OCORA

Open CCS On-board Reference Architecture

Gap Analysis – OCORA and UNISIG SUBSET-119
Gamma Release

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0.08	Final Review Session with SNCF, NS and SBB	FF/JL/JH/MM	2020-12-07
1.00	Ready for Gamma release	BJ	2020-12-07

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References

Reader's note: please be aware that the numbers in square brackets, e.g. [1], as per the list of referenced documents below, is used throughout this document to indicate the references.

The following references are used in this document:

[1] UNISIG SUBSET-119 – v. 1.0.15

[2] SUBSET-034 – v. 3.2.0

1 Introduction

1.1 Disclaimer

The following disclaimers apply to this document:

- This specification and referred models are following state of the art engineering rules, best practice and proofed implementation work.
- Some possible improvements are already identified and the specification and models will be optimized and maintained by feedback from experts, implementation and application within the future release phases and process defined by OCORA as published on https://github.com/OCORA-Public/Publication.
- The technical solutions developed by OCORA must not favour any particular product or supplier. Technical solutions shall allow a variety of products and methods/processes.
- This analysis is based on the actual OCORA knowledge base. Since UNISIG is preparing a revision of version of the SUBSET-119 [1], to be published about the same time as this OCORA gamma release document, and important empirical information is expected to be generated by ongoing retrofit projects, a revision of this document will be prepared for the OCORA Delta release.

1.2 Scope and purpose of the document

This document aims at identifying the gaps between the UNISIG SUBSET-119 and the OCORA SUBSET-119 Proposal. It addresses the following points:

- The ETCS - TCMS interface is subject to a standardization effort, resulting in the definition of SUBSET-119 [1] and SUBSET-034 [2] .
- From the OCORA community point of view the current status of the SUBSET-119 [1] and SUBSET-034 [2] are not sufficient to meet the OCORA requirements regarding standardisation.
- The term ‘standardised specification’ will be defined in paragraph 2.
- This gap analysis is based on the expected standard interface as defined in paragraph 2.

2 Definition of a standard ETCS – TCMS interface

The interface specification must define an unambiguous, complete, and functionally correct data set and data formats, including the tools to validate and verify their unambiguousness, completeness, and correctness. It also must include the HW level interface specification.

The specific implementation should be verified by that ETCS on-board – to vehicle (TCMS) specification.

This interface specification has been developed to ensure a deterministic functional behaviour of the ETCS on-board system as part of the vehicle and to enable Plug & Play exchangeability of the ETCS on-board system without affecting the integrity of the vehicle (consider like-for-like spare part replacement).

The understanding of 'Plug & Play' is to enable exchanging the ETCS on-board system as a whole or of its core constituents as a separate part of the vehicle without (1) the requirement of specific engineering or (2) the need for renewed approval of the vehicle, (3) vehicle functions or (4) ETCS on-board functions that do not need to be exchanged. In case of issue (4), this is not restricted to the ETCS to TCMS interface but involves defining the interfaces between these ETCS on-board functions and the core ETCS on-board function.

Plug & Play exchangeability of the ETCS on-board system in the rail vehicle shall be accomplished in a stepwise approach. In the current situation both the ETCS on-board as well as the vehicle consist of multiple proprietary solutions. Safe integration of proprietary ETCS on-board systems in proprietary vehicle architectures require project specific development of communication protocols. See figure 1 below.

