Elimination of MVB and CAN from the Subsets

Approval by approvers

Type of Approval	✔ Document Approval
Approvals	Nicolas Ykman : Approved , MOTTOLA, Giuseppe Diodato : Approved , Domínguez Fernández, Silvia : Approved , Klose, Christoph (SMO RI R&D) : Approved , Ghielmetti Cirillo (I-NAT-GST-CCS) : Approved , MARTA FERNANDEZ ORDAS : Approved , BITSCH Friedemann : Approved
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Attachments	

SP Identification number

SP-CR 26918

Headline

Elimination of MVB and CAN from the Subsets

Impacted System

ETCS

Reference Baseline Release

ETCS B4R1 & ATO B1R1 & RMR B1R1 (TSI CCS annex A as per Regulation (EU) 2023/1695)

Documents and/or References

Subset-147, V.1.0.0

Subset-119, V.4.0.0

Error/Enhancement

Enhancement

Problem/Need description

SS-147 still allows to use MVB and CAN. These options (currently allowed also on new vehicle not being newly developed vehicle designs) shall be removed. In case of installing ETCS-OB in an existing train, the vehicle (rolling stock) shall be responsible for the data adaption to be SUBSET-119 compliant. The standardised communication stack will allow to install one ETCS-OB on different vehicles in order to reduce the complexity, leading to cost-efficient solutions with lower total cost of ownership (TCO). It brings more flexibility for vehicle owners if they want to scale the on-board CCS subsystem or change to another supplier. Additionally, the flexible Ethernet-based communication solution paves the way for adding new functions (evolvability) in the future (e.g. software update, configuration, diagnostics etc.).

Supporting document(s) for problem/need description

None

Solution Proposal by submitter

See solution proposal in: ERJU_solution_proposal_for_SP-CR-26918.docx

Supporting document(s) for solution proposal

ERJU_solution_proposal_for_SP-CR-26918.docx

SOLUTION PROPOSAL FOR SP-CR 26918

Modifications to SUBSET-147 v1.0. 0

Modifications to chapter 2:

Modify table 2-1 in section 2.4 to read:

(R)	The statements made in this Subset are assigned to the following categories: (I) or (R) R = Requirement (indicated by '(R)' at the end of the clause). This paragraph is a requirement and for a transition period of 7 years it is mandatory for the on-board CCS subsystem on newly developed vehicles designs requiring a first authorization and for the Interoperability Constituent ETCS On-board (independent from its specific application). For all vehicles, which do not fall under the definition "newly developed vehicles designs", its application is voluntary at the discretion of the system integrator for a transition period of 7 years. The (R) requirements are mandatory for the integration of ERTMS/ETCS on-board equipment for which the design phase ends after the 7 years of CCS TSI entry into force. This implies e.g. that the MVB and CAN specifications cannot be used anymore for the integration of ERTMS/ETCS on-board equipment for which the design phase ends after the transition period.

Modify section 2.6 to read:

2.6.1.13 For a transition period of 7 years the chapters 7, 8, and 9 are mandatory only for 'newly developed vehicle designs' requiring a first authorisation as defined in Article 14 of Commission Implementing Regulation 2018/545 and for the Interoperability Constituent ETCS On-board (independent from its specific application). The chapters 7, 8 and 9 are mandatory for the integration of ERTMS/ETCS on-board equipment for which the design phase ends after the 7 years of CCS TSI entry into force. This implies e.g. that the MVB and CAN specifications cannot be used anymore for the integration of ERTMS/ETCS on-board equipment for which the design phase ends after the transition period. (R)

Modifications to chapter 3:

Modify clauses of chapter 3. to read:

3. GENERAL REQUIREMENTS

3.1.1.1 This specification includes the solutions regarding the Ethernet, MVB and CAN based on [Ref 5], [Ref 7], and [Ref 8]. (I)

Modifications to SUBSET-119 v4.0. 0

Modifications to chapter 2:

Modify section 2.1 to read:

2.1 Architecture

…

2.1.1.8 The ERTMS/ETCS on-board equipment shall support as serial interface one or several of the following types of bus: CAN, MVB and ECN as defined in chapter 4 for a transition period of 7 years. ECN is mandatory for the integration of ERTMS/ETCS on-board equipment for which the design phase ends after the 7 years of CCS TSI entry into force. This implies e.g. that the MVB and CAN specifications cannot be used anymore for the integration of ERTMS/ETCS on-board equipment for which the design phase ends after the transition period.

FFFIS update for SUBSET-027 for CCS Ethernet Consist Network

Approval by approvers

Type of Approval	✔ Document Approval
Approvals	Nicolas Ykman : Approved , MOTTOLA, Giuseppe Diodato : Approved , Domínguez Fernández, Silvia : Approved , Klose, Christoph (SMO RI R&D) : Approved , MARTA FERNANDEZ ORDAS : Approved , Ghielmetti Cirillo (I-NAT-GST-CCS) : Approved , BITS CH Friedemann : Approved
Comments	**#2 Approval comment** by **MARTA FERNANDEZ ORDAS** on 2026-02-16 19:18 CR approved in my role as co-leader of TrainCS System Architecture subgroup, based on its alignment with the evolution of the CCS On-Board System Architecture.
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SP Identification number

SP CR 27490

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FFFIS update for SUBSET-027 for CCS Ethernet Consist Network

Impacted System

ETCS

Reference Baseline Release

ETCS B4R1 & ATO B1R1 & RMR B1R1 (TSI CCS annex A as per Regulation (EU) 2023/1695)

Documents and/or References

- SUBSET-027, V4.0.0: FIS Juridical Recording
- SUBSET-147, V1.0.0

Error/Enhancement

Enhancement

Problem/Need description

Already with TSI CCS 2023 the standardised Ethernet Consist Network communication stack of SUBSET-147 shall be used, in the case of newly designed vehicle types, for the CCS on-board communication on the interfaces internal to the CCS subsystem, among different applications (e.g. ETCS on-board, ATO on-board) and on the interfaces to the subsystem rolling stock. SUBSET-147 establishes a standardised communication backbone in order to improve modularity, exchangeability and evolvability.

The current application layer SUBSETs specifications shall be updated according to the standardised Ethernet Consist Network communication stack of SUBSET-147. One of the application layer SUBSETs to be updated shall be SUBSET-027 "FIS Juridical Recording", see also figure 2-2 "Interfaces and related specifications for ETCS & ATO on-board and Rolling Stock" of SUBSET-147. According to the CCS on-board architecture target 1 of ERJU System Pillar Train CS domain also the communication to the ORD shall be based on ECN CCS (SUBSET-147, Message Data based on SP CR-26860). This facilitates the integration of ETCS onboard and ORD into vehicles and allows exchangeability.

With the establishment of the standardised Ethernet Consist Network communication stack with the SUBSET-147 the ETCS-ORD communication of SUBSET-027 should become a FFFIS by referencing to the communication layers (OSI layers 1 to 6) of SUBSET-147. The variables and processes on application layer should remain and not change with this CR.

Supporting document(s) for problem/need description

none

Solution Proposal by submitter

According to the CCS on-board architecture target 1 of ERJU System Pillar Train CS domain also the communication to the ORD shall be based on ECN CCS (SUBSET-147, Message Data based on SP CR-26860).

Add SUBSET-147 to the references in chap 3.2 and define usage of communication layers defined in SUBSET-147 for the transmission of JRU messages to chapter 4.1.

Supporting document(s) for solution proposal

ERJU_solution_proposal_for_SP-CR-27490_JRU.docx

SOLUTION PROPOSAL FOR SP-CR27490

Modifications to SUBSET-027 v4.0.0

Modification of Title

Modify Title of the document to read: FFFIS Juridical Recording

Modifications to chapter 3:

Modify chapter 3.1 to read:

3.1.1.1 This document is a Form Fit Functional Interface Specification for juridical recording.

3.1.1.2 It describes the interface between the ERTMS/ETCS on-board function charged to provide juridical data and the on-board recording device.

3.1.1.4 This document is inside the ERTMS/ETCS project scope. It is based on the documents [1], [2], [3], [4], [5], [6], [7] and [8].

Add the following reference in chapter 3.2 to read:

[8] CCS Consist Network Communication Layers – SUBSET-147

Modifications to chapter 4:

Change title of chapter 4 to read:

4. Interface Definition

Add clause 4.1.1.6 to read:

4.1.1.6 The messages will be sent as message data via point-to-point push communication using TRDP with priority service class (PCP) 3 according to [8].

Modify clause 4.2.2.2 to read:

4.2.2.2 A message shall be composed of:

1. A common header (fields 1 to 11). Therefore, the variables 3 to 11 must be captured with each event of the table 2.
2. Complementary variables as needed by application (fields 12-N) according to the messages list. Data associated to the message. Its length depends on the message content. Always rounded up to align on bytes unit for the whole message

Update of S-147 for the limitation of the middle layer to TRDP as Ethernet technology for process data

Approval by approvers

Type of Approval	✔ Document Approval
Approvals	Nicolas Ykman : Approved , MOTTOLA, Giuseppe Diodato : Approved , Domínguez Fernández, Silvia : Approved , Klose, Christoph (SMO RI R&D) : Approved , MARTA FERNANDEZ ORDAS : Approved , Ghielmetti Cirillo (I-NAT-GST-CCS) : Approved , BITS CH Friedemann : Approved
Comments	**#1 Approval comment** by **MARTA FERNANDEZ ORDAS** on 2026-02-16 17:39 CR approved in my role as co-leader of TrainCS System Architecture subgroup, based on its alignment with the evolution of the CCS On-Board System Architecture.
Attachments	

SP Identification number

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Headline

Update of S-147 for the limitation of the middle layer to TRDP as Ethernet technology for process data

Impacted System

ETCS / ATO

Reference Baseline Release

ETCS B4R1 & ATO B1R1 & RMR B1R1 (TSI CCS annex A as per Regulation (EU) 2023/1695)

Documents and/or References

SUBSET-147, 1.0.0

SUBSET-119, 4.0.0

Error/Enhancement

Enhancement

Problem/Need description

A standardised communication technology on all OSI-Layers shall be established for each communication type to improve modularity, exchangeability and evolvability. Today the SUBSET-147 v1.0.0 defines a standard communication solution on the OSI-Layers 1 & 2 for some interfaces of new vehicles. With the update of the existing SUBSET-147 to a new release version 2.0.0 also the layers 3 to 6 and the safety layer shall be unambiguously standardised. Currently there are limited options for using TRDP, Profinet, SUBSET-143 and OPC-UA as Ethernet-based technologies on the middle layers for process data communication. The aim is to define one single protocol stack for each communication type. In a first step, SUBSET-147 needs to be updated to limit of the middle layer to TRDP as Ethernet technology for the use of process data communication. For the safe data transmission SUBSET-147 shall define safety layers for functions of different SIL levels. Together with the application layer specifications in other SUBSETs (e.g. SS-119 for ETCS <> TCMS) a full standard communication stack is created. The standardised communication stack shall be used for any onboard CCS process data communication, on the interfaces internal to the CCS subsystem, among different applications (e.g. ETCS on-board, ATO on-board) and on the interfaces to the subsystem rolling stock. This will reduce the complexity, leading to cost-efficient solutions with lower total cost of ownership (TCO). It brings more flexibility for vehicle owners if they want to scale the on-board CCS subsystem or change to another supplier. Additionally, the flexible Ethernet-based communication solution paves the way for adding new functions (evolvability) in the future (e.g. software update, configuration, diagnostics etc.).

Supporting document(s) for problem/need description

None.

Solution Proposal by submitter

See solution proposal in ERJU_solution_proposal_for_SP-CR-26831.docx

Supporting document(s) for solution proposal

ERJU_solution_proposal_for_SP-CR-26831.docx

SOLUTION PROPOSAL FOR SP-CR26831

Modifications to SUBSET-147 v1.0.0

Modifications to chapter 2:

2.6 Scope and purpose of the document

...

Modify clause 2.6.1.6 and 2.6.1.7 to read:

2.6.1.6 Secondly, this document provides the requirements for the Ethernet CCS Consist Network, which will be the future harmonised communication platform for the on-board CCS subsystem on basis of which functional building blocks of the on-board CCS subsystem (ETCS on-board, ATO on-board, FRMCS, etc.) will communicate with each other. This communication platform constitutes the definitions of all OSI layers 1 to 6.(I)

2.6.1.7 This approach creates an abstraction of the application layer from the communication, which leads to more stable application layer specifications and to more stable implementation of the application layer. Furthermore, it fixes a set of optional legacy technology for the transition period at discretion of the system integrator (normally the vehicle manufacturer). This avoids the risk of introducing new technology which will become obsolete shortly with the target harmonised communication platform (Ethernet CCS Consist Network). The definition of the Ethernet CCS Consist Network will allow vehicle manufacturers to prepare newly developed vehicles for this future technology. (I)

Modify clause Figure 2-2 to read:

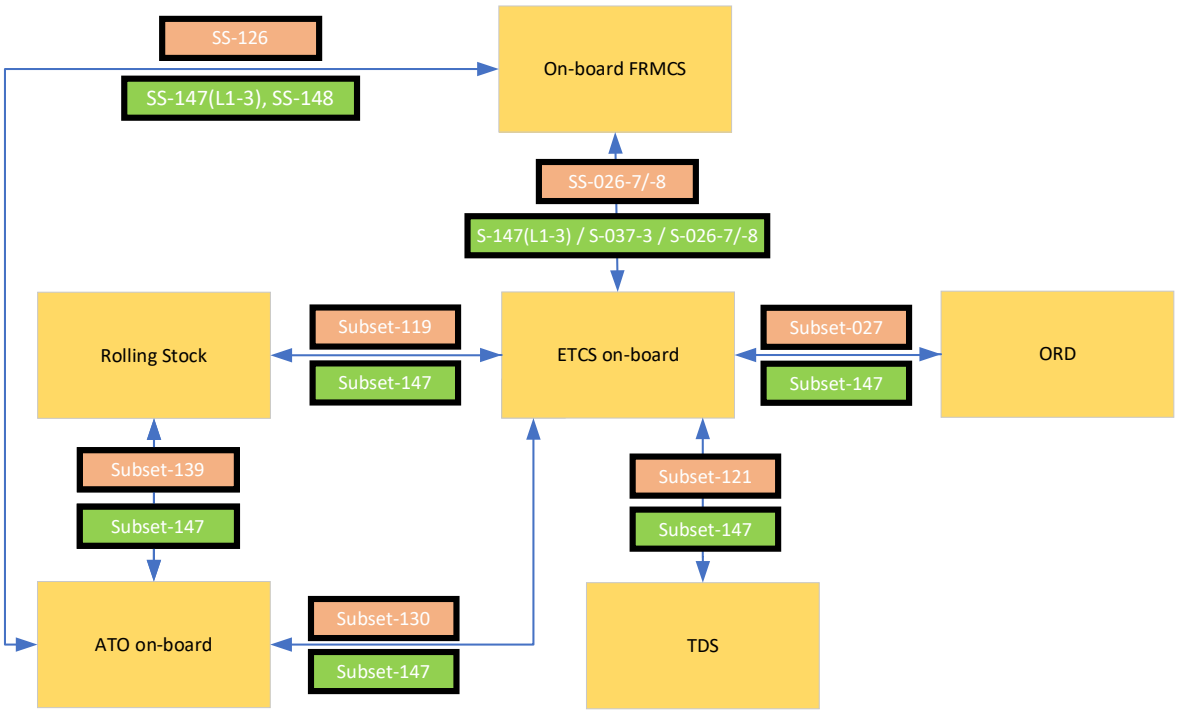

Figure ¡Error! No hay texto con el estilo especificado en el documento.**-1: Interfaces and related specifications for ETCS & ATO on-board and Rolling Stock**

Modify clause Table 2-2 to read:

2.6.1.9 **¡Error! No se encuentra el origen de la referencia.** gives an overview on the application of Subset-147. (I)

Entity 1	**Entity 2**	**Reference**	**Local Serial Communication**	**Service Class, see §**¡Error! No se encuentra el origen de la referencia.
ATO on-board	ETCS on-board	SS-130	SS-147	5
…	…	…	…	…

Modify clause 2.6.1.12 to read:

2.6.1.12 Intentionally deleted.

2.7 Reference documents

Modify Table 2-3 to read:

Ref. N°	Title	Reference	Author
[Ref 9]	Intentionally deleted.		
[Ref 10]	Intentionally deleted.		
[Ref 12]	Intentionally deleted.		
[Ref 16]	Intentionally deleted.		
…	…	…	…
[REF 31]	Internet Protocol Specification	RFC 791	Internet Engineering Task Force (IETF)

Table 2-3: Reference Documents

Modifications to chapter 3:

3. GENERAL REQUIREMENTS

...

Modify 3.1.1.6 to read:

3.1.1.6 For process data, communication technology TRDP **¡Error! No se encuentra el origen de la referencia.**is the mandatory supplementary protocol for the application of Ethernet. (R)

Modifications to chapter 8:

8. ETHERNET CCS CONSIST NETWORK

8.4 Definition of requirements

...

Modify 8.4.9.1 and 8.4.9.3 and add new clauses 8.4.9.2.1 and 8.4.9.4 to read:

8.4.9 OSI layers 3 to 6

8.4.9.1 For the application of Ethernet CCS Consist Network the communication technology TRDP (see IEC61375-2-3 **¡Error! No se encuentra el origen de la referencia.**) shall be used.. (R)

8.4.9.2 The OSI layers 3 to 6 are implicitly defined by the chosen communication technology. (I)

8.4.9.2.1 The Ethernet CCS Consist Network shall support IPv4 according to RFC 791, [REF 31]. (R)

…

8.4.9.3 Intentionally deleted.

8.4.9.4 For SIL2 data SDTv2 according to IEC 61375-2-3 [6] and for SIL4 data SDTv4 (see Shift2Rail's CONNECTA Drive-by-Data Architecture Specification **¡Error! No se encuentra el origen de la referencia.**[1]) shall be used on top of TRDP. (R)

Modifications to SUBSET-119 v4.0.0

Modifications to chapter 1:

1. INTRODUCTION

1.3 References

…

Modify the references [21], [22] and [23] to read:

[21] Intentionally deleted

[22] Intentionally deleted

[23] Intentionally deleted

Modifications to chapter 4:

4. GENERAL REQUIREMENTS FOR THE SERIAL INTERFACE

4.1 General Requirements

Modify clauses 4.1.1.2.1 to read:

4.1.1.2.1 Note: The application communication protocol TRDP is the only supplementary protocol to be used for the application of ECN.

4.3 Coding

4.3.2 Serial Interface Signals

…

Modify clauses 4.3.2.3 to read:

4.3.2.3 Intentionally deleted.

4.6 ECN

[1] The specification of SDTv4 will become an integral part of the IEC/EN 61375-2-3 Annex B in the subsequent version of the standard.

4.6.1 General

4.6.1.1 The lower communications layers are specified in [14].

Modify clause 4.6.1.2 to read:

4.6.1.2 In case of architecture b) (see 4.2.3) the safe data transmission shall be implemented in accordance with [14], section 8.4.9.

Modify clause 4.6.2 to read:

4.6.2 Data Properties and Application of the Safety Protocol

4.6.2.1 TR Packet 1

Properties:

ComId: configurable

Source device: TR

Sink device: OBU

Data class: Process data

Priority service class (PCP) according to [14]: 5

Maximum cycle time of source device: 100 ms

Dataset ID: configurable

…

4.6.2.2 TR Packet 2

Properties:

ComId: configurable

Source device: TR

Sink device: OBU

Data class: Process data

Priority service class (PCP) according to [14]: 5

Maximum cycle time of source device: 200 ms

Dataset ID: configurable

…

4.6.2.3 TR Packet 3

Properties:

ComId: configurable

Source device: TR

Sink device: OBU

Data class: Process data

Priority service class (PCP) according to [14]: 5

Maximum cycle time of source device: 200 ms

Dataset ID: configurable

…

4.6.2.4 OBU Packet 1

Properties:

ComId: configurable

Source device: OBU

Sink device: TR

Data class: Process data

Priority service class (PCP) according to [14]: 5

Maximum cycle time of source device: 100 ms

Dataset ID: configurable

…

4.6.2.5 OBU Station Platform Packet (OBU Packet 2)

Properties:

ComId: configurable

Source device: OBU

Sink device: TR

Data class: Process data

Priority service class (PCP) according to [14]: 5

Maximum cycle time of source device: 200 ms

Dataset ID: configurable

…

4.6.2.6 OBU Packet 3 to OBU Packet 7

Properties:

ComId: configurable

Source device: OBU

Sink device: TR

Data class: Process data

Priority service class (PCP) according to [14]: 5

Maximum cycle time of source device: 200 ms

Dataset ID: configurable

…

Modifications to chapter 7:

Modify headline of chapter 7 to read:

7 Intentionally deleted

Modifications to SUBSET-130 v1.0.0

Modify table 1 to read:

Ref. N°	Title	Reference
[Ref 1]	ERTMS/ATO System Requirements Specification	SUBSET-125
[Ref 2]	ATO-OB / ATO-TS FFFIS Application Layer	SUBSET-126
[Ref 3]	ERTMS/ATO Glossary	13E154
[Ref 4]	ERTMS/ETCS System Requirements Specification	SUBSET-026
[Ref 5]	FIS Juridical Recording	SUBSET-027
[Ref 6]	Dimensioning and Engineering rules	SUBSET-040
[Ref 7]	IEEE 802.3 Ethernet Standard	NA
[Ref 8]	FFFIS STM Application Layer	SUBSET-058
[Ref 9]	Glossary of Terms and Abbreviations	SUBSET-023
[Ref 10]	FFFIS part: CCS Consist Network Communication Layers	SUBSET-147

Table 1 Reference Documents

Modify chapter 5:

5. PRINCIPLES

5.1 Definition of the Variables

5.1.1.1 Intentionally deleted.

5.1.1.2 Intentionally deleted.

5.1.1.3 Intentionally deleted.

Move Subset-143, v1.0.0, section 8.1 to this chapter.

5.2 Definition of the Packets

5.2.1.1 Intentionally deleted.

Move Subset-143, v1.0.0, section 8.2 to this chapter.

Modify Table 2 and chapter 6.1.1.2:

6. PACKET DESCRIPTION

6.1 List of Packets

Packet Number	Packet Name	Source	Sink	Transmitting cycle [ms]	Data Class [Ref 10]	Priority Service Class [Ref 10]	Timeout [ms]
0	ATO_ETCS_Status	ATO	ETCS	100	Process Data	5	1000
1	ATO_ETCS_DMI	ATO	ETCS	100	Process Data	5	1000
2	ATO_ETCS_Data_Entry_Need	ATO	ETCS	NA	Message Data	<see CR on message data>	-
3	ATO_ETCS_Data_Entry_Request	ATO	ETCS	NA	Message Data	<see CR on message data>	-
4	ATO_ETCS_Data_View_Values	ATO	ETCS	NA	Message Data	<see CR on message data>	-
5	ETCS_ATO_Static	ETCS	ATO	1000	Process Data	5	3000
6	ETCS_ATO_Dynamic	ETCS	ATO	200	Process Data	5	1000
7	ETCS_ATO_Driver_Inputs	ETCS	ATO	100..200	Process Data	5	1000
8	ETCS_ATO_Data_Entry_Values	ETCS	ATO	NA	Message Data	<see CR on message data>	-
9	ETCS_ATO_Data_Entry_Flag	ETCS	ATO	NA	Message Data	<see CR on message data>	-
10	ETCS_ATO_Data_View_Values_ Request	ETCS	ATO	NA	Message Data	<see CR on message data>	-
11	ETCS_ATO_BRAKE_DECELERATIONS	ETCS	ATO	200	Process Data	5	1000

Table 2 Packet summary

…

6.1.1.2 The packet numbers defined in Table 2 correspond to NID_PACKET definition given in [Ref 10]. This interface uses Slot 1 (see chapter 5).

Modifications to SUBSET-139 v1.0.0

7.3 List of Packets

7.3.1.1 Following packets are used for communication between ATO-OB a Rolling stock (RST):

Modify Table 16:

Packet Name	**Packet identificator**	**Source**	**Sink**	**Transmitting cycle [ms]** (max)	**Data Class** [Ref 8]	**Priority Service Class [Ref 10]**	**Timeout [ms]**
ATO_RST_data	31	ATO	RST	50	Process Data	5	250
RST_ATO_data fast	32	RST	ATO	50	Process Data	5	250
RST_ATO_data slow	33	RST	ATO	500	Process Data	5	2500

Table 3: Packet summary

Introduction of new communication types (e.g. bulk and event-based communication) in addition to process data communication

Approval by approvers

Type of Approval	
Approvals	Nicolas Ykman : Approved , MOTTOLA, Giuseppe Diodato : Waiting , Domínguez Fernández, Silvia : Approved , Klose, Christoph (SMO RI R&D) : Approved , MARTA FERNANDEZ ORDAS : Approved , Ghielmetti Cirillo (I-NAT-GST-CCS) : Approved , BITS CH Friedemann : Approved
Comments	**#1 Approval comment** by **MARTA FERNANDEZ ORDAS** on 2026-02-16 17:42 CR approved in my role as co-leader of TrainCS System Architecture subgroup, based on its alignment with the evolution of the CCS On-Board System Architecture. **#2 Approval comment** by **BITSCH Friedemann** on 2026-02-16 19:03 The approval of Christoph and Giuseppe is in the headline.
Attachments	

SP Identification number

SP-CR-26860

Headline

Introduction of new communication types (e.g. bulk and event-based communication) in addition to process data communication

Impacted System

ETCS / ATO

Reference Baseline Release

ETCS B4R1 & ATO B1R1 & RMR B1R1 (TSI CCS annex A as per Regulation (EU) 2023/1695)

Documents and/or References

SUBSET-147, 1.0.0

Error/Enhancement

Enhancement

Problem/Need description

The current SUBSET-147 specifies process data communication only as current application layer SUBSETs only specify process data communication. For new functions in the future (e.g. software update, configuration, diagnostics etc.) SUBSET-147 needs to be extended for other communication types as:

- Message data
- Event based communication
- Remote Procedure Calls (RPC)
- Bulk data communication

Supporting document(s) for problem/need description

None.

Solution Proposal by submitter

See solution proposal inERJU_solution_proposal_for_SP-CR-26860.docx

Supporting document(s) for solution proposal

ERJU_solution_proposal_for_SP-CR-26860.docx

SOLUTION PROPOSAL FOR SP-CR26860

Modifications to SUBSET-147 v1.0.0

Modifications to chapter 3:

Add clause 3.1.1.10 to read:

3.1.1.10 This specification includes the solutions with different data types and corresponding protocols for layers 3 to 6. (I)

Modifications to chapter 8:

8. ETHERNET CCS CONSIST NETWORK

8.4 Definition of requirements

...

Modify 8.4.9 to read:

8.4.9 Network Layer (OSI layers 3)

…

Add a new chapter 8.4.11 to read:

8.4.11 Middle Layers (OSI layers 4 to 6)

8.4.11.1 The middle layers specifications are divided into the following different communication types of the onboard communication:

- Process Data Communication
- Message Data Communication
- Event based Communication
- Remote Procedure Calls (RPC) also called Request/Reply or Remote Method Invocations (RMI)
- Bulk Data Communication

8.4.11.2 There is no generic security solution for all communication types suitable on lower layers (OSI layer 2 or 3). Therefore, the topic of security is addressed for each communication type separately on the middle layers (OSI layers 4 to 6). (I)

8.4.11.3 The same is applicable for the aspect of safety. Also, safety is addressed for each communication type separately as part of the middle layers (OSI layers 4 to 6). (I)

8.4.11.4 In the following subchapters each communication type is introduced and the main requirements and open points are noted. (I)

Add a new chapter 8.5 to read:

8.5 Process Data Communication

8.5.1 Informative Introduction

Large portions of communication needs for on-train applications are the cyclic communication of so-called process data. Process data refer to the information generated during the operation of a system, process or application. Process data is typically time-critical and includes data related to the inputs, outputs, and operational parameters of a system, process or application. (I)

Typically, safety requirements from applications are associated, where the discovery of unintended changes on the data needs to be reliably discovered. (I)

For process data communication, the Train Real-Time Data Protocol (TRDP) will be used. It is a specialized communication standard tailored for the railway industry, focusing on the effective transmission of real-time data among various systems and devices within a train environment. Its primary goal is to enhance operational efficiency, safety, and interoperability across different railway applications. For safety-related data, the special protocols SDTv2 and SDTv4 are defined on top of TRDP. (I)

8.5.2 Requirements on Process Data Communication

8.5.2.1 For process data communication TRDP according to IEC 61375-2-3 [5] process data (PD) shall be used. (R)

8.5.2.2 For safety-related process data SDTv2 according to IEC 61375-2-3 [5] and SDTv4 according to Shift2Rail's CONNECTA Drive-by-Data Architecture Specification [2][1] shall be used on top of TRDP process data. (R)

Add a new chapter 8.6 to read:

8.6 Message Data

8.6.1 Informative Introduction

8.6.1.1 In addition to cyclic process data, which represents a state, spontaneous / acyclic data messages or events are also present in vehicle communication. Message data refer to less time-sensitive and sporadic information generated during the operation of a system or application. Message data in contrast to event-based communication is more process-oriented and has lower data sizes.(I)

8.6.1.2 For message data communication, the Train Real-Time Data Protocol (TRDP) will be used. It is a specialized communication standard tailored for the railway industry, focusing on the effective transmission of data among various systems and devices within a train environment. Its primary goal is to enhance operational efficiency, safety, and interoperability across different railway applications. For safety-related message data, the special protocols SDTv2 and SDTv4 can be used on top of TRDP. (I)

8.6.1.3 Note: Message Data should only be used for existing functionality. Future functionality (e.g. enhanced diagnostic or maintenance) shall be based on event-based data according to chapter 8.7

[1] The specification of SDTv4 will become an integral part of the IEC/EN 61375-2-3 Annex B in the subsequent version of the standard.

8.6.2 Requirements on Message Data Communication

8.6.2.1 For message data communication TRDP according to IEC 61375-2-3 [5] message data (MD) shall be used. (R)

8.6.2.2 For safety-related message data SDTv2 according to IEC 61375-2-3 [5] and SDTv4 according to Shift2Rail's CONNECTA Drive-by-Data Architecture Specification [2][2] shall be used on top of TRDP message data. (R)

8.6.2.3 Note: For safety-related message data a parallel safe connection based on TRDP process data has to be established according to IEC 61375-2-3 [5] B.17.(I)

Add a new chapter 8.7 to read:

8.7 EVENT BASED COMMUNICATION

8.7.1 Informative Introduction

8.7.1.1 In addition to process-oriented process data and message data, an additional event-based communication for new and less time-critical but larger payload data shall be established. (I)

8.7.1.2 Applications for event data may include:

- Diagnostic messages (operational, maintenance, protocol)
- Data change events (I)

8.7.1.3 The publish/subscribe pattern will be used here, in contrast to the request/response pattern, which is commonly employed in other services, for example the bulk data transfer. Communication patterns can be connected to one-to-one and one-to-many communication scenarios in general. Event-driven communication is often connected to one-to-many scenarios without explicit need for an acknowledgement. This is in contrast to other application fields (e.g., remote procedure call scenarios), where one might specifically require a direct feedback from a specific recipient of a request / datagram / message. (I)

8.7.1.4 Another typical property of event communication is that the sender of an event is not interested in the actual receivers. Event receivers may dynamically come and go without interfering with the sender. The publish/subscribe pattern exactly serves this need. Using message brokers in between the sender and the receivers complete the decoupling of both sides. (I)

8.7.1.5 The architectural pattern chosen here is the publish/subscribe pattern, the chosen technology is AMQP:

8.7.1.5.1 The Advanced Message Queuing Protocol (AMQP) is an open and standardised binary network protocol designed for the exchange of messages across distributed networks, supporting various broker architectures. It enables asynchronous communication and both point-to-point and publish-subscribe messaging patterns. (I)

8.7.1.5.2 AMQP is implemented on a standard TCP/IP protocol stack. The core components of AMQP include the Message Broker, which routes messages between senders and receivers; the Queue,

[2] The specification of SDTv4 will become an integral part of the IEC/EN 61375-2-3 Annex B in the subsequent version of the standard.

where messages wait for consumption; the Exchange, which directs messages to queues based on rules; and the Binding, which defines the routing relationship. These elements work together to enable flexible and interoperable messaging. AMQP supports message-oriented communication with message-delivery guarantees such as at-most-once, at-least-once and exactly once. Furthermore, it ensures the authentication and encryption of messages based on Transport Layer Security (TLS). Topic-based access control is also typically available in modern AMQP broker implementations in contrast to non-broker-based (e.g. HTTP-based) approaches. (I)

8.7.1.5.3 While AMQP is the preferred solution for the future, there might exist scenarios (e.g. retrofit) where already existing TRDP Message Data (MD) use would be beneficial to be maintained. For those cases, and only those cases, TRDP MD could be continued to be used. (I)

8.7.2 Requirements on Event based Communication

8.7.2.1 For event-based communication, AMQP according to ISO/IEC 19464 [8] shall be used. (R)

8.7.2.2 For secured event-based communication, AMQP with TLS shall be used. (R)

8.7.2.3 Configuration and concrete architecture / setup of an AMQP broker service are beyond this specification. (I)

8.6.2.6 This specification intentionally does not specify a safety layer for AMQP. It is left for the user to decide if AMQP fulfils the safety needs of a specific application context. As an alternative, TRDP process or message data (with its safety layers) may be used (I)

Add a new chapter 8.8 to read:

8.8 REMOTE PROCEDURE CALLS (RPC)

8.8.1 Informative Introduction

8.8.1.1 In addition to cyclic process data and acyclic event-based data exchange, Remote Procedure Calls (RPC) – also called Request/Reply or Remote Method Invocations (RMI) – represent a communication paradigm that is also present in vehicle communication. Consequently, it is necessary for common integration services to provide a mechanism for RPC/RMI communication. (I)

8.8.1.2 Typical IT and OT use cases for RPCs may include:

- Asynchronous command execution,
- Client-server communication,
- Communication between microservices,
- Inter-process communication,
- Remote administration. (I)

8.8.1.3 A resemblance to or a combination with bulk data transfer solutions is often observed in RPC/RMI applications, such as the combination of an RPC-driven upload trigger with the subsequent data transfer. We therefore direct the reader to the separate chapter 11.4 on the evaluation of bulk data transfer technologies for further information on some of the technologies discussed in this paper. (I)

8.8.1.4 A distinction can be made between the use cases of RPC and those of event-driven communication. This distinction is rooted in the underlying communication paradigm. Event-driven communication is often employed in scenarios involving one-to-many communication, whereas RPC use cases, at least in railway applications, rely on a one-to-one communication paradigm. This is because procedure calls are directed to a specific receiver, who is typically responsible for confirming the call's receipt and execution. For further information regarding technologies that specifically tackle one-to-many communication use cases, please refer to chapter 8.6 on event-based communication. (I)

8.8.1.5 RPC will be realised with HTTP/1.x or HTTP/2 plus TCP as the underlying transport protocol and RESTful designed APIs to employ standard HTTP methods (e.g., GET, POST, PUT, DELETE) to perform CRUD (i.e., Create, Read, Update, Delete) operations on resources, which are represented in formats such as JSON or XML. Specific HTTP requests are hence mapped to remote methods or procedures. Each API endpoint is associated with a method call, with the HTTP methods representing different operations on these calls. The Representational State Transfer (REST) design principle describes that method information are not encoded in the Unified Resource Identifier (URI), as the URI specifies the location and name of the resource, but not the functionality that the (web) service offers for the resource. (I)

8.8.1.6 While HTTP/1.x and HTTP/2 both rely on TCP as transport layer, HTTP/3 introduces QUIC as a new transport layer. As QUIC is not yet very commonly used today, and HTTP/1.x and HTTP/2 already fulfil our requirements quite well, HTTP/3 is intentionally not part of the current specification. It might be added in a later version. (I)

8.8.2 Requirements on Remote Procedure Calls (RPC)

8.8.2.1 For RPC communication HTTP over TCP according to according to IETF RFC 2616 or RFC 7540/7541 shall be used. (R)

8.8.2.2 The endpoints of RPC services shall be implemented in a RESTful designed API. (R)

8.8.2.3 For secured communication HTTP over TLS (HTTPS) according to IETF RFC 2818 shall be used. (R)

8.8.2.4 The minimum version a client or a server shall support is HTTP/1.1 according to IETF RFC 2616. (R)

8.8.2.5 Optionally HTTP/2 according to IETF RFC 7540/7541 can be supported and used on mutual handshake. (R)

Add a new chapter 8.9 to read:

8.9 Bulk Data Communication

8.9.1 Informative Introduction

8.9.1.1 In addition to cyclic process data, acyclic event-based data exchange and RPC, bulk data communication is another fundamental communication paradigm for vehicle communication differentiated by its application specifics. Consequently, it is necessary for common integration services to provide a (transport) mechanism for bulk data transfer/communication. (I)

8.9.1.2 Typical IT and OT use cases for bulk data communication may include:

- Data warehousing (i.e., loading large volumes of data into internal or external data storages),
- Backup and restore (e.g., of system images),
- Software updates (e.g., for firmware images or containers),
- Data replication and synchronization,
- Management and diagnosis (i.e., log file transfer). (I)

8.9.1.3 A resemblance to or a combination with Remote Procedure Calls (RPC) solutions is often observed in bulk data applications, such as the triggering of a data upload process via a separate procedure call. We therefore direct the reader to the separate chapter 11.3 on the RPC technologies for further information. (I)

8.9.1.4 The chosen technology here is the Hyper Text Transfer Protocol (HTTP) and the Representational State Transfer (REST) architectural concept. (I)

8.9.1.5 This pair represents a standardised and well-known approach in the contemporary Internet, facilitating the web-based transfer of data. HTTP versions 1 and 2 are deployed with the Transmission Control Protocol (TCP) as the underlying transport layer, whereas security is provided by using HTTP over TLS (HTTPS). The handshake to establish a secure connection is performed on top of the separate TCP handshake, which results in communication overhead for secured connections. In comparison with HTTP/1.x, HTTP/2 is the more complex and extensive protocol, leading to more extensive implementations and more load on client/server side. An upgrade path between different HTTP versions is available as common libraries and client/server implementations typically support both HTTP/1.x and HTTP/2 nowadays. (I)

8.9.1.6 While HTTP/1.x and HTTP/2 both rely on TCP as transport layer, HTTP/3 introduces QUIC as a new transport layer. As QUIC is not yet very commonly used today, and HTTP/1.x and HTTP/2 already fulfil our requirements quiet well, HTTP/3 is intentionally not part of the current specification. It might be added in a later version. (I)

8.9.1.7 For bulk data applications, standard HTTP methods (e.g., GET, POST, PUT, DELETE) are employed to perform operations on resources, which are identified by Uniform Resource Locators (URLs). RESTful Application Programming Interfaces (APIs) are stateless, meaning that each client request contains all the information necessary to process the request. This improves scalability since services can be offered and implemented in a distributed fashion. For bulk data transfers, a REST API can support endpoints that accept large payloads, typically in formats like JSON or XML, using POST or PUT methods to create or update multiple records at once. Furthermore, custom implementations of pagination, filtering, and batching mechanisms enable the efficient handling of large datasets, ensuring manageable request sizes and reducing server load. Additionally, the use of HTTP headers and status codes provides control over data transfer processes, allowing for reliable and standardised communication between clients and servers. Different HTTP versions can provide different features to simplify such implementations. (I)

8.9.2 Requirements on Bulk Data Communication

8.9.2.1 For bulk data transfer, HTTP over TCP according to according to IETF RFC 2616 or RFC 7540/7541 shall be used. (R)

8.9.2.2 The endpoints of bulk data transfer services shall be implemented in a RESTful designed API. (R)

8.9.2.3 For secured communication HTTP over TLS (HTTPS) according to IETF RFC 2818 shall be used. (R)

8.9.2.4 The minimum version a client or a server shall support is HTTP/1.1 according to IETF RFC 2616. (R)

8.9.2.5 Optionally and only in addition to 8.8.2.1, HTTP/2 according to IETF RFC 7540/7541 can be supported and used on mutual handshake. (R)

8.9.2.6 Optionally and only in addition to 8.8.2.1, SFTPv3 can be used for bulk data transfer. Although not being formally specified by itself, the term SFTPv3 refers to the variant running over a ssh channel. Ssh itself is defined in IETF RFCs 4250-4256. (R)

8.9.2.7 SFTP must not be confused with FTPS (IETF RFC 4217). Either FTP (IETF RFC 959), or FTPS are not allowed for bulk data transfer. (I)

8.9.2.8 Being a legacy technology from the perspective of this specification, SFTP for bulk data communication is deprecated and will be removed in a future version of the specification. (I)

Modifications to SUBSET-130 v1.0.0

Modify table 1 to read:

Ref. N°	Title	Reference
1.	ERTMS/ATO System Requirements Specification	SUBSET-125
2.	ATO-OB / ATO-TS FFFIS Application Layer	SUBSET-126
3.	ERTMS/ATO Glossary	13E154
4.	ERTMS/ETCS System Requirements Specification	SUBSET-026
5.	FIS Juridical Recording	SUBSET-027
6.	Dimensioning and Engineering rules	SUBSET-040
7.	IEEE 802.3 Ethernet Standard	NA
8.	FFFIS STM Application Layer	SUBSET-058
9.	Glossary of Terms and Abbreviations	SUBSET-023
10.	FFFIS part: CCS Consist Network Communication Layers	SUBSET-147

Table 1 Reference Documents

Modify chapter 5:

5. PRINCIPLES

5.1 Definition of the Variables

5.1.1.1 Intentionally deleted.

5.1.1.2 Intentionally deleted.

5.1.1.3 Intentionally deleted.

Move Subset-143, v1.0.0, section 8.1 to this chapter.

5.2 Definition of the Packets

5.2.1.1 Intentionally deleted.

Move Subset-143, v1.0.0, section 8.2 to this chapter.

Modify Table 2 and clause 6.1.1.2 and add a new clause 6.1.1.3:

6. PACKET DESCRIPTION

6.1 List of Packets

Packet Number	Packet Name	Source	Sink	Transmitting cycle [ms]	Data Class [Ref 10]	Priority Service Class [Ref 10]	Timeout [ms]
0	ATO_ETCS_Status	ATO	ETCS	100	Process Data	<see CR on process data>	1000
1	ATO_ETCS_DMI	ATO	ETCS	100	Process Data	<see CR on process data>	1000
2	ATO_ETCS_Data_Entry_Need	ATO	ETCS	NA	Message Data	3	-
3	ATO_ETCS_Data_Entry_Request	ATO	ETCS	NA	Message Data	3	-
4	ATO_ETCS_Data_View_Values	ATO	ETCS	NA	Message Data	3	-
5	ETCS_ATO_Static	ETCS	ATO	1000	Process Data	<see CR on process data>	3000
6	ETCS_ATO_Dynamic	ETCS	ATO	200	Process Data	<see CR on process data>	1000
7	ETCS_ATO_Driver_Inputs	ETCS	ATO	100..200	Process Data	<see CR on process data>	1000
8	ETCS_ATO_Data_Entry_Values	ETCS	ATO	NA	Message Data	3	-
9	ETCS_ATO_Data_Entry_Flag	ETCS	ATO	NA	Message Data	3	-
10	ETCS_ATO_Data_View_Values_ Request	ETCS	ATO	NA	Message Data	3	-

Packet Number	Packet Name	Source	Sink	Transmitting cycle [ms]	Data Class [Ref 10]	Priority Service Class [Ref 10]	Timeout [ms]
11	ETCS_ATO_BRAKE_DECELERATIONS	ETCS	ATO	200	Process Data	<see CR on process data>	1000

Table 2 Packet summary

…

6.1.1.2 The packet numbers defined in Table 2 correspond to NID_PACKET definition given in [Ref 10]. This interface uses Slot 1 (see chapter 5).

6.1.1.3 The packets sent by message data will be sent as TRDP Message Data over TCP via point-to-point push communication.

Adaptation of Application Layer Subsets to an XML-based description of the communication packets

Approval by approvers

Type of Approval	✔ Document Approval
Approvals	Nicolas Ykman : Waiting , MOTTOLA, Giuseppe Diodato : Approved , Domínguez Fernández, Silvia : Approved , Klose, Christoph (SMO RI R&D) : Approved , MARTA FERNANDEZ ORDAS : Approved , Ghielmetti Cirillo (I-NAT-GST-CCS) : Approved , BITS CH Friedemann : Approved
Comments	**#2 Approval comment** by **BITSCH Friedemann** on 2026-02-14 07:29 the approval of Nicoals is available via e-mail **#3 Approval comment** by **MARTA FERNANDEZ ORDAS** on 2026-02-16 19:22 CR approved in my role as co-leader of TrainCS System Architecture subgroup, based on its alignment with the evolution of the CCS On-Board System Architecture.
Attachments	

SP Identification number

SP-CR 26889

Headline

Adaptation of Application Layer Subsets to an XML-based description of the communication packets

Impacted System

ETCS / ATO

Reference Baseline Release

ETCS B4R1 & ATO B1R1 & RMR B1R1 (TSI CCS annex A as per Regulation (EU)

2023/1695)

Documents and/or References

- SUBSET-119, V4.0.0: Train Interface FFFIS
- SUBSET-130, V1.0.0: ATO-OB / ETCS-OB FFFIS Application Layer
- SUBSET-139, V1.0.0: ATO-OB / Rolling Stock FFFIS Application Layer
- SUBSET-143, V1.0.0: ERTMS/ATO On-board Interface Specifications Communication Layers

Error/Enhancement

Enhancement

Problem/Need description

The next version 2.0.0 of the SUBSET-147 will establish a standardised communication backbone in order to improve modularity, exchangeability and evolvability. The standardised communication stack shall be used for the onboard CCS communication, on the interfaces internal to the CCS subsystem, among different applications (e.g. ETCS on-board, ATO on-board) and on the interfaces to the subsystem rolling stock.

The current application layer SUBSETs specifications are based on process data communication. These SUBSETs shall be updated according to the new version 2.0.0 of the SUBSET-147 based on TRDP process data communication. For the definition of process data the XML data format according IEC 61375-2-3 Annex C shall be used. Thereby, the variables and processes on application layer should generally remain. Beside the the data itself also communication parameters like e.g. cycle time or priority shall be defined in the XML-Files. This allows to directly configure the communication entities in projects.

The concerned mandatory application layer specifications are (the list is not exhaustive):

- SUBSET-119: Train Interface FFFIS
- SUBSET-130: ATO-OB / ETCS-OB FFFIS Application Layer
- SUBSET-139: ATO-OB / Rolling Stock FFFIS Application Layer

With the update of SUBSET-130 the following specification will be obsolete:

- SUBSET-143: ERTMS/ATO On-board Interface Specifications

Communication Layers

With the new way of application layer data specification a new data-centric approach in contrast to the current point-to-point interface specification shall be established. All application layer data shall be published to any subscriber who is interested in the information. The data is only published by the original source of information. This approach stimulates innovation and allows to quickly introduce new features or deploy updates in the future. Overall, standardised interfaces on all communication layers in a machine readable format facilitate the integration of ETCS onboard and ATO onboard into vehicles, allowing exchangeability.

Supporting document(s) for problem/need description

None

Solution Proposal by submitter

See solution proposal in: ERJU_solution_proposal_for_SP-CR-26889.docx

Supporting document(s) for solution proposal

ERJU_solution_proposal_for_SP-CR-26889.docx

SOLUTION PROPOSAL FOR SP-CR26889

Modifications to SUBSET-119 v4.0.0, SUBSET-130 v1.0.0 and SUBSET-139 v1.0.0

The packet specifications of the concerned application layer SUBSETs (e.g. SUBSET-119 and SUBSET-139) and any new Application Layer FFFIS of the next CCS TSI shall be complemented with additional XML files for direct use of these configuration files in projects.

The format shall follow EN 61375-2-3, Annex C.

Example for Subset-119 v4.0.0, 4.3.5, TR packet 3:

TR Packet 3			
Data name	**Type**	**Description (as a complement to Table** 4-1**)**	**Byte.Bit Offset**
TR_OBU_ L_CONSISTFRONTCABAMAX	UNSIGNED16		0.0
TR_OBU_ L_CONSISTFRONTCABAMIN	UNSIGNED16		2.0
TR_OBU_ L_CONSISTFRONTCABANOM	UNSIGNED16		4.0
TR_OBU_ L_CONSISTREARCABAMAX	UNSIGNED16		6.0
TR_OBU_ L_CONSISTREARCABAMIN	UNSIGNED16		8.0
TR_OBU_ L_CONSISTREARCABANOM	UNSIGNED16		10.0
Spare1	UNSIGNED16		12.0
Spare2	UNSIGNED16		14.0
Spare3	UNSIGNED16		16.0
Spare4	UNSIGNED16		18.0
Spare5	UNSIGNED16		20.0
Spare6	UNSIGNED16		22.0
Validity	UNSIGNED16	Validity of value of variables contained in bytes 0 to 11 of the packet. The validity of the signal with offset 0.0 is in	24.0

TR Packet 3			
Data name	**Type**	**Description (as a complement to Table 4-1)**	**Byte.Bit Offset**
		bit 0. The validity of the signal with offset 22.0 is in bit 11.	

This shall be complemented with an XML file containing:

```
<device>
    <data-set-list>
        <data-set id="3" name="TR packet 3" >
            <element type="UINT16" name="TR_OBU_L_CONSISTFRONTCABAMAX" />
            <element type="UINT16" name="TR_OBU_L_CONSISTFRONTCABAMIN" />
            <element type="UINT16" name="TR_OBU_L_CONSISTFRONTCABANOM" />
            <element type="UINT16" name="TR_OBU_L_CONSISTREARCABAMAX" />
            <element type="UINT16" name="TR_OBU_L_CONSISTREARCABAMIN" />
            <element type="UINT16" name="TR_OBU_L_CONSISTREARCABANOM" />
            <element type="UINT16" name="Spare1" />
            <element type="UINT16" name="Spare2" />
            <element type="UINT16" name="Spare3" />
            <element type="UINT16" name="Spare4" />
            <element type="UINT16" name="Spare5" />
            <element type="UINT16" name="Spare6" />
            <element type="UINT16" name="Validity" />
        </data-set>
    </data-set-list>
</device>
```

The application of the XML files shall be optional.

Proposal of XML files for the three Subsets:

Modifications to SUBSET-119 v4.0.0:

Add a new appendix:

8. Appendix B – XML file for the packets

8.1.1.1 The application of the XML file is optional.

8.1.1.2 The format follows EN 61375-2-3, Annex C.

subset-119_v04.xml

Modifications to SUBSET-139 v1.0.0:

Add a new appendix:

Appendix 3: XML file for the packets

The application of the XML file is optional.

The format follows EN 61375-2-3, Annex C.

subset-139_v02.xml

Modifications to SUBSET-130 v1.0.0:

Add a new appendix:

Appendix 1: XML file for the packets

The application of the XML file is optional.

The format follows EN 61375-2-3, Annex C.

subset-130_v02.xml

SOLUTION PROPOSAL FOR SP-CR26947

Modifications to SUBSET-147 v1.0.0

Modifications to chapter 2:

Modify clause 2.6.1.10 to read:

2.6.1.10 The overall goal of the CCS Consist Network is to allow to integrate components within the CCS-subsystem without any change to these components (interchangeability) in the future. This will avoid multiple logical and physical adapters between the systems in scope. (I)

Modifications to chapter 9:

Modify the headline 9. to read:

9. INTENTIONALLY DELETED

Establish new SUBSET-155 for Train Time and Location Services FFFIS

A new SUBSET-155 shall be established for Train Time and Location Services (TTLS) FFFIS. The Train Time and Location Services shall be allocated to a new dedicated Interoperabiltiy Constituent (IC) in the TSI CCS.

SP Identification number

SP-CR 26947

Approval by approvers

Type of Approval	✔ Document Approval
Attachments	
Comments	**#1 Approval comment** by **BITSCH Friedemann** on 2026-02-13 12:37 Comments from UNIFE/UNISIG mirror group have to be discussed in a proper way before the solution is approved. **#2 Approval comment** by **MOTTOLA, Giuseppe Diodato** on 2026-02-16 15:40 See Friedemann comment **#3 Approval comment** by **MARTA FERNANDEZ ORDAS** on 2026-02-16 19:20 See Friedemann comment
Approvals	Nicolas Ykman : Waiting , MOTTOLA, Giuseppe Diodato : Disapproved , Domínguez Fernández, Silvia : Waiting , Klose, Christoph (SMO RI R&D) : Waiting , MARTA FERNANDEZ ORDAS : Disapproved , Ghielmetti Cirillo (I-NAT-GST-CCS) : Waiting , BIT SCH Friedemann : Disapproved , Prins, Martien MD : Waiting

Headline

Consistency of SUBSET-147 specification with FRMCS v3 workstream

Impacted System

ETCS / ATO

Reference Baseline Release

ETCS B4R1 & ATO B1R1 & RMR B1R1 (TSI CCS annex A as per Regulation (EU) 2023/1695)

Documents and/or References

SUBSET-147 v1.0.0

FFFIS-7950, FRMCS FFFIS v1.0.0

AT-7800, FRMCS SRS v1.0.0

TOBA-7510, TOBA FRS v1.0.0

Error/Enhancement

Enhancement

Problem/Need description

The current mandatory SUBSET-147 v1.0.0 has the following touch points with the FRMCS specifications:

1. Missing communication layer 3 (Network Layer) specification in SUBSET-147.
2. Train time and location services specification in addition to FRMCS internal time and location services.

In the current SUBSET-147 the specified Train Time and Location Services (TTLS) are ambiguous and not comprehensive as they have some errors and gaps (e.g. see open CR-1444). Further, the TTLS is currently not assigned to any interoperability constituent. In addition, in the current FRMCS specifications there are time and location services defined internal to onboard FRMCS. To prevent duplicate services (and roof antennas), in SUBSET-147 for general purpose within CCS domain, and in onboard FRMCS specifications for FRMCS internal use only, the FRMCS time and location service data shall be made available also to FRMCS external systems. Under the assumption that the FRMCS internal time and location services will be provided to FRMCS external systems, the specification of the TTLS has to be aligned with the FRMCS specifications in order to have the ability to merge the TTLS and the FRMCS internal time and location services. With this change a single source of information will be established onboard, which results in cost efficient solutions (e.g. less roof antennas).

Furthermore, the synchronisation of the system time of ETCS onboard and ATO onboard to UTC is currently not specified.

Supporting document(s) for problem/need description

None.

Solution Proposal by submitter

It shall be ensured that the specifications are consistent:

- SUBSET-147
- FFFIS-7950- FRMCS FFFIS
- AT-7800, FRMCS SRS
- TOBA-7510, TOBA FRS v1.0.0

Under the assumptions, that:

1. Mandatory support of IP version 4 in AT-7800, FRMCS SRS clause 6.5.1.3

2. Provision of time and location services from FRMCS to FRMCS external systems like ETCS, ATO incl. support of CCS onboard needs for non-safe time and location information.

the following changes in the ETCS / ATO specifications shall be done:

1. The specification of the TTLS has to be aligned with the FRMCS specifications in order to have the ability to merge the TTLS and the FRMCS internal time and location services. Train Time and Location Service (TTLS) shall be extracted from chapter 9 of SS-147 and put in a new dedicated SUBSET (SS-155) for the TTLS as it is not related to communication layers. Further, the TTLS functionality has to be allocated to an interoperability constituent of the TSI CCS. TTLS function shall be referenced in TSI LOC&PAS in order to enlarge the scope to TCMS.

2. Mandatory use of TTLS by ETCS onboard and ATO onboard for synchronisation of their system time to UTC.

Supporting document(s) for solution proposal

ERJU_solution_proposal_for_SP-CR-26947_FRMCS.docx

SUBSET-155 - v001 - Train Time and Location Services FFFIS.docx

TTLS_tracked_changes_SS-147v100ch.9_to_SS-155v001.docx

TTLS_update_description_SS-147v100ch.9_to_SS-155v001.docx

ERTMS Data Applications

Train Time and Location Services
FFFIS

REF : SUBSET-155

ISSUE : 0.0.1

DATE : 27/01/2026

Company	Technical Approval	Management approval
ALSTOM		
AZD		
CAF		
HITACHI RAIL STS		
MERMEC		
SIEMENS		

MODIFICATION HISTORY

Issue Number Date	Section Number	Modification / Description	Author
0.0.1 27-01-2026	all	First issue of the document	S. Schuerch

INTRODUCTION

1.4 Abbreviations

1.4.1.1 For ETCS related abbreviations see SUBSET-023 [Ref 1]. (I)

CCS	Control, Command and Signalling CCS means the subsystems on-board CCS and trackside CCS as defined in the EU directive 2016/797 and described in the technical specifications for interoperability for the control, command and signalling subsystems.
DHCP	Dynamic Host Configuration Protocol
FRMCS	Future Railway Mobile Communication System
(I)	The statements made in this Subset are assigned to the following categories: (I) or (R) I = Informative (indicated by '(I)' at the end of the clause). This is not a requirement. It is only for better understanding of the specification.
NTP	Network Time Protocol
NTS	Network Time Security
PCP	Priority Code Point
(R)	The statements made in this Subset are assigned to the following categories: (I) or (R) R = Requirement (indicated by '(R)' at the end of the clause). This paragraph is a requirement and it is mandatory for the on-board CCS subsystem.
TTLS	Train Time and Location Services
UTC	Coordinated Universal Time

Table 1: Abbreviations

1.5 Reference documents

Ref. N°	Title	Reference	Author
[Ref 1]	Glossary of Terms and Abbreviations	SUBSET-023	ERA, UNISIG, EEIG ERTMS Users Group
[Ref 2]	Network Time Protocol Version 4: Protocol and Algorithms Specification	RFC 5905: 2010	Internet Engineering Task Force (IETF)

Ref. N°	Title	Reference	Author
[Ref 3]	DHCP Options and BOOTP Vendor Extensions	RFC 2132: 1997	Network Working Group
[Ref 4]	Electronic railway equipment - On board driving data recording system - Part 1: System specification	IEC 62625-1:2013	International Electrotechnical Commission
[Ref 5]	Internet Engineering Task Force (IETF), Request for Comments (RFC) 8915, Network Time Security for the Network Time Protocol	RFC 8915 September 2020	Internet Engineering Task Force (IETF)

Table 2: Reference Documents

3. TRAIN TIME AND LOCATION SERVICES

3.1 General

3.1.1.1 The Train Time and Location Services (TTLS) shall provide on one hand a common reference time and on the other hand the current absolute location information for all applications on the vehicle. These are both defined as a non-safe service function. Both services are interconnected through a shared source of information, namely the GNSS module. The device, on which the services are running, is out of scope of this specification. (I)

3.1.1.2 It is assumed that the system integrator/vehicle manufacturer ensures that the time service for the on-board CCS subsystem and the ORD according to this specification will be made available in each consist. (I)

3.1.1.3 Some applications need an additional safe but relative time. Therefore, these implement an independent time counter. An example of such an application is the ETCS onboard implementing a time counter for safe communication with STMs or the RBC. The Train Time Service does not provide such a safe (relative) time information. (I)

3.2 Architecture

3.2.1.1 Primarily using an external GNSS module as time and location source, the TTLS (marked blue in Figure 9-1) will provide an NTP server for time distribution and a location service delivering location and speed information. (I)

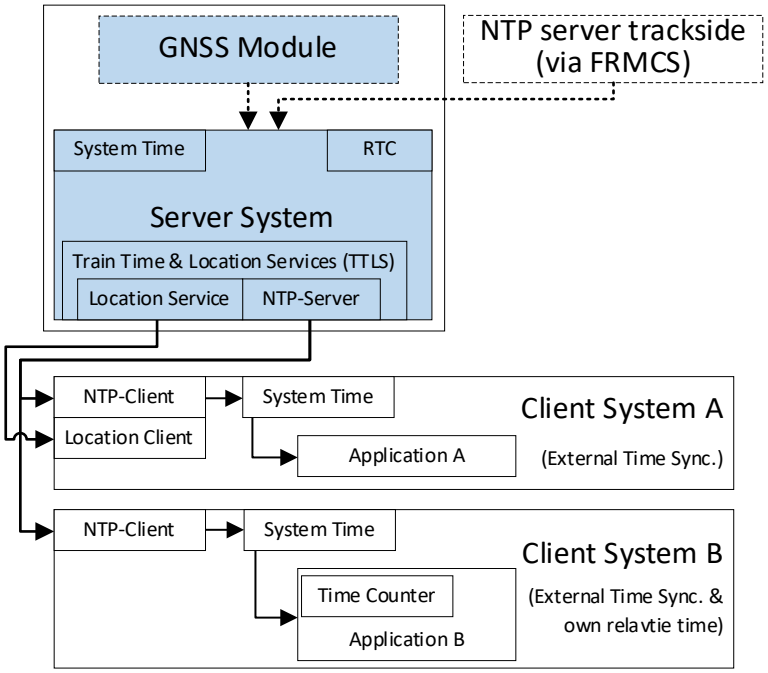

Figure 9-1: Embedded Time and Location Services

3.2.1.2 The provided services as described in this chapter shall be used by all applications connected to the network which require a common time or (non-safe) location or velocity information, for example by

- ATO for time-table related functions (e.g. calculation of energy efficient speed profile)
- ETCS (e.g. time display on the screen or tagging of events according to SS-027)
- Cab Radio
- PKI communication
- ORD
- any monitoring or diagnosis system (R)

3.2.1.3 The time service implements an onboard NTP server. Over the NTP protocol every system (NTP client) can synchronize its system time to the system time of the NTP server. By default, the system time of a client system (NTP client) is not continuous. Time jumps can be caused by leap seconds or transient effects for NTP synchronisation. For client systems needing a continuous system time the NTP client can be configured accordingly. (I)

3.3 Requirements

3.3.1 General Requirements

3.3.1.1 There shall be two active services, providing the two interfaces to the applications:

- Time Service providing Time Synchronisation to UTC.
- Location service that provides location information (including also speed, acceleration attitude) along with a timestamp indicating when the data was valid. (R)

3.3.1.2 A watchdog function shall check if the Train Time and Location Services (TTLS) are running as expected and restart them automatically if these are not available. (R)

3.3.2 Requirements on Time and Location Sources

3.3.2.1 The onboard NTP server shall work as Stratum 1 or 2. (R)

3.3.2.2 The onboard NTP server shall be able to use the following sources:

- Primary time source:
  - Energy-buffered local real-time clock (RTC). Note: to be used after startup if there is no time with higher precision available, and whenever during operation time with higher precision is interrupted.
  - GNSS module
- Secondary time source:
  - NTP-Server (supporting NTS according to RFC 8915 [Ref 5]) Stratum 1 from trackside e.g. over FRMCS

3.3.2.3 Optionally several sources (e.g. GNSS and one or more trackside NTP servers) can be used for error detection. (I)

3.3.2.4 If available, several time sources shall be used simultaneously by the time service in a redundant manner to minimise the loss of time reference. (R)

3.3.2.5 The time service shall resynchronise after interrupted time sources availability when time sources are available again. (R)

3.3.2.6 The energy-buffered local real-time clock (RTC) shall be maintenance free for 15 years (e.g. no battery change). It shall run at least 7 days (168 h) without power supply. If energy re-charge is needed, the energy required for the period of 7 days shall be re-charged within 1 hour.

3.3.2.7 During periods with GNSS reception or connected trackside NTP server, the system time of the NTP server shall be written at least once per hour to the local real-time clock (RTC). (R)

3.3.2.8 The deviation of the system time of the NTP server to UTC shall be less than 30 µs with a steady 3-dimensional GNSS fix. (R)

Info: In order to meet the requirement, the GNSS receiver can output a pulse-per-second (PPS) signal. This PPS signal can be directly connected to NTP server and can be used as a time source signal. (I)

3.3.2.9 The clock drift of the NTP servers' system time shall not exceed ±2.5ppm within the operating temperature range class OT3 according to EN 50155:2021 in a cabinet. (R)

3.3.2.10 Justification: The deviation of the system time of the NTP server to UTC shall not exceed 10 ms within 1 hour GNSS reception loss. The accuracy of the system time shall be below the cycle time of client applications (e.g. ATO 50 ms, JRU logs 50 ms). Additionally, the defined accuracy value of 10 ms corresponds to the resolution of the current onboard train time (T_TRAIN) defined in SS-026-7 7.5.1.154. (I)

3.3.2.11 Info: by using a high-quality temperature compensated crystal oscillator (TCXO) in the GNSS receiver and using the NTP implementation "chrony" with its clock frequency calibration to PPS signal, the accuracy requirement can be met. (I)

3.3.2.12 After startup, once having a steady GNSS reception, the location and speed information shall be available even in areas without GNSS reception (e.g. tunnels, stations etc.). For this function of "dead reckoning", additional sensors (e.g. accelerometer, gyroscope, counting of external wheel tick pulses) to the GNSS receiver are needed. (R)

3.3.2.13 The 2D position error of the GNSS positioning shall be less or equal to 2 m CEP50 (circular error probable) in open sky environment with a roof mounted antenna. (R)

3.3.2.14 The position error during GNSS reception loss shall be max. 3% of the travelled distance. (68% error incurred without GNSS as a percentage of travelled distance of 3000m) (R)

3.3.2.15 The navigation update rate in normal conditions shall be min. 1 Hz. (R)

3.3.2.16 The GNSS receiver shall implement a jamming and spoofing detection. (R)

3.3.3 Interface to Application

3.3.3.1 Time Service (Clock Synchronisation to UTC)

3.3.3.1.1 The local (onboard) synchronisation to UTC time shall take place via NTP protocol RFC 5905 [Ref 2]. (R)

3.3.3.1.1.1 The time service must comply with the NTP era detection and handling mechanisms described in RFC 5905. (R)

3.3.3.1.2 The derivation of the local time is in the responsibility of the client system (e.g. DMI). (I)

3.3.3.2 Time provision shall be started not later than 50 s after power on. (R)

3.3.3.3 Justification: The start-up time of the NTP server shall be faster (with some margin) than the JRU start-up time of 60 s defined in chapter 4.3.1.1 of EN 62625-1 [Ref 4]. (I)

3.3.3.3.1 The system time of the time service (NTP server) is not continuous. Time jumps can be caused by leap seconds or transient effects for NTP synchronisation. (I)

3.3.3.3.2 The system time of the time service (NTP server) shall step at the moment a leap second occurs. (R)

3.3.3.3.3 Leap seconds shall be indicated by the NTP server with the leap indicator according to RFC 5905 [Ref 2]. (R)

3.3.3.3.4 To get a continuous system time on the client system with no or only little time jumps, the NTP client in the client system can be configured accordingly. (I)

3.3.3.3.5 Network Time Security (NTS) according to RFC 8915 [Ref 5] shall be supported additionally by the local NTP server. (R)

3.3.3.3.6 In accordance with SUBSET-147 [18] chapter 8.4.4.1.2 the NTP packets for time synchronization shall be sent with PCP value 6 to get high priority in the network and therefore high synchronisation accuracy. This requirement is not only valid for the NTP server (train time service) but also for the NTP clients (clients of the train time service). (R)

3.3.3.3.7 The address of the time service shall be distributed by means of a DHCP service according to RFC 2132 [Ref 3]. (R)

3.3.3.4 Location Service

3.3.3.4.1 The location (including also speed, acceleration, attitude, timestamp) shall be derived from GNSS. The time information (timestamp) indicates the time, when the location and the speed information was valid. (R)

3.3.3.4.2 The information shall be distributed locally (onboard) over the traffic mechanisms “process data”. (R)

3.3.3.4.3 For process data the following packet shall be distributed (R):

3.3.3.4.4 PVAAT Packet (Position, Velocity, Attitude, Acceleration, Time):

Properties:

ComId:	configurable
Data class:	Time-critical process data (VLAN Prio 6)
max. Cycle Time:	1000 ms

Byte Offset	Type	Name	Unit	Description	classification in case of 2D/3D fix
0	UINT8	VERSION		Version of the message, current version: 1	mandatory
1	UINT16	VALIDITY		Flags: Bit 0: valid date (UTC_YEAR, UTC_MONTH, UTC_DAY) Bit 1: valid time (UTC_HOUR, UTC_MINUTE, UTC_SECOND, UTC_NANO) Bit 2: valid sensor configuration (GNSS_TO_EXTREMITY_1/2) Bit 3: valid position (POSITION_LAT, POSITION_LONG) Bit 4: valid altitude (ALT_HAE) Bit 5: valid track angle (TRACK) Bit 6: valid speed (SPEED) Bit 7: valid acceleration (ACCELERATION_X/Y/Z) Bit 8: valid climb (CLIMB) Bit 9: valid heading angle (HEADING) Bit 10:valid pitch angle (PITCH) Bit 11:valid roll angle (ROLL)	mandatory
3	UINT8	STATUS		Status: 0: no fix 1: Dead Reckoning (DR) 2: 2D GNSS fix 3: 3D GNSS fix 4: 3D GNSS fix + Dead Reckoning (DR)	mandatory
4	BOOL (UINT8)	JAMMING_STATE		Jamming detection status: 0: no jamming detected 1: jamming detected	mandatory
5	BOOL (UINT8)	SPOOFING_STATE		Spoofing detection status: 0: no spoofing detected 1: spoofing detected	mandatory
6	UINT16	UTC_YEAR	y	Year of UTC date and time associated to the data collection.	mandatory
8	UINT8	UTC_MONTH	month	Month of UTC date and time associated to the data collection. Range 1…12	mandatory
9	UINT8	UTC_DAY	d	Day of UTC date and time associated to the data collection. Range 1…31	mandatory
10	UINT8	UTC_HOUR	h	Hour of UTC date and time associated to the data collection. Range 0…23	mandatory
11	UINT8	UTC_MINUTE	min	Minute of UTC date and time associated to the data collection. Range 0…59	mandatory
12	UINT8	UTC_SECOND	s	Second of UTC date and time associated to the data collection. Range 0…60	mandatory
13	UINT32	UTC_NANO	ns	Fraction of second in nanoseconds of UTC date and time associated to the data collection. Range 0…999'999'999.	mandatory
17	UINT32	UTC_ERROR_EST	ns	Estimated time error in nanoseconds associated to the data collection. Value 0 if no error estimate is available.	optional
21	FLOAT32	GNSS_TO_EXTREMITY_1	m	Distance from the center of the GNSS antenna to the consist end on extremity 1 in meters. GNSS_TO_EXTREMITY_1 + GNSS_TO_ EXTREMITY _2 = overall consist length.[1]	mandatory
25	FLOAT32	GNSS_TO_EXTREMITY_2	m	Distance from the center of the GNSS antenna to the consist end on extremity 2 in meters. GNSS_TO_ EXTREMITY _1 + GNSS_TO_ EXTREMITY _2 = overall consist length.[1]	mandatory

29	FLOAT32	POSITION_LAT	deg	Latitude in degrees in the WGS84 reference system Range: -90.000000° to +90.000000° +/- signifies North/South	mandatory
33	FLOAT32	POSITION_LONG	deg	Longitude in degrees in the WGS84 reference system Range: -180.000000° to +180.000000° +/- signifies East/West	mandatory
37	FLOAT32	POSITION_ ERROR_EST	m	Estimated horizontal position error in meters. Value 0 if no error estimate is available.	mandatory
41	FLOAT32	ALT_HAE	m	Altitude / height above WGS84 ellipsoid in meters	mandatory (only 3D fix)
45	FLOAT32	ALT_ERROR_EST	m	Estimated vertical position (altitude) error in meters	optional
49	FLOAT32	TRACK	deg	Course of motion over ground in degrees clockwise from true north	mandatory
53	FLOAT32	TRACK_ERROR_E ST	deg	Estimated track direction (direction of ground speed) error in degrees. Value 0 if no error estimate is available.	optional
57	FLOAT32	SPEED	m/s	Speed over ground (2D) in meters per second	mandatory
61	FLOAT32	SPEED_ERROR_E ST	m/s	Estimated speed error in meters per second. Value 0 if no error estimate is available.	optional
65	FLOAT32	ACCELERATION_X	m/s^2	Compensated x-axis acceleration (gravity free) in meters per second square (m/s^2)[1]	mandatory
69	FLOAT32	ACCELERATION_Y	m/s^2	Compensated y-axis acceleration (gravity free) in meters per second square (m/s^2)[1]	mandatory
73	FLOAT32	ACCELERATION_Z	m/s^2	Compensated z-axis acceleration (gravity free) in meters per second square (m/s^2)[1]	mandatory
77	FLOAT32	ACCELERATION_E RROR_EST	m/s^2	Estimated acceleration error over the ground in meters per second square (m/s^2). Value 0 if no error estimate is available.	optional
81	FLOAT32	CLIMB	m/s	Climb (positive) or sink (negative) rate in meters per second	mandatory
85	FLOAT32	CLIMB_ERROR_ES T	m/s	Estimated climb error in meters per second. Value 0 if no error estimate is available.	optional
89	FLOAT32	HEADING	deg	Heading of vehicle towards extremity 1 over ground in degrees clockwise from true north	mandatory
93	FLOAT32	HEADING_ERROR_ EST	deg	Estimated heading direction error in degrees[1]. Value 0 if no error estimate is available.	optional
97	FLOAT32	PITCH	deg	Pitch angle in degrees between -90 and + 90	mandatory
101	FLOAT32	PITCH_ERROR_ES T	deg	Estimated pitch error in degrees. Value 0 if no error estimate is available.	optional
105	FLOAT32	ROLL	deg	Roll angle in degrees between -180 and + 180	mandatory
109	FLOAT32	ROLL_ERROR_EST	deg	Estimated roll error in degree. Value 0 if no error estimate is available.	optional

Table 3: Process Data Specification PVAAT Packet

[1] The consist and vehicle directions and axis are defined according to IEC 61375-1:2012 chapter 5.5. The x-axis is the vehicle longitudinal axis oriented toward the extremity 1. The y-axis is the orthogonal to the vehicle longitudinal axis oriented to the left (side A). The z-axis is the orthogonal to the vehicle x-axis and y-axis oriented upwards.

3.3.4 Hardware Requirements

3.3.4.1 Reliability equivalent to ORD requirements according IEC 62625-1 [Ref 4], chap. 4.3.1.4; MTBF > 50.000 h. (R)

f

ERTMS Data Applications

Train Time and Location Services
Tracked changes from SS-147 v100 to SS-155 v001

REF :

ISSUE :

DATE : 27/01/2026

Company	Technical Approval	Management approval
ALSTOM		
AZD		
CAF		
HITACHI RAIL STS		
MERMEC		
SIEMENS		

1. MODIFICATION HISTORY

Issue Number Date	Section Number	Modification / Description	Author
14.11.2024		Changes in tracked change mode corresponding to error correction TTLS solution proposal	S. Schuerch F. Kaiser F. Bitsch
10.12.2025 07.01.2026 27/01/2026		Added a few requirements in tracked change mode	S. Schuerch

2. INTRODUCTION

2.4 Abbreviations

2.4.1.1 For ATO related abbreviations see ERTMS/ATO Glossary [Ref 1]. (I)

2.4.1.2 For ETCS related abbreviations see SUBSET-023 [Ref 3]. (I)

API	Application Programming Interface
CAN	Controller Area Network
CCS	Control, Command and Signalling CCS means the subsystems on-board CCS and trackside CCS as defined in the EU directive 2016/797 and described in the technical specifications for interoperability for the control, command and signalling subsystems.
CN	Network/bus connecting equipment within a consist.
DHCP	Dynamic Host Configuration Protocol
DST	Daylight Saving Time
ED	End Device
ECN	Ethernet Consist Network as per IEC 61375-3-4
EMD	Electrical Middle Distance Bus
ESD+	Electrical Short Distance Bus
FRMCS	Future Railway Mobile Communication System
HW	Hardware
(I)	The statements made in this Subset are assigned to the following categories: (I) or (R) I = Informative (indicated by '(I)' at the end of the clause). This is not a requirement. It is only for better understanding of the specification.
NTP	Network Time Protocol
NTS	Network Time Security
OCCB	One common on-board CCS bus: A platform for the communication networks internal and external to the on-board CCS subsystem.
OMS	Online Monitoring System

MAC	Medium Access Control, subfunction on OSI layer 2
MVB	Multifunction Vehicle Bus
OSI	Open Systems Interconnection
PCP	Priority Code Point
Realtime data	Data that needs to be communicated within a certain upper time limit.
RPC	Remote Procedure Call
RST	Rolling Stock
(R)	The statements made in this Subset are assigned to the following categories: (I) or (R) R = Requirement (indicated by '(R)' at the end of the clause). This paragraph is a requirement and it is mandatory for the on-board CCS subsystem on newly developed vehicles designs requiring a first authorization and for the Interoperability Constituent ETCS On-board (independent from its specific application). For all vehicles, which do not fall under the definition "newly developed vehicles designs", its application is voluntary at the discretion of the system integrator.
SW	Software
TTLS	Train Time and Location Services
UTC	Coordinated Universal Time
Zone	Logical part of the on-train system architecture. In alignment with the security concepts the typical zones are: FRMCS, CCS, Rolling Stock, TOS, Passenger Network

Table 1: Abbreviations

2.7 Reference documents

Ref. N°	Title	Reference	Author
[Ref 1]	ERTMS/ATO Glossary	13E154	EEIG ERTMS Users Group
[Ref 2]	ERTMS/ATO System Requirements Specification	SUBSET-125	UNISIG
[Ref 3]	Glossary of Terms and Abbreviations	SUBSET-023	ERA, UNISIG, EEIG ERTMS Users Group

Ref. N°	Title	Reference	Author
[Ref 4]	System Requirements Specification	SUBSET-026	ERA, UNISIG, EEIG ERTMS Users Group
[Ref 5]	Electronic railway equipment – Train communication network (TCN) – Part 3-4: Ethernet Consist Network (ECN)	IEC 61375-3-4:2014	International Electrotechnical Commission
[Ref 6]	Train Communication Network – Communication Profile	IEC61375-2-3:2015 TCN	International Electrotechnical Commission
[Ref 7]	Train Communication Network – MVB	IEC61375-3-1:2012 TCN	International Electrotechnical Commission
[Ref 8]	Train Communication Network – CAN	IEC61375-3-3:2012 TCN	International Electrotechnical Commission
[Ref 9]	Serie Profinet	IEC61158-1:2019 / 61158-5-10 :2020 / 61158-6-10:2019	International Electrotechnical Commission
[Ref 10]	Profisafe	IEC61784-2:2019/ -3-3:2021	International Electrotechnical Commission
[Ref 11]	Train Communication Network – Train Communication Network – WTB	IEC61375-2-1:2012 TCN	International Electrotechnical Commission
[Ref 12]	Open Platform Communications Unified Architecture (OPC-UA)	IEC62541-1/-2:2016 / -3 – -14:2020 / -100:2015	International Electrotechnical Commission
[Ref 13]	Performance Requirements for Interoperability	SUBSET-041	UNISIG
[Ref 14]	Performance Requirements for STMs	SUBSET-059	UNISIG
[Ref 15]	TDS / ETCS On-board DMI-EVC Interface FFFIS	SUBSET-121	UNISIG
[Ref 16]	ERTMS/ATO: Interface Specification Communication Layers for On-board Communication	SUBSET-143	UNISIG
[Ref 17]	Network Time Protocol Version 4: Protocol and Algorithms Specification	RFC 5905: 2010	Internet Engineering Task Force (IETF)
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[Ref 19]	Electronic railway equipment - On board driving data recording system - Part 1: System specification	IEC 62625-1:2013	International Electrotechnical Commission
[Ref 20]	ERTMS End-to-End Security Layer	SUBSET-146	UNISIG
[Ref 21]	ATO-OB / Rolling Stock FFFIS Application Layer	SUBSET-139	UNISIG
[Ref 22]	TSI LOC&PAS	1302/2014	European Commission Regulation
[Ref 24]	Industrial communication networks - Network and system security – Part 3-3: System security requirements and security levels	IEC 62443-3-3: 2013	International Electrotechnical Commission
[Ref 25]	IEEE Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks	IEEE 802.1Q-2018	IEEE
[Ref 26]	FRMCS FFFIS – Form Fit Functional Interface Specification	FRMCS FFFIS-7950	UIC
[Ref 27]	EuroRadio FIS - FRMCS Communication Functional Module	Subset-037-3	UNISIG
[Ref 28]	ERTMS/ATO System Requirement Specification	Subset-125	UNISIG
[Ref 29]	ATO-OB / ATO-TS FFFIS Application Layer	Subset-126	UNISIG
[Ref 30]	ATO-OB / ATO-TS Interface Specification - Transport and Security Layers	Subset-148	UNISIG
[Ref 31]	GPSd location service definition	https://gpsd.gitlab.io/gpsd/	-
[Ref 32]	Internet Engineering Task Force (IETF), Request for Comments (RFC) 8915, Network Time Security for the Network Time Protocol	RFC 8915 September 2020	Internet Engineering Task Force (IETF)

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9. TRAIN TIME AND LOCATION SERVICES

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9.1.1.2 It is assumed that the system integrator/vehicle manufacturer ensures that the time service for the on-board CCS subsystem and the ORD according to this specification will be made available in each consist. (I)

9.1.1.3 Some applications need an additional safe but relative time. Therefore, these implement an independent time counter. An example of such an application is theETCS onboard implementing a time counter for safe communication with STMs or the RBC. The Train Time Service does not provide such a safe (relative) time information. (I)

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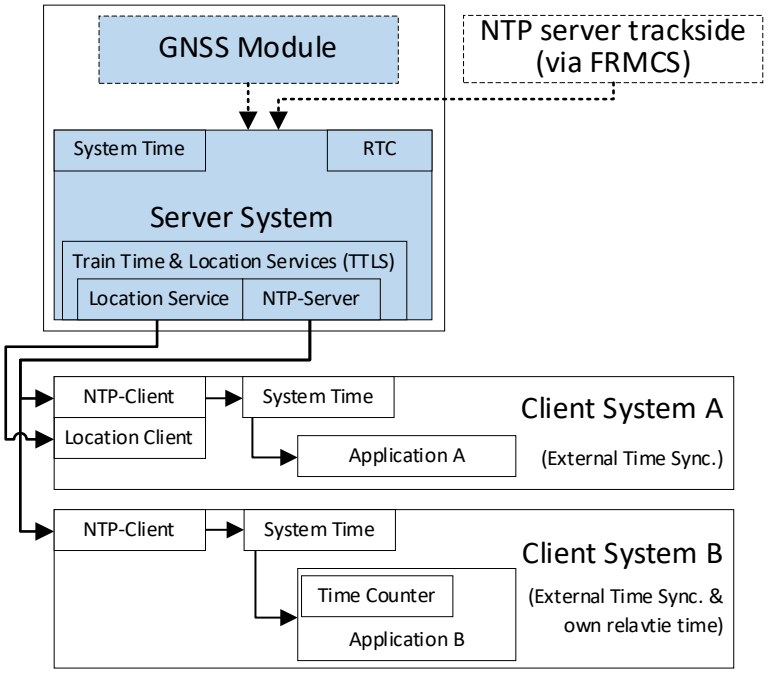

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9.2.1.2 The provided services as described in this chapter shall be used by all applications connected to the network which require a common time or (non-safe) location or speed information, for example by

- ATO for time-table related functions (e.g. calculation of energy efficient speed profile)
- ETCS (e.g. time display on the screen or tagging of events according to SS-027)
- Cab Radio
- PKI communication
- ORD
- any monitoring or diagnosis system (R)

9.2.1.3 The time service implements an onboard NTP server. Over the NTP protocol every system (NTP client) can synchronize its system time to the system time of the NTP server. By default, the system time of a client system (NTP client) is not continuous. Time jumps can be caused by leap seconds or transient effects for NTP synchronisation. For client systems needing a continuous system time the NTP client can be configured accordingly. (I)

9.3 Requirements

9.3.1 General Requirements

9.3.1.1 There shall be two active services, providing the two interfaces to the applications:

- Time Service providing Time Synchronisation to UTC
- Location service that provides location information (including also speed, acceleration attitude) along with a timestamp indicating when the data was valid. (R)

9.3.1.2 A watchdog function shall check if the Train Time and Location Services (TTLS) are running as expected and restart them automatically if these are not available.(R)

9.3.2 Requirements on Time and Location Sources

9.3.2.1 The onboard NTP server shall work as Stratum 1 or 2. (R)

9.3.2.2 The onboard NTP server shall be able to use the following sources:

- Primary time source:
  - Energy-buffered local real-time clock (RTC). Note: to be used after startup if there is no time with higher precision available, and whenever during operation time with higher precision is interrupted.
  - GNSS module
- Secondary time source:
  - NTP-Server (supporting NTS according to RFC 8915 [Ref 32]) Stratum 1 from trackside e.g. over FRMCS

9.3.2.3 Optionally several sources (e.g. GNSS and one or more trackside NTP servers) can be used for error detection. (I)

9.3.2.4 If available, several time sources shall be used simultaneously by the time service in a redundant manner to minimise the loss of time reference. (R)

9.3.2.5 The time service shall resynchronise after a interrupted time sources availability when time sources are available again. (R)

9.3.2.6 The energy-buffered local real-time clock (RTC) shall be maintenance free for 15 years (e.g. no battery change). It shall run at least 7 days (168 h) without power supply. If energy re-charge is needed, the energy required for the period of 7 days shall be re-charged within 1 hour.

9.3.2.7 During periods with GNSS reception or connected trackside NTP server, the system time of the NTP server shall be written at least once per hour to the local real-time clock (RTC). (R)

9.3.2.8 The deviation of the system time of the NTP server to UTC shall be less than 30 µs with a steady 3-dimensional GNSS fix. (R)

Info: In order to meet the requirement, the GNSS receiver can output a pulse-per-second (PPS) signal. This PPS signal can be directly connected to NTP server and can be used as a time source signal. (I)

9.3.2.9 The clock drift of the NTP servers' system time shall not exceed ±2.5ppm within the operating temperature range class OT3 according to EN 50155:2021 in a cabinet. (R)

9.3.2.10 Justification: The deviation of the system time of the NTP server to UTC shall not exceed 10 ms within 1 hour GNSS reception loss. The accuracy of the system time shall be below the cycle time of client applications (e.g. ATO 50 ms, JRU logs 50 ms). Additionally, the defined accuracy value of 10 ms corresponds to the resolution of the current onboard train time (T_TRAIN) defined in SS-026-7 7.5.1.154. (I)

9.3.2.11 Info: By using a high-quality temperature compensated crystal oscillator (TCXO) and using the NTP implementation "chrony" with its clock frequency calibration to PPS signal, the accuracy requirement can be met. (I)

9.3.2.12 After startup, once having a steady GNSS reception, the location and speed information shall be available even in areas without GNSS reception (e.g. tunnels, stations etc.). For this function of "dead reckoning", additional sensors (e.g. accelerometer, gyroscope, counting of external wheel tick pulses) to the GNSS receiver are needed. (R)

9.3.2.13 The 2D position error of the GNSS positioning shall be less or equal to 2 m CEP50 (circular error probable) in open sky environment with a roof mounted antenna. (R)

9.3.2.14 The position error during GNSS reception loss shall be max. 3% of the travelled distance. (68% error incurred without GNSS as a percentage of travelled distance of 3000m) (R)

9.3.2.15 The navigation update rate in normal conditions shall be min. 1 Hz. (R)

9.3.2.16 The GNSS receiver shall implement a jamming and spoofing detection. (R)

9.3.3 Interface to Application

9.3.3.1 Time Service (Clock Synchronisation to UTC)

9.3.3.1.1 The local (onboard) synchronisation to UTC time shall take place via NTP protocol RFC 5905 [Ref 17]. (R)

9.3.3.1.1.1 The time service must comply with the NTP era detection and handling mechanisms described in RFC 5905. (R)

9.3.3.1.2 The derivation of the local time is in the responsibility of the client system (e.g. DMI). (I)

9.3.3.2 Time provision shall be started not later than 50 s after power on. (R)

9.3.3.3 Justification: The start-up of the NTP server shall be faster (with some margin) than the JRU start-up time of 60 s defined in chapter 4.3.1.1 of EN 62625-1 [Ref 19]. (I)

9.3.3.3.1 The system time of the time service (NTP server) is not continuous. Time jumps can be caused by leap seconds or transient effects for NTP synchronisation. (I)

9.3.3.3.2 The system time of the time service (NTP server) shall step at the moment a leap second occurs. (R)

9.3.3.3.3 Leap seconds shall be indicated by the NTP server with the leap indicator according to RFC 5905 [Ref 17]. (R)

9.3.3.3.4 To get a continuous system time on the client system with no or only little time jumps, the NTP client in the client system can be configured accordingly. (I)

9.3.3.3.5 Network Time Security (NTS) according to RFC 8915 [Ref 32] shall be supported additionally by the local NTP server. (R)

9.3.3.3.6 In accordance with SUBSET-147 [18] chapter 8.4.4.1.2 the NTP packets for time synchronization shall be sent with PCP value 6 to get high priority in the network and therefore high synchronisation accuracy. This requirement is not only valid for the NTP server (train time service) but also for the NTP clients (clients of the train time service). (R)

9.3.3.3.7 The address of the time service shall be distributed by means of a DHCP service according to RFC 2132 [Ref 18]. (R)

9.3.3.4 Location Service

9.3.3.4.1 The location (including also speed, acceleration, attitude, timestamp) shall be derived from GNSS. The time information (timestamp) indicates the time, when the location and the speed information was valid. (R)

9.3.3.4.2 The information shall be distributed locally (onboard) over the traffic mechanisms “process data”. (R)

9.3.3.4.3 For process data the following packet shall be distributed (R):

9.3.3.4.4 PVAAT Packet (Position, Velocity, Attitude, Acceleration, Time):

Properties:
ComId: configurable
Data class: Time-critical process data (VLAN Prio 6)
max. Cycle Time: 1000 ms

Byte Offset	Type	Name	Unit	Description	classification in case of 2D/3D fix

0	UINT8	VERSION		Version of the message, current version: 1	mandatory
1	UINT16	VALIDITY		Flags: Bit 0: valid date (UTC_YEAR, UTC_MONTH, UTC_DAY) Bit 1: valid time (UTC_HOUR, UTC_MINUTE, UTC_SECOND, UTC_NANO) Bit 2: valid sensor configuration (GNSS_TO_EXTREMITY_1/2) Bit 3: valid position (POSITION_LAT, POSITION_LONG) Bit 4: valid altitude (ALT_HAE) Bit 5: valid track angle (TRACK) Bit 6: valid speed (SPEED) Bit 7: valid acceleration (ACCELERATION_X/Y/Z) Bit 8: valid climb (CLIMB) Bit 9: valid heading angle (HEADING) Bit 10:valid pitch angle (PITCH) Bit 11:valid roll angle (ROLL)	mandatory
3	UINT8	STATUS		Status: 0: no fix 1: Dead Reckoning (DR) 2: 2D GNSS fix 3: 3D GNSS fix 4: 3D GNSS fix + Dead Reckoning (DR)	mandatory
4	BOOL (UINT8)	JAMMING_STATE		Jamming detection status: 0: no jamming detected 1: jamming detected	mandatory
5	BOOL (UINT8)	SPOOFING_STATE		Spoofing detection status: 0: no spoofing detected 1: spoofing detected	mandatory
6	UINT16	UTC_YEAR	y	Year of UTC date and time associated to the data collection.	mandatory
8	UINT8	UTC_MONTH	month	Month of UTC date and time associated to the data collection. Range 1…12	mandatory
9	UINT8	UTC_DAY	d	Day of UTC date and time associated to the data collection. Range 1…31	mandatory
10	UINT8	UTC_HOUR	h	Hour of UTC date and time associated to the data collection. Range 0…23	mandatory
11	UINT8	UTC_MINUTE	min	Minute of UTC date and time associated to the data collection. Range 0…59	mandatory
12	UINT8	UTC_SECOND	s	Second of UTC date and time associated to the data collection. Range 0…60	mandatory
13	UINT32	UTC_NANO	ns	Fraction of second in nanoseconds of UTC date and time associated to the data collection. Range 0…999'999'999.	mandatory
17	UINT32	UTC_ERROR_EST	ns	Estimated time error in nanoseconds associated to the data collection. Value 0 if no error estimate is available.	optional
21	FLOAT32	GNSS_TO_EXTREMITY_1	m	Distance from the center of the GNSS antenna to the consist end on extremity 1 in meters. GNSS_TO_EXTREMITY_1 + GNSS_TO_ EXTREMITY _2 = overall consist length.[2]	mandatory
25	FLOAT32	GNSS_TO_EXTREMITY_2	m	Distance from the center of the GNSS antenna to the consist end on extremity 2 in meters. GNSS_TO_ EXTREMITY _1 + GNSS_TO_ EXTREMITY _2 = overall consist length.[2]	mandatory
29	FLOAT32	POSITION_LAT	deg	Latitude in degrees in the WGS84 reference system Range: -90.000000° to +90.000000° +/- signifies North/South	mandatory

33	FLOAT32	POSITION_LONG	deg	Longitude in degrees in the WGS84 reference system Range: -180.000000° to +180.000000° +/- signifies East/West	mandatory
37	FLOAT32	POSITION_ ERROR_EST	m	Estimated horizontal position error in meters. Value 0 if no error estimate is available.	mandatory
41	FLOAT32	ALT_HAE	m	Altitude / height above WGS84 ellipsoid in meters	mandatory (only 3D fix)
45	FLOAT32	ALT_ERROR_EST	m	Estimated vertical position (altitude) error in meters	optional
49	FLOAT32	TRACK	deg	Course of motion over ground in degrees clockwise from true north	mandatory
53	FLOAT32	TRACK_ERROR_E ST	deg	Estimated track direction (direction of ground speed) error in degrees. Value 0 if no error estimate is available.	optional
57	FLOAT32	SPEED	m/s	Speed over ground (2D) in meters per second	mandatory
61	FLOAT32	SPEED_ERROR_E ST	m/s	Estimated speed error in meters per second. Value 0 if no error estimate is available.	optional
65	FLOAT32	ACCELERATION_X	m/s^2	Compensated x-axis acceleration (gravity free) in meters per second square $(m/s^2)^2$	mandatory
69	FLOAT32	ACCELERATION_Y	m/s^2	Compensated y-axis acceleration (gravity free) in meters per second square $(m/s^2)^2$	mandatory
73	FLOAT32	ACCELERATION_Z	m/s^2	Compensated z-axis acceleration (gravity free) in meters per second square $(m/s^2)^2$	mandatory
77	FLOAT32	ACCELERATION_E RROR_EST	m/s^2	Estimated acceleration error over the ground in meters per second square (m/s^2). Value 0 if no error estimate is available.	optional
81	FLOAT32	CLIMB	m/s	Climb (positive) or sink (negative) rate in meters per second	mandatory
85	FLOAT32	CLIMB_ERROR_ES T	m/s	Estimated climb error in meters per second. Value 0 if no error estimate is available.	optional
89	FLOAT32	HEADING	deg	Heading of vehicle towards extremity 1 over ground in degrees clockwise from true north	mandatory
93	FLOAT32	HEADING_ERROR_ EST	deg	Estimated heading direction error in degrees[1]. Value 0 if no error estimate is available.	optional
97	FLOAT32	PITCH	deg	Pitch angle in degrees between -90 and + 90	mandatory
101	FLOAT32	PITCH_ERROR_ES T	deg	Estimated pitch error in degrees. Value 0 if no error estimate is available.	optional
105	FLOAT32	ROLL	deg	Roll angle in degrees between -180 and + 180	mandatory
109	FLOAT32	ROLL_ERROR_EST	deg	Estimated roll error in degree. Value 0 if no error estimate is available.	optional

Table 3: Process Data Specification PVAAT Packet

9.3.4 Hardware Requirements

9.3.4.1 Reliability equivalent to ORD requirements according IEC 62625-1 [Ref 19], chap. 4.3.1.4; MTBF > 50.000 h. (R)

[1] The consist and vehicle directions and axis are defined according to IEC 61375-1:2012 chapter 5.5. The x-axis is the vehicle longitudinal axis oriented toward the extremity 1. The y-axis is the orthogonal to the vehicle longitudinal axis oriented to the left (side A). The z-axis is the orthogonal to the vehicle x-axis and y-axis oriented upwards.

9.3.4.2

update description SS-147v100ch9 to SS-155v001	**Introduction** In the current mandatory SUBSET-147 v1.0.0, Train Time and Location Services (TTLS) are specified. The Train Time and Location Services (TTLS) provide on one hand a common reference time and on the other hand 3D location information. They are both defined as a non-safe on-board service function. The specification of the TTLS in SS-147 v1.0.0 has some errors and gaps. **Error Correction Time Service** • Some of the time sources defined in the current version 1.0.0 of the SUBSET-147 cannot be used for the time service as expected or are not specified in sufficient details for a FFFIS and for implementation. Therefore the following changes are needed: o The onboard NTP server should be defined as stratum 1 in case of using GNSS as source or stratum 2 in case of using a stratum 1 trackside NTP server. o Time protocol (TP) over FRMCS as secondary time source should be deleted as it cannot be used for time synchronization in sufficient quality. o A real-time clock (RTC) with battery backup shall be introduced as time source after startup until GNSS or trackside NTP server is available. • The accuracy of the NTP servers' system time to UTC has to be improved in order to meet current application needs (e.g. ETCS logging in ORD). The deviation of the system time of the NTP server to UTC shall not exceed 10 ms within 1 h GNSS reception loss. Reasons for the definition of the deviation to UTC in normal operation of max. 10 ms are: o SUBSET-027 defines the events the ERTMS/ETCS on-board equipment shall detect. When such an event occurs, the ERTMS/ETCS on-board equipment registers the current UTC time with a resolution of 50 ms. The resolution is in the range of the computing cycle time of ETCS onboard. The accuracy of the time synchronisation shall be below the resolution and the cycle time of the application. o SUBSET-026-7 (§7.5.1.154) defines the train borne clock T_TRAIN used for time-stamping of messages and for supervision of time-outs. This clock establishes a relative time and has a resolution of 10 ms. o If sources with high time synchronisation accuracy are available (normally <128 ms) NTP can adjust its system time in a continuous manner without time steps . This is beneficial for a correct timing behaviour of all client applications. Overall, the requirement is feasible and can be fulfilled with a standard computing unit and a standard GNSS module. Also a later introduced time synchronisation to a trackside NTP stratum 1 server over FRMCS leads to the accuracy in the range of ±10 ms. A time synchronisation with an accuracy of ±10 ms to UTC can initially be implemented with negligible additional costs but will be expensive if introduced in a second step due to hardware replacement. • The priority of the NTP packets from the time server to the end devices is not defined. The definition of the priorities on the

	Ethernet CCS consist network is an integral part of the communication defined in SUBSET-147 in order to ensure the expected quality of service. • The time service defined by the current version v1.0.0 of the SUBSET-147 is not supporting network time security. IEEE 802.1X:2004 as defined in SS-147 layer 2 is not sufficient to secure the time synchronization. *86400* **Error Correction Location Service** • The data provided by the location service defined in the current version 1.0.0 of the SUBSET-147 is not specified in sufficient details (exactly defined variables and their format, missing coordination system, missing variables etc.) for a FFFIS and for implementation. As a consequence, e.g. the format used by the OMS in SUBSET-149 cannot be harmonized. • After having once a steady GNSS reception after startup, the location and velocity information shall be available even in areas without GNSS reception (e.g. tunnels, stations etc.). For this function of “dead reckoning”, additional sensors (e.g. accelerometer, gyroscope, counting of external wheel tick pulses) to the GNSS receiver are needed. The additional sensors are available directly integrated in a state-of-the-art (standard) GNSS module.