OCORA

Open CCS On-board Reference Architecture

Addendum to SUBSET-147 (CCN)

CCS Consist Network

Document ID: OCORA-TWS02-030

Version: 3.00

Date: 31.01.2025

Revision History

Version	Change Description	Initials	Date of change
1.00	Official version for OCORA Release R4	SSt	2023-06-23
2.00	Official version for OCORA Release R5	SSt	2023-11-24
2.05	Official version for OCORA Release R5.1	SSt	2024-07-01
2.06	Moved content to polarion	SSt	2024-10-17
2.07	Network layer requirement added	SSt	2024-11-20
2.08	TWS02 review completed with following changes from Release R5.1 to R6 - Optional requirements on MAC security (layer 2) were deleted due to market unavailability and hop-by-hop security protection (OCORA-10647 and OCORA-10655 deleted) - TRDP and SDTv2/v4 as mandatory requirement for process data communication (OCORA-10652, OCORA-10651, OCORA-10650 changed from optional to mandatory) - Explicit requirement on Network Layer for IPv4 in accordance with R2DATO WP23 D23.4. Before it was implicitly defined with TRDP. - TRDP message data removed in OCORA-10652. In accordance with todays SUBSETs specification event driven data will be transferred as process data. This also implies a change in OCORA Addendum to SS-119.	SSt	2024-11-25
3.00	Official version for OCORA Release R6	SSt	2025-01-31

Table of Contents

References

Reader's note: please be aware that the document ids in square brackets, e.g. [OCORA-BWS01-010], as per the list of referenced documents below, are 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.

[OCORA-BWS01-010] – Release Notes

[OCORA-BWS01-020] – Glossary

[OCORA-TWS02-010] – CCS Communication Network (CCN) – Evaluation

[SUBSET-026-7] - ERTMS/ETCS - System Requirements Specification - Chapter 7 - ERTMS/ETCS language

[SUBSET-026-8] - ERTMS/ETCS - System Requirements Specification - Chapter 8 - Messages

[SUBSET-037-3] - ERTMS/ETCS - EuroRadio FIS - FRMCS Communication Functional Module

[SUBSET-119] - ERTMS/ETCS - Train Interface FFFIS

[SUBSET-125] - ERTMS/ATO - System Requirements Specification

[SUBSET-126] - ERTMS/ATO - ATO-OB / ATO-TS FFFIS Application Layer

[SUBSET-147] - ERTMS Data Applications - FFFIS part: CCS Consist Network Communication Layers

[SUBSET-148] - ERMTS/ATO - ATO-OB / ATO-TS FFFIS - Transport and Security Layers

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

[IEC 61375-2-3:2015] - Electronic railway equipment - Train communication network (TCN) - Part 2-3: TCN communication profile

[IEEE 802.1Q-2022] - IEEE Standard for Local and Metropolitan Area Networks - Bridges and Bridged Networks

[IETF RFC 791:1981] - Internet Protocol

1 Introduction

1.1 Purpose of the document

The purpose of this document is to specifiy of what is left open in the [SUBSET-147] to get a standardised and unambiguous implementation of the onboard CCS process data communication. This document is based on the CCN evaluation report [OCORA-TWS02-010] elabor ated in former phases. The [SUBSET-147] is a mandatory specification of the TSI-CCS 2023 release which aims to define the standard network technology to be used for the on-board CCS system.
This OCORA Addendum is intended to be used in further specification activities in ERJU e.g. Innovation Pillar focus project R2DATO work package WP23/24 or System Pillar Train CS domain as well as the standardisation activities in EuroSpec. At a later point in time it is intended to be used in tenders for CCS on-board systems or one of its building blocks, either as part of a new rollingstock or as enhancement or replacement in existing legacy rollingstocks.

This document is addressed to experts in the CCS domain 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 [OCORA-BWS01-040] .
If you are a railway undertaking, you may find useful information to compile tenders for OCORA-inspired CCS building blocks, for tendering complete on-board CCS systems, or for on-board CCS replacements for functional upgrades or life-cycle considerations.
If you are an organization interested in developing CCS on-board building blocks according to the OCORA design principles, the information provided in this document can be used as input for your development.