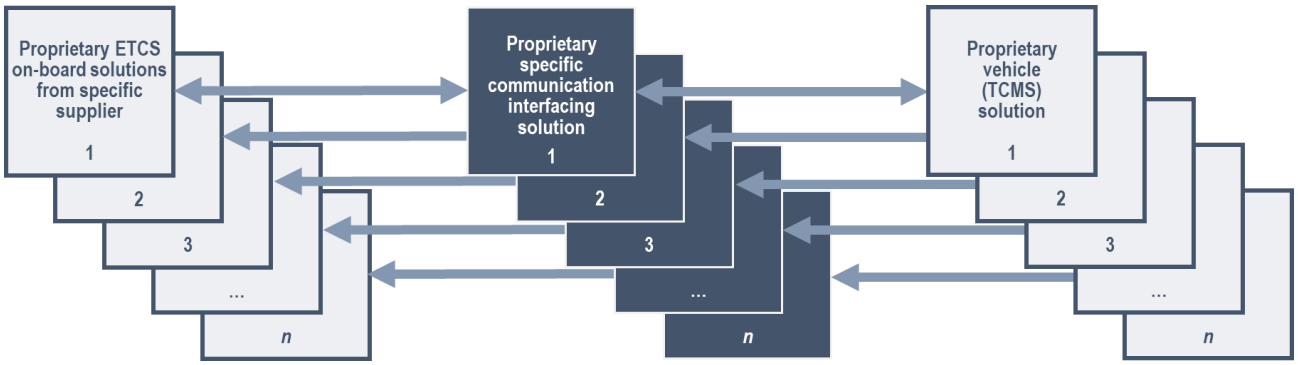

Figure 1 Today proprietary solution

Harmonization (In the process of OCORA we will address the requirements for harmonization of the interfaces) of SS119 [1] shall support Plug & Play exchangeability for the ETCS on-board system in case of rolling stock retrofit by harmonizing the data exchange. In this situation, alignment of harmonized ETCS on-board data with multiple proprietary vehicle (TCMS) products remains necessary. Solutions have to be discussed with and can be engineered by vehicle suppliers. See figure 2 below.

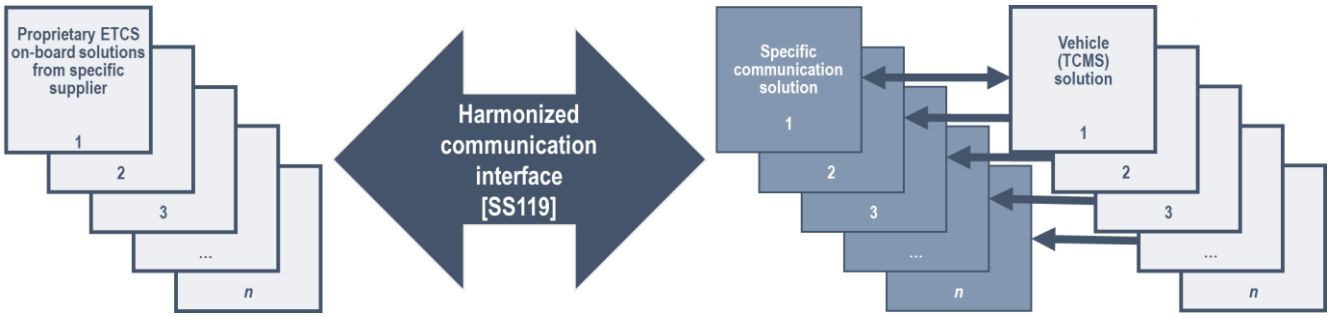

Figure 2 Standardized solution for retrofit

For newly built rolling stock, a harmonised data protocol supporting Plug & Play interfacing between ETCS on-board system and vehicle according to SUBSET-119 [1] will be available to be included in tender requirements, that are to be applied at the discretion of the supplier. For the concept see Figure 3. The ongoing development of a generic communication bus network will further support the technological foundation a for harmonised data exchange between the vehicle and the ETCS domain. In the long run the ETCS on-board solution can be simplified, e.g. the requirement for hardwire connection will be reduced. Also, an evolution from proprietary to generic ETCS on-board and vehicle solutions is foreseen. See figure 3 below.

Figure 3 Standardized solution for new vehicle

3 Gap analysis of OCORA and UNISIG SS119 specifications

This section will provide a brief description of the gaps identified between the OCORA and the UNISIG SS119 [1] requirement specifications and an indication of the expected impact.

This analysis is based on the actual OCORA knowledge base. Since UNISIG is preparing a revision of version the SUBSET-119 [1], to be published about the same time as this OCORA gamma release document, and important empirical information is expected to be generated by ongoing retrofit projects, a revision of this document will be prepared for the OCORA Delta release.

