OCORA

Open CCS On-board Reference Architecture

Standard Communication Interface Specification Interface: SCI-TCMS

Interface between CCS on-board and TCMS or Functional Vehicle Adapter

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Revision history

Version	Change Description	Initial	Date of change
1.00	Official version for OCORA Delta Release.	CG	30.06.2021
2.00	Update of the OCORA Release R1: ▪ Update of references. ▪ Modifications to be consistent with the OCORA System Architecture. ▪ Elaboration of chapter 4.1. Official version published in OCORA Release R1.	CG	03.12.2021
3.00	Updated as follows: ▪ Update of references. ▪ Modifications to be consistent with the OCORA System Architecture. ▪ Update of chapter 4.1. ▪ Elaboration of chapter 4.2 ▪ New chapter 4.3 ▪ Elaboration of chapter 5 ▪ Adaptations to new OCORA document template. Version first published in OCORA Release R2.	CG	20.06.2022
4.00	Updated as follows: ▪ Update of references. ▪ Modifications to be consistent with the OCORA System Architecture. ▪ Adaptations of chapter 4.1 and 5 to be consistent with new versions of SUBSET-119. Version first published in OCORA Release R3.	CG	01.12.2022
4.10	Update as follows: ▪ Update of references. ▪ Modifications to be consistent with the OCORA System Architecture. ▪ Adaptations of chapters 3.1, 4.1 and 5 after evolved understanding and to be consistent with new versions of SUBSET-119. Version first published in OCORA Release R4.	CG	03.04.2023
5.10	Update as follows: ▪ Updated definition of different variables in chapter 5. ▪ Editorial corrections. Version first published in OCORA Release R5.	CG	23.11.2023

Table of contents

Table of figures

Table of tables

References

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

[1]   OCORA-BWS01-010 – Release Notes

[2]   OCORA-BWS01-020 – Glossary

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

[4]   OCORA-BWS01-040 – Feedback Form

[5]   OCORA-BWS02-030 – Technical Slide Deck

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

[7]   OCORA-BWS04-010 – Problem Statements

[8]   OCORA-TWS01-030 – System Architecture

[9]   OCORA-TWS04-010 – Functional Vehicle Adapter – Introduction

[10]   EN 50159:2010-09 – Railway applications - Communication, signalling and processing systems - Safety-related communication in transmission systems

[11]   TSI CCS: 02016R0919 - EN - 16.06.2019 - 001.001 - 1: COMMISSION REGULATION (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union, amended by Commission Implementing Regulation (EU) 2019/776 of 16 May 2019 L 139I

[12]   SUBSET-139, ATO over ETCS - ATO-OB / TCMS FFFIS, version 0.0.13

[13]   SUBSET-139, ATO over ETCS - ATO-OB / TCMS FFFIS, version 0.0.22

[14]   SUBSET-139, ATO over ETCS - ATO-OB / TCMS FFFIS, version 0.1.0

[15]   OCORA-40-006-Gamma_CCS-TCMS-Interface-ETCS-Functionality

[16]   SUBSET-026, ERTMS/ETCS System Requirements Specification, version 3.6.0

[17]   SUBSET-034, ERTMS/ETCS – Train Interface FIS, version 3.9.2

[18]   SUBSET-119, ERTMS/ETCS – Train Interface FFFIS, version 3.9.2

[19]   ERA_ERTMS_015560 - ETCS Driver Machine Interface, version 3.6.0

[20]   TSI LOC & PAS, 1302/2014

1 Introduction

1.1 Purpose of the document

The purpose of the document is to specify the standard communication interface of the Functional Vehicle Adapter or TCMS (SCI-TCMS) with the aim to provide to the reader:

- The approach and methodology used for defining the interface between the functional vehicle adapter (or the TCMS) and the CCS on-board applications.

- The functional interface specification between the functional vehicle adapter (or the TCMS) and the CCS on-board applications.

- The definition of the variables used in the interface between the functional vehicle adapter (or the TCMS) and the CCS on-board applications.

- Non-functional requirements associated with the implementation of the interface between the functional vehicle adapter (or the TCMS) and the CCS on-board applications.

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

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

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

1.2 Applicability of the document

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

1.3 Context of the document

This document is published as part of an OCORA Release, together with the documents listed in the Release Notes [1]. Before reading this document, it is recommended to read the Release Notes [1]. If you are interested in the context and the motivation that drives OCORA we recommend to read the Introduction to OCORA [6], and the Problem Statements [7]. The reader should also be aware of the Glossary [2] and the Question and Answers [3].

The interface specification defined in this document is based on the OCORA approach for integrating the CCS on-board with the vehicle by means of a Functional Vehicle Adapter. Therefore, it is suggested to previously read the Functional Vehicle Adapter introduction document [9] that illustrates the context of the Functional Vehicle Adapter itself.

2 Approach and methodology of the interface definition

This chapter describes the approach and methodology for the definition of the interface between the functional vehicle adapter (or TCMS) and the CCS on-board applications. This is the standardized interface between the different CCS on-board applications and the FVA (or TCMS), and that shall be applicable without modification independently from the vehicle type.

The envisaged approach and methodology consist of the following steps:

1. Identify the functions that involve a data exchange between the CCS on-board applications and the vehicle (FVA/TCMS).

2. For each function provide the rationale that triggers the required data exchange. This allows to better asses the details of the transferred data.

3. Based on the functions define the content that needs to be transferred via the interface as variables (including indication of safety relevance, need for confidence interval).

4. For each variable define the details (e.g. data type, value range, unit, cyclic time, refresh time, required freshness, etc.), so that the interface can be described in more detail.

5. Consolidate the different variables that have been defined based on the functions: possibly different functions need the same variable, or the same variable is needed with different resolutions, etc. All variables with the same content that have been identified multiple times shall be consolidated to one variable that is used for all involved functions.

6. Define how the variables shall be grouped in the interface (e.g. packet / telegram containing a specific set of variables). This allows to implement the interface.

3 Functions in the context of CCS on-board applications

This chapter lists the functions for the situations where the CCS on-board applications interact with the vehicle through the Functional Vehicle Adapter (or TCMS). Furthermore, it provides the rationale why each specific interaction is needed.

3.1 Functions in the context ETCS on-board application

The following table lists the functions for the situations where the ETCS on-board application is interacting with the vehicle:

Note: the table includes functions when a national train control (NTC) on-board is integrated with the ETCS on-board as an STM. The situation of an NTC running in the OCORA environment but not being integrated with the ETCS on-board as an STM is not considered reasonable or will have implemented its own integration into the vehicle and is therefore not reflected.

Note: for each specific function not all requirements / conditions from the SUBSETs will be listed in the table. The scope of the table is to identify the functions involving a data exchange between ETCS on-board and the vehicle.

Note: for the list of functions all paragraphs of SUBSET-034 [17] and SUBSET-119 [18] have been considered.

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ETCS on-board application				
F-ETCS-In-01	*Cabin status*	The FVA publishes the status of the vehicle cabin(s) information which indicates if the cabin(s) is / are either active or not active. The status of 1 or 2 cabins needs to be published, depending on the vehicle design. Note: only 1 cabin can be active at a time.	*SS-026: 4.6.3 SS-026: 5.4.4 step 'S0' SS-034: 2.5.1 SS-119: 5.4.1 [18]* *SS-035: 5.2.4.4*	▪ *The cabin status input is used by ETCS on-board for various purposes, for instance as transition condition.* ▪ *The cabin status input is forwarded by ETCS on-board to NTC on-board for various purposes, for instance to start its operation.*

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ETCS on-board application				

F-ETCS-In-02	*Train data information*	The FVA publishes the vehicle values of the following items:
		▪ train category(ies) for cant deficiency
		▪ train length
		▪ traction / brake parameters
		  o traction model
		  o braking model or brake percentage
		  o brake position
		  o on-board correction factors
		  o nominal rotating mass
		▪ maximum train speed
		▪ loading gauge
		▪ axle load category
		▪ traction system(s) accepted by engine
		▪ train fitted with airtight system.
		▪ axle number.
			SS-026:
			3.18.3 / 5.17
			SS-034: 2.6.3
			SS-119: 5.5.1 /
			5.5.4 [18]
				The train data information is an input that enables the ETCS on-board equipment to determine values for any of the indicated train data items. This information is used by the ETCS on-board to adapt the vehicle supervision for the characteristics of the vehicle.

F-ETCS-In-03	*Type of train configuration*	The FVA publishes the type of train configuration variable value which has a project specific meaning.	*SS-034: 2.6.4* *SS-119: 5.5.1.1.1 /* *5.5.1.2 [18]*	*The variable 'type of train configuration' is used as "identifier" input by the ETCS on-board to select the appropriate train data set among the pre-configured project specific list.*
F-ETCS-In-04	*Type of train data entry*	The FVA publishes the type of train data entry information which indicates if the type of data entry is either fixed, or flexible or switchable.	*SS-026: 3.18.3.2* *SS-034: 2.6.1* *SS-119: 5.5.2 [18]*	*The input value indicates the type of train data entry configuration to be applied on the DMI.*
F-ETCS-In-05	*Sleeping*	The FVA publishes a vehicle command to ETCS on-board indicating if the sleeping is either requested or not requested.	*SS-026:* *4.4.6 / 4.6.3* *SS-034: 2.2.1* *SS-119: 5.1.1 [18]*	*The input value "sleeping requested" is used by ETCS on-board as one of the conditions for the transition to sleeping mode.*
F-ETCS-In-06	*Passive shunting*	The FVA publishes a vehicle command to ETCS on-board indicating if the passive shunting is either permitted or not permitted.	*SS-026:* *4.4.20 / 4.6.3* *SS-034: 2.2.2* *SS-119: 5.1.2 [18]*	*The input value "passive shunting permitted" is used by ETCS on-board as one of the conditions for the transition to passive shunting mode.*
F-ETCS-In-07	*Non-leading*	The FVA publishes a vehicle command to ETCS on-board indicating if the non-leading is either permitted or not permitted.	*SS-026:* *4.4.15 / 4.6.3* *SS-034: 2.2.3* *SS-119: 5.1.3 [18]*	*The input value "non-leading permitted" is used by ETCS on-board as one of the conditions for the transition to non-leading mode.*
F-ETCS-In-08	*Brake pressure*	The FVA publishes the value of the vehicle brake pressure which represent either the pressure in the main brake pipe or in the brake cylinder.	*SS-026:* *3.13.2.2.7 / A.3.10* *SS-034: 2.3.2* *SS-119: 5.2.2 [18]*	*The brake pressure input is used by ETCS on-board in the service brake feedback model.*

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ETCS on-board application				
F-ETCS-In-09	*Special brake status*	The FVA publishes the vehicle special brake status information which indicates if the special brake is either active or not active.	*SS-026: 3.13* *SS-034: 2.3.6* *SS-119: 5.2.6 [18]*	*The special brake status input is used by ETCS on-board to adapt the braking curve model for the characteristics of the service brake, the emergency brake, or both, according to the possible configurations of ETCS on-board.*
F-ETCS-In-10	*Additional brake status*	The FVA publishes the additional vehicle brake status information which indicates if the additional brake is either active or not active.	*SS-026: 3.13* *SS-034: 2.3.7* *SS-119: 5.2.7 [18]*	*The additional brake status input is used by ETCS on-board to adapt the braking curve model for the characteristics of the additional brakes which are independent of wheel/rail adhesion.*
F-ETCS-In-11	*Set speed*	The FVA publishes a vehicle command to ETCS on-board indicating if the set speed information is either to be displayed or not to be displayed on the DMI. Furthermore, the FVA publishes the vehicle set speed value information.	*SS-026: 4.7.2* *SS-034: 2.5.5* *SS-119: 5.4.5 [18]*	*The set speed input is used by ETCS on-board only for display of the set speed on the DMI.*
F-ETCS-In-12	*Direction controller*	The FVA publishes the vehicle direction controller information which is given with the three states: forward, neutral, and backward. Indication is relative to the active cabin.	*SS-026:* *3.14.2 / 5.13.1.4* *SS-034: 2.5.2* *SS-119: 5.4.2 [18]* *SS-035: 5.2.4.4*	▪ *The direction controller input is used by ETCS on-board to prevent train movement which conflicts with the current position of the direction controller in the active cab and to detect the driver's intention to reverse, which is one of the conditions for entering reversing mode.* ▪ *The direction controller input is forwarded by ETCS on-board to NTC on-board.*
F-ETCS-In-13	*Train integrity*	The FVA publishes the result of the train integrity supervision which indicates if integrity is confirmed, is unknown, or has been lost.	*SS-026: 3.6.5.2.1* *SS-034: 2.5.3* *SS-119: 5.4.3 [18]*	*Under ETCS Level 3, in case trackside track occupation/vacancy detection is no longer in operation (trackside Train Detection Devices are no longer used), this input is used by ETCS on-board as confirmation of train integrity meaning that the train length, stored as valid train data at the time the train was last known to be integer, can be used for reporting the train position to the trackside, which will allow the latter to safely use the information about the train rear end position.*
F-ETCS-In-14	*National system isolation*	The FVA publishes the national system isolation status information which indicates if the national system is either isolated or not isolated.	*SS-034: 2.8* *SS-119: 5.7 [18]* *SS-035:* *10.3.3.5 / 10.3.3.6 e) / 10.14.1.2*	*The national system isolation input shall be used by the ETCS on-board in case it is interfaced to the national system through an STM and this national system requires isolation of the STM to be implemented.*

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ETCS on-board application				
F-ETCS-In-15	*Traction status for NTC*	The FVA publishes the vehicle traction status information which indicates if the traction is either on or off. Note: based on SS-119 §5.4.4.2.1 "traction off" refers to traction zero or negative (electro-dynamic brake) whereas "traction on" refers when traction is positive.	*SS-034: 2.5.4* *SS-119: 5.4.4 [18]* *SS-035: 5.2.4.4*	*The traction status input is forwarded to NTC on-board that possibly uses it as a feedback loop - NTC on-board can supervise if traction is cut off in case NTC on-board orders traction cut off.* ***Note**: the purpose / rationale has to be further clarified.*
F-ETCS-In-16	*Emergency Brake feedback*	This is the feedback loop which indicates if the Emergency Brake is commanded or not commanded.	*SS-034: 2.3.3* *SS-119: 5.2.3 [18]*	*The Emergency Brake feedback information is used by ETCS on-board to evaluate if Emergency Brake has been applied successfully (diagnostic) and for test purposes.* *The information is directly acquired by means of wired inputs by the ETCS on-board.* ***Note**: the use of this function is explicitly excluded in the FVA context as it is a direct wired connection involved in a SIL4 function.*
F-ETCS-In-17	*Train running number*	The FVA publishes the train running number which indicates the operated train number. Content added in SUBSET-119 version 1.2.7.	*SS-034: 2.7.1* *SS-119: 5.6.1 [18]*	*The published information is used by the ETCS on-board during the start of mission process. Publishing this information from TCMS to the ETCS on-board prevents the driver from having to enter the train running number twice: in the TCMS and in the ETCS on-board.*
F-ETCS-In-18	*Overall consist length information*	The FVA publishes the nominal, minimum and maximum distance values from the end of the engine to the end of the consist (or whole train) for the side of cabin A and the opposite side.	*SS-034: 2.6.2* *SS-119: 5.5.3 [18]*	*The published information is used by the ETCS on-board in supervised manoeuvre mode to calculate the relevant distances when supervising train movements. In this mode the active cabin of the ETCS on-board could be located somewhere in the middle of the train, not exclusively at the front.* *This information is also a prerequisite for delivering a position report with train integrity confirmed.*
F-ETCS-In-19	*Driver ID*	The FVA publishes the driver-ID information which indicates the ID of the driver.		*The information is used by the TCMS for identification of the driver: drive permission, immobilizer, driver's logbook, seat adjustment, etc. The ETCS on-board uses the driver-ID for the purpose of juridical recording. Publishing this information from TCMS to ETCS on-board prevents the driver from having to enter his ID twice: in the TCMS and in the ETCS on-board.*

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ETCS on-board application				
F-ETCS-In-20	*Train condition*	The FVA publishes the condition information which indicates the condition of the train (e.g. updating, running, failure, etc.).		*The train condition information is used by the ETCS on-board to decide how to handle the data received by the FVA (TSMC) and behave accordingly.*
F-ETCS-In-21	*Tilting health status*	The FVA publishes the tilting health status information which indicates if the tilting system is either operational or not operational.		***Note****: the use of this function is explicitly excluded in the OCORA environment as it has been removed in SUBSET-034 and -119. The function has been merged with F-ETCS-In-03 and F-ETCS-In-22.*
F-ETCS-In-22	*Train type*	The FVA publishes the train type information which is an identifier for the type of train related to the actual vehicle. The number of values and their meaning is project specific.		***Note****: the use of this function is explicitly excluded in the OCORA environment as it has been removed in SUBSET-034 and -119. The function has been merged with F-ETCS-In-03 and F-ETCS-In-21.*
F-ETCS-In-23	*Sensor variables*	The FVA publishes the vehicle sensor information for some sensors which indicates the sensor values currently applied within the TCMS.		***Note****: the use of the packet 30 defined in document [15] is explicitly excluded in the OCORA environment as the rationale for its use is missing and the consistent concept needs to be developed before.*
F-ETCS-In-24	*Text messages*	The FVA publishes the vehicle text messages to be displayed on the DMI.		***Note****: the use of the packets 31 and 32 defined in document [15] is explicitly excluded in the OCORA environment as the rationale for its use is missing and the consistent concept needs to be developed before.*
F-ETCS-In-25	*Mathematical braking curve model*	The FVA publishes the mathematical braking curve model information from the vehicle which provides the braking curve for emergency brake and system brake.		***Note****: the use of the packet 33 defined in document [15] is explicitly excluded in the OCORA environment as the involved data is related to a SIL4 function and the rationale for its use is missing. A proper concept needs to be developed before.*
F-ETCS-In-26	*Brake test result*	The FVA publishes the vehicle brake test result information which provides the result of the performed brake tests.		***Note****: the use of the packet 34 defined in document [15] is explicitly excluded in the OCORA environment as the rationale for its use is missing and the consistent concept needs to be developed before.*
F-ETCS-In-27	*Brake reason feedback*	The FVA publishes the vehicle braking reason feedback information which provides the reason for having applied the service or emergency brake.		***Note****: the use of the packet 36 defined in document [15] is explicitly excluded in the OCORA environment as the rationale for its use is missing and the consistent concept needs to be developed before.*

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ETCS on-board application				
F-ETCS-In-28	*Feedback variables*	The FVA publishes the vehicle feedback information for some variables which indicates the values currently applied within the TCMS.		***Note***: *the use of the packet 37 defined in document [15] is explicitly excluded in the OCORA environment as the rationale for its use is missing and the consistent concept needs to be developed before.*

Table 1   Functions in the context of ETCS on-board application: data from FVA (or TCMS) to ETCS on-board

Note: in Table 1 the functions F-ETCS-In-23, F-ETCS-In-24, F-ETCS-In-25, F-ETCS-In-26, F-ETCS-In-27 and F-ETCS-In-28 are listed on purpose. These functions haven not been deleted to have evidence that these functions are not forgotten (for the case where these would have been deleted), but are explicitly excluded.