1.2 Applicability of the document

This document defines a solution for a standard process data communication (OSI-Layer 1 - 6 incl. Safety Layer) that can be used for the on-board CCS system to establish communication on the internal interfaces of the system and on the interfaces with the system TCMS. It does not define a standard communication technology within other systems (e.g. the TCMS, Passenger Information System). But especially for new vehicles it is highly recommended for railway undertakings to request the same communication technology in the CCS and TCMS domains.
On session layer it defines a standard protocol especially designed for the main CCS application process data communication within the CCS on-board system.
The application layer data between CCS on-board building blocks is not part of this document. The application data between different CCS on-board building blocks is defined in different SUBSETs (e.g. [SUBSET-119] for ETCS<>TCMS). Furthermore, it does not contain protocol specifications for other data classes like bulk data (e.g. for software update) or streaming data (e.g. for Cab Voice

Radio).

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 [OCORA-BWS01-010] . All abbreviations and terms used are defined in the Glossary [OCORA-BWS01-020].

1.4 Problem Description

Today the interfaces between CCS components on the vehicle are proprietary. The proprietary interfaces do not allow to exchange CCS components from different suppliers. The vendor lock-in created by proprietary interfaces leads to a complex lifecycle management. Furthermore, the existing proprietary interfaces do not allow to easily add new functions impeding innovation.
Moreover, these interfaces are implemented using heterogeneous fieldbus technologies. This leads to increased complexity and extensive effort for the operator/maintainer to handle these heterogeneous systems.

1.5 Concept

The OCORA architecture [3] aims for plug and play interchangeability within the CCS on-board domain through isolation of specific functions in combination with the specification of a generic, open and standardized communication backbone, the CCS Consist Network (CCN). The CCN connects different components of the future CCS on-board systems as for example:

- European Train Protection On-Board (ETP-OB)
- Localization On-Board (LOC-OB)
- Train Display System (TDS)
- National Train Protection (NTP) or Specific Transmission Module (STM)
- Cabin Voice Device On-Board (CVR-OB)
- Gateway to Train Control Management System Network, Operator Network, Communication Network or Security Network (ECN/ECN Gateway)

In the [SUBSET-147] for the CCN the equivalent terms “Ethernet CCS Consist Network” or “One Common Bus” are used. Basically, all three terms cover the same CCS Communication backbone.
In the final vision of the system an open and standardized CCN (OSI-Layers 1 to 6 & Safety Layer) ensures safe data connections between CCS on-board components. The network allows simple upgrades / enhancements of the CCS on-board System by introducing new functions or components. It also enables procurement on a building-block-based granularity which leads to more flexibility in the lifecycle management and optimal components due to larger market size. For the CCN itself, modifications due to future technological evolutions are facilitated by the communication layering

concept.

2 Ethernet CCS Consist Network Requirements

2.1 Connected End Devices

OCORA-10656 - Separation/Segmentation of traffic towards end devices

If the end device connected to an Ethernet interface shall support tagged traffic, the end device has to tag every Ethernet frame with the Priority Code Point (PCP) value according to the data class as in Table 8-1 of [SUBSET-147] in order to fulfil QoS requirements.

Status	✓ Approved
Classification	Requirement
Rationale	• With the tagged traffic to the end device, the end device can define the service class for every data packet accordingly to the specification of [SUBSET-147] Table 8-1. Without tagged traffic, only one service class can be defined for any traffic related to that specific end device.
Remark	• This requirement closes a gap that is left open in the current version of [SUBSET-147].
Acceptance Criteria	• Assess data sheets with offer and first article inspection
Acceptance Method	Design Review

OCORA-10775 - Network Layer Specification

The Ethernet CCS Consist Network shall support IPv4 according to [IETF RFC 791:1981] - Internet Protocol.

Status	✓ Approved
Classification	Requirement
Rationale	• To be compliant with the onboard network standard according to IEC 61375.
Remark	• This requirement closes a gap that is left open in the current version of [SUBSET-147].

Acceptance Criteria	• Inspection of data point test report with first integration inspection
Acceptance Method	Inspection

OCORA-10652 - Transport and Session Layer Specification for CCS process data

End devices exchanging local CCS process data (according to PCP values 3, 5 and 6 defined in Table 8-1 of [SUBSET-147]) over an Ethernet interface shall use the communication technology TRDP (according to [IEC 61375-2-3:2015]).

Info: In case of communication from on-board entities over FRMCS the corresponding specifications shall be applied (e.g. [SUBSET-026-7], [SUBSET-026-8], [SUBSET-037-3] for ETCS or [SUBSET-125], [SUBSET-126], [SUBSET-148] for ATO).