In general, OCORA appreciates the work done by UNISIG so far as it provides a solid base for a joint effort to establish a final version that can be supported by the entire railway community.

Nevertheless, OCORA identified some limitations in the UNISIG proposal. These are globally indicated below and further elaborated in the Appendix of this discussion document.

OCORA proposes to jointly align the OCORA and UNISIG versions, e.g. in a LinX4Rail alignment workshop.

3.1 No application layer identifiable

3.1.1 Description

The interface description does not adhere to an OSI compliant layered approach.

There is no application layer interface for the ETCS on-board.

3.1.2 Impact

The boundary between ETCS on-board and TCMS is not clear and no standardisation as described in paragraph 2 is feasible.

Additional costs and efforts because plug and play exchangeability of the ETCS on-board system remains impossible and any solution will be proprietary (vendor-lock).

3.2 Inconsistencies between SS026-7 and UNISIG SS 119

3.2.1 Description

The OCORA version is fully compliant with SUBSET-026-7. The UNISIG representation of track conditions, however, is not consistent with SUBSET-026-7 definitions. (example change of SUBSET-026 QSCALE/D_ /L_ approach to a fixed scale ENTRY/EXIT representation). This leads to problems of aligning SS026-7 and SS119 [1] requirements.

This is equally true for platform information, change of traction system and others. Where the telegram contents are well described by UNISIG and also a lot of effort was put into explaining variables and procedures, the specification does not completely cover the necessary definition of functional aspects (e.g. how to cope with the list of track conditions that must be maintained by the interface in case of a change of train reference).

The on-board ETCS should transmit the track condition information to the TCMS, but without evaluating/processing and without executing commands. The traction management, the passenger door management, and other should be in the responsibility of the TCMS and not the on-board CCS.

Today's implementations of on-board ETCS manage traction system track conditions: e.g. the on-board ETCS manages the commands of the pantographs, considering the position of the pantographs and the delay for lowering them. That implies a lot of parametrization of the on-board ETCS for each vehicle.

Proposal: EVC should receive the track conditions from Eurobalise or RBC, transmit the data and position to the TCMS. The TCMS ensures the treatment and control-command depending on its own characteristics.

3.2.2 Impact

Risk of inconsistent/or incompatible implementations is not mitigated and the standardisation as described in paragraph 2 remains problematic. This will also increase the effort for parametrization of the ETCS on-board EVC for track conditions.

Additional costs and efforts for alignment of exchanged parameters.

3.3 Data missing or provenance uncertain

3.3.1 Description

The empirically proven implementation defines data to be exchanged with the TCMS that are not described in UNISIG version of the SUBSET-119 [1]. For example, there is no data exchange defined for e.g. the train position and odometry data. Furthermore, in some vendor specific implementations, train data is exchanged at the interface for which is not described in SUBSET-119 [1]. These are missing in the UNISIG SUBSET-119 [1] but nevertheless in practice applied by UNISIG partners. This needs to be clarified.

3.3.2 Impact

The boundary between ETCS on-board and TCMS is not clear and not standardised in conformity with paragraph 2.

Additional costs and efforts because project specific solutions has to be developed and engineered.

3.4 Data for functional testing and test cases are missing

3.4.1 Description

As the ETCS – TCMS interface is an important standard interface between vehicle and the ETCS on-board system (see paragraph 2), the possibility of functional testing within a specific project is necessary from an RU point of view. In principle the project specific interface specifications shall be verified and validated for correctness by means of functional tests within a real environment, before these are used in the specific project. If this is not done, the correctness of the project specific interface specifications has to be proven for the project specific implementations, and it has to be repeated for each further implementation based on it. Functional testing of the interface as part of development life cycle of the project specific specification implies that the ETCS - TCMS interface specification, as defined in the UNISIG SUBSET-119 [1], is consistently correctly implemented.

