve25519), basic hardening, or SHA256 and encrypted traffic min. AES 256, monitoring/detection of malware (SIEM) with central logging
	wired (external)	no measure	signed data (e.g. SHA256, Curve25519), basic hardening	signed data (e.g. SHA256, Curve25519), basic hardening	signed data (e.g. SHA256, Curve25519), basic hardening, monitoring/detection of malware (SIEM) with central logging	strong signed data (e.g. SHA512, Curve25519), basic hardening, or SHA256 and encrypted traffic min. AES 256, monitoring/detection of malware (SIEM) with central logging
	radio (external)	no measure	signed data (e.g. SHA256, Curve25519), basic hardening	signed data (e.g. SHA256, Curve25519), basic hardening	signed data (e.g. SHA256, Curve25519), basic hardening, monitoring/detection of malware (SIEM) with central logging	strong signed data (e.g. SHA512, Curve25519), basic hardening, or SHA256 and encrypted traffic min. AES 256, monitoring/detection of malware (SIEM) with central logging

		APR highest requirement from **Availability**				
		not relevant	low	medium	high	very high
component	**data (information) at rest and software**	no measure	protect component availability low (no standby); automated back-up, role-back strategy	protect component availability medium (cold-standby); automated back-up, role-back strategy	protect component availability high (redundancy, hot-standby); automated back-up, 3-2-1 rule (3 copies, 2 media types, 1 external storage (other location, cloud, ..), role-back strategy, desaster recovery process	protect component availability (parallel operation); automated back-up, 3-2-1 rule (3 copies, 2 media types, 1 external storage (other location, cloud, ..), role-back strategy, desaster recovery process
	SW 2 SW comm. (pure internal)	no measure	secure coding; resource availability	secure coding; resource availability	secure coding; resource availability (resource management)	secure coding; resource availability (resource management)
Connection type	**internal network**	no measure	protect node	protect node and/or edge redundancy, network-style setup, routing	protect node and edge redundancy, network-style setup, routing; components very reliable and high available	protect node and edge redundancy, network-style setup, routing; components very reliable and very high available
	wired (external)	no measure	protect node	protect node and/or edge redundancy, network-style setup, routing	protect node and edge redundancy, network-style setup, routing; components very reliable and high available	protect node and edge redundancy, network-style setup, routing; components very reliable and very high available
	radio (external)	no measure	one network, simple design, basic availability concepts	two radio networks, one or more core networks	two radio networks with own core or high availability one-network-design; with automated detection of availability load handling and "switching" between networks; or combination radio and wired networks	multi-network, multi-source, multi-operator (not service provider, operator!) with automated detection of availability load handling and "switching" between networks + cabled network or "wire breackage proof" required (process recilienc y to connection interruption)

		APR highest requirement from **Non Repudiation**				
		not relevant	low	medium	high	very high
component	**data (information) at restand software**	no measure	changing information is directly transferred to a protected logging capability and saved on the component for a predefined timespanif logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	changing information is directly transferred to an independent logging facility and saved on the device for a predefined timespan in case of communication interruption (take time for connection reestablishment/repair into account); integrity of local log is protected with a signature similar to integrity level "high";if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	changing information is directly transferred to an independent logging facility and saved on the device for a predefined timespan in case of communication interruption (take time for connection reestablishment/repair into account); integrity of local log is protected with level "high"; authenticity is protected with level "high" (authenticity of devices/service must be protected with similar measures); availability is protected with level at least "high"if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	changing information is directly transferred to an independent logging facility and saved on the device for a predefined timespan in case of communication interruption (take time for connection reestablishment/repair into account); integrity of local log is protected with level "very high"; authenticity is protected with level "very high" (authenticity of devices/service must be protected with similar measures); availability is protected with level at least "very high"if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"
	SW 2 SW comm. (pure internal)	no measure	log information integrity protected with integrity level "low" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	log information is protected with integrity level "medium" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	local/process log information is protected with integrity level "high"; information is written to local storage and processed as "data at rest" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	local/process log information is protected with integrity level "very high"; information is written to local storage and processed as "data at rest" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"

Connection type	**internal network**	no measure	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "low" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "medium" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "high" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "very high" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"
	wired (external)	no measure	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "low" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "medium" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "high" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "very high" if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"

	radio (external)	no measure	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "low"if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "medium"if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "high"if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"	the fact that this information is transferred is logged (time stamp and source/target) at both processual endpoints of the transfer. This log must be protected like component data at rest with integrity and availability similar as "very high"if logged data contain privacy-related information the log has to be protected with measures similar to confidentiality "high"

		APR highest requirement from **Authenticity** (only Human-Machine-Interfaces)				
		not relevant	low	medium	high	very high
component	**data (information) at rest and software**	not applicable	not applicable	not applicable	not applicable	not applicable
	SW 2 SW comm. (pure internal)	not applicable	not applicable	not applicable	not applicable	not applicable
	HMI process	no measure	username, no or weak password; roles for authorization	username, strong password; roles for authorization	username, multi-factor authentication; roles for authorization	username, multi-factor authentication; roles for authorization
Connection type	**internal network**	not applicable	not applicable	not applicable	not applicable	not applicable
	wired (external)	not applicable	not applicable	not applicable	not applicable	not applicable
	radio (external)	not applicable	not applicable	not applicable	not applicable	not applicable

Max per Component

Component	Confidentiality	Integrity	Availability	Non-Repudiation	Authenticity (only Human-Machine-Interaction)
APM	Not relevant	Very High	High	Middle	Low
AREP-OB	Not relevant	Low	Low	Low	Not relevant
AT	Not relevant	Low	Low	Low	Not relevant
AUG	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
AV	Not relevant	Very High	High	Middle	Not relevant
CDS	Not relevant	Very High	High	Middle	Not relevant
CMD	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
CVR	Not relevant	Very High	Low	Middle	Not relevant
CVR-HMI	Not relevant	Very High	Low	Middle	Not relevant
DAS	Not relevant	Low	Low	Low	Not relevant
DAS-OB	Not relevant	Low	Low	Low	Not relevant
DDW	Not relevant	Middle	Middle	Middle	Not relevant
DM	Not relevant	Very High	High	Middle	Not relevant
DREP-OB	Not relevant	Very High	High	Middle	Not relevant
DRU	Not relevant	Middle	Middle	Middle	Not relevant
DRV	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
ENV	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
ETCS-DMI	Not relevant	Very High	Middle	Middle	Not relevant
EUB	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
EVAL	Not relevant	Low	Low	Low	Not relevant
FVA	Not relevant	Very High	High	Middle	Not relevant
IAM	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
IAM-OB	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
IPM-ISM	Not relevant	Low	Low	Low	Low
ISM	Not relevant	High	Low	Middle	Not relevant
JDW	Not relevant	Middle	Middle	Middle	Not relevant

JRU	Not relevant	Middle	Middle	Middle	Not relevant
KMAC-OB	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
KMC	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
MDCM	Very High	Very High	Low	Middle	Very High
MDCM-OB	Very High	Very High	Low	Middle	Very High
MI-HMI	Not relevant	Very High	Middle	Middle	Very High
MID	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
MLM	Not relevant	Very High	High	Middle	Not relevant
MNT	Very High	Very High	Low	Middle	Very High
NTC	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
NTC-APP	Not relevant	Very High	High	Middle	Not relevant
NTPs	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
OBS	Not relevant	Middle	Low	Low	Not relevant
ODS	Not relevant	Low	Low	Low	Not relevant
OT	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
PER-OB	Not relevant	Very High	Low	Middle	Not relevant
PETS	Not relevant	Very High	High	Middle	Not relevant
PISA	Not relevant	Very High	Low	Middle	Not relevant
RBC	Not relevant	Very High	Low	Middle	Not relevant
RC	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
RMTO	Not relevant	Very High	High	Middle	Not relevant
RMTO-OB	Not relevant	Very High	High	Middle	Not relevant
SCV	Not relevant	Very High	Low	Middle	Not relevant
STM	Not relevant	Very High	Low	Middle	Not relevant
STMC	Not relevant	Very High	High	Middle	Not relevant
TCMS	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
TCS	Not relevant	Middle	Middle	Middle	Not relevant
TECH	Not relevant	Very High	Low	Middle	Very High
TM	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
TRD	Not relevant	Low	Low	Low	Not relevant
TS	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant

TS-OB	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
UID-HMI	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
VCS	Not relevant	Very High	Low	Middle	Not relevant
VETS	Not relevant	Very High	Low	Middle	Not relevant
VL	Not relevant	Very High	High	Middle	Not relevant
VLSs	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
VS	Not relevant	Very High	High	Middle	Not relevant
VTCS-OB	Not relevant	Very High	High	Middle	Not relevant
WIOC	Not relevant	High	Low	Middle	Not relevant
WSA	Not relevant	Very High	Low	Middle	Not relevant
ETP-OB	Not relevant	Very High	Low	Middle	Not relevant

Max per Building Block

Building Block	Confidentiality	Integrity	Availability	Non-Repudiation	Authenticity (only Human-Machine-Interaction)
ATO-OB	Not relevant	Very High	High	Middle	Low
External	Very High	Very High	High	Middle	Very High
ETP-OB	Not relevant	Very High	High	Middle	Not relevant
CVR	Not relevant	Very High	Low	Middle	Not relevant
TDS	Not relevant	Very High	Middle	Middle	Very High
DAS-OB	Not relevant	Low	Low	Low	Not relevant
DREP-OB	Not relevant	Very High	High	Middle	Not relevant
TA	Not relevant	Very High	High	Middle	Not relevant
SSS-OB	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant
MDCM-OB	Very High	Very High	Low	Middle	Very High
NTPs	Not relevant	Very High	High	Middle	Not relevant
PER-OB	Not relevant	Very High	Low	Middle	Not relevant
RMTO-OB	Not relevant	Very High	High	Middle	Not relevant
SCV	Not relevant	Very High	Low	Middle	Not relevant
VETS	Not relevant	Very High	Low	Middle	Not relevant
LOC-OB	Not relevant	Very High	High	Middle	Not relevant
VTCS-OB	Not relevant	Very High	High	Middle	Not relevant