Status	✓ Approved
Classification	Requirement
Rationale	• One dedicated standard protocol ensures modularity and exchangeability. • With the definition of the communication technology on session layer, the transport and network layers are implicitly defined.
Remark	• This requirement closes a gap that is left open in the current version of [SUBSET-147].
Acceptance Criteria	• Inspection of data point test report with first integration inspection
Acceptance Method	Inspection

OCORA-10651 - Safety Layer Definition for Functions of SIL 1 and SIL 2

End Devices exchanging local CCS process data (according to PCP values 3, 5 and 6 defined in Table 8-1 of [SUBSET-147]) over an Ethernet interface for safety functions of SIL 1 and SIL 2 shall use the safety layer SDTv2 according to [IEC 61375-2-3:2015].

Status	✓ Approved
Classification	Requirement

Rationale	• The integrity of safety-related data sent over a black channel has to be protected with a safety layer aligned with the SIL of the overall safety function.
Remark	• This requirement closes a gap that is left open in the current version of [SUBSET-147].
Acceptance Criteria	
Acceptance Method	Certification

OCORA-10650 - Safety Layer Definition for Functions of SIL 3 and SIL 4

End devices exchanging local CCS process data (according to PCP values 3, 5 and 6 defined in Table 8-1 of [SUBSET-147]) over an Ethernet interface for safety functions of SIL 3 and SIL 4 shall use the safety layer SDTv4 according to the Drive-by-Data Architecture Specification of Shift2Rail's CONNECTA project.

Info: SDTv4 is currently in elaboration to be integrated in [IEC 61375-2-3:2015] Annex B.

Status	✓ Approved
Classification	Requirement
Rationale	• The integrity of safety-related data sent over a black channel has to be protected with a safety layer aligned with the SIL of the overall safety function.
Remark	• This requirement closes a gap that is left open in the current version of [SUBSET-147].
Acceptance Criteria	
Acceptance Method	Certification

2.2 Network Components

OCORA-10654 - Quality-of-Service inside the on-board core network: Hardware queues on egress ports

Every consist switch shall implement eight queues per port to use one dedicated queue per layer 2 (VLAN) priority (PCP value according to [IEEE 802.1Q-2022]) for each incoming layer 2 frame. The bidder provides the corresponding data sheets with its offer.

Status	✔ Approved
Classification	Requirement
Rationale	• In order to have the physical priorisation as granular as the PCP value, eight queues per port are needed. This is needed to separate safety-related (time-critical) traffic from non safety related traffic.
Remark	• This requirement closes a gap that is left open in the current version of [SUBSET-147].
Acceptance Criteria	• Assess data sheets with offer and first article inspection
Acceptance Method	Design Review

OCORA-10653 - Quality-of-Service inside the on-board core network: Prioritisation Scheme

Every consist switch shall support “strict priority” according to [IEEE 802.1Q-2022] as transmission selection mechanism on all of priority queues, i.e. all higher priority frames shall egress from port before the lower priority frames egress. The bidder provides the corresponding data sheets or description of another prioritisation scheme with its offer.

Note: The use of other transmission selection mechanisms like “weighted round robin” or a combination of different mechanisms is up to the CCS system integrator.

Status	✔ Approved
Classification	Requirement
Rationale	• With this requirement the typical total bandwidth at least for the high priority service classes (process data) defined in Table 8-1 of [SUBSET-147] can be ensured. This is important for the availability of safety-related process data transmission.

Remark	• This requirement closes a gap that is left open in the current version of [SUBSET-147].
Acceptance Criteria	• Assess data sheets or provided prioritisation scheme with offer and first article inspection
Acceptance Method	Design Review

OCORA-10649 - MTBF of Consist Switches

Every consist switch shall have a mean time between failure (MTBF) of 250’000 hours or more. The MTBF shall be calculated using the techniques specified in [EN 50126-1:2017] , unless same or better reliability values can be demonstrated from field experience in similar applications.

Status	✓ Approved
Classification	Requirement
Rationale	• Network components (e.g. consist switches) are an integral part of the CCS onboard system and therefore a high but feasible MTBF is needed.
Remark	• This requirement closes a gap that is left open in the current version of [SUBSET-147].
Acceptance Criteria	
Acceptance Method	Design Review