3.4.2 Impact

Lack of tested reference interface specifications that include all different functions, originated from different projects and vehicle types, causes the functional correctness of such interfaces to be demonstrated in each specific projects and implementations. This implies:

Repeated investment, planning and performance risks for the customer, since the life cycle of rolling stock overruns the life cycle of the ETCS on-board system, potentially involving multiple ETCS on-board replacement projects per rolling stock type, depending on the residual life cycle of the rolling stock.

A complete description of the ETCS on-board system functionality, including the needed data and the expected behaviour, at least at the level of the application layer (see Appendix A) including test cases and the expected behaviour and success criteria, needs to be developed for each and every implementation to enable functional testing.

Preferably this testing is mutually agreed between TCMS and ETCS on-board suppliers and OCORA. As a result, the parties have a reference to test and can develop the interface based on it (independently). It may also serve as reference in case of integration problems. For that, it is also important that the completeness (full coverage) of the test is ensured.

Appendix A: Examples for findings

Missing application layer

The SUBSET-119 [1] specification is mixing descriptions of how the hard- wired interface shall be implemented for various TCMS configurations (chapter 4), coding (chapter 5) and implicit functional specifications.

As several aspects (configuration of hardwired interfaces, serial architecture, data models (see chapter 'Inconsistencies between SS026-7 and UNISIG SS119´) are intertwined, the specification amounts to a description of how to create a vehicle-specific ETCS on-board to TCMS interface. There is no way to have Plug & Play interchangeability between different ETCS OBUs.

What is required is an interface that abstracts all vehicle specifics, so that only application data need to be considered on the ETCS side. At least a full Plug & Play solution through all OSI- layer is required.

Inconsistencies between SS026-7 and UNISIG SS119

See the table below

Data	SUBSET-119	SUBSET-026-7	Analysis	Recommendation
Start Location of Track Condition	D_ENTRY ***(SUBSET-119 [1] Table 5.21)***	Q_SCALE ***(SUBSET-026 §7.5.1.129)*** D_TRACKCOND ***(SUBSET-026 §7.5.1.77)*** ***The variables Q_SCALE and D_TRACKCOND in combination define the End Location of Track Condition,***	Instead of Q_SCALE and D_TRACKCOND, a D_ENTRY (distance to the beginning of the track condition) on a fixed scale of 1m resolution shall be sent to the TCMS. What shall happen if Q_SCALE and D_TRACKCOND lead to a value of D_ENTRY that is one of the special values: 7FFFh (the value to be transmitted is higher than the highest value of the transmittable range. This special value is a flag indicating that the remaining distance value to be transmitted is higher than the max value of the range, i.e. > 32766 m.) or 8001h (The value to be transmitted is lower than the lowest value of the transmittable range. This special value is a flag indicating that the remaining distance value to be transmitted is lower than the min value of the range, i.e. < -32766 m)? In this case, the list has to store the original scaled values, but transmit the values according to SUBSET-119 [1] Table 5.2.1 in order to avoid loss of information.	1. Define an application layer interface that corresponds to the definition of SUBSET-026 2. If the D_ENTRY notation is absolutely desired on the TCMS interface, provide clear specification for translation.

Data	SUBSET-119	SUBSET-026-7	Analysis	Recommendation
			This is described nowhere. It is easy to imagine several technical approaches that provide a correct implementation.	
End Location of Track Condition	D_EXIT ***(SUBSET-119 [1] Table 5.22)***	Q_SCALE ***(SUBSET-026 §7.5.1.129)*** D_TRACKCOND ***(SUBSET-026 §7.5.1.77)*** L_TRACKCOND ***(SUBSET-026 §7.5.1.55)*** ***The variables Q_SCALE, D_TRACKCOND and L_TRACKCOND in combination define the End Location of Track Condition,***	Instead of Q_SCALE and D_TRACKCOND, a D_EXIT (distance to the beginning of the track condition) on a fixed scale of 1m resolution shall be sent to the TCMS. What shall happen if Q_SCALE and D_TRACKCOND and L_TRACKCOND lead to a value of D_EXIT that is one of the special values: 7FFFh (the value to be transmitted is higher than the highest value of the transmittable range. This special value is a flag indicating that the remaining distance value to be transmitted is higher than the max value of the range, i.e. > 32766 m.) or 8001h (The value to be transmitted is lower than the lowest value of the transmittable range. This special value is a flag indicating that the remaining distance value to be transmitted is lower than the min value of the range, i.e. < -32766 m)? In this case, the list has to store the original scaled values, but transmit the values according to SUBSET-119 [1] Table 5.2.2 in order to avoid loss of information. This is described nowhere. It is easy to imagine several technical approaches that provide a correct implementation.	1. Define an application layer interface that corresponds to the definition of SUBSET-026 2. If the D_ENTRY notation is absolutely desired on the TCMS interface, provide clear specification for translation.
Track Condition Encoding	OB _TR_TC_TYPE ***(SUBSET-119 [1] § 4.3.5.5)***	M_TRACKCOND (SUBSET-026 §7.5.1.77)	The low- level coding of the track conditions has been changed. Also, the allocation of some of the track	1. Provide an application layer interface 2. Ensure completeness and consistency

<table>
<tr><th>Data</th><th>SUBSET-119</th><th>SUBSET-026-7</th><th>Analysis</th><th>Recommendation</th></tr>
<tr><td></td><td><table>
<tr><td>0x00</td><td>Regenerative Brake Inhibition</td></tr>
<tr><td>0x01</td><td>Magnetic Shoe Brake Inhibition</td></tr>
<tr><td>0x02</td><td>Eddy Current Brake for SB Inhibition</td></tr>
<tr><td>0x03</td><td>Eddy Current Brake for EB Inhibition</td></tr>
<tr><td>0x04</td><td>Air Tightness Section</td></tr>
<tr><td>0x05</td><td>Powerless Section with Pantograph to be Lowered</td></tr>
<tr><td>0x06</td><td>Powerless Section with Main Power switch to be Switched Off</td></tr>
<tr><td>0x07-0xFF</td><td>Spare values</td></tr>
</table></td><td><table>
<tr><td>0000</td><td>Non stopping area</td></tr>
<tr><td>0001</td><td>Tunnel stopping area</td></tr>
<tr><td>0010</td><td>Sound horn</td></tr>
<tr><td>0011</td><td>Powerless section – lower pantograph</td></tr>
<tr><td>0100</td><td>Radio hole</td></tr>
<tr><td>0101</td><td>Air tightness</td></tr>
<tr><td>0110</td><td>Switch off regenerative brake</td></tr>
<tr><td>0111</td><td>Switch off eddy current brake for service brake</td></tr>
<tr><td>1000</td><td>Switch off magnetic shoe brake</td></tr>
<tr><td>1010</td><td>Powerless section – switch off the main power switch</td></tr>
<tr><td>1011</td><td>Switch off eddy current brake for emergency brake</td></tr>
<tr><td>1100-1111</td><td>Spare</td></tr>
</table></td><td>conditions has been changed or omitted (for example: sound horn)</td><td>3. Avoid change of coding. Define spare values as far as specific information is irrelevant for the TCMS.</td></tr>
<tr><td>Packet(s) related to Track Conditions</td><td>OBU Telegrams 3-7

(SUBSET-119 [1] §4.3.8-§4.3.12)

Variables for Generic Telegram Structure
In particular: 4.3.5.3
OB _TR_TC_ID1 – OB _TR_TC_ID20</td><td>Packet 68 Track Condition

(SUBSET-026 §7.4.2.20)</td><td>A relatively sophisticated data structure for transmitting track condition data telegrams to the TCMS is provided.

Implementation will require design decisions that with a high propability will lead to incompatible solutions.

There is no precise specification on how to assign the “Track Condition IDs”.

Formal analysis of the specification has shown that in order to implement the described functionality, several design decisions have to be taken by the vendor. The probability that this leads to compatible Plug & Play solutions is limited.

An example for this finding is the various possible ways how to handle the list of track conditions.