ID	Title	Description	SUBSET Ref.	Rationale
Output from the ETCS on-board application				
F-ETCS-Out-01	*Emergency brake command*	The FVA receives the ETCS on-board order to the vehicle that the emergency brake is either commanded or not commanded. Originally the order might be triggered by ETCS on-board or NTC on-board. Note: when emergency brake is commanded the ETCS on-board in parallel also orders to cut off the traction.	*SS-026: 3.13.10 / 3.14.1 / 4.4.14 / 4.4.4 / 4.4.5 / 4.4.13 / 5.11 SS-034: 2.3.3 SS-119: 5.2.3 [18] SS-035: 5.2.5*	*Command used by ETCS on-board or NTC on-board to brake the vehicle. Also used to revoke the braking action.* ***Note***: *if the emergency brake is only commanded through hard-wired signals, then the FVA is not involved. This command is only sent if emergency brake through serial connection is configured in ETCS on-board.*
F-ETCS-Out-02	*Traction cut off*	The FVA receives the ETCS on-board order to the vehicle that the traction has either to be cut off or not to be cut off. Originally the order might be triggered by ETCS on-board or NTC on-board.	*SS-026: 3.13.2.2.8 / 5.20 SS-034: 2.4.9 SS-119: 5.3.12 [18] SS-035: 5.2.4.3*	*Command used by ETCS on-board or NTC on-board to brake the vehicle by removing the traction power. Also used to apply again the traction power.*
F-ETCS-Out-03	*Service brake command*	The FVA receives the ETCS on-board order to the vehicle that the service brake is either commanded or not commanded. Originally the order might be triggered by ETCS on-board or NTC on-board. Note: when service brake is commanded the ETCS on-board in parallel also orders to cut off the traction.	*SS-026: 3.13.2.2.7 / 3.13.10 / 3.14.1 SS-034: 2.3.1 SS-119: 5.2.1 [18] SS-035: 5.2.5*	*Command used by ETCS on-board or NTC on-board to brake the vehicle. Also used to revoke the braking action.*

ID	Title	Description	SUBSET Ref.	Rationale
Output from the ETCS on-board application				
F-ETCS-Out-04	*Isolation*	ETCS on-board isolation status information which indicates if the ETCS on-board is either isolated or not isolated. This information is only processed through hard-wired connection. The information is generated by the ETCS on-board isolation device and directly provided to the vehicle (e.g. TCMS).	*SS-026: 4.4.3.1.1* *SS-034: 2.2.4* *SS-119: 5.1.4 [18]*	*The published information might be used by the vehicle to activate specific measures.*
F-ETCS-Out-05	*Remote shunting*	The FVA receives from the ETCS on-board the information if the ETCS on-board itself is in a mode permitting remote shunting or not in a mode permitting remote shunting.	*SS-026: 4.4.8.1.4* *SS-034: 2.2.6* *SS-119: 5.1.6 [18]*	*The published information is used to indicate if ETCS on-board is in a mode permitting remote shunting or not. The vehicle can then allow or inhibit a radio remote control unit to control the train.*
F-ETCS-Out-06	*Change of traction system*	The FVA receives from the ETCS on-board the remaining distance information from the max safe front end of the train to the location where the change of traction system occurs. Furthermore, it receives the identity of the new traction system.	*SS-026: 3.12.1 / 5.20* *SS-034: 2.4.1* *SS-119: 5.3.2 [18]*	*The published information is used by the vehicle to change to the appropriate traction system at the given location.*
F-ETCS-Out-07	*Pantograph to be lowered*	The FVA receives from the ETCS on-board the distance information related to a powerless section with pantograph to be lowered, for instance the remaining distance information from the max safe front end of the train to the location where the powerless section starts.	*SS-026: 3.12.1 / 5.20* *SS-034: 2.4.2* *SS-119: 5.3.3 [18]*	*The published information is used by the vehicle to lower and raise the pantograph at the given locations.*
F-ETCS-Out-08	*Main power switch to be switched off*	The FVA receives from the ETCS on-board the distance information related to a powerless section with main power switch to be switched off, for instance the remaining distance information from the max safe front end of the train to the location where the powerless section starts.	*SS-026: 3.12.1 / 5.20* *SS-034: 2.4.7* *SS-119: 5.3.8 [18]*	*The published information is used by the vehicle to switch off and switch on the main power switch at the given locations.*
F-ETCS-Out-09	*Special brake inhibition area*	The FVA receives from the ETCS on-board the distance information related to a special brake inhibition area, for instance the remaining distance information from the max safe front end of the train to the location where the special brake inhibition area starts.	*SS-026: 3.12.1 / 5.20* *SS-034: 2.3.4* *SS-119: 5.2.4 [18]*	*The published information is used by the vehicle to not operate the different special brake types along the given location information.*
F-ETCS-Out-10	*Air tightness area*	The FVA receives from the ETCS on-board the distance information related to an air tightness area, for instance the remaining distance information from the max safe front end of the train to the location where the air tightness area starts.	*SS-026: 3.12.1 / 5.20* *SS-034: 2.4.4* *SS-119: 5.3.5 [18]*	*The published information is used by the vehicle to activate and release the air tightness at the given locations.*

ID	Title	Description	SUBSET Ref.	Rationale
Output from the ETCS on-board application				
F-ETCS-Out-11	*Station platform*	The FVA receives from the ETCS on-board the distance information related to the station platform, for instance the remaining distance information from the max safe front end of the train to the location where the station platform starts. Furthermore, it receives information about the station platform.	*SS-026: 3.12.1 / 5.20* *SS-034: 2.4.6* *SS-119: 5.3.7 [18]*	*The published information is used by the vehicle to enable passenger doors opening, side permission and opening with or without steps. The evaluation to consider the location.*
F-ETCS-Out-12	*Change of allowed current consumption*	The FVA receives from the ETCS on-board the remaining distance information from the max safe front end of the train to the location where the change of allowed current consumption occurs. Furthermore, it publishes the new allowed current consumption.	*SS-026: 3.12.1 / 5.20* *SS-034: 2.4.10* *SS-119: 5.3.10 [18]*	*The published information is used by the vehicle to respect the new allowed current consumption starting at the given location.*
F-ETCS-Out-13	*NTC pantograph order*	The FVA receives the ETCS on-board redirection about the NTC on-board order to the vehicle that the pantograph has either to be raised or lowered.	*SS-035: 5.2.4.3* *SS-034: 2.4.3* *SS-119: 5.3.4 [18]*	*Command used by NTC on-board to raise or lower the pantograph immediately based on knowledge about track conditions.*
F-ETCS-Out-14	*NTC main power switch order*	The FVA receives the ETCS on-board redirection about the NTC on-board order to the vehicle that the main power switch has either to be opened or closed.	*SS-035: 5.2.4.3* *SS-034: 2.4.8* *SS-119: 5.3.9 [18]*	*Command used by NTC on-board to open or close the main power switch immediately based on knowledge about track conditions.*
F-ETCS-Out-15	*NTC special brake inhibition*	The FVA receives the ETCS on-board redirection about the NTC on-board order to the vehicle that the special brake has either to be inhibited or not inhibited.	*SS-035: 5.2.4.3* *SS-034: 2.3.5* *SS-119: 5.2.5 [18]*	*Command used by NTC on-board to inhibit or allow the different special brake types use based on knowledge about track conditions.*
F-ETCS-Out-16	*NTC air tightness order*	The FVA receives the ETCS on-board redirection about the NTC on-board order to the vehicle that the air tightness flap has either to be opened or closed.	*SS-035: 5.2.4.3* *SS-034: 2.4.5* *SS-119: 5.3.6 [18]*	*Command used by NTC on-board to open or close the air tightness flap based on knowledge about track conditions.*
F-ETCS-Out-17	*Automatic driving*	The FVA receives from the ETCS on-board the information if ETCS on-board is in automatic driving mode or not in automatic driving mode.	*SS-034: 2.2.5* *SS-119: 5.1.5 [18]*	*The published information is used by the TCMS to confirm that commands from 'ATO Vehicle' shall be processed.*
F-ETCS-Out-18	*Engine Orientation in Supervised Manoeuvre*	The FVA receives from the ETCS on-board the information if the engine orientation is the same as the supervised manoeuvre authorisation or is not the same as the supervised manoeuvre authorisation.	*SS-034: 2.4.11* *SS-119: 5.3.11 [18]*	*This function is used in supervised manoeuvre mode. The published information is used by the TCMS to interpret the distance indications for track conditions and correctly perform the indicated actions.*
F-ETCS-Out-19	*Odometry data*	The FVA receives from the ETCS on-board the odometry information.		*The published information is used by the vehicle to consider it in the speed evaluation process and improve the speed accuracy. Furthermore, it may be used to evaluate the exact position for track conditions.*

ID	Title	Description	SUBSET Ref.	Rationale
Output from the ETCS on-board application				
F-ETCS-Out-20	*Track gradients*	The FVA receives from the ETCS on-board the track gradients information.		*The published information is used by the braking and traction systems of the vehicle to optimize the brake and traction control.*
F-ETCS-Out-21	*Packet 44*	The FVA receives from the ETCS on-board the packet 44 information.		*The published information is used by different systems in the vehicle depending on what information the track provides with packet 44.*
F-ETCS-Out-22	*ETCS on-board condition*	The FVA receives from the ETCS on-board the condition information which indicates the condition of the ETCS on-board.		*The published information is used by the vehicle as diagnostic information that is centrally collected (and possibly displayed) for the whole vehicle. The information can then be used for specific operational processes.*
F-ETCS-Out-23	*Driver ID*	No longer used here.		*On purpose no longer used as output in this table. It has been moved as input to ETCS on-board application.*
F-ETCS-Out-24	*Train running number*	No longer used here.		*On purpose no longer used as output in this table. It has been moved as input to ETCS on-board application. This to be in line with SS-119[18].*

Table 2   Functions in the context of ETCS on-board application: data from ETCS on-board to FVA (or TCMS)

3.2   Functions in the context of ATO Vehicle application

The following table shows the functions for the situations where the 'ATO Vehicle' (AV) application is interacting with the vehicle:

Note: the tables are restricted to functions when 'ATO Vehicle' is running with GoA up to 2 (GoA 3 and 4 are excluded).

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ATO vehicle application				
F-ATO-In-01	*Traction ready*	The FVA publishes the traction ready information which indicates if the conditions for applying the traction are either fulfilled or not fulfilled.	*SS-139: 6.3.1.1 row 3 / 7.4.2 offset 11 / A1.1 [14]*	*The published information is used by 'ATO Vehicle' to monitor if traction can be applied. If 'traction ready' is not fulfilled 'ATO Vehicle' will order coasting (no traction).*
F-ATO-In-02	*Dynamic brake usable*	The FVA publishes dynamic brake usable information which indicates if the dynamic brake is available or not available. In case it is available it is also indicated if the conditions for applying the dynamic brake are either fulfilled or not fulfilled.	*SS-139: 6.4.2.1 rows 3 & 4 / 6.4.3.1 row 3 & 4 / 7.4.2 offset 11 / A1.2 / A1.3 [14]*	*Only used for locos in case the 'ATO Vehicle' needs to control each brake individually (including the dynamic brake), for instance in case of cargo operations.*

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ATO vehicle application				
F-ATO-In-03	*Train applicable conditions for engagement*	The FVA publishes the train applicable conditions for engagement information which indicates if the train applicable conditions for engagement are either fulfilled or not fulfilled.	*SS-139: 6.3.1.1 row 4 / 7.4.2 offset 11 [14]*	*The published information is used by 'ATO Vehicle' to monitor if engagement of ATO operation is allowed.* *If engagement is not fulfilled, then 'ATO Vehicle' will disengage.*
F-ATO-In-04	*Traction status*	The FVA publishes the traction status information which indicates if the traction is either applied or not applied.	*SS-139: 6.3.1.1 row 5 / 7.4.2 offset 11 / A1.7 [14]*	*The published information is used by 'ATO Vehicle' to monitor if traction is being applied when requested (feedback signal). It can be used by 'ATO Vehicle' of some suppliers to make a forecast computation.* *.* ***Note***: *the implementation is mandatory on the TCMS side of the interface, but it is optional for 'ATO Vehicle'.*
F-ATO-In-05	*Dynamic brake status*	The FVA publishes the dynamic brake status information which indicates if the dynamic brake is either applied or not applied.	*SS-139: 6.4.2.1 rows 5 / 6.4.3.1 row 5 / 7.4.2 offset 11 / A1.8 [14]*	*Feedback signal only used for locos in case the 'ATO Vehicle' needs to control each brake individually (including the dynamic brake), for instance in case of cargo operations. It can be used by 'ATO Vehicle' of some suppliers to make a forecast computation.* ***Note***: *the implementation is mandatory on the TCMS side of the interface, but it is optional for 'ATO Vehicle'.*
F-ATO-In-06	*Brake status*	The FVA publishes the brake status information which indicates if the brake is either applied or not applied.	*SS-139: 6.4.2.1 rows 6 / 7.4.2 offset 11 / A1.9 [14]*	*Feedback signal only used for locos in case the 'ATO Vehicle' needs to control each brake individually (including the dynamic brake), for instance in case of cargo operations. It can be used by 'ATO Vehicle' of some suppliers to make a forecast computation.* ***Note***: *the implementation is mandatory on the TCMS side of the interface, but it is optional for 'ATO Vehicle'.*
F-ATO-In-07	*Standstill according TSI LOC & PAS*	The FVA publishes the standstill status information (as defined in TSI LOC & PAS) which indicates if the vehicle is either at standstill or not at standstill.	*SS-139: 6.6.1.1 row 18 / 7.4.2 offset 11 [14]*	*The published information is used by 'ATO Vehicle' to automatically command the doors releasing or opening when vehicle is at standstill according to the definition in TSI LOC & PAS.*
F-ATO-In-09	*Emergency brake status*	The FVA publishes the emergency brake status information which indicates if the emergency brake is either released or not released.	*SS-139: 6.4.1.1 row 1 / 7.4.2 offset 12 [14]*	*The published information is used by 'ATO Vehicle' to monitor if emergency brake is released or not. If emergency brake is not released 'ATO Vehicle' shall not be ready for ATO operation (ATO Operational conditions are not fulfilled).*

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ATO vehicle application				
F-ATO-In-11	*Holding brake status*	The FVA publishes the holding brake status information which indicates if the holding brake is either applied or not applied.	*SS-139: 6.4.5.1 row 2 / 7.4.2 offset 12 [14]*	*The published information is used by 'ATO Vehicle' to monitor if holding brake is being applied when requested (feedback signal). If the feedback is not consistent with the order the service brake application is ordered by 'ATO Vehicle'.*
F-ATO-In-13	*Status for traction over brake*	The FVA publishes the status information for traction over brake which indicates if the request is either enabled or not enabled to apply traction even while service brake is applied.	*SS-139: 6.4.1.1 row 2 / 7.4.2 offset 12 [14]*	*The published information is used by 'ATO Vehicle' for multiple purposes, for instance in case of brake cleaning mode or for a hill start (preventing roll-back).*
F-ATO-In-14	*Brake low pressure overcharging*	The FVA publishes the status of the brake low-pressure overcharging function which indicates if it was either applied or not applied. Content added in SUBSET-139 between version 0.0.21 and 0.0.22.	*SS-139 6.4.4.1 row 7 / 7.4.2 offset 12 [14]*	*The published information is used by 'ATO Vehicle' in some countries to detect if the overcharging function is applied.* *According to some national rules is the use of this function is requested in specific situations.* *Information: the low pressure overcharging makes it possible to force the release of one or more boogies that remained tight during the mission or during the brake test, if it works it avoids having to isolate the bogie.*
F-ATO-In-15	*Brake high pressure filling stroke*	The FVA publishes the status of the brake high-pressure filling stroke function which indicates if it was either applied or not applied. Content added in SUBSET-139 between version 0.0.21 and 0.0.22.	*SS-139 6.4.4.1 row 8 / 7.4.2 offset 12 [14]*	*The published information is used by 'ATO Vehicle' to detect which function is used for quick brake release (feedback signal). Also, to estimate the brake releasing time (based on table 3 of SS-125).* *According to some national rules it is forbidden to use the train brake for some time after this function has been applied (excluding emergency situations).*
F-ATO-In-19	*Relative traction or brake set value*	The FVA publishes the degree of traction or brake performance set to the vehicle. Note: in SS-139 this information is transmitted by using one variable. From robustness perspective it is preferable to use two independent variables: one for traction degree and one for brake degree.	*SS-139: 6.3.1.1 row 6 / 7.4.2 offset 0 [14]*	*The published information can be used by 'ATO Vehicle' to monitor if the ordered degree of traction or brake has been properly processed in the vehicle (feedback signal) and as comfort function for smooth transition.* *In these cases, it can be used by 'ATO Vehicle' of some suppliers to make a forecast computation (possibly also from energy saving perspective).* ***Note**: the implementation is mandatory on the TCMS side of the interface, but it is optional for 'ATO Vehicle'.*

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ATO vehicle application				
F-ATO-In-20	*Train brake effect*	The FVA publishes the train brake effect information. Content changed in SUBSET-139 between version 0.0.17 and 0.0.18.	*SS-139: 6.4.4.1 row 4 / 7.4.2 offset 2 [14]*	*Informative signal for train (indirect) brake control, mainly used for locos in case the 'ATO Vehicle' needs to control each brake individually, for instance in case of cargo operations. It indicates the pressure drop in brake pipe as a percentage of maximum pressure drop for full service brake application.*
F-ATO-In-21	*Locomotive brake effect*	The FVA publishes the locomotive brake effect information. Content changed in SUBSET-139 between version 0.0.17 and 0.0.18.	*SS-139: 6.4.4.1 row 5 / 7.4.2 offset 3 [14]*	*Informative signal for locomotive (indirect) brake control, used in case the 'ATO Vehicle' needs to control each brake individually, for instance in case of cargo operations. It indicates the pressure drop in brake pipe as a percentage of maximum pressure drop for full service brake application.*
F-ATO-In-24	*Doors status*	The FVA publishes the doors status.	*SS-139: 6.5.1.1 row 4 / 7.4.2 offset 10 [14]*	*Even though doors status is used as an engagement condition by the TCMS (F-ATO-In-03), the published information is used by 'ATO Vehicle' to display the doors status on the DMI to the driver.* *Furthermore, intention is that by means of this signal the TCMS can impede the engaging, if some conditions are not fulfilled that are not known yet.*
F-ATO-In-25	*Traction / brake lever or generally the brake lever(s) position*	The FVA publishes the traction / brake lever or generally the brake lever(s) position.	*SS-139: 6.6.1.1 rows 10 & 11 / 7.4.2 offset 13 & 14 [14]*	*The published information is used by 'ATO Vehicle' to monitor if the driver is intervening in the control of the train. If position of the lever changes to something different than zero position, then 'ATO Vehicle' should disengage as the driver has made an intervention.*
F-ATO-In-27	*Maximum available tractive force*	The FVA publishes the maximum available tractive force (for the whole train).	*SS-139: 6.6.1.1 row 2 / 7.4.3 offset 4 [14]*	*The published information is used by 'ATO Vehicle' to compute speed profiles: this is the theoretical maximum available tractive force.*
F-ATO-In-28	*Currently available tractive force*	The FVA publishes the maximum tractive force at current speed (for the whole train).	*SS-139: 6.6.1.1 row 4 / 7.4.2 offset 4 [14]*	*The published information is used by 'ATO Vehicle' to compute speed profiles: this is the practical available tractive force based on the current conditions.*
F-ATO-In-29	*Maximum available tractive output power*	The FVA publishes the maximum available tractive output power (for the whole train).	*SS-139: 6.6.1.1 row 3 / 7.4.3 offset 6 [14]*	*The published information is used by 'ATO Vehicle' to compute speed profiles. Power is needed to optimize energy consumption and smooth power peaks.*

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ATO vehicle application				
F-ATO-In-30	*Maximum available dynamic brake force*	The FVA publishes the maximum available dynamic brake force (for the whole train).	*SS-139: 6.6.1.1 row 5 / 7.4.3 offset 8 [14]*	*Mainly used for locos in case the 'ATO Vehicle' needs to control each brake individually (including the dynamic brake), for instance in case of cargo operations. The published information is used by 'ATO Vehicle' to compute speed profiles.* *This is the theoretically maximum available dynamic brake force.*
F-ATO-In-31	*Currently available dynamic brake force*	The FVA publishes the available dynamic brake force at current speed (for the whole train).	*SS-139: 6.6.1.1 row 7 / 7.4.2 offset 6 [14]*	*Mainly used for locos in case the 'ATO Vehicle' needs to control each brake individually (including the dynamic brake), for instance in case of cargo operations. The published information is used by 'ATO Vehicle' to compute speed profiles.* *This is the practically available dynamic brake force based on the current conditions.*
F-ATO-In-32	*Maximum available dynamic brake power*	The FVA publishes the maximum available dynamic brake power (for the whole train).	*SS-139: 6.6.1.1 row 6 / 7.4.3 offset 10 [14]*	*Mainly used for locos in case the 'ATO Vehicle' needs to control each brake individually (including the dynamic brake), for instance in case of cargo operations. The published information is used by 'ATO Vehicle' to compute speed profiles.* *This is the maximum power from regenerative (electrical) brake.*
F-ATO-In-33	*Current train mass*	The FVA publishes the current train mass (for the whole train).	*SS-139: 6.6.1.1 row 9 / 7.4.3 offset 14 [14]*	*The published information is used by 'ATO Vehicle' to compute current speed profile.*
F-ATO-In-34	*Brake position*	The FVA publishes the brake position in the vehicle.	*SS-139: 6.6.1.1 row 12 / 7.4.3 offset 16 [14]*	*The published information is used by 'ATO Vehicle' to compute speed profiles. Mainly used for locos in case the 'ATO Vehicle' needs to control each brake individually, for instance in case of cargo operations.*
F-ATO-In-38	*Cabin status*	The FVA publishes the status of each vehicle cabin information which indicates if each cabin is either active or not active. Content added in SUBSET-139 between version 0.0.18 and 0.0.21.	*SS-139: 6.6.1.1 row 14 / 7.4.3 offset 45 [14]*	*The published information is used by 'ATO Vehicle' to recognise which train direction is forward or backward. Some information (direction, door side, etc.) is given in relation to the active cabin.*
F-ATO-In-40	*Maximum train speed*	The FVA publishes the current maximum train speed respecting all technical constraints of the vehicle. Content added in SUBSET-139 between version 0.0.13 and 0.0.17.	*SS-139: 6.6.1.1 row 1 / 7.4.3 offset 0 [14]*	*The published information is used by 'ATO Vehicle' to compute speed profiles (used as one of the speed limits).*

ID	Title	Description	SUBSET Ref.	Rationale
Input to the ATO vehicle application				
F-ATO-In-41	*Maximum available service brake force*	The FVA publishes the maximum available service brake force (C-type trains only, for the whole train). Content added in SUBSET-139 between version 0.0.13 and 0.0.17.	*SS-139: 6.6.1.1 row 8 / 7.4.3 offset 12 [14]*	*The published information is used by 'ATO Vehicle' to compute speed profiles.*
F-ATO-In-42	*Direction controller position*	The FVA publishes the position of the direction controller. Content added in SUBSET-139 between version 0.0.17 and 0.0.18.	*SS-139: 6.6.1.1 row 17 / 7.4.3 offset 21 [14]*	*The published information is used by 'ATO Vehicle' to recognise in which direction the train moves: forward or backward.*
F-ATO-In-43	*Train brake control specific values*	The FVA publishes the train brake control specific values. Content added in SUBSET-139 between version 0.0.17 and 0.0.18.	*SS-139: 6.4.4.1 row 6 / 7.4.3 offset 17 & 18 & 19 & 20 / A2 [14]*	*The published information is used by 'ATO Vehicle' to know the margins of train brake control and behave accordingly. The margins are defined according to the technical behaviour of train brake.*
F-ATO-In-44	*Slip / slide information*	The FVA publishes the slip / slide information. Content added in SUBSET-139 between version 0.0.18 and 0.0.21.	*SS-139 6.6.1.1 row 13 / 7.4.2 offset 15 [14]*	*The published information is used by 'ATO Vehicle' to react in case of slip or slide by reducing the requested traction or brake force.*
F-ATO-In-45	*Brake force of holding brake*	The FVA publishes the brake force of the holding brake. Content added in SUBSET-139 between version 0.0.21 and 0.0.22.	*SS-139 6.6.1.1 row 15 / 7.4.3 offset 22 [14]*	*The published information is used by 'ATO Vehicle' to decide whether the brake force of the holding brake is sufficient to hold the train at standstill, or if it is required supporting the holding brake by using the train brake (due to steep track gradient).* *The use is especially for heavy freight trains with single locomotive.*
F-ATO-In-46	*Currently available service brake force*	The FVA publishes the maximum available service brake force at current speed (C-type trains only, for the whole train). Content added in SUBSET-139 between version 0.0.21 and 0.0.22.	*SS-139 6.6.1.1 row 16 / 7.4.2 offset 8 [14]*	*The published information is used by 'ATO Vehicle' to compute speed profiles.*
F-ATO-In-47	*Train condition*	The FVA publishes the condition information which indicates the condition of the train (e.g. updating, running, failure, etc.).		*The train condition information is used by the 'ATO Vehicle' to decide how to handle the data received by the FVA (or TCMS) and behave accordingly.*

Table 3   Functions in the context of ATO Vehicle application: data from FVA (or TCMS) to ATO Vehicle

The functions in the following table providing input to the ATO Vehicle application are listed on purpose although no longer used. This to have evidence that these functions are not forgotten (for the case where these would have been deleted) but are explicitly excluded and no longer considered, also no longer considered in SUBSET-139.

ID	Title	Description	SUBSET Ref.	Rationale
Inputs to the ATO Vehicle application that are no longer considered, listed here to have evidence that these functions have not been forgotten.				
F-ATO-In-08	*Standstill according to national rules (door opening permitted)*	The FVA publishes the standstill status information (as defined by national rules) which indicates if the vehicle is either at standstill or not at standstill. Content removed in SUBSET-139 between version 0.0.13 and 0.0.17.	*SS-139 6.2.5.2 / 7.3.4-32 [12]*	*The published information is used by 'ATO Vehicle' to automatically open the doors when vehicle is at standstill according to the definition by the national rules.* ***Note**: the use of this function is explicitly excluded in the OCORA environment as it is project specific.*
F-ATO-In-10	*Service brake status*	The FVA publishes the service brake status information which indicates if the service brake is either applied or not applied. Content removed in SUBSET-139 between version 0.0.17 and 0.0.18.	*SS-139 6.2.4.1 / 7.3.4 [12]*	*The published information is used by 'ATO Vehicle' to monitor if service brake is applied (feedback signal). If service brake is applied 'ATO Vehicle' will order coasting (no traction).* ***Note**: the use of this function is explicitly excluded in the OCORA environment as it does not add any particular benefit.*
F-ATO-In-12	*Direct brake status*	The FVA publishes the direct brake status information which indicates if the direct brake is either applied or not applied. Content removed in SUBSET-139 between version 0.0.17 and 0.0.18.	*SS-139 6.2.4.8 / 7.3.4 [12]*	*Feedback signal mainly used for locos in case the 'ATO Vehicle' needs to control each brake individually (including the direct brake), for instance in case of cargo operations. The published information is used by 'ATO Vehicle' to monitor if direct brake is being applied when requested.* ***Note**: the use of this function is explicitly excluded in the OCORA environment as it does not add any particular benefit.*
F-ATO-In-16	*Actual speed*	The FVA publishes the value of the vehicle speed which is evaluated / used outside of the CCS domain. Content removed in SUBSET-139 between version 0.0.22 and 0.1.0.	*SS-139: 6.5.1.2 row 1 / 7.3.4 offset 8 [13]*	*The published value can optionally be used by 'ATO Vehicle' (if it is of sufficient quality) to compute speed profiles and for train control.* ***Note**: the use of this function is explicitly excluded in the OCORA environment, the 'ATO Vehicle' shall only use the speed information from ETCS on-board.*

ID	Title	Description	SUBSET Ref.	Rationale
Inputs to the ATO Vehicle application that are no longer considered, listed here to have evidence that these functions have not been forgotten.				
F-ATO-In-17	*Actual acceleration*	The FVA publishes the value of the vehicle acceleration which is evaluated / outside of the CCS domain. Content removed in SUBSET-139 between version 0.0.22 and 0.1.0.	*SS-139: 6.5.1.2 row 2 / 7.3.4 offset 12 [13]*	*The published value can optionally be used by 'ATO Vehicle' (if it is of sufficient quality) to compute speed profiles and for train control.* ***Note****: the use of this function is explicitly excluded in the OCORA environment, the 'ATO Vehicle' shall only use the acceleration information from ETCS on-board.*
F-ATO-In-18	*Travelled distance*	The FVA publishes a distance value counter being evaluated outside of the CCS domain. Content removed in SUBSET-139 between version 0.0.22 and 0.1.0.	*SS-139: 6.5.1.2 row 3 / 7.3.4 offset 0 & 4 [13]*	*The published value can optionally be used by 'ATO Vehicle' (if it is of sufficient quality) to compute speed profiles and for train control.* ***Note****: the use of this function is explicitly excluded in the OCORA environment, the 'ATO Vehicle' shall only use the distance information from ETCS on-board.*
F-ATO-In-22	*Brake pipe pressure at brake distributor output*	The FVA publishes the brake pipe pressure at brake distributor output. Content removed in SUBSET-139 between version 0.0.17 and 0.0.18.	*SS-139 6.2.4.8 / 7.3.4 [12]*	*Feedback signal mainly used for locos in case the 'ATO Vehicle' needs to control each brake individually (including the dynamic brake), for instance in case of cargo operations. The published information is used by 'ATO Vehicle' when it controls the brake force splitting and/or brake blending.* ***Note****: the use of this function is explicitly excluded in the OCORA environment as its use has not proven to be practical.*
F-ATO-In-23	*Relative traction / brake request limitation*	The FVA publishes the relative traction / brake request limitation (for the whole train) in percentage. Content removed in SUBSET-139 between version 0.0.17 and 0.0.18.	*SS-139 6.2.7.1 / 7.3.4-22 [12]*	*The published information is used by 'ATO Vehicle' to compute speed profiles.* *The TCMS is in charge of maintaining the current value according to the track condition "allowed current consumption" and others.* ***Note****: the use of this function is explicitly excluded in the OCORA environment as the track condition information shall directly be received by ATO from the ETCS and then processed.*

ID	Title	Description	SUBSET Ref.	Rationale
Inputs to the ATO Vehicle application that are no longer considered, listed here to have evidence that these functions have not been forgotten.				
F-ATO-In-26	*Adhesion factor reduction*	The FVA publishes the reduction of adhesion determined by the vehicle. Content removed in SUBSET-139 between version 0.0.17 and 0.0.18.	*SS-139 6.2.7.1 / 7.3.4 [12]*	*The published information is used by 'ATO Vehicle' to inform the 'ATO trackside' about the determined limitation.* ***Note****: the use of this function is explicitly excluded in the OCORA environment as the track condition information shall directly be received by ATO from the ETCS and then processed.*
F-ATO-In-35	*Current value of wheel diameters*	The FVA publishes the current value of the wheel diameters for the different axles. The FVA publishes the different TCMS speed sensor(s) pulses per km information. Content changed in SUBSET-139 between version 0.0.13 and 0.0.17. Assumption for this function is that the pulse generator speed sensors are directly connected to 'ATO Vehicle' via a wired connection.	*SS-139 6.2.7.1 / 7.3.5 [12]* *SS-139 6.2.7.1 / 7.3.4-16 [12]*	*The published information is used by 'ATO Vehicle' to compute the current speed from raw sensor signals (limited to pulse generation sensors). This if 'ATO Vehicle' does not use an external speed source.* ***Note****: the use of this function is explicitly excluded in the OCORA environment as it is project specific and resource consuming.*
F-ATO-In-36	*Speed sensor(s) status*	The FVA publishes the speed sensor(s) status. Content slightly changed in SUBSET-139 between version 0.0.13 and 0.0.17. Assumption for this function is that the pulse generator speed sensors are directly connected to 'ATO Vehicle' via a wired connection.	*SS-139 7.3.4 [12]* *SS-139 6.2.5.2 / 7.3.3-22 / 7.3.3.1 [12]*	*The published information is used by 'ATO Vehicle' to compute the current speed from raw sensor signals (limited to pulse generation sensors). This if 'ATO Vehicle' does not use an external speed source.* ***Note****: not clear why 'ATO Vehicle' does not make its own sensor status evaluation for the directly connected speed sensors (pulse generator sensors).* ***Note****: the use of this function is explicitly excluded in the OCORA environment as it is project specific and resource consuming.*

ID	Title	Description	SUBSET Ref.	Rationale
Inputs to the ATO Vehicle application that are no longer considered, listed here to have evidence that these functions have not been forgotten.				
F-ATO-In-37	*Time synchronisation*	The FVA provides functionality for time synchronisation between 'ATO Vehicle' and vehicle. *Note: the overall time synchronisation concept needs to be elaborated in OCORA also considering trackside and defining a standardised time master (for the whole vehicle but also considering CCS trackside). A different approach than currently defined in SUBSET-139 would be to introduce a time counter.* Content removed in SUBSET-139 between version 0.0.13 and 0.0.17.	*SS-139 6.2.8 / 7.3.4 [12]*	*Note: the use of this function is explicitly excluded in the OCORA environment as it is project specific.*
F-ATO-In-39	*Raw signals from speed sensors*	The FVA publishes the number of pulses per time as a frequency signal. Content removed in SUBSET-139 between version 0.0.13 and 0.0.17.	*SS-139 7.3.4.1 [12]*	*The published information is used by 'ATO Vehicle' to compute the current speed from raw sensor signals (limited to pulse generation sensors). This if 'ATO Vehicle' does not use an external speed source.* *Note: the use of this function is explicitly excluded in the OCORA environment as it is project specific and resource consuming.*

Table 4   Functions providing input to ATO Vehicle application but explicitly excluded

The functions in the following table are the output from the ATO Vehicle application.

ID	Title	Description	SUBSET Ref.	Rationale
Output from the ATO vehicle application				
F-ATO-Out-01	*ATO status*	The FVA receives from the 'ATO Vehicle' the status information which indicates the status (mode) of the 'ATO Vehicle'.	*SS-139: 6.2.1.1 row 1 / 7.4.1 offset 4 [14]*	*From SUBSET-139: TCMS uses ATO status signal to decide which 'ATO Vehicle' output signals from the list of ATO active functions is valid and will be followed.*
F-ATO-Out-03	*Relative traction or brake request*	The FVA receives the 'ATO vehicle' order to the vehicle to apply a specific degree of traction or brake performance.	*SS-139: 6.3.1.1 row 1 / 6.4.2.1 row 1 / 6.4.3.1 row 1 / 7.4.1 offset 0 [14]*	*The 'ATO Vehicle' needs to drive the vehicle for this it provides a value that is in the range from positive to negative. A positive value indicates traction order, a negative value indicates brake order, a neutral order indicates coasting (no traction, no brake applied).*

ID	Title	Description	SUBSET Ref.	Rationale
Output from the ATO vehicle application				
F-ATO-Out-04	*Train brake request*	The FVA receives the 'ATO vehicle' order to the vehicle to apply a certain brake degree specifically on the train (indirect) air brake.	*SS-139: 6.4.4.1 row 1 / 7.4.1 offset 2 [14]*	*Mainly used in case the 'ATO Vehicle' needs to directly control each brake individually, for instance in case of cargo operations. The command is used by 'ATO Vehicle' to directly control the pneumatic brake on S-type trains.*
F-ATO-Out-05	*Locomotive brake request*	The FVA receives the 'ATO vehicle' order to the vehicle to apply a certain brake degree specifically on the locomotive (direct) air brake.	*SS-139: 6.4.4.1 row 2 / 7.4.1 offset 3 [14]*	*Mainly used for locos in case the 'ATO Vehicle' needs to directly control each brake individually, for instance in case of cargo operations. The command is used by 'ATO Vehicle' to directly control the pneumatic brake on S-type trains.*
F-ATO-Out-06	*Traction request*	The FVA receives the 'ATO Vehicle' order to the vehicle that the traction is either requested or not requested.	*SS-139: 6.3.1.1 row 2 / 7.4.1 offset 5 / A1.4 [14]*	*The exchanged data corresponds to the binary information of the traction / brake lever position that is needed by the TCMS to drive the vehicle.*
F-ATO-Out-07	*Dynamic brake request / Brake request*	The FVA receives the 'ATO Vehicle' order to the vehicle that the dynamic brake is either requested or not requested.	*SS-139: 6.4.2.1 row 2 / 6.4.3.1 row 2 / 7.4.1 offset 5 / A1.5 / A1.6 [14]*	*Mainly used for locos in case the 'ATO Vehicle' needs to directly control each brake individually, for instance in case of cargo operations. The command is used by 'ATO Vehicle' to order the application of the dynamic brake.*
F-ATO-Out-08	*Holding brake request*	The FVA receives the 'ATO Vehicle' order to the vehicle that the holding brake is either requested or not requested.	*SS-139: 6.4.5.1 row 1 / 7.4.1 offset 5 [14]*	*The 'ATO Vehicle' requests to apply the holding brake to ensure that the vehicle is not rolling away after stopping at a station.* *Before departing the holding brake is released.*
F-ATO-Out-09	*Quick brake release request*	The FVA receives the 'ATO Vehicle' order to the vehicle that the quick release of the brake is either requested or not requested.	*SS-139: 6.4.4.1 row 3 / 7.4.1 offset 5 [14]*	*The 'ATO Vehicle' requests to quickly release the brake to quickly be able to depart from a station, usually with long trains. This is mainly applicable to the pneumatic brake.*
F-ATO-Out-10	*Dynamic brake inhibition*	The FVA receives the 'ATO Vehicle' order to the vehicle that the inhibition of the dynamic brake (including brake blending) is either requested or not requested. Content added in SUBSET-139 between version 0.0.21 and 0.0.22.	*SS-139: 6.4.2.1 row 7 / 6.4.3.1 row 6 / 7.4.1 offset 5 [14]*	*The 'ATO Vehicle' requests to inhibit the use of the dynamic brake (including brake blending) to ensure that TCMS does not use the dynamic brake at all.* *In some countries dynamic brake inhibition is requested in some situations like approaching to buffer stop or during brake test.*
F-ATO-Out-11	*Traction over brake request*	The FVA receives the 'ATO Vehicle' order to the vehicle that allowing traction even if service brake is applied is either requested or not requested. Content added in SUBSET-139 between version 0.0.21 and 0.0.22.	*SS-139: 6.4.1.1 row 3 / 7.4.1 offset 5 [14]*	*The 'ATO Vehicle' requests to allow traction even if service brake is applied to inform TCMS that this function is intentionally needed, for instance in case of a hill start managed by ATO.*

ID	Title	Description	SUBSET Ref.	Rationale
Output from the ATO vehicle application				
F-ATO-Out-12	*Doors release request*	The FVA receives the 'ATO Vehicle' order to the vehicle that doors release for individual opening by the passengers is either requested or not requested. Content changed in SUBSET-139 between version 0.0.13 and 0.0.17.	*SS-139: 6.5.1.1 row 1 / 7.4.1 offset 6 & 7 [14]*	*The 'ATO Vehicle' can automatically enable the passengers to open the doors when stopping at a station.*
F-ATO-Out-13	*Doors open request*	The FVA receives the 'ATO Vehicle' order to the vehicle that the doors opening is requested or not requested. Content changed in SUBSET-139 between version 0.0.13 and 0.0.17.	*SS-139: 6.5.1.1 row 2 / 7.4.1 offset 8 & 9 [14]*	*The 'ATO Vehicle' can automatically open the doors when stopping at a station.* ***Note**: the doors commands are supervised by a SIL2 TCMS.*
F-ATO-Out-14	*Doors close request*	The FVA receives the 'ATO Vehicle' order to the vehicle that the doors closing is requested or not requested. Content changed in SUBSET-139 between version 0.0.13 and 0.0.17.	*SS-139: 6.5.1.1 row 3 / 7.4.1 offset 10 & 11 [14]*	*The 'ATO Vehicle' can automatically close the doors before departing from the station.*
F-ATO-Out-15	*'ATO Vehicle' condition*	The FVA receives from the 'ATO Vehicle' the condition information which indicates the condition of the 'ATO Vehicle'.		*The published information is used by the vehicle as diagnostic information that is centrally collected (and possibly displayed to service technician) for the whole vehicle. The information can then be used for specific operational processes.*
F-ATO-Out-16	*Requested traction direction*	The FVA receives the 'ATO Vehicle' order to the vehicle that indicates in which direction traction is requested (zero or forward or backward).		*Note: the information seems to be missing in SUBSET-139 what allows 'ATO Vehicle' to indicate in which direction traction shall be applied. Used for instance in the automated train joining / splitting process.*
F-ATO-Out-17	*Hitch control*	The FVA receives the 'ATO Vehicle' order to the vehicle that indicates if during train splitting / joining procedure the hitch shall be opened or closed.		*Note: according to the Operational Requirements v 1.12 20/08/2020 for ATO GoA2 the automated joining and splitting of a train is foreseen (§ "ATO 5.7 Joining and splitting a train"). However, for the automated train splitting and joining operation it seems that some data exchange is missing in SUBSET-139. This line is listed here as reminder.*
Output from the ATO Vehicle application that is no longer considered, listed here to have evidence that this function has not been forgotten.				

ID	Title	Description	SUBSET Ref.	Rationale
Output from the ATO vehicle application				
F-ATO-Out-02	***ATO behaviour configuration***	The FVA receives from the 'ATO Vehicle' the ATO behaviour configuration information which indicates how the relative traction or brake request shall be interpreted. Content removed in SUBSET-139 between version 0.0.17 and 0.0.18.	*SS-139: 6.2.2.1 / 6.2.3.6 / 6.2.3.7 / 7.3.3 [12]*	*TCMS uses ATO behaviour configuration indication to identify how to interpret the 'ATO Vehicle' output signal for relative traction or brake request - whether the option I or option II is used (see SUBSET-139 for details).* ***Note**: the use of this function is explicitly excluded in the OCORA environment as its use has not proven to be practical.*

Table 5   Functions in the context of ATO Vehicle application: data from ATO Vehicle to FVA (or TCMS)

4 Interface definition per CCS on-board application

4.1 Interface between FVA (or TCMS) and ETCS on-board application

In this section the variables used in the interface between Functional Vehicle Adapter (or TCMS) and the ETCS on-board application are identified: in the system architecture it is indicated with the interfaces SCI-TCMS, SCI-VL.

4.1.1 FVA (or TCMS) to ETCS on-board data

This chapter defines the variables related to each described function from chapter 3.1. More specifically, it allocates to each specific function of chapter 3.1, where the data source is the Functional Vehicle Adapter (or TCMS), the required variables that are used in the interface.

The columns of the table below are as follows:

- Function ID: the reference to the specific item from chapter 3.1.

- Variable Name: the name of the specific variable.

- Description: the description of the specific variable.

- Max. Cycle Time: it defines the maximum allowed time period length to cyclically transmit the specific variable.

- SUBSET Ref.: the reference to the specific SUBSET and chapter where the specific signal / variable is being described. If nothing is being indicated, then no SUBSET handles the specific variable.

- Remarks: additional information to the specific variable.

Function ID	Variable Name	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ETCS-In-01	TR_OBU_CabStatusA	Indication if cab A is active or not active.	100 ms	SS-034: 2.5.1 SS-119: 5.4.1	It is undefined if component 'Vehicle Supervisor' or 'Vehicle Locator' or both are needing this information. See the System Architecture document [8] for details about these components.
	TR_OBU_CabStatusB	Indication if cab B is active or not active.	100 ms		
F-ETCS-In-02	TR_OBU_TrainCatCantDef	Train category for cant deficiency.	200 ms	SS-026 3.18.3.2 SS-119: 5.5.3.2.1	SS-119 defines to evaluate this value either based on "type of train configuration" or by receiving directly the value.
	TR_OBU_TrainLength	Length of the train.	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.3	
	TR_OBU_T_Traction_cut_off (proposal, not defined in SS-119)	Brake parameters: traction model. (value of time delay T_traction_cut_off as per [16] 3.13.2.2.2.1)	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.4.2	In SS-119 the value is determined based on "type of train configuration".
	TR_OBU_T_brake_emergency (proposal, not defined in SS-119)	Brake parameters: brake build up time model value for emergency brake. (T_brake_emergency as per [16] 3.13.2.2.3.2)	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.4.3.1	SS-119 defines alternative proposals to evaluate this value either based on "type of train configuration" and the status of the special brakes or based on "brake position" and "train length".
	TR_OBU_T_brake_service (proposal, not defined in SS-119)	Brake parameters: brake build up time model value for service brake. (T_brake_service as per [16] 3.13.2.2.3.2)	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.4.3.1	SS-119 defines alternative proposals to evaluate this value either based on "type of train configuration" and the status of the special brakes or based on "brake position" and "train length".
	TR_OBU_BrakePercentage	Brake parameters: brake percentage.	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.4.4	
	TR_OBU_BrakePosition1 TR_OBU_BrakePosition1_Not TR_OBU_BrakePosition2 TR_OBU_BrakePosition2_Not	Brake parameters: brake position.	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.4.5	Details are defined in chapter 5.14.
	-	Brake parameters: on-board correction factors. (as described in [16] 3.13.2.2.9)	-	SS-026 3.18.3.2 SS-119 5.5.3.4.1.3 5.5.3.4.1.4	According to SS-119 these values are pre-configured in the ETCS on-board and not exchanged through the interface. Alternative proposal is that the correction factor values could be determined based on "type of train configuration".
	TR_OBU_NomRotMass (proposal, not defined in SS-119)	Brake parameters: nominal rotating mass.	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.4.6	In SS-119 the value is determined based on "type of train configuration".

Function ID	Variable Name	Description	Max. Cycle Time	SUBSET Ref.	Remarks
	TR_OBU_MaxTrainSpeed (proposal, not defined in SS-119)	Maximum train speed.	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.5	In SS-119 the value is determined based on "type of train configuration".
	TR_OBU_LoadingGauge	Loading gauge.	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.6	
	TR_OBU_AxleLoadCat	Axle load category.	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.7	
	TR_OBU_ SupTractionSys	Indication with a list of the supported available traction systems.	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.8	Supported traction systems are indicated based on a pre-configured project specific list containing 31 combinations of NID_CTRACTION and M_VOLTAGE. List is pre-configured in ETCS on-board and TCMS.
	TR_OBU_AirTightFitted	Indication if train is fitted or not fitted with airtight system.	200 ms	SS-026 3.18.3.2 SS-119 5.5.3.9	
	-	List of National Systems available on-board that are connected to ETCS on-board as an STM.	-	SS-026 3.18.3.2 SS-119 5.5.3.1.3	This list is pre-configured in ETCS on-board and TCMS for the specific project.
	- (not applicable, see SS-119)	Axle number.	-	SS-026 3.18.3.2 SS-119 5.5.3.1.3	Value is purely static data that is pre-configured in the ETCS on-board.
F-ETCS-In-03	TR_OBU_TypeTrainConfiguration	Type of train configuration.	200 ms	SS-034: 2.6.2.4 SS-119: 5.5.1.1.1 / 5.5.1.1.7	Some train parameters and their values are adjusted by means of the variable "type of train configuration" based on a project specific list pre-configured in the ETCS on-board and the TCMS. In chapter 5.18 it is defined which parameters can be adjusted by "type of train configuration". It is possible to only adjust a reduced set of the parameters indicated in chapter 5.18.
F-ETCS-In-04	TR_OBU_TypeTrainData_S1	Indication if the data entry designating the 'type of train configuration' is either fixed, flexible or switchable.	200 ms	SS-026: 3.18.3.2 SS-034: 2.6.1 SS-119: 5.5.2	Details are defined in chapter 5.19.
	TR_OBU_TypeTrainData_S2				
F-ETCS-In-05	TR_OBU_TrainSleepReq (proposal, different than SS-119)	Indication if sleeping mode is requested or not requested.	100 ms	SS-026: 4.4.6 / 4.6.3 SS-034: 2.2.1 SS-119: 5.1.1	
	TR_OBU_TrainSleepReq_Not (proposal, different than SS-119)	Antivalent.			
F-ETCS-In-06	TR_OBU_PassiveShunting	Indication if passive shunting mode is permitted or not permitted.	100 ms	SS-026: 4.4.20 / 4.6.3 SS-034: 2.2.2 SS-119: 5.1.2	

Function ID	Variable Name	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ETCS-In-07	TR_OBU_NLEnabled	Indication if non-leading mode is enabled or not enabled.	100 ms	SS-026: 4.4.15 / 4.6.3 SS-034: 2.2.3 SS-119: 5.1.3	
F-ETCS-In-08	TR_OBU_BrakePressure	Indication of the brake pressure.	100 ms	SS-026: 3.13.2.2.7 / A.3.10 SS-034: 2.3.2 SS-119: 5.2.2	The value indicates the pressure in the main brake pipe or in the brake cylinder.
F-ETCS-In-09	TR_OBU_Brake_Status	Indication of the status of the different special brakes showing if each of these brakes is active or not active.	100 ms	SS-026: 3.13 SS-034: 2.3.6 SS-119: 5.2.6	
	TR_OBU_Brake_Performance (proposal, not defined in SS-119)	Indication of the available brake performance for each specific special brake, value given in percentage.	100 ms		100% indicates full braking power available, 0% indicates that no braking power is available. Note: this variable is not defined in SS-119.
F-ETCS-In-10	-	Indication of the status of the different additional brakes showing if each of these brakes is active or not active.	-	SS-026: 3.13 SS-034: 2.3.7 SS-119: 5.2.7	Currently not used as no brakes are known that would qualify for "additional brakes".
F-ETCS-In-11	TR_OBU_SetSpeedDisplay	Command if the set speed information shall be displayed or not displayed.	100 ms	SS-026: 4.7.2 SS-034: 2.5.5 SS-119: 5.4.5	
	TR_OBU_SetSpeedValue	Indication of the set speed value.	100 ms		
F-ETCS-In-12	TR_OBU_DirectionFW	Indication of the vehicle direction controller position with the four states: forward, neutral, backward and invalid.	100 ms	SS-026: 3.14.2 / 5.13.1.4 SS-034: 2.5.2 SS-119: 5.4.2 SS-035: 5.2.4.4	Indication is relative to the active cabin.
	TR_OBU_DirectionBW				
F-ETCS-In-13	TR_OBU_TrainIntegrity_S1 TR_OBU_TrainIntegrity_S1_Not TR_OBU_TrainIntegrity_S2 TR_OBU_TrainIntegrity_S2_Not	Indication of the train integrity with the four states: confirmed, lost, unknown and invalid.	100 ms[1]	SS-026: 3.6.5.2.1 SS-034: 2.5.3 SS-119: 5.4.3	

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[1] In SS-119 version 1.2.4 this value is defined with 200 ms. OCORA has the feeling that this is somehow inconsistent with other variables like 'direction controller position' or 'brake status', especially under ETCS Level 3 in case trackside track occupation/vacancy detection is no longer in operation (trackside Train Detection Devices are no longer used).

Function ID	Variable Name	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ETCS-In-14	TR_OBU_NTCIsolated	Indication of the isolation status of the different installed national systems showing if each of these systems is isolated or not isolated.	100 ms	SS-034: 2.8 SS-119: 5.6 SS-035: 10.3.3.5 / 10.3.3.6 e) / 10.14.1.2	The indication can be provided for up to 16 national systems. The available NTCs is a list that is pre-configured in ETCS on-board and TCMS for the specific project.
F-ETCS-In-15	TR_OBU_Traction_Status	Indication if the train traction is off or on.	100 ms	SS-034: 2.5.4 SS-119: 5.4.4 SS-035: 5.2.4.4	The indication is used by some national systems.
F-ETCS-In-16	-	Feedback indication about emergency brake application.	-	SS-034: 2.3.3 SS-119: 5.2.3	Not used in the context of the FVA. Processed internally in the ETCS on-board.
F-ETCS-In-17	TR_OBU_NID_Operational	Indication of the train running number.	200 ms	SS-034: 2.7.1 SS-119: 5.6.1	This variable has been introduced in SS-119 version 1.2.7.
F-ETCS-In-18	TR_OBU_L_ CONSISTFRONTCABAMAX	Max Consist Length in direction of the active cabin (nominal engine orientation corresponding to the active cabin) and counted from the end of the engine, based on the active cabin.	200 ms	SS-034: 2.6.2 SS-119: 5.5.3	This information is used in supervised manoeuvre mode. In this mode the active cabin of the ETCS on-board could be located somewhere in the middle of the train, not exclusively at the front. This information is also a prerequisite for delivering a position report with train integrity confirmed.
	TR_OBU_L_ CONSISTFRONTCABAMIN	Min Consist Length in direction of the active cabin (nominal engine orientation corresponding to the active cabin) and counted from the end of the engine, based on the active cabin.			
	TR_OBU_L_ CONSISTFRONTENGINENOM	Nominal Consist Length in direction of the active cabin (nominal engine orientation corresponding to the active cabin) and counted from the end of the engine, based on the active cabin.			
	TR_OBU_L_ CONSISTREARCABAMAX	Max Consist Length in opposite direction of the active cabin (nominal engine orientation corresponding to the active cabin) and counted from the end of the engine, based on the active cabin.			

Function ID	Variable Name	Description	Max. Cycle Time	SUBSET Ref.	Remarks
	TR_OBU_L_ CONSISTREARCABAMIN	Min Consist Length in opposite direction of the active cabin (nominal engine orientation corresponding to the active cabin) and counted from the end of the engine, based on the active cabin.			
	TR_OBU_L_ CONSISTREARCABANOM	Nominal Consist Length in opposite direction of the active cabin (nominal engine orientation corresponding to the active cabin) and counted from the end of the engine, based on the active cabin.			
F-ETCS-In-19	TR_OBU_Driver_ID (proposal, not defined in SS-119)	Indication of the driver ID.	200 ms		
F-ETCS-In-20	-	Indication of the train condition.	-		Defined in chapter 4.3.1.
F-ETCS-In-21	-	Indication if tilting system is operational or not operational.	-		No longer used, this variable has explicitly been deleted.
F-ETCS-In-22	-	Train type	-		No longer used, this variable has explicitly been deleted.
F-ETCS-In-23	-	Indications of some sensor values.	-		The use has explicitly been excluded.
F-ETCS-In-24	-	Indication of text messages to be displayed on the DMI.	-		The use has explicitly been excluded.
F-ETCS-In-25	-	Indication of the mathematical braking curve model to be used by ETCS on-board.	-		The use has explicitly been excluded.
F-ETCS-In-26	-	Indication of the results from the brake test.	-		The use has explicitly been excluded.
F-ETCS-In-27	-	Indication of the reason for having applied the brake.	-		The use has explicitly been excluded.
F-ETCS-In-28	-	Indication of the value for some variables used by the TCMS.	-		The use has explicitly been excluded.

Table 6   Allocation of variables to the different functions: FVA (or TCMS) to ETCS on-board application

4.1.2   ETCS on-board to FVA (or TCMS) data

This chapter defines the variables related to each described function from chapter 3.1. More specifically, it allocates to each specific function of chapter 3.1 ,where the data source is the ETCS on-board application, the required variables that are used in the interface.

The columns of the table below are as follows:

- Function ID: the reference to the specific item from chapter 3.1.

- Variable Name: the name of the specific variable.

- Description: the description of the specific variable.

- Max. Cycle Time: it defines the maximum allowed time period length to cyclically transmit the specific variable.

- SUBSET Ref.: the reference to the specific SUBSET and chapter where the specific signal / variable is being described. If nothing is being indicated, then no SUBSET handles the specific variable.

- Remarks: additional information to the specific variable.

Function ID	Variable Name	Description	Max. Cycle Time or Trigger Event	SUBSET Ref.	Remarks
F-ETCS-Out-01	OBU_TR_EB3_Cmd	Command of the emergency brake to the train.	100 ms	SS-026: 3.13.10 / 3.14.1 / 4.4.14 / 4.4.4 / 4.4.5 / 4.4.13 / 5.11 SS-034: 2.3.3 SS-119: 5.2.3 SS-035: 5.2.5	**Note**: if the emergency brake is only commanded through hard-wired signals, then the FVA is not involved. This command is only sent if emergency brake through serial connection is configured in ETCS on-board.
F-ETCS-Out-02	OBU_TR_TCO_Cmd	Command of the traction cut-off to the train.	100 ms	SS-026: 3.13.2.2.8 / 5.20 SS-034: 2.4.9 SS-119: 5.3.11 SS-035: 5.2.4.3	
F-ETCS-Out-03	OBU_TR_ServiceBrake	Command of the service brake to the train.	100 ms	SS-026: 3.13.2.2.7 / 3.13.10 / 3.14.1 SS-034: 2.3.1 SS-119: 5.2.1 SS-035: 5.2.5	
F-ETCS-Out-04	-	Indication of the ETCS on-board isolation.	-	SS-026: 4.4.3.1.1 SS-034: 2.2.4 SS-119: 5.1.4	The use of serial connection has explicitly been excluded, only handled through hard-wired connection.
F-ETCS-Out-05	OBU_TR_RS_Status	Indication if the ETCS on-board is in a mode permitting remote shunting.	100ms	SS-026: 4.4.8.1.4 SS-034: 2.2.6 SS-119: 5.1.6	
F-ETCS-Out-06	OBU_TR_CTS_D_Change	Indication of the remaining distance from the max safe front end of the train to the location of the change of traction system.	100 ms	SS-026: 3.12.1 / 5.20 SS-034: 2.4.1 SS-119: 5.3.2	
	OBU_TR_CTS_NewId	Indication of the country identifier for the new traction system.	100 ms		

Function ID	Variable Name	Description	Max. Cycle Time or Trigger Event	SUBSET Ref.	Remarks
	OBU_TR_CTS_New_Voltage	Indication of the voltage of the new traction system.	100 ms		
F-ETCS-Out-07	OBU_TR_PG_D_Entry	Indication of the remaining distance from the max safe front end of the train to the start location of the powerless section with pantograph to be lowered.	200 ms	SS-026: 3.12.1 / 5.20 SS-034: 2.4.2 SS-119: 5.3.3	
	OBU_TR_PG_D_Exit	Indication of the remaining distance from the min safe front end of the train to the end location of the powerless section with pantograph to be lowered.	200 ms		
F-ETCS-Out-08	OBU_TR_MPS_D_Entry	Indication of the remaining distance from the max safe front end of the train to the start location of the powerless section with main power switch to be switched off.	200 ms	SS-026: 3.12.1 / 5.20 SS-034: 2.4.7 SS-119: 5.3.8	
	OBU_TR_MPS_D_Exit	Indication of the remaining distance from the min safe front end of the train to the end location of the powerless section with main power switch to be switched off.	200 ms		
F-ETCS-Out-09	OBU_TR_RBI_D_Entry	Indication of the remaining distance from the max safe front end of the train to the start location of the regenerative brake inhibition area.	200 ms	SS-026: 3.12.1 / 5.20 SS-034: 2.3.4 SS-119: 5.2.4	
	OBU_TR_RBI_D_Exit	Indication of the remaining distance from the min safe rear end of the train to the end location of the regenerative brake inhibition area.	200 ms		
	OBU_TR_MGI_D_Entry	Indication of the remaining distance from the max safe front end of the train to the start location of the magnetic shoe brake inhibition area.	200 ms		
	OBU_TR_MGI_D_Exit	Indication of the remaining distance from the min safe rear end of the train to the end location of the magnetic shoe brake inhibition area.	200 ms		
	OBU_TR_ECS_D_Entry	Indication of the remaining distance from the max safe front end of the train to the start location of the inhibition area of the eddy current brake for service brake.	200 ms		

Function ID	Variable Name	Description	Max. Cycle Time or Trigger Event	SUBSET Ref.	Remarks
	OBU_TR_ECS_D_Exit	Indication of the remaining distance from the min safe rear end of the train to the end location of the inhibition area of the eddy current brake for service brake.	200 ms		
	OBU_TR_ECE_D_Entry	Indication of the remaining distance from the max safe front end of the train to the start location of the inhibition area of the eddy current brake for emergency brake.	200 ms		
	OBU_TR_ECE_D_Exit	Indication of the remaining distance from the min safe rear end of the train to the end location of the inhibition area of the eddy current brake for emergency brake.	200 ms		
F-ETCS-Out-10	OBU_TR_AT_D_Entry	Indication of the remaining distance from the max safe front end of the train to the start location of the air tightness area.	200 ms	SS-026: 3.12.1 / 5.20 SS-034: 2.4.4 SS-119: 5.3.5	
	OBU_TR_AT_D_Exit	Indication of the remaining distance from the min safe rear end of the train to the end location of the air tightness area	200 ms		
F-ETCS-Out-11	OBU_TR_SP_D_Entry(k)	Indication of the remaining distance from the max safe front end of the train to the start location of the platform (k).	200 ms	SS-026: 3.12.1 / 5.20 SS-034: 2.4.6 SS-119: 5.3.7	Platform information can be provided for up to 5 platforms.
	OBU_TR_SP_D_Exit(k)	Indication of the remaining distance from the min safe front end of the train to the end location of the platform (k).	200 ms		
	OBU_TR_SP_Height(k)	Indication of the height of the platform (k).	200 ms		
	OBU_TR_SP_Right(k)	Indication of the side the platform (k) is on.	200 ms		
	OBU_TR_SP_Left(k)		200 ms		
F-ETCS-Out-12	OBU_TR_ACC_D_Change	Indication of the remaining distance from the max safe front end of the train to the location of change of the allowed current consumption.	100 ms	SS-026: 3.12.1 / 5.20 SS-034: 2.4.10 SS-119: 5.3.10	
	OBU_TR_ACC_Limit	Indication of the new current consumption limitation.	100 ms		

Function ID	Variable Name	Description	Max. Cycle Time or Trigger Event	SUBSET Ref.	Remarks
F-ETCS-Out-13	OBU_TR_PG_Cmd	Command from the national system for the pantograph to be lowered or raised.	100 ms	SS-035: 5.2.4.3 SS-034: 2.4.3 SS-119: 5.3.4	
F-ETCS-Out-14	OBU_TR_MPS_Cmd	Command from the national system for the main power switch to be switched off or not to be switched off.	100 ms	SS-035: 5.2.4.3 SS-034: 2.4.8 SS-119: 5.3.9	
F-ETCS-Out-15	OBU_TR_RBInhibit_Cmd	Command from the national system for the regenerative brake to be inhibited or not to be inhibited.	100 ms	SS-035: 5.2.4.3 SS-034: 2.3.5 SS-119: 5.2.5	
	OBU_TR_MGInhibit_Cmd	Command from the national system for the magnetic shoe brake to be inhibited or not to be inhibited.	100 ms		
	OBU_TR_ECSInhibit_Cmd	Command from the national system for the eddy current brake for service brake to be inhibited or not to be inhibited.	100 ms		
	OBU_TR_ECEInhibit_Cmd	Command from the national system for the eddy current brake for emergency brake to be inhibited or not to be inhibited.	100 ms		
F-ETCS-Out-16	OBU_TR_AT_Cmd	Command from the national system for the air conditioning intake to be opened or closed.	100 ms	SS-035: 5.2.4.3 SS-034: 2.4.5 SS-119: 5.3.6	
F-ETCS-Out-17	OBU_TR_AD_Status	Indication if the ETCS on-board is in automatic driving mode or not in automatic driving mode.	100 ms	SS-034: 2.2.5 SS-119: 5.1.5	This variable has been introduced in SS-119 version 1.2.4.
F-ETCS-Out-18	OBU_TR_EngOrientSM	Indication if the engine orientation is the same as the orientation of the last received supervised manoeuvre authorisation or if the engine orientation is opposite to the orientation of the last received supervised manoeuvre authorisation.	100 ms	SS-034: 2.4.11 SS-119: 5.3.11	This information is only used in supervised manoeuvre mode.
F-ETCS-Out-19	OBU_TR_Speed (proposal, not defined in SS-119)	Indication of the current speed as used by the ETCS on-board.	200 ms	SS-035: 12 SS-058: 7.3.2	The speed indication to be provided in positive and negative values. Positive value indicates that current travel direction relative to the active cabin is forward. Negative value indicates that current travel direction relative to the active cabin is backward.

Function ID	Variable Name	Description	Max. Cycle Time or Trigger Event	SUBSET Ref.	Remarks
	OBU_TR_Speed_ConfMax (proposal, not defined in SS-119)	Indication of the maximum speed based on the current speed confidence interval.	200 ms		
	OBU_TR_Speed_ConfMin (proposal, not defined in SS-119)	Indication of the minimum speed based on the current speed confidence interval.	200 ms		
	OBU_TR_Dist_Counter (proposal, not defined in SS-119)	Indication of a continuously incremented distance counter based on the distance information used by the ETCS on-board.	200 ms		Distance counter information can be used by the vehicle to make specific distance evaluations, for instance for track conditions, but also for specific packet 44 content. The value wraps around when the maximum value is reached.
	OBU_TR_Dist_Counter_Max (proposal, not defined in SS-119)	Indication of a continuously incremented maximum distance counter based on the measured distance confidence interval.	200 ms		This variable is defined as the highest possible position of the vehicle in the vehicle coordinate system.
	OBU_TR_Dist_Counter_Min (proposal, not defined in SS-119)	Indication of a continuously incremented minimum distance counter based on the measured distance confidence interval.	200 ms		This variable is defined as the lowest possible position of the vehicle in the vehicle coordinate system.
F-ETCS-Out-20	N_ITER (proposal, not defined in SS-119)	Indication of the number of iterations for the following gradient information.	200 ms		Indication for the number of iterations (k) that provide the gradient information. Each iteration (k) corresponds to a gradient leg. Defined in chapter 7 of [16].
	OBU_TR_D_Gradient(k) (proposal, not defined in SS-119)	For k = 1: Indication of the remaining distance from the max safe front end of the train to the start location of the gradient profile leg with 'k = 1'. For k > 1: Indication of the incremental distance to next change of gradient (k).	200 ms		Details are defined in chapter 5.5.
	OBU_TR_Q_GDir(k) (proposal, not defined in SS-119)	Indication of the gradient (k) slope describing if it is downhill or uphill.	200 ms		
	OBU_TR_G_A(k) (proposal, not defined in SS-119)	Indication of the absolute value of the engineered gradient (k).	200 ms		

Function ID	Variable Name	Description	Max. Cycle Time or Trigger Event	SUBSET Ref.	Remarks
F-ETCS-Out-21	OBU_TR_P44 (proposal, not defined in SS-119)	Indication of the packet 44 content from a balise telegram.	Whenever a packet 44 with specific NID_XUSER is received. Latency[2] to not be longer than 500 ms.		Only Packets 44 according to a pre-configured list of NID_XUSER shall be forwarded from ETCS on-board to FVA. The list is defined project specific.
F-ETCS-Out-22	-	Indication of the condition of the ETCS on-board system with the severity indication.	-		Defined in chapter 4.3.2.
	-	Indication of the event code as additional information to the condition.	-		
	-	Indication of the EVC hardware version.	-		
	-	Indication of the EVC software version.	-		
	-	Indication of the EVC configuration version.	-		

Table 7   Allocation of variables to the different functions: ETCS on-board application to FVA (or TCMS)

4.2   Interface between FVA (or TCMS) and 'ATO Vehicle' application

In this section the variables used in the interface between Functional Vehicle Adapter (or TCMS) and the 'ATO Vehicle' application are identified: in the system architecture it is indicated with the interface SCI-TCMS.

Note: the interface definition is restricted to functions when 'ATO Vehicle' is running with GoA up to 2 (GoA 3 and 4 are excluded).

4.2.1   FVA (or TCMS) to 'ATO vehicle' data

This chapter defines the variables related to each described function from chapter 3.2. More specifically, it allocates to each specific function of chapter 3.2,where the data source is the Functional Vehicle Adapter (or TCMS), the required variables that are used in the interface.

The columns of the table below are as follows:

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[2] Latency between the time the packet 44 is forwarded by the component reading the balise messages (in SUBSET-026 chapter 2 indicated as BTM) and the time the information is forwarded on the SCI-TCMS to the FVA (or TCMS).

- Function ID: the reference to the specific item from chapter 3.2.

- Variable Name: the name of the specific variable.

- bit: when different signals are aggregated to one variable, this column indicates how the binary data is mapped to the single signal.

- Description: the description of the specific variable.

- Max. Cycle Time: it defines the maximum allowed time period length to cyclically transmit the specific variable.

- SUBSET Ref.: the reference to the specific SUBSET and chapter where the specific signal / variable is being described. If nothing is being indicated, then no SUBSET handles the specific variable.

- Remarks: additional information to the specific variable.

Function ID	Variable Name	bit	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ATO-In-01	Q_RST_SupTB	0	Traction status: all conditions for applying the traction are fulfilled or are not fulfilled.	50 ms	SS-139: 6.3.1.1 row 3 / 7.4.2 *offset 11* / A1.1 [14]	
F-ATO-In-02		1	General indication if dynamic brake is available or is not available.	50 ms	SS-139: 6.4.2.1 row 3 / 6.4.3.1 row 3 / 7.4.2 *offset 11* / A1.2 [14]	
		2	Indication if the dynamic brake is ready (all conditions for applying are fulfilled) or is not ready.	50 ms	SS-139: 6.4.2.1 row 4 / 6.4.3.1 row 4 / 7.4.2 *offset 11* / A1.3 [14]	If dynamic brake is ready, then ATO-OB is allowed to request the dynamic brake.
F-ATO-In-03		3	Train applicable conditions for engagement status: all conditions for engagement are fulfilled or are not fulfilled.	50 ms	SS-139: 6.3.1.1 row 4 / 7.4.2 *offset 11* [14]	
F-ATO-In-04		4	Traction status: the traction is applied or not applied.	50 ms	SS-139: 6.3.1.1 row 5 / 7.4.2 *offset 11* / A1.7 [14]	Note: the implementation is mandatory on the TCMS side of the interface, but it is optional for 'ATO Vehicle'.
F-ATO-In-05		5	Dynamic brake status: the dynamic brake is applied or not applied.	50 ms	SS-139: 6.4.2.1 row 5 / 6.4.3.1 row 5 / 7.4.2 *offset 11* / A1.8 [14]	Note: the implementation is mandatory on the TCMS side of the interface, but it is optional for 'ATO Vehicle'.

Function ID	Variable Name	bit	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ATO-In-06		6	Brake status on C-type trains: the dynamic, pneumatic (service) or blending brake is either applied or not applied.	50 ms	SS-139: 6.4.2.1 row 6 / 7.4.2 *offset 11* / A1.9 [14]	Note: the implementation is mandatory on the TCMS side of the interface, but it is optional for 'ATO Vehicle'.
F-ATO-In-07		7	Status of standstill according TSI LOC & PAS: vehicle is at standstill or vehicle is not at standstill.	50 ms	SS-139: 6.6.1.1 row 18 / 7.4.2 *offset 11* [14]	Standstill is defined in accordance with [20] - 4.2.5.5.2 (5).
F-ATO-In-09		0	Emergency brake released indication: emergency brake is released or is not released.	50 ms	SS-139: 6.4.1.1 row 1 / 7.4.2 *offset 12* [14]	
F-ATO-In-11		1	Holding brake status: holding brake is applied or is not applied.	50 ms	SS-139: 6.4.5.1 row 2 / 7.4.2 *offset 12* [14]	
F-ATO-In-13	Q_RST_BrakeStat	2 & 3	Status for traction over brake: indication of the possibility to request traction even if service brake is applied.	50 ms	SS-139: 6.4.1.1 row 2 / 7.4.2 *offset 12* [14]	
F-ATO-In-14		4	Brake overcharging status: low pressure overcharging is either being applied or not being applied.	50 ms	SS-139: 6.4.4.1 row 7 / 7.4.2 *offset 12* [14]	
F-ATO-In-15		5	Brake filling stroke status: high pressure filling stroke is either being applied or not being applied.	50 ms	SS-139: 6.4.4.1 row 8 / 7.4.2 *offset 12* [14]	
F-ATO-In-16	-		Indication of the actual speed.	-		The use of the TCMS speed has explicitly been excluded.
F-ATO-In-17	-		Indication of the actual acceleration.	-		The use of the TCMS acceleration has explicitly been excluded.
F-ATO-In-18	-		Indication of the travelled distance by means of an odometry counter. Also, indication if distance is unknown.	-		The use of the TCMS distance has explicitly been excluded.
	-		Indication of the timestamp for the travelled distance information by means of a time counter.	-		
F-ATO-In-19	M_RST_TBsetVal		Indication of the relative traction or brake set value.	50 ms	SS-139: 6.3.1.1 row 6 / 7.4.2 *offset 0* [14]	Note: the implementation is mandatory on the TCMS side of the interface, but it is optional for 'ATO Vehicle'.

Function ID	Variable Name	bit	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ATO-In-20	M_RST_TraBrEff		Indication of the train brake effect. Also, indication if it is unknown or not used.	50 ms	SS-139: 6.4.4.1 row 4 / 7.4.2 *offset 2* [14]	
F-ATO-In-21	M_RST_LocoBrEff		Indication of the locomotive brake effect. Also, indication if it is unknown or not used.	50 ms	SS-139: 6.4.4.1 row 5 / 7.4.2 *offset 3* [14]	
F-ATO-In-24	Q_RST_DoorStat	0	Door status: doors control is available or is not available.	50 ms	SS-139: 6.5.1.1 row 4 / 7.4.2 *offset 10* [14]	
		1	Door status: all left doors are closed & locked or are not closed & locked.	50 ms		
		3	Door status: all right doors are closed & locked or are not closed & locked.	50 ms		
F-ATO-In-25	M_RST_TBLpos		Traction / brake lever position status: zero position or tractioning position or braking position. Also, indication if status is unknown.	50 ms	SS-139: 6.6.1.1 row 10 / 7.4.2 *offset 13* [14]	
	M_RST_BLpos		Brake levers status: any of brake levers is out of neutral position or all brake levers are in zero position. Also, indication if status is unknown.	50 ms	SS-139: 6.6.1.1 row 11 / 7.4.2 *offset 14* [14]	
F-ATO-In-27	M_RST_Fmax		Indication of the maximum available tractive force (for the whole train).	500 ms	SS-139: 6.6.1.1 row 2 / 7.4.3 *offset 4* [14]	
F-ATO-In-28	M_RST_FcurAva		Indication of the maximum available tractive force at current speed (for the whole train).	50 ms	SS-139: 6.6.1.1 row 4 / 7.4.2 *offset 4* [14]	
F-ATO-In-29	M_RST_Pmax		Indication of the maximum available tractive output power (for the whole train).	500 ms	SS-139: 6.6.1.1 row 3 / 7.4.3 *offset 6* [14]	
F-ATO-In-30	M_RST_FmaxDB		Indication of the maximum available dynamic brake force (for the whole train).	500 ms	SS-139: 6.6.1.1 row 5 / 7.4.3 *offset 8* [14]	
F-ATO-In-31	M_RST_FcurAvaDB		Indication of the maximum available dynamic brake force at current speed (for the whole train).	50 ms	SS-139: 6.6.1.1 row 7 / 7.4.2 *offset 6* [14]	

Function ID	Variable Name	bit	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ATO-In-32	M_RST_PmaxDB		Indication of the maximum available dynamic brake power (for the whole train).	500 ms	SS-139: 6.6.1.1 row 6 / 7.4.3 *offset 10* [14]	
F-ATO-In-33	M_RST_TrnMass		Indication of the current train mass (for the whole train). Also, indication if it is unknown.	500 ms	SS-139: 6.6.1.1 row 9 / 7.4.3 *offset 14* [14]	
F-ATO-In-34	Q_RST_BrPos	0 to 3	Brake position status: is the position in G or P (for freight train) or P (for passenger train) or R.	500 ms	SS-139: 6.6.1.1 row 12 / 7.4.3 *offset 16* [14]	
		4 to 7	Electronic train brake control unit (EP brake) information: standard UIC brake or EP light brake or EP assist brake or EP direct brake.	500 ms		
F-ATO-In-38	M_RST_21	4	Cabin 1 status information: cabin 1 (or A) is either active or not active.	500 ms	SS-139: 6.6.1.1 row 14 / 7.4.3 *offset 21* [14]	
		5	Cabin 2 status information: cabin 2 (or B) is either active or not active.	500 ms		
F-ATO-In-40	V_RST_Vmax		Indication of the currently possible maximum train speed. Also, indication if it is unknown.	500 ms	SS-139: 6.6.1.1 row 1 / 7.4.3 *offset 0* [14]	
F-ATO-In-41	M_RST_FmaxSB		Indication of the maximum available service brake force (C-type trains only, for the whole train). Also, indication if it is unknown or not used.	500 ms	SS-139: 6.6.1.1 row 8 / 7.4.3 *offset 12* [14]	
F-ATO-In-42	M_RST_DirContr		Direction controller position status: zero position or forward position or backward position. Also, indication if status is unknown.	500 ms	SS-139: 6.6.1.1 row 17 / 7.4.3 *offset 21* [14]	
F-ATO-In-43	M_RST_LastRel		Indication of the last release step. Also, indication if it is not used.	500 ms	SS-139: 6.4.4.1 row 6 / 7.4.3 *offset 17 & 18 & 19 & 20* / A2 [14]	It indicates the minimum value that can be requested by 'ATO Vehicle' when decreasing the brake request from higher brake effect values.
	M_RST_FirstBr		Indication of the first braking step. Also, indication if it is not used.	500 ms		It indicates the minimum value that can be requested by 'ATO Vehicle' for first brake application after brake release.

Function ID	Variable Name	bit	Description	Max. Cycle Time	SUBSET Ref.	Remarks
	M_RST_LastPossBr		Indication of the last possible braking step. Also, indication if it is not used.	500 ms		It indicates the limit of linear behaviour of train brake before full service brake application. This limit is defined to make sure that the pressure in the Brake Cylinder is changed if 'ATO Vehicle' increases the brake request to a higher value. **Note**: it has to be assessed if this variable is really necessary for ATO operation.
	M_RST_MinChang		Indication of the minimum change of train brake request. Also, indication if it is not used.	500 ms		It indicates the minimum step for a brake change request. With a smaller requested change it is not sure that the train brake will react accordingly.
F-ATO-In-44	M_RST_SlipSlide	0	Slip status: the train is either slipping or not slipping.	50 ms	SS-139: 6.6.1.1 row 13 / 7.4.2 *offset 15* [14]	
		1	Slide status: the train is either sliding or not sliding.	50 ms		
F-ATO-In-45	M_RST_BrForceHB		Indication of the available holding brake force.	500 ms	SS-139: 6.6.1.1 row 15 / 7.4.3 *offset 22* [14]	
F-ATO-In-46	M_RST_FcurAvaSB		Indication of the maximum available service brake force at current speed (C-type trains only, for the whole train).	50 ms	SS-139: 6.6.1.1 row 16 / 7.4.2 *offset 8* [14]	
F-ATO-In-47	-		Indication of the FVA train condition.	-		Defined in chapter 4.3.1.

Table 8   Allocation of variables to the different functions: FVA (or TCMS) to 'ATO Vehicle' application

4.2.2   'ATO vehicle' to FVA (or TCMS) data

This chapter defines the variables related to each described function from chapter 3.2. More specifically, it allocates to each specific function of chapter 3.2, where the data source is the 'ATO Vehicle' application, the required variables that are used in the interface.

The columns of the table below are as follows:

- Function ID: the reference to the specific item from chapter 3.2.

- Variable Name: the name of the specific variable.

- bit: when different signals are aggregated to one variable, this column indicates how the binary data is mapped to the single signal.

- Description: the description of the specific variable.

- Max. Cycle Time: it defines the maximum allowed time period length to cyclically transmit the specific variable.

- SUBSET Ref.: the reference to the specific SUBSET and chapter where the specific signal / variable is being described. If nothing is being indicated, then no SUBSET handles the specific variable.

- Remarks: additional information to the specific variable.

Function ID	Variable Name	bit	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ATO-Out-01	M_ATO_State	0 to 7	ATO state: the 'ATO Vehicle' is either in state 'No Power' or 'ATO Configuration' or 'Not Available' or 'ATO Available' or 'ATO Ready' or 'ATO Engaged' or 'ATO Disengaging' or 'ATO Failure'.	50 ms	SS-139: 6.2.1.1 row 1 / 7.4.1 offset 4 [14]	
F-ATO-Out-02	-		ATO behaviour configuration	-		The use has explicitly been excluded.
F-ATO-Out-03	M_ATO_RTBRq		Indication of the relative traction or brake requested by 'ATO Vehicle'.	50 ms	SS-139: 6.3.1.1 row 1 / 6.4.2.1 row 1 / 6.4.3.1 row 1 / 7.4.1 offset 0 [14]	
F-ATO-Out-04	M_ATO_TraBrRq		Indication of the brake request for the dedicated control of train (indirect) air brake.	50 ms	SS-139: 6.4.4.1 row 1 / 7.4.1 offset 2 [14]	The command is used by 'ATO Vehicle' to directly control the pneumatic brake on S-type trains.
F-ATO-Out-05	M_ATO_LocoBrRq		Indication of the brake request for the dedicated control of locomotive (direct) air brake.	50 ms	SS-139: 6.4.4.1 row 2 / 7.4.1 offset 3 [14]	The command is used by 'ATO Vehicle' to directly control the pneumatic brake on S-type trains.
F-ATO-Out-06		0	Traction request control: the traction is either requested or not request.	50 ms	SS-139: 6.3.1.1 row 2 / 7.4.1 offset 5 / A1.4 [14]	Supporting signal requesting to traction when 'ATO Vehicle' intends to traction.
F-ATO-Out-07	Q_ATO_SupTB	1	S-type trains - dynamic brake control: to brake dynamically is either requested or not requested. C-type trains - brake control: to brake is either requested or not requested.	50 ms	SS-139: 6.4.2.1 row 2 / 6.4.3.1 row 2 / 7.4.1 offset 5 / A1.5 / A1.6 [14]	Supporting signal requesting to brake. S-type trains: the command is used by 'ATO Vehicle' when it intends to brake dynamically. C-type trains: the command is used by 'ATO Vehicle' when it intends to brake.

Function ID	Variable Name	bit	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ATO-Out-08		2	Holding brake control: the holding brake is either requested or not requested.	50 ms	SS-139: 6.4.5.1 row 1 / 7.4.1 offset 5 [14]	Supporting signal requesting to apply holding brake when intended by 'ATO Vehicle'.
F-ATO-Out-09		3	Quick brake release control: quick brake release is either requested or not requested.	50 ms	SS-139: 6.4.4.1 row 3 / 7.4.1 offset 5 [14]	Supporting signal requesting to quickly release the brake when intended by 'ATO Vehicle'.
F-ATO-Out-10		4	Dynamic brake inhibition control: inhibition of dynamic brake use (including brake blending) is either requested or not requested.	50 ms	SS-139: 6.4.2.1 row 7 / 6.4.3.1 row 6 / 7.4.1 offset 5 [14]	
F-ATO-Out-11		5	Traction over brake control: allowing traction even if service brake is applied is either requested or not requested.	50 ms	SS-139: 6.4.1.1 row 3 / 7.4.1 offset 5 [14]	'ATO Vehicle' informs TCMS that it intentionally requests to use this function.
F-ATO-Out-12	M_ATO_DooLrel		Left doors release control: to release the left doors for individual opening by passengers is either requested or not requested.	50 ms	SS-139: 6.5.1.1 row 1 / 7.4.1 offset 6 & 7 [14]	
	M_ATO_DoorRrel		Right doors release control: to release the right doors for individual opening by passengers is either requested or not requested.	50 ms		
F-ATO-Out-13	M_ATO_DoorLOp		Left doors open control: to open the left doors is either requested or not requested.	50 ms	SS-139: 6.5.1.1 row 2 / 7.4.1 offset 8 & 9 [14]	
	M_ATO_DoorROp		Right doors open control: to open the right doors is either requested or not requested	50 ms		
F-ATO-Out-14	M_ATO_DoorLCl		Left doors close control: to close the left doors is either requested or not requested.	50 ms	SS-139: 6.5.1.1 row 3 / 7.4.1 offset 10 & 11 [14]	
	M_ATO_DoorRCl		Right doors close control: to close the right doors is either requested or not requested.	50 ms		
F-ATO-Out-16	Q_ATO_TracDir (proposal, not defined in SS-139)		Traction direction control: zero direction or forward direction or backward direction is requested. Also, indication if requested direction is undefined.	50 ms		The undefined direction is used when 'ATO Vehicle' has not evaluated any needed direction, this is different than zero direction.
F-ATO-Out-17	M_ATO_HitchCont (proposal, not defined in SS-139)		Hitch control: the hitch is either to be opened or to be closed. Also, indication if no action is needed.	50 ms		The 'no action' control value is used when ATO has no need to control the hitch.

Table 9   Allocation of variables to the different functions: 'ATO Vehicle' application to FVA (or TCMS)

4.3 Interface between FVA (or TCMS) and 'MDCM-OB' application

In this section the monitoring and diagnostic variables used in the interface between Functional Vehicle Adapter (or TCMS) and the 'MDCM-OB' application are identified: in the system architecture it is indicated with the interface SCI-TCMS.

4.3.1 FVA (or TCMS) to MDCM-OB data

This chapter defines the variables related to some functions described in chapters 3.1 and 3.2. More specifically, it defines for some monitoring and diagnostic functions of the chapters 3.1 and 3.2, where the data source is the Functional Vehicle Adapter (or TCMS), the required variables that are used in the interface.

The columns of the table below are as follows:

- Function ID: the reference to the specific item from chapter 3.1 or 3.2.

- Variable Name: the name of the specific variable.

- Description: the description of the specific variable.

- Max. Cycle Time: it defines the maximum allowed time period length to cyclically transmit the specific variable.

- SUBSET Ref.: the reference to the specific SUBSET and chapter where the specific signal / variable is being described. If nothing is being indicated, then no SUBSET handles the specific variable.

- Remarks: additional information to the specific variable.

Function ID	Variable Name	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ETCS-In-20	TR_OBU_Train_Condition (proposal, not defined in SS-119)	Information of the train condition with the severity indication.	500 ms		Information is only provided for train functions that are relevant to ETCS on-board. Details are indicated in chapter 0.
F-ATO-In-47	Q_RST_Train_Condition (proposal, not defined in SS-139)	Information of the train condition with the severity indication.	500 ms		Information is only provided for train functions that are relevant to 'ATO Vehicle'. Details are indicated in chapter 5.13.

Table 10   Allocation of variables to the different functions: FVA (or TCMS) to MDCM-OB application

This chapter defines the variables related to some functions described in chapters 3.1 and 3.2. More specifically, it defines some monitoring and diagnostic functions of the chapters 3.1 and 3.2, where the data source is the 'MDCM-OB' application, the required variables that are used in the interface.

The columns of the table below are as follows:

- Function ID: the reference to the specific item from chapter 3.1 or 3.2.

- Variable Name: the name of the specific variable.

- Description: the description of the specific variable.

- Max. Cycle Time: it defines the maximum allowed time period length to cyclically transmit the specific variable.

- SUBSET Ref.: the reference to the specific SUBSET and chapter where the specific signal / variable is being described. If nothing is being indicated, then no SUBSET handles the specific variable.

- Remarks: additional information to the specific variable.

Function ID	Variable Name	Description	Max. Cycle Time	SUBSET Ref.	Remarks
F-ETCS-Out-22	OBU_TR_ETCS_Condition (proposal, not defined in SS-119)	Indication of the condition of the ETCS on-board system with the severity indication.	500 ms		Details are indicated in chapter 5.6.
	OBU_TR_Event_Code (proposal, not defined in SS-119)	Indication of the event code as additional information to the condition.	500 ms		Details are indicated in chapter 5.10.
	OBU_TR_ETCS_HW_Version (proposal, not defined in SS-119)	Indication of the EVC hardware version.	500 ms		Details are indicated in chapter 5.8.
	OBU_TR_EVC_SW_Version (proposal, not defined in SS-119)	Indication of the EVC software version.	500 ms		Details are indicated in chapter 5.9.
	OBU_TR_EVC_Cfg_Version (proposal, not defined in SS-119)	Indication of the EVC configuration version.	500 ms		Details are indicated in chapter 5.7.
F-ATO-Out-15	Q_ATO_Condition (proposal, not defined in SS-139)	Indication of the condition of the 'ATO Vehicle' system with the severity indication or the running process.	500 ms		Details are indicated in chapter 5.12.
	M_ATO_Event_Code (proposal, not defined in SS-139)	Indication of the event code as additional information to the condition.	500 ms		Details are indicated in chapter 5.2.

Function ID	Variable Name	Description	Max. Cycle Time	SUBSET Ref.	Remarks
	M_ATO_HW_Version (proposal, not defined in SS-139)	Indication of the 'ATO Vehicle' hardware version.	500 ms		Details are indicated in chapter 5.3.
	M_ATO_SW_Version (proposal, not defined in SS-139)	Indication of the 'ATO Vehicle' software version.	500 ms		Details are indicated in chapter 5.4.
	M_ATO_Cfg_Version (proposal, not defined in SS-139)	Indication of the 'ATO Vehicle' configuration version.	500 ms		Details are indicated in chapter 5.1.

Table 11   Allocation of variables to the different functions: MDCM-OB application to FVA (or TCMS)

5 Definition and description of variables

This chapter describes each single variable used by the Functional Vehicle Adapter in the different interfaces to other applications. The current document version mainly describes new variables that are not yet included in SUBSET-119 and -139, or not described in sufficient precision.

5.1 M_ATO_Cfg_Version

The "ATO Configuration Version" indicates the version of the configuration (file) that is operational in the 'ATO Vehicle' application. The configuration version information exposes the version of the configuration file that is currently being applied by the software of the 'ATO Vehicle'. The configuration file defines all configurable parameters of the 'ATO Vehicle'. The supplier of the equipment must provide the description how his equipment discloses the configuration version by means of this variable. Furthermore, the supplier must document the version of each released configuration file.

The variables "ATO Configuration Version" are composed as follows:

Variable Name	Size	Meaning	
M_ATO_Cfg_Version_1 to M_ATO_Cfg_Version_8	32 bits	0..7	xxx major version Reserved value: 127, if the major version is not used.
		8..15	yyy minor version Reserved value: 127, if the minor version is not used.
		16..23	zzz patch version Reserved value: 127, if the patch version is not used.
		24..31	1 ASCII character Reserved value: "-" (decimal=45, hex=2D), if the ASCII character is not used.

Table 12   Definition for variable "ATO Configuration Version".

The numerical values and the ASCII character of the "ATO Configuration Version" variable can be compiled into the following format: "xxx.yyy.zzz/A".

Example of a compiled 'ATO Vehicle' application configuration version: 3.24.19/C

Note: not all equipment from the different suppliers makes use of a configuration file. In case no configuration file is used, then in all sections the reserved values for 'not used' shall be applied.

5.2 M_ATO_Event_Code

The "ATO Event Code" provides a numerical value that corresponds to an event code for the whole supplied 'ATO Vehicle' system. The meaning of the event code (each value) is specific to the installed equipment. The supplier of the equipment has the freedom to make use of the 4 variables in the way that best suits to him (technically the one variable of size 128 bits had to be split into 4 smaller variables). The supplier must provide the documentation describing the specific meaning of each event code.

The variable "ATO Event Code" is composed of 4 variables as follows:

Variable Name	Size	Meaning	
M_ATO_Event_Code_1	32 bits	0.. 4'294'967'295	Project specific
M_ATO_Event_Code_2	32 bits	0.. 4'294'967'295	Project specific
M_ATO_Event_Code_3	32 bits	0.. 4'294'967'295	Project specific

M_ATO_Event_Code_4	32 bits	0.. 4'294'967'295	Project specific
M_ATO_Event_Code_5	32 bits	0.. 4'294'967'295	Project specific
M_ATO_Event_Code_6	32 bits	0.. 4'294'967'295	Project specific
M_ATO_Event_Code_7	32 bits	0.. 4'294'967'295	Project specific
M_ATO_Event_Code_8	32 bits	0.. 4'294'967'295	Project specific

Table 13   Definition for variable "ATO Event Code".

The "ATO Event Code" variables can be used in different manners:

- Each numerical value has a specific meaning.

- The variable can be regarded as a bit field where each bit is specific for a component.

- The variable can be regarded as a bit field, where more than one bits are grouped for a specific component. This group of bits has then a specific meaning for the particular component.

- A combination of the above variants is thinkable, where the assignment is distributed over the different variables.

- Other possible use of the available variables.

5.3   M_ATO_HW_Version

The "ATO Hardware Version" indicates the version of the hardware that is running in the 'ATO Vehicle' device. The supplier of the equipment must provide the description how his equipment discloses the hardware version by means of this variable. Furthermore, the supplier must document the version of each supplied hardware equipment.

The variables "ATO Hardware Version" are composed as follows:

Variable Name	Size	Meaning	
M_ATO_HW_Version_1 to M_ATO_HW_Version_8	32 bits	0..7	xxx major version Reserved value: 127, if the major version is not used.
		8..15	yyy minor version Reserved value: 127, if the minor version is not used.
		16..23	zzz patch version Reserved value: 127, if the patch version is not used.
		24..31	1 ASCII character Reserved value: "-" (decimal=45, hex=2D), if the ASCII character is not used.

Table 14   Definition for variable "ATO Hardware Version".

The numerical values and the ASCII character of the "ATO Hardware Version" variable can be compiled into the following format: "xxx.yyy.zzz/A".

Example of a compiled 'ATO Vehicle' hardware version: 52.7.34/D

5.4   M_ATO_SW_Version

The "ATO Software Version" indicates the version of the software that is operational by the 'ATO Vehicle' application. The supplier of the equipment must provide the description how his equipment discloses the software version by means of this variable. Furthermore, the supplier must document the version of each released software file.

The variables "ATO Software Version" are composed as follows:

Variable Name	Size	Meaning	
M_ATO_SW_Version_1 to M_ATO_SW_Version_8	32 bits	0..7	xxx major version Reserved value: 127, if the major version is not used.
		8..15	yyy minor version Reserved value: 127, if the minor version is not used.
		16..23	zzz patch version Reserved value: 127, if the patch version is not used.
		24..31	1 ASCII character Reserved value: "-" (decimal=45, hex=2D), if the ASCII character is not used.

Table 15   Definition for variable "ATO Software Version".

The numerical values and the ASCII character of the "ATO Software Version" variable can be compiled into the following format: "xxx.yyy.zzz/A".

Example of a compiled 'ATO Vehicle' application software version: 3.49.11/F

5.5   OBU_TR_D_Gradient

The "Gradient Distance" indicates the incremental distance to the next change of gradient.

The variable "Gradient Distance" is composed as follows:

Variable Name	Size	Meaning	
OBU_TR_D_Gradient(k)	22 bits	Minimum value: 0 cm Maximum value: 327.67 km	Distance indication with a resolution of 10 cm. For k = 1: Indication of the remaining distance from the max safe front end of the train to the start location of the gradient profile leg with 'k = 1'. For k > 1: Indication of the incremental distance to next change of gradient (k).

Table 16   Definition for variable "Gradient Distance".

Explanation of the concept for relative distance information transformation:

- The start location for the first gradient profile leg (leg with 'k = 1') is not reached yet: the "Gradient distance" for the leg with 'k = 1' is the remaining distance from the max safe front end of the train to the start location of the gradient profile leg with 'k = 1'. This is much like the concept applied to track conditions in SUBSET-119 [18].

- The start location for the first gradient profile leg (leg with 'k = 1') has been passed:

    o The "Gradient Distance" for the leg 'k = 1' gets the value 0.

    o The "Gradient Distance" is continuously evaluated for the start of the next gradient profile leg 'k = 2': the "Gradient distance" for the leg with 'k = 2' is the remaining distance from the max safe front end of the train to the start location of the gradient profile leg with 'k = 2'.

- The end location for the first gradient profile leg (leg with 'k = 1') has been passed:

    o   The information for the gradient profile leg with 'k = 1' is completely removed.

    o   The iteration counter is shifted between gradient profile legs: the gradient profile leg 'k = 2' gets then iteration value 'k = 1', while leg 'k = 3' gets the new iteration value 'k = 2, and so on.

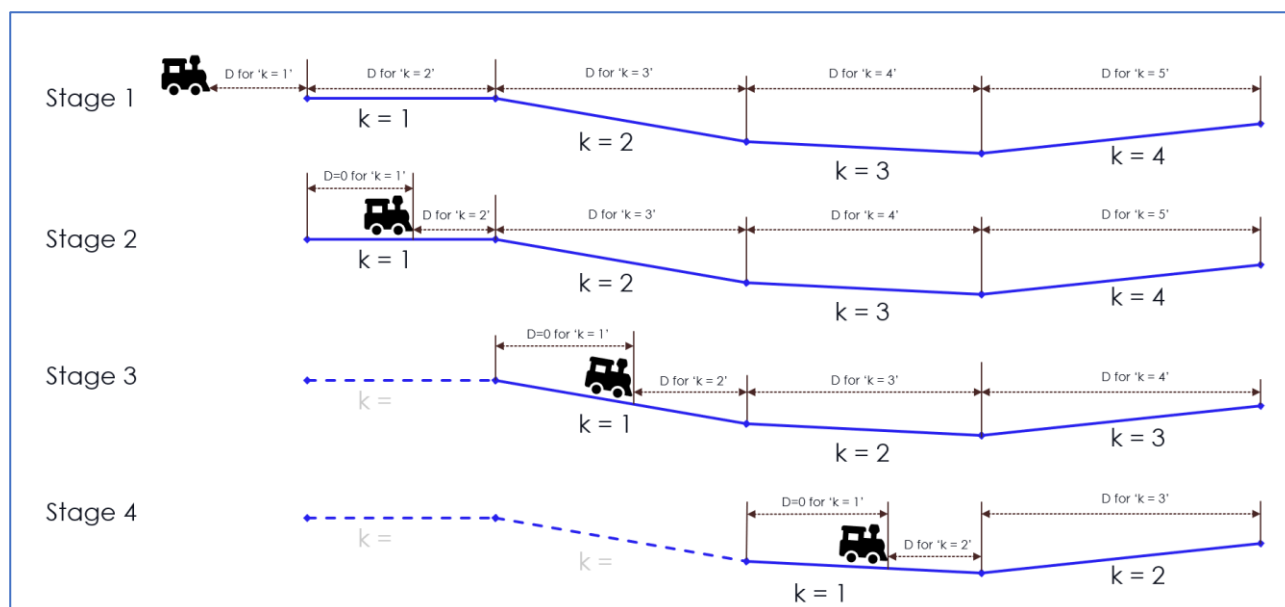Below is an explanatory figure showing the "Gradient Distance" indication concept for the different stages:

Figure 1   Explanation of concept for "Gradient Distance" indication

5.6   OBU_TR_ETCS_Condition

The "ETCS Condition" provides the condition information of the ETCS on-board indicating the severity of an active event or the currently executed process.

The meaning of the "ETCS on-board condition" variable is as follows:

Variable Name	Size	Meaning	
OBU_TR_ETCS_Condition	4 bits	0	Spare value
		1	Initialising
		2	Auto test
		3	Updating
		4	Maintenance mode
		5	Running (OK)
		6	Warning issue
		7	Error issue
		8	Critical issue
		9	Shutting down
		10..15	Spare values

Table 17   Definition for variable "ETCS on-board condition".

The "ETCS Condition" value is indicated according to the event or process with the highest severity.

Note: the "ETCS Condition" variable is not intended for use in safety relevant functions.

5.7 OBU_TR_ETCS_Cfg_Version

The "ETCS Configuration Version" indicates the version(s) of the configuration (file) for the different line replaceable unit (LRU) components operational in the ETCS on-board. The configuration version information exposes the version of the configuration (file) that is currently being applied by the software of the different LRU components of the ETCS on-board. The configuration file defines all configurable parameters of the specific LRU component. The supplier of the equipment must provide the description how his equipment discloses the configuration version by means of this variable. Furthermore, the supplier must document the version of each released LRU configuration file.

The variable "ETCS on-board Configuration Version" is composed as follows:

Variable Name	Size	Meaning	
OBU_TR_ETCS_Cfg_Version_1 to OBU_TR_ETCS_Cfg_Version_8	32 bits	0..7	xxx major version Reserved value: 127, if the major version is not used.
		8..15	yyy minor version Reserved value: 127, if the minor version is not used.
		16..23	zzz patch version Reserved value: 127, if the patch version is not used.
		24..31	1 ASCII character Reserved value: "-" (decimal=45, hex=2D), if the ASCII character is not used.

Table 18   Definition for variable "ETCS on-board Configuration Version".

The numerical values and the ASCII character of the "ETCS on-board Configuration Version" variable can be compiled into the following format: "xxx.yyy.zzz/A".

Example of a compiled ETCS on-board LRU component configuration version: 15.48.3/H

Note: not all equipment from the different suppliers makes use of a configuration file. In case no configuration file is used, then the version of the parametrisation inserted by other means into the component shall be provided. In case no parametrisation version is managed, then in all sections the reserved values for "not used" shall be applied.

5.8 OBU_TR_ETCS_HW_Version

The "ETCS on-board Hardware Version" indicates the version of the hardware for the different line replaceable unit (LRU) components running in the ETCS on-board. The supplier of the equipment must provide the description how his LRU component discloses the hardware version by means of this variable. Furthermore, the supplier must document the version of each supplied LRU hardware component.

The variable "ETCS on-board Hardware Version" is composed as follows:

Variable Name	Size	Meaning	
OBU_TR_ETCS_HW_Version_1 to OBU_TR_ETCS_HW_Version_8	32 bits	0..7	xxx major version Reserved value: 127, if the major version is not used.
		8..15	yyy minor version Reserved value: 127, if the minor version is not used.
		16..23	zzz patch version Reserved value: 127, if the patch version is not used.

		24..31	1 ASCII character Reserved value: "-" (decimal=45, hex=2D), if the ASCII character is not used.

Table 19   Definition for variable "ETCS on-board Hardware Version".

The numerical values and the ASCII character of the "ETCS Hardware Version" variable can be compiled into the following format: "xxx.yyy.zzz/A".

Example of a compiled ETCS on-board LRU component hardware version: 34.8.25/F

5.9   OBU_TR_ETCS_SW_Version

The "ETCS on-board Software Version" indicates the version of the software for the different line replaceable unit (LRU) components operational in the ETCS on-board. The supplier of the equipment must provide the description how his LRU component discloses the software version by means of this variable. Furthermore, the supplier must document the version of each released LRU software file.

The variable "ETCS on-board Software Version" is composed as follows:

Variable Name	Size	Meaning	
OBU_TR_ETCS_SW_Version_1 to OBU_TR_ETCS_SW_Version_8	32 bits	0..7	xxx major version Reserved value: 127, if the major version is not used.
		8..15	yyy minor version Reserved value: 127, if the minor version is not used.
		16..23	zzz patch version Reserved value: 127, if the patch version is not used.
		24..31	1 ASCII character Reserved value: "-" (decimal=45, hex=2D), if the ASCII character is not used.

Table 20   Definition for variable "ETCS on-board Software Version".

The numerical values and the ASCII character of the "ETCS on-board Software Version" variable can be compiled into the following format: "xxx.yyy.zzz/A".

Example of a compiled ETCS on-board LRU component software version: 2.23.16/B

5.10   OBU_TR_Event_Code

The "ETCS on-board Event Code" provides a numerical value that corresponds to an event code for the whole ETCS on-board subsystem. The meaning of the event code (each value) is specific to the installed equipment. The supplier of the equipment has the freedom to make use of the 8 variables in the way that best suits to him (technically the one variable of size 256 bits had to be split into 8 smaller variables). The supplier must provide the documentation describing the specific meaning of each event code.

The variable "ETCS on-board Event Code" is composed of 8 variables as follows:

Variable Name	Size	Meaning	
OBU_TR_Event_Code_1	32 bits	0.. 4'294'967'295	Project specific
OBU_TR_Event_Code_2	32 bits	0.. 4'294'967'295	Project specific
OBU_TR_Event_Code_3	32 bits	0.. 4'294'967'295	Project specific
OBU_TR_Event_Code_4	32 bits	0.. 4'294'967'295	Project specific
OBU_TR_Event_Code_5	32 bits	0.. 4'294'967'295	Project specific

OBU_TR_Event_Code_6	32 bits	0.. 4'294'967'295	Project specific
OBU_TR_Event_Code_7	32 bits	0.. 4'294'967'295	Project specific
OBU_TR_Event_Code_8	32 bits	0.. 4'294'967'295	Project specific

Table 21   Definition for variable "ETCS on-board Event Code".

The "ETCS on-board Event Code" variables can be used in different manners:

▪ Each numerical value has a specific meaning.

▪ The variable can be regarded as a bit field where each bit is specific for a component.

▪ The variable can be regarded as a bit field, where a specific number of bits are grouped for a specific component. This group of bits has then a specific meaning for the particular component.

▪ A combination of the above variants is thinkable, where the assignment is distributed over the different variables.

▪ Other possible use of the available variables.

5.11   OBU_TR_G_A

The "Gradient Value" indicates the absolute value of the engineered gradient between two defined locations.

The variable "Gradient Value" is defined as follows:

Variable Name	Size	Meaning	
OBU_TR_G_A(k)	8 bits	0..254	Numerical gradient value indicating the slope with a resolution of $1^0/_{00}$.
		255	Non numerical value indicating that the gradient description ends at the distance OBU_TR_D_Gradient (see chapter 5.5) with the same value of identifier 'k'.

Table 22   Definition for variable "Gradient Value".

5.12   Q_ATO_Condition

The "ATO Condition" provides the condition information of the 'ATO Vehicle' indicating the severity of an active event or the currently executed process.

The meaning of the "ATO Condition" variable is as follows:

Variable Name	Size	Meaning	
Q_ATO_Condition	4 bits	0	Spare value
		1	Initialising
		2	Auto test
		3	Updating
		4	Maintenance mode
		5	Running (OK)
		6	Warning issue
		7	Error issue
		8	Critical issue
		9	Shutting down
		10..15	Spare values

Table 23   Definition for variable "ATO Condition".

The "ATO Condition" value is indicated according to the event or process with the highest severity.

5.13   Q_RST_Train_Condition

The "Train Condition" provides the global condition information of the 'train' indicating the severity of an active event or the currently executed process. The indication shall be valid for train functions that are relevant to 'ATO Vehicle' only. These are all the functions where the variables defined in this document, in the context of the 'ATO Vehicle' application, are involved.

The meaning of the "Train Condition" variable is as follows:

Variable Name	Size	Meaning	
Q_RST_Train_Condition	4 bits	0	Spare value
		1	Initialising
		2	Auto test
		3	Updating
		4	Running (OK)
		5	Warning issue
		6	Error issue
		7	Critical issue
		8..15	Spare values

Table 24   Definition for variable "Train Condition" to 'ATO Vehicle'.

The "Train Condition" value is indicated according to the event or process with the highest severity. The Functional Vehicle Adapter is seen as part of the 'train'. Accordingly, all issues within the Functional Vehicle Adapter are handled as 'train' issues and reported appropriately.

This variable provides a global condition information, while the details are assessed by the 'ATO Vehicle' based on the single variables. These are the variables providing information about brakes, traction, doors, cabin, standstill, maximum train speed, traction / brake lever position, direction controller position, slip and slide.

For "Train Condition" information with the values "Initialising", "Auto test" and "Updating" the 'ATO Vehicle' shall wait for a configurable time period until the process on the train is completed. If the configured time period is elapsed but the process is not terminated yet, the 'ATO Vehicle' shall rise an event indicating that the train is not ready for operation.

5.14   TR_OBU_BrakePosition

The "Brake Position" variable indicates the position of the brake that shall be used by the ETCS on-board.

The meaning of the "Brake Position" variables is as follows:

Variable Names				Size
TR_OBU_Brake Position1	TR_OBU_Brake Position1_Not	TR_OBU_Brake Position2	TR_OBU_Brake Position2_Not	Boolean variables (1 bit each)
Values				**Meaning**
0	0	0	0	Invalid
0	0	0	1	Invalid
0	0	1	0	Invalid
0	0	1	1	Invalid
0	1	0	0	Invalid
0	1	0	1	Invalid
0	1	1	0	Passenger train in P
0	1	1	1	Invalid

1	0	0	0	Invalid
1	0	0	1	Freight train in P
1	0	1	0	Freight train in G
1	0	1	1	Invalid
1	1	0	0	Invalid
1	1	0	1	Invalid
1	1	1	0	Invalid
1	1	1	1	Invalid

Table 25   Definition for variable "Brake Position".

5.15   TR_OBU_Driver_ID

The "Driver ID" indicates the driver identifier number of the person that is driving the train.

The variable "Driver ID" is composed as follows:

Variable Name	Size	Meaning	
TR_OBU_Driver_ID	128 bits	16 alphanumeric characters, with 8 bits length each	Characters according to ISO 8859-1, also known as Latin Alphabet #1.

Table 26   Definition for variable "Driver ID".

Note: the information of this variable is personal data and needs to be handled with confidentiality. This must be considered when integrating the equipment into the vehicle.

5.16   TR_OBU_SupTractionSys

The "Traction System(s) Supported by the Engine" variable indicates based on a project specific list the tractions system(s) that are supported by the vehicle. The list contains up to 31 combinations of NID_CTRACTION and M_VOLTAGE and is pre-configured in ETCS on-board and TCMS.

The meaning of the "Traction System(s) Supported by the Engine" variable is as follows:

Variable Name	Size	Meaning	
TR_OBU_SupTractionSys	32 bits	0	Spare value
		1..31	A bit field representing the project specific list of provided traction systems, every bit corresponds to an entry in the list. This bit field is transmitted as a binary mask, indicating which traction systems configured in the ETCS on-board and the TCMS shall be considered as supported (value 1 is available, 0 is not available).

Table 27   Definition for variable "Traction System(s) Supported by the Engine".

5.17 TR_OBU_Train_Condition

The "Train Condition" provides the global condition information of the 'train' indicating the severity of an active event or the currently executed process. The indication shall be valid for train functions that are relevant to ETCS on-board only. These are all the functions where the variables defined in this document, in the context of the ETCS on-board application, are involved.

The meaning of the "Train Condition" variable is as follows:

Variable Name	Size	Meaning	
TR_OBU_Train_Condition	4 bits	0	Spare value
		1	Initialising
		2	Auto test
		3	Updating
		4	Running (OK)
		5	Warning issue
		6	Error issue
		7	Critical issue
		8..15	Spare values

Table 28   Definition for variable "Train Condition" to ETCS on-board.

The "Train Condition" value is indicated according to the event or process with the highest severity. The Functional Vehicle Adapter is seen as part of the 'train'. Accordingly, all issues within the Functional Vehicle Adapter are handled as 'train' issues and reported appropriately.

This variable provides a global condition information, while the details are assessed by the ETCS on-board according to the set validity bits defined in SUBSET-119 [18].

For "Train Condition" information with the values "Initialising", "Auto test" and "Updating" the ETCS on-board shall wait for a configurable time period until the process on the train is completed. If the configured time period is elapsed but the process is not terminated yet, the ETCS on-board shall rise an event indicating that the train is not ready for operation.

5.18 TR_OBU_TypeTrainConfiguration

The "Type of Train Configuration" variable can be used to adjust values for specific train data parameters, "Type of Train Configuration" is an 'identifier' for an entry in a list containing train data parameters values. The used values of the "Type of Train Configuration" variable and their meaning are project specific.

Basically, the "Type of Train Configuration" variable references an entry of a project specific list pre-configured in the ETCS on-board and the TCMS. The "Type of Train Configuration" value is used by the ETCS on-board to determine specific train data parameters:

Variable Name	Size	Meaning	
TR_OBU_TypeTrainConfiguration	5 bits	0..31	Each value references a specific data set of a project specific list pre-configured in the ETCS on-board and the TCMS.

Table 29   Definition for variable "Type of Train Configuration".

The values for the following train data parameters can be determined by means of the "Type of Train Configuration" variable:

Parameter	Description	Remark
Cant deficiency	Parameter NC_CDTRAIN as indicated in [16] 7.5.1.82.2.	

Train length	Parameter as indicated in [16] A.3.11 (chapter 3).	
Brake model parameter set: • Traction model • Brake build up time model and speed dependent deceleration model • Brake percentage • Brake position • Nominal rotating mass	• T_traction_cut_off as per [16] chapter 3.13.2.2.2.1. • T_brake_emergency values and T_brake_service values see [16] 3.13.2.2.3.2, speed dependent deceleration model values (A_brake_emergency(V) and A_brake_service(V), see [16] 3.13.2.2.3 • Parameter as indicated in [15] A.3.11 • See variable description in chapter 5.14 • Percentage of the total weight of the train	• Also defined as independent variable. • Also defined as independent variable.
Maximum train speed	Parameter as indicated in [16] A.3.11.	
Loading gauge	Parameter as indicated in [16] A.3.11.	Also defined as independent variable.
Axle load category	Parameter as indicated in [16] A.3.11.	Also defined as independent variable.
Traction system(s) supported by the engine	See variable description in chapter 5.15.	Also defined as independent variable.
Train fitted with airtight system	Parameter as indicated in [16] A.3.11.	Also defined as independent variable.

Table 30   Train data parameters adjustable with variable "Type of Train Configuration".

It is possible to only adjust a reduced set of the train data parameters indicated in the above table by means of "Type of Train Configuration".

The use of the "Type of Train Configuration" variable is dependent on the "Type of Train Data Entry" variable as described in chapter 5.19.

In case "Type of Train Configuration" variable is employed but only a reduced set of the train data parameters is adjusted by means of "Type of Train Configuration" then the excluded parameters are provided directly using the specific variables.

5.19   TR_OBU_TypeTrainData

The "Type of Train Data Entry" variables indicate the type of train data entry configuration to be applied.

The meaning of the "Type of Train Data Entry" variables is as follows:

Variable Names		Size
TR_OBU_TypeTrainData_S1	TR_OBU_TypeTrainData_S2	Boolean variables (1 bit each)
Values		**Meaning**
0	0	Invalid
0	1	Fixed
1	0	Flexible
1	1	Switchable

Table 31   Definition for variable "Type of Train Data Entry".

By means of this input the ETCS on-board evaluates the type of train data entry configuration to be applied, according to it a corresponding mask is shown to the driver (see clause 11.3.9.6 of [19]).

5.20 OBU_TR_Q_GDir

The "Gradient Slope Qualifier" indicates if the gradient leg climbs or descends.

The variable "Gradient Slope Qualifier" is defined as follows:

Variable Name	Size	Meaning	
OBU_TR_Q_GDir(k)	1 bit	0	Downhill
		1	Uphill

Table 32   Definition for variable "Gradient Slope Qualifier".