

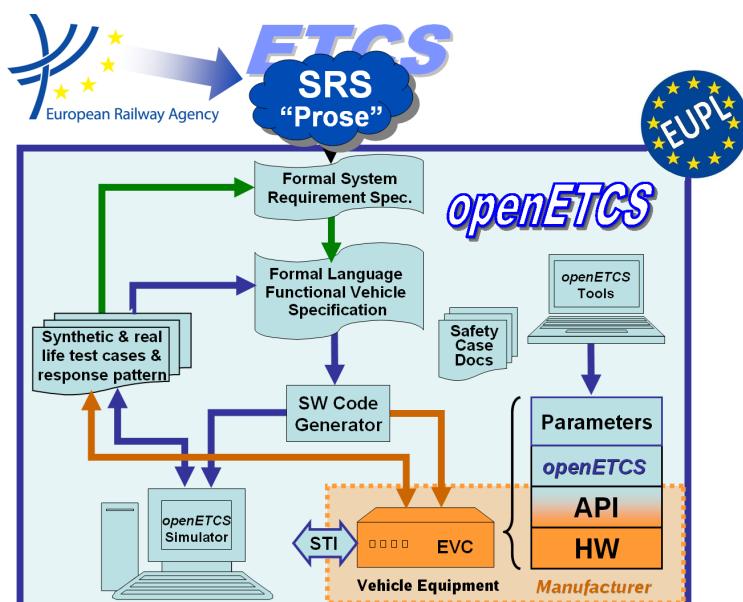
Work Package 3: “Modeling”

openETCS Architecture and Design Specification

Software Component Design and Internal Interface Specification

Dr. Peter Mahlmann, Bernd Hekele, Baseliyos Jacob, Peyman Farhangi, Uwe Steinke, Dr. Christian Stahl, Jakob Gärtner, Mairamou Haman Adji, Stefan Karg, Thorsten Schulz, Marielle Petit-Doche and Alexander Stante

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Work Package 3: “Modeling”

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October 2015

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Document approbation

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Architecture and Design Specification

Prepared for openETCS@ITEA2 Project

Abstract: This document describes the architecture and design specification of the openETCS onboard unit (OBU) model. The functional scope of the openETCS OBU model is to cover the functionality required for running on the ETCS level 2 Utrecht Amsterdam track. The OBU model is developed iteratively and the system model is documented in D3.5.x and the functional model is documented in D3.5.x, where x denotes the iteration.

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Modification History

Version	Sections	Modification / Description	Author	Date
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1 Introduction

A primary goal of the openETCS ITEA2 project is to provide a formal specification and a non-vital reference implementation of an ETCS onboard unit (OBU) according to the specification defined in Subset-026 [1] by the European Railway Agency (ERA).

This deliverable, i.e. D3.5.x, describes the architecture and design specification of the openETCS onboard (OBU) model. As the development of the OBU model is done iteratively according to a SCRUM process, the last digit of the deliverable identifier, i.e. x, denotes the current iteration of the model. This document should be considered as a complement to the following project outcomes respectively deliverables:

- the corresponding SysML model (SCADE System), available at https://github.com/openETCS/modeling/tree/master/model/sysml/openETCS_EVC,
- the corresponding functional model (SCADE Suite), available at https://github.com/openETCS/modeling/tree/master/model/Scade/System/OBU_PreIntegrations/openETCS_EVC,
- the corresponding functional design description, i.e. D3.6.x, and
- the documentation of the generic openETCS Application Programming Interface (API), available at <https://github.com/openETCS/modeling/blob/master/API/description/api-description.pdf>.

1.1 Input Documents

The following documents have been the basis for the analysis, functional decomposition, and design of the openETCS OBU model:

- ERA Subset-026 [1], V3.3.0
- ERA TSI CCS Documents
- openETCS API documentation, available at <https://github.com/openETCS/modeling/blob/master/API/description/api-description.pdf>
- openETCS requirements, i.e. D2.1, D2.2,..., D2.9, available at <https://github.com/openETCS/requirements/tree/master/Reference>

1.2 Software and Tools used for Development

The following software and tools have been used in the openETCS development process:

SCADE System Version 16.1b of SCADE System has been used for the generation of SysML models.

SCADE Suite Version 16.1b of SCADE Suite has been used for the functional modelling of the openETCS OBU components. Executable models are generated via the SCADE Suite code generator (KCG), which has been certified for CENELEC EN 50128 at SIL 3/4.

SCADE Display Version 16.1b of SCADE Display has been used for the development of the Driver Machine Interface (DMI).

GitHub The web based Git repository hosting service GitHub has been used for distributed revision control and source code respectively model management.

1.3 General Remarks on the openETCS OBU Model

The openETCS OBU model has been developed according the specification given in ERA Subset-026 [1], Version 3.3.0. The software release of the openETCS OBU documented and described in this document is publicly available at <https://github.com/openETCS/modeling/tree/master/model> and refers to the commit corresponding to the following hashtag:

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In particular, the root of the SysML model is located at <https://github.com/openETCS/modeling/tree/master/model/system> and the root of the functional SCADE Suite model is located at <https://github.com/openETCS/modeling/tree/master/model/Scade>.

Note that all components of the openETCS OBU have been developed from scratch, no existing components have been reused.

Part I

System Architecture and Functional Breakdown

2 System Architecture

The system architecture of the openETCS OBU is adopted from the system structure defined in ERA Subset-026, Chapter 2.5 [1]. Figure 1 shows which parts of the reference architecture are in the scope of the openETCS OBU model, cf. dashed red line. Note that also specific parts of the ETCS trackside (e.g. Eurobalise and RBC blocks) have been modeled to have an integrated test environment, cf. dashed black line in Figure 1.

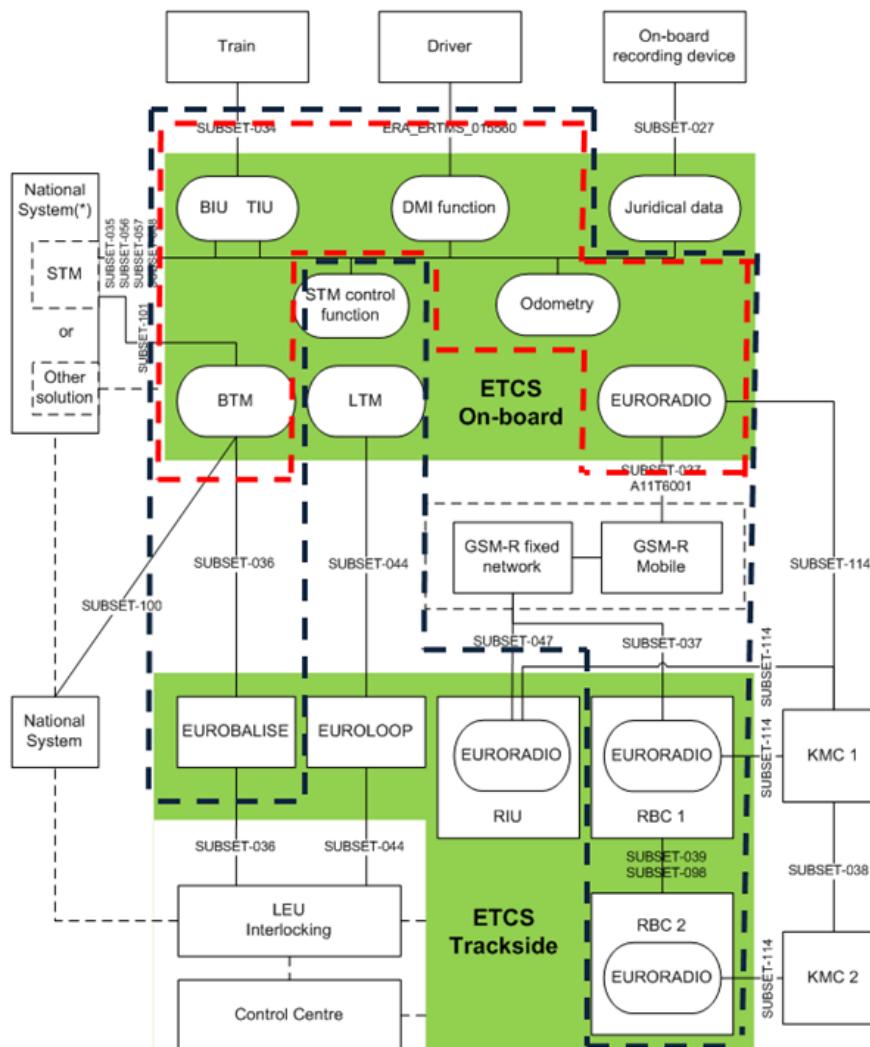


Figure 1. Scope of openETCS OBU model system according to ERA TSI Chapter 2.5. Functional blocks in the scope of openETCS have been marked by the dashed black line. The dashed red line shows the OBU blocks in the scope of openETCS.

2.1 Top Level Architecture and External Interfaces

Figure 2 shows the top level architecture with external interfaces E1, E2, ..., E10. The external interfaces are used for the communication between the openETCS OBU (dashed red line) and systems out of the scope of the openETCS project and the ETCS Onboard Unit System. In the following we give brief overview of the interfaces:

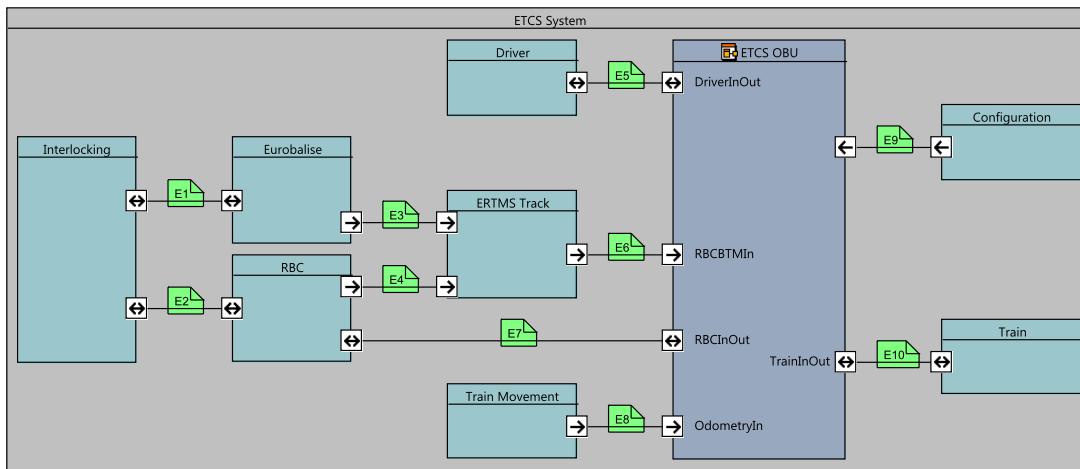


Figure 2. Top level architecture with external interfaces E1 to E10.

- E1:** In- and out flow between the Interlocking and the Eurobalise. Only relevant for controlled Eurobalises.
- E2:** Input and output interface between the Interlocking and Radio Block Center (RBC).
- E3:** Input interface from the Eurobalise to the ERTMS Track module.
- E4:** Input interface from the RBC to the ERTMS Track module.
- E5:** This interface is used for the interaction between the driver and the display (Driver Machine Interface, DMI).
- E6:** This interface is a compound structure and combines the interfaces E3 and E4 to send track side messages from Eurobalises or RBC to the ETCS OBU.
- E7:** Input and output interface between RBC and ETCS OBU. This interface is used for the management of radio communication, e.g. session management, and sending radio messages from the ETCS OBU to the RBC. Note that the ETCS OBU receives radio messages via interface E6.
- E8:** Input interface to the odometry subsystem of the ETCS OBU. Used for sending information to the train if there is any movement outside the ETCS system, e.g. "cold movement".
- E9:** Input interface to the ETCS OBU to set configuration data such as fixed values, system values, national values and train configuration.
- E10:** Input and output interface between the ETCS OBU and the train. This interface is used for the interaction between the train and the ETCS OBU such as brake control, traction control, door control, etc.

2.2 Functional breakdown of the ETCS OBU

Figure 3 depicts the functional breakdown of the ETCS OBU block shown in Figure 2. The ETCS OBU consists out of 7 functional modules. These are:

- F1 Receive Information from Trackside** This module is responsible for receiving RBC and BTM messages and passing these to the F2 ETCS Kernel module. A detailed description is given in Chapter 4.
- F2 ETCS Kernel** This module represents core component of the openETCS OBU. A detailed description is given in Chapter 5.

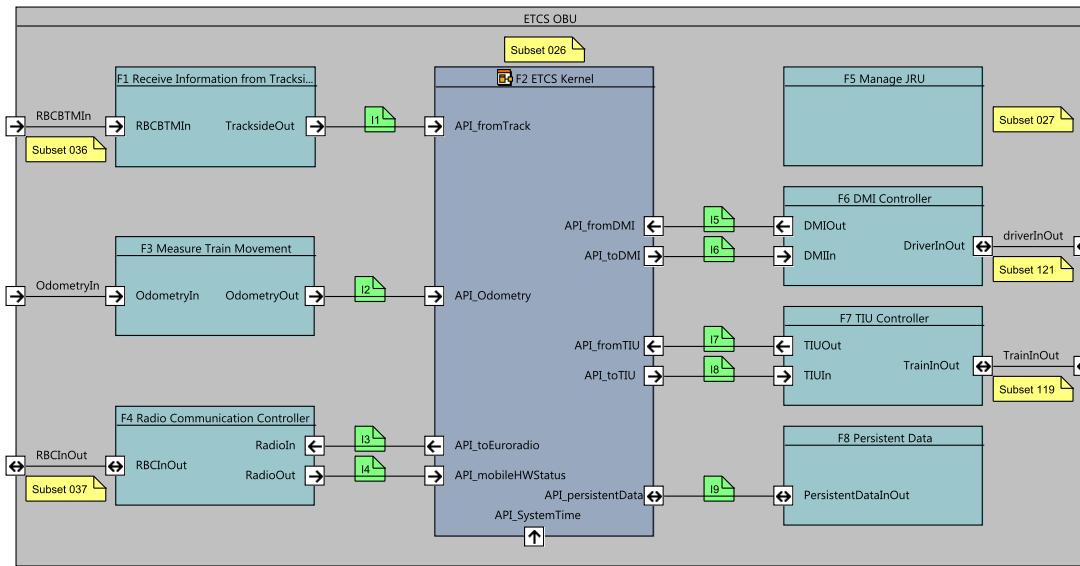


Figure 3. ETCS OBU system architecture view with internal interfaces I1 to I9.

F3 Measure Train Movement This module provides odometry data to the F2 ETCS Kernel module.

F4 Radio Communication Controller This module controls radio transmission modules. Up to 2 modules (e.g., mobiles) can be implemented in this unit. Each module is used for setting up a communication channel between RBC and EVC.

F5 Manage JRU This module manages the juridical date. Note that this component is not included in the functional scope of the openETCS OBU respectively project currently.

F6 DMI Controller This module implements the control of the display to the driver and the driver machine interface.

F7 TIU Controller This module connects the train components with the EVC. It is also responsible for providing the interface to the brakes of the train.

F8 Persistent Data This module provides persistent data about the train to the ETCS Kernel.

These components are interacting via the internal interfaces I1 to I8. In the following we give a brief description of the interfaces.

I1: Input interface that allows the F2 ETCS Kernel module to receive information from the Balise Transmission Module as well as the Radio Block Center.

I2: Input interface from the Odometry (ODO) to the F2 ETCS Kernel module.

I3: Output interface between the F4 Radio Communication controller module and the F2 ETCS Kernel module. This interface is used for radio session management and sending radio messages from the OBU to the track side.

I4: Input interface between the F4 Radio Communication Controller module and the F2 ETCS Kernel module.

I5: Input interface between the F6 DMI Controller module and the F2 ETCS Kernel module.

I6: Output interface between the F6 DMI Controller module and the F2 ETCS Kernel module.

I7: Input interface between the F7 TIU Controller module and the F2 ETCS Kernel module.

I8: Output interface between the F7 TIU Controller module and the F2 ETCS Kernel module.

I9: Input and output interface to the persistent storage of the OBU. In this storage data is made available for initialising the EVC with appropriate train status information.

Part II

Design Description

3 General Design Decisions

This section will be completed in a later version of the document.

4 F1: Receive Information from Trackside

4.1 ETCS Messaging: TrackMessages

4.1.1 Component Requirements

Component name	TrackMessages::Read_P005
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ETCS_Messaging/TrackMessages
SCADE designer	Jakob Gärtner, LEA Railergy Mairamou Haman Adjé, LEA Railergy
Description	<p>TrackMessages is a library containing functionality to:</p> <ul style="list-style-type: none"> • Transport TrainToTrack and TrackToTrain messages and packets using a compressed format which is conceptually close to the ETCS language as defined in Subset-026 • Compress trackside information and decompress it in the on-board unit, taking into account different baseline versions and providing transparent translation. • Compress trainside information and decompress it in the track-side simulation models, taking into account different baseline versions and providing transparent translation. <p>As TrackMessages is a library with various components supporting all packets and messages defined in Subset-026, we have selected one exemplary function to document the concept. As only the packet/ message- related functionality is specific, this approach will allow a first understanding of the concept and the related interfaces. For a full discussion of the library, refer to the [specifc chapter? document?]</p> <p>The function Read_P005 extracts a packet 5 (Gradient Profile) from the compressed packets data flow, if present. It translates the integer-coded compressed data with the help of the metadata in the header section of the CompressedPackets_T formatted data flow. After performing variable-level translation and exception detection, a baseline-3 conformal packet 5 is available for use within the relevant OBU functions.</p>
Input documents	<p>Subset-026, Chapter 6 Subset-026, Chapter 7 Subset-026, Chapter 8</p> <p>The objective of this component (the full TrackMessages library) is to provide a full formalisation of above chapters in Subset-026</p>

Safety integrity level	4
Time constraints	n/a (for the provided example function)
API requirements	In the demonstrator context, the API is fully defined on SCADE model level. For integration with external systems (BTM, Radio, Subset-076 or Subset-94), additional conversion to/ from bit-level representation will be required

4.1.2 Interface

An overview of the interface of component TrackMessages is shown in The inputs and outputs are described in detail in Section 4.1.2.1 respectively 4.1.2.2.

4.1.2.1 Inputs

4.1.2.1.1 Message_In

Input name	Message_In
Description	Message_In takes the compressed track-to-train messages that have either been compressed by the trackside simulation components of the TrackMessages library, or have been filled by the API. All packets that are part of the same message are transmitted within one cycle of the model's execution. Message_IN is taking the compressed packet information from the track to train dataflow.
Source	Manage_TrackSideInformation_Integration
Type	Common_Types_Pkg::CompressedPackets_T
Valid range of values	The consistency of the metadata is checked at the input side. The ranges of the transported variables are checked at the conversion step (from integer format to SRS-conform format).
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	The content of this input is not checked, as any issues will be found at conversion level. If the metadata are not matching the search criteria the packet will be considered as non existent and will therefore be ignored.

4.1.2.2 Outputs

4.1.2.2.1 received

Output name	received
Description	Flag to indicate reception of a packet 5 from trackside in the current cycle.

Destination	Any calling component.
Type	bool
Valid range of values	
	true Packet 5 has been received in the current cycle.
	false Packet 5 has not been received in the current cycle.
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

4.1.2.2.2 P005_OBU_out

Output name	P005_OBU_out
Description	Gradient Profile (Packet 5) according to 7.4.2.2
Destination	Any calling operator
Type	TM::P005_OBU_T

Valid range of values TM::P005_OBU_T is a complex data type. Values are given for each element. Format is: Type Name: range/list of values

- bool valid: [true | false]
- q_dir Q_DIR:
[Q_DIR_Both_directions |
Q_DIR_Nominal |
Q_DIR_Reverse]
- l_packet L_PACKET: (0-8191)
- q_scale Q_SCALE:
[ENUM_Q_SCALE_10cm |
ENUM_Q_SCALE_1m |
ENUM_Q_SCALE_10m]
- n_iter N_ITER: (0-33) (*Remark: start section from the original packet is integrated into the list of sections*)

The structured element sections is an array of type P005_section_enum_T. For each element, the valid range of values is as follows:

- bool valid: [true | false] (*Remark: Check for consistency with the value of n_iter*)
- d_link D_LINK: (0-32767)
- q_newcountry Q_NEWCOUNTRY:
[TM_conversions::ENUM_Q_NEWCOUNTRY_same |
TM_conversions::ENUM_Q_NEWCOUNTRY_not_same]
- nid_c NID_C: (0-1023)
- nid_bg NID_BG: (0-16383)
- q_linkorientation Q_LINKORIENTATION:
[TM_conversions::ENUM_Q_LINKORIENTATION_reverse |
TM_conversions::ENUM_Q_LINKORIENTATION_nominal]
- q_linkreaction Q_LINKREACTION:
[TM_conversions::ENUM_Q_LINKREACTION_Train_trip |
TM_conversions::ENUM_Q_LINKREACTION_Apply_service_brake |
TM_conversions::ENUM_Q_LINKREACTION_No_Reaction]
- q_locacc Q_LOCACC: (0-63)

Only an output structure with the structured element "valid" set to "true" is to be considered as received. If this field is set to true, the Output 1 (received) must equally be set to "true".

Behaviour when value is n/a
at boundary

Behaviour for values out of valid range

The component is prepared for the upcoming error/exception handling concept. An error flag is, at the moment, raised internally if any of the compressed input values is out of range. A hierarchical error processing is foreseen.

The types that have been defined in the package S026_7 do not provide any default/ invalid value. The following fields are therefore set to an arbitrary value upon reception of an out-of-range value from track side, and the internal error flag is raised:

- q_dir Q_DIR:
set to: Q_DIR_Both_directions
- q_scale Q_SCALE:
set to: ENUM_Q_SCALE_10cm
- q_newcountry Q_NEWCOUNTRY:
set to:[TM_conversions::ENUM_Q_NEWCOUNTRY_same | TM_conversions::ENUM_Q_NEWCOUNTRY_not_same]
- q_newcountry Q_NEWCOUNTRY:
set to: TM_conversions::ENUM_Q_NEWCOUNTRY_not_same
- q_linkorientation Q_LINKORIENTATION:
set to: TM_conversions::ENUM_Q_LINKORIENTATION_reverse
- q_linkreaction Q_LINKREACTION:
set to: TM_conversions::ENUM_Q_LINKREACTION_Train_trip

Behaviour when value is erroneous, absent or unwanted (i.e. spurious)

4.1.3 Subcomponents

4.1.3.1 Read_Packets

4.1.3.1.1 Component Requirements

Component name	TM_lib_internal::RECV_ReadPackets
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ETCS_Messaging/TrackMessages
SCADE designer	Jakob Gärtner, LEA Railergy

Description	<p>RECV_ReadPackets extracts packet data information and raw compressed packet data from the compressed packets data flow, using filter criteria provided through parameter inputs:</p> <ul style="list-style-type: none"> • NID_PACKET: search for a specific packet. • Version Number: search for a specific version number. • Q_DIR: search for packets that are only valid for a specific direction. • Serial number: search for a specific packet instance, if several instances of a given packet type exist. • F_Version: Flag to decide whether to evaluate or ignore packet version information. • F_id: Flag whether to evaluate or ignore packet serial number information.
-------------	--

The operator TM_lib_internal::RECV_ReadPackets takes a set of parameter data to:

1. Search the metadata of the compressed packets data flow using the provided parameters to determine if a matching packet is contained in any given cycle.
2. Output the flag "received" exactly in any cycle a matching packet is found
3. Output an array of compressed packet data that is filled with the data from the identified packet.

Input documents	<p>Subset-026, Chapter 7 This function is not directly traceable to Subset-026, but is built from derived requirements.</p>
Safety integrity level	4
Time constraints	n/a
API requirements	<p>In the demonstrator context, the API is fully defined on SCADE model level. For integration with external systems (BTM, Radio, Subset-076 or Subset-94), additional conversion to/ from bit-level representation will be required.</p>

4.1.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

4.1.3.2 Extract Packet 5

4.1.3.2.1 Component Requirements

Component name	TM_conversions::trackside.C_P005_compr_onboard
----------------	--

Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/ System/ObuFunctions/ETCS_Messaging/TrackMessages
SCADE designer	Jakob Gärtner, LEA Railergy
Description	If a matching packet 5 has been received, TM_conversions::trackside.C_P005_compr_onboard: takes the compressed packet data and converts them to an SRS conformal onboard packet format. Trailing 0 beyond the valid length of the packet are ignored.
Input documents	Subset-026, Chapter 7
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

4.1.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5 F2: ETCS Kernel

In this chapter we describe the main components of the openETCS OBU model. Section 5.1 gives an overview of the external interfaces of this functional block and gives a brief overview of its components and their interaction. The following Sections 5.2 to 5.14 give a detailed description for each of the components in F2: ETCS Kernel.

5.1 ETCS Kernel Overview

The ETCS Kernel module consists of the 13 functional components, i.e. F2.1 to F2.13 as depicted in Figures 4 to 16. Note that due to the complexity of the Kernel module the SysML diagram has been splitted into 13 figures. Each of the figures shows one of the subcomponents F2.1 to F2.13 and its connections to the other components in F2 and the inputs respectively outputs of F2. In the following we briefly describe the functionality of these components.

F2.1: Manage_TrackSideInformation_Integration This component is responsible for receiving Eurobalise telegrams and Euroradio messages from the API and performs several consistency checks on the inputs. The corresponding SysML diagram is shown in Figure 4. For further details we refer to Section 5.2.

F2.2: Manage_ETCS_Procedures This component describes the Start of Mission procedure of the train until the current status will change to another mode, level or other procedure. The corresponding SysML diagram is shown in Figure 5. For further details we refer to Section 5.3.

F2.3: trainData Implementation of the train data with the corresponding interfaces to driver and RBC. The corresponding SysML diagram is shown in Figure 6. For further details we refer to Section 5.4.

F2.4: TrackAtlas Implementation of the track database as a function of the evc. The corresponding SysML diagram is shown in Figure 7. For further details we refer to Section 5.5.

F2.5: ManageLevelAndMode Defines the behaviour of Modes and Levels transitions. The corresponding SysML diagram is shown in Figure 8. For further details we refer to Section 5.6.

F2.6: calculateTrainPosition The purpose of this component is to calculate the locations of linked and unlinked balise groups and the current train position while the train is running along the track. The corresponding SysML diagram is shown in Figure 9. For further details we refer to Section 5.7.

F2.7: SpeedSupervision_Integration This component monitors the current speed of the train and its location to ensure that the speed remains within the given speed and distance limits. The corresponding SysML diagram is shown in Figure 10. For further details we refer to Section 5.8.

F2.8: Provide_Position_Report The component builds a position report for the RBC, i.e., message 132, and provides it as an output. The corresponding SysML diagram is shown in Figure 11. For further details we refer to Section 5.9.

F2.9: MoRC_HO This component implements the onboard management of a single communication session with the track, i.e. a single RBC. It controls the establishment, maintenance and termination process of a radio communication session and steers the underlying com-

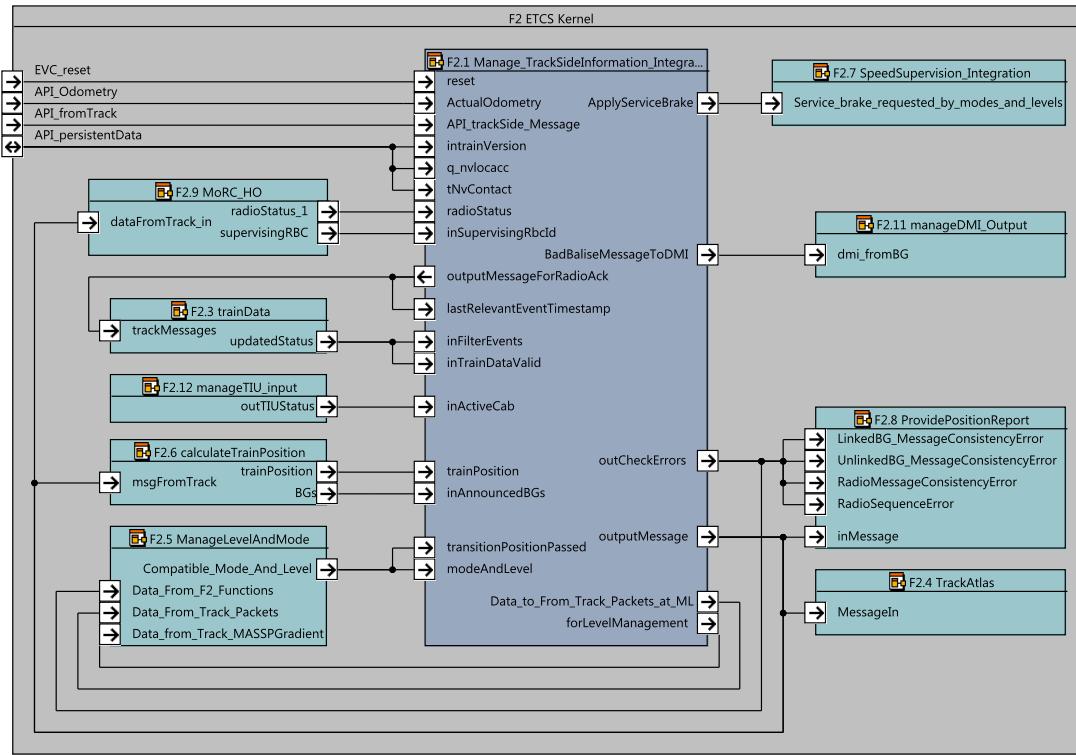


Figure 4. F2: ETCS Kernel SysML diagram with focus on F2.1 Manage_TrackSideInformation_Integration component.

munication safety layer as well as the mobile device. Those and the data transfer itself are not part of this component. The corresponding SysML diagram is shown in Figure 12. For further details we refer to Section 5.10.

F2.10: manageDMI_input This component handles messages respectively data coming from the Driver Machine Interface (DMI) to the ETCS OBU. The corresponding SysML diagram is shown in Figure 13. For further details we refer to Section 5.11.

F2.11: manageDMI_output This component handles messages respectively data being send from the ETCS OBU to the DMI. The corresponding SysML diagram is shown in Figure 14. For further details we refer to Section 5.12.

F2.12: manageTIU_input This component handles messages respectively data coming from the Train Interface Unit (TIU) to the ETCS OBU. The corresponding SysML diagram is shown in Figure 15. For further details we refer to Section 5.13.

F2.13: manageTIU_output This component handles messages respectively data being send from the ETCS OBU to the TIU. The corresponding SysML diagram is shown in Figure 16. For further details we refer to Section 5.14.

5.1.1 External Interfaces

This section gives a detailed overview of the external inputs and outputs of module F2: ETCS Kernel.

5.1.1.1 External Inputs

5.1.1.1.1 EVC_reset

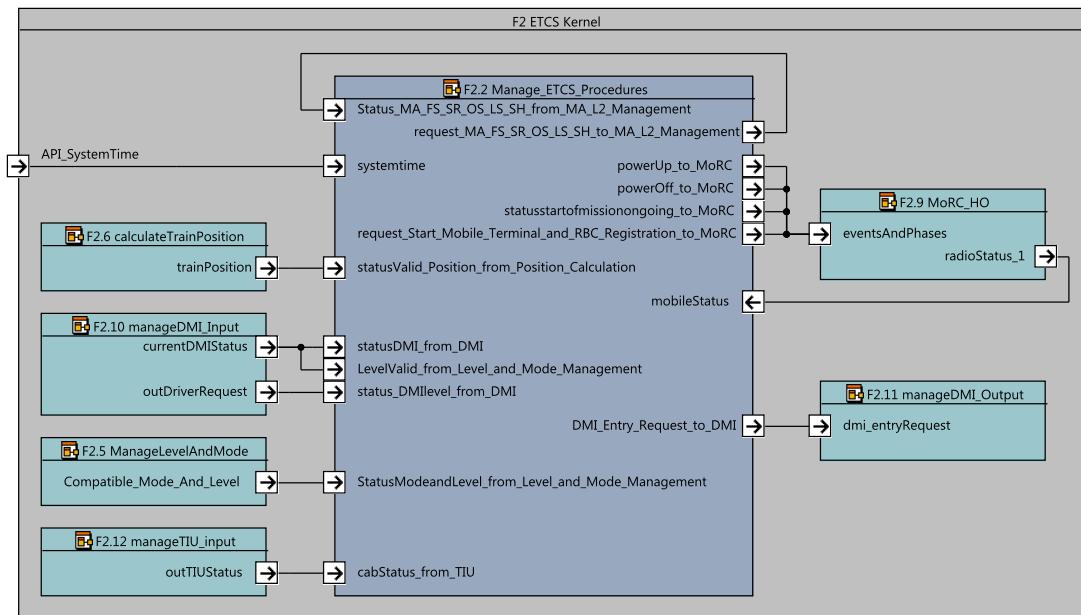


Figure 5. F2: ETCS Kernel SysML diagram with focus on F2.2 Manage_ETCS_Procedures component.

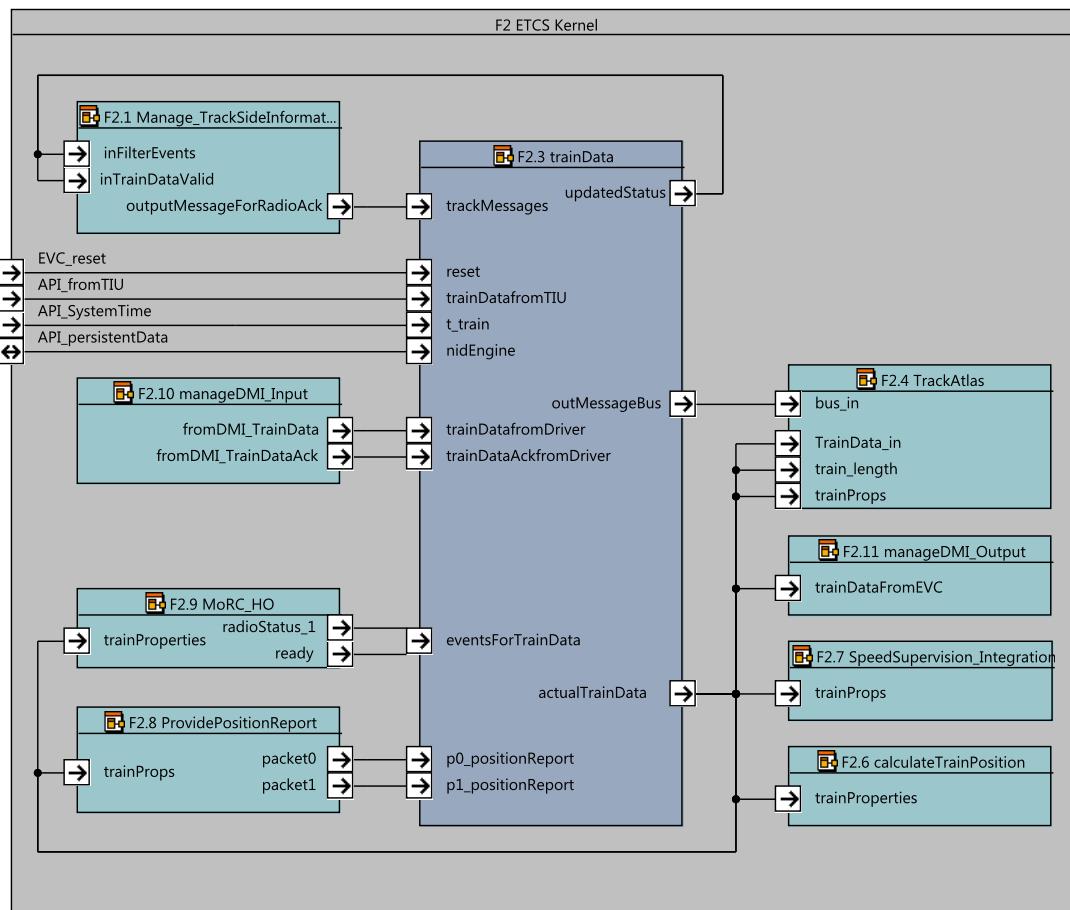


Figure 6. F2: ETCS Kernel SysML diagram with focus on F2.3 trainData component.

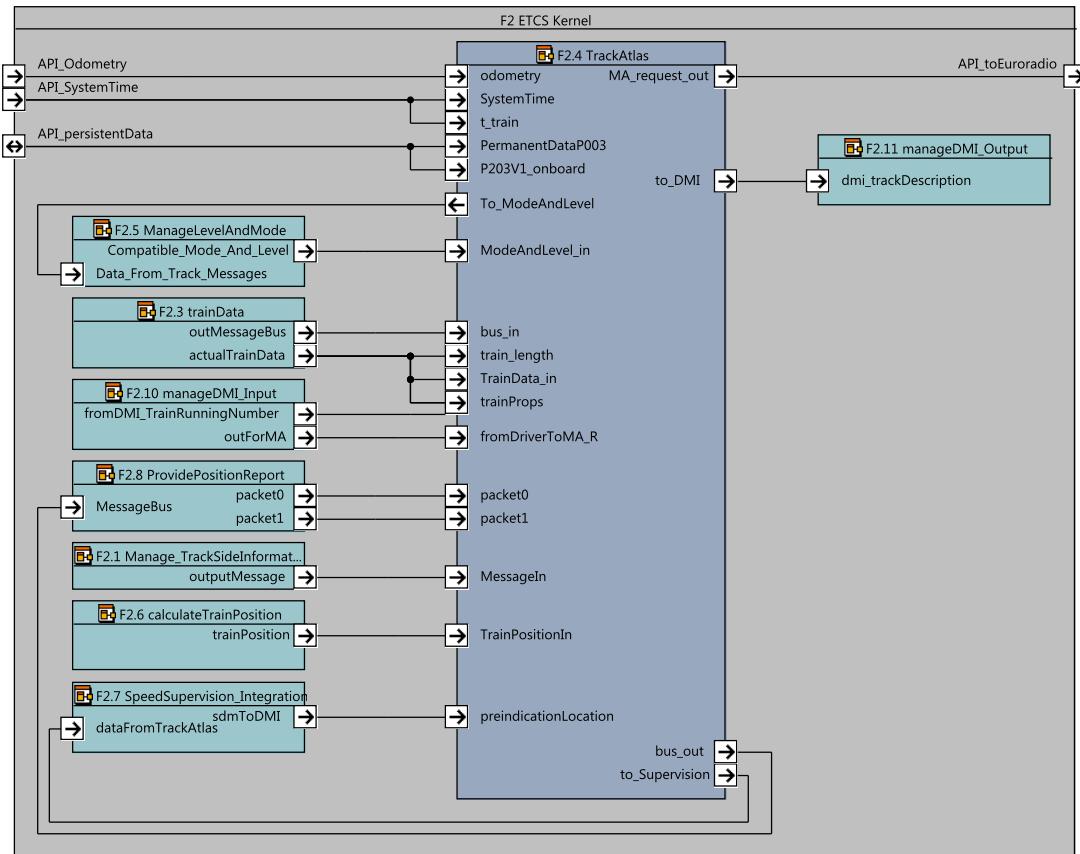


Figure 7. F2: ETCS Kernel SysML diagram with focus on F2.4 TrackAtlas component.

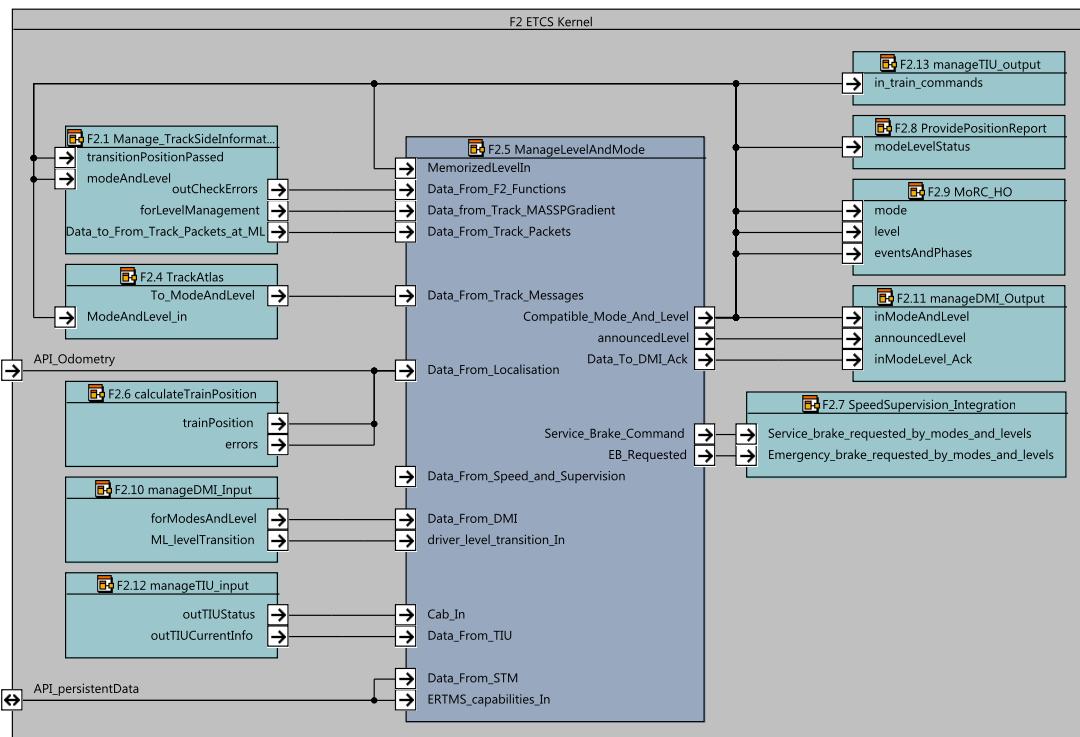


Figure 8. F2: ETCS Kernel SysML diagram with focus on F2.5 Mode_and_Level component.

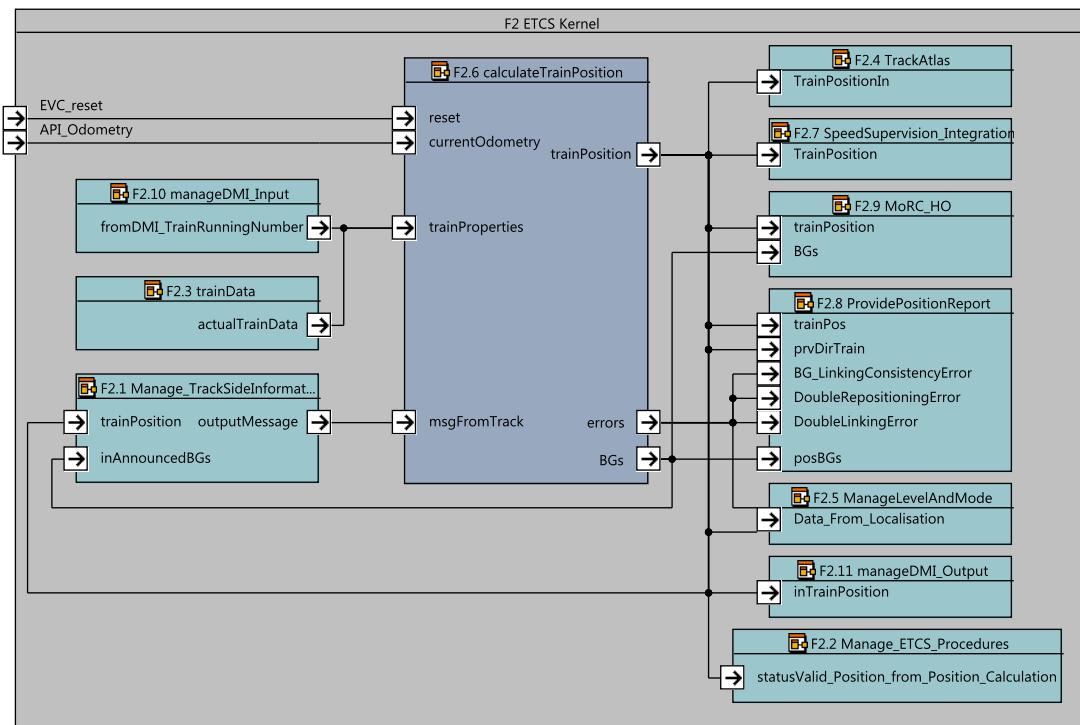


Figure 9. F2: ETCS Kernel SysML diagram with focus on F2.6 calculateTrainPosition component.

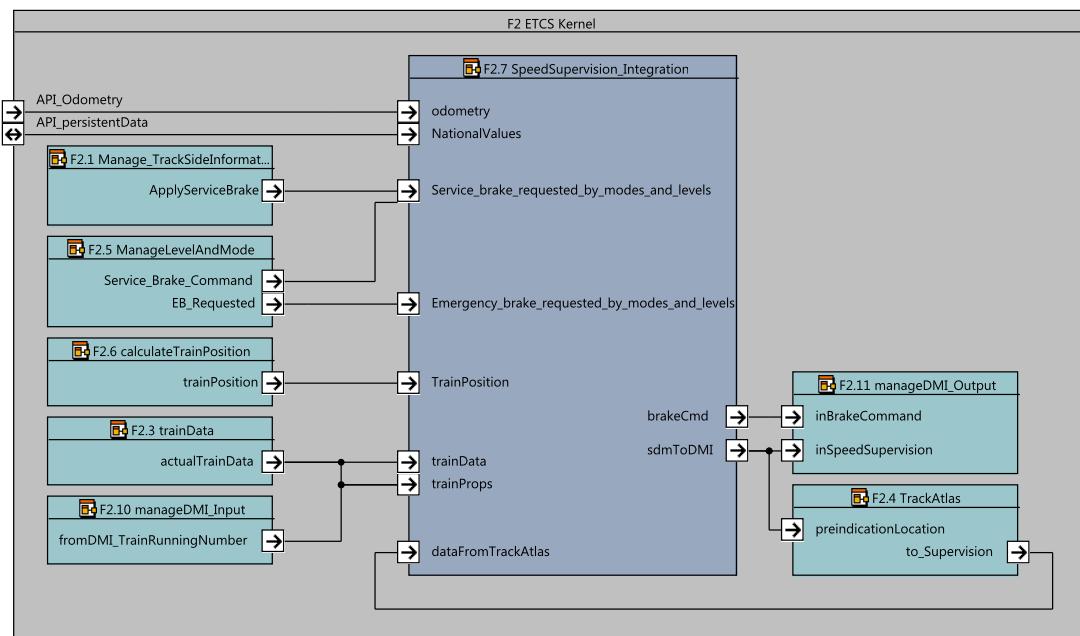


Figure 10. F2: ETCS Kernel SysML diagram with focus on F2.7 SpeedSupervision_Integration component.