What shall happen if Q_SCALE and D_TRACKCOND lead to a value of D_ENTRY or</td><td>1. Provide an application layer
2. Provide complete and unambiguous specification list for maintenance
3. See also next section, for “Track description deletion information”</td></tr>
</table>

Data	SUBSET-119	SUBSET-026-7	Analysis	Recommendation
			D_EXIT that is one of the special values: 7FFFh (The value to be transmitted is higher than the highest value of the transmittable range. This special value is a flag indicating that the remaining distance value to be transmitted is higher than the max value of the range, i.e. > 32766 m.) or 8001h (the value to be transmitted is lower than the lowest value of the transmittable range. This special value is a flag indicating that the remaining distance value to be transmitted is lower than the min value of the range, i.e. < -32766 m)? In this case, the list has to store the original scaled values, but transmit the values according to SUBSET-119 [1] table 5.2.1 in order to avoid loss of information. This is described nowhere. It is easy to imagine several incompatible technical approaches that provide a correct implementation with relation to SUBSET-119 [1]. Moreover, there is no description of when/ how a given track condition description shall be deleted/ its transmission stopped.	

Data missing or provenance uncertain

Some TCMS systems require information which is not specified in the SUBSET-119 [1]. The ETCS / TCMS interface of the reference system provides, for example, means to send the following packets:

Data	SUBSET-119	DB reference implementation	Analysis	Recommendation
Odometry Data	Non existent	OBU Packet 2[i]	The TCMS of some vehicles requires this information, as it calculates some data based on train position.	Add to interface (using application layer architecture)
Gradients	Non existent	OBU Packet 14[ii]	The braking system of some Vehicles or Locomotives require gradient information for brake control	Add to interface (using application layer architecture)
Track description deletion information	Non existent	OBU Packet 11[iii]	SUBSET-119 [1] provides no specification of how to make sure that expired track description is only transmitted as long as required	Totally rework the track description information handling
Train information	Non existent	OBU Packet 9[iv]	Some EMUs require this information in order to streamline the start of mission process (in the Start of Mission procedure, the correct train data is then already present and needs only to be acknowledged by the driver on the TCMS and GSM-R radio DMIs	Add to interface (using application layer architecture)
Inputs from train devices	Non existent	TIU Packet 0[v]	Some ETCS OBUs need sensor information	Add to interface (using application layer architecture)
Plain text message	Non existent	TIU Packet 1[vi]	TCMS needs to display information on DMI (empirically proven implementation)	Add to interface (using application layer architecture)
Fixed text message	Non existent	TIU Packet 2[vii]	TCMS needs to display information on DMI (empirically proven implementation)	Add to interface (using application layer architecture)
Braking model	Non existent	TIU Packet 3[viii]	The braking model from the TCMS as input to the ETCS on-board system. This way the ETCS on-board system remains generic. Note: These are parameters regarding braking and traction.	Add to interface (using application layer architecture)
Test and failure detection	Non existent	TIU Packet 6[ix]	Standardization required to allow failure state information. Now each TCMS/ EVC integration uses custom format.	Add to interface (using application layer architecture)
Diagnostic	Non existent	TIU Packet 12[x]	Standardization required now each TCMS/ EVC integration uses custom format. To exchange generic diagnostic information for e.g. condition based maintenance.	Add to interface (using application layer architecture)
Data used by applications outside the ERTMS/ETCS system	Non existent	SUBSET-026-7 Packet Number 44[xi]:	Allows for structured integration of system outside of ERTMS/ETCS additional functionality by using package 44.	Add to interface (using application layer architecture)

i Packet number refers to reference system implementation
ii Packet number refers to reference system implementation
iii Packet number refers to reference system implementation
iv Packet number refers to reference system implementation
v Packet number refers to reference system implementation
vi Packet number refers to reference system implementation
vii Packet number refers to reference system implementation

viii Packet number refers to reference system implementation
ix Packet number refers to reference system implementation
x Packet number refers to reference system implementation
xi Packet number refers to ETCS SRS SUBSET-026 Chapter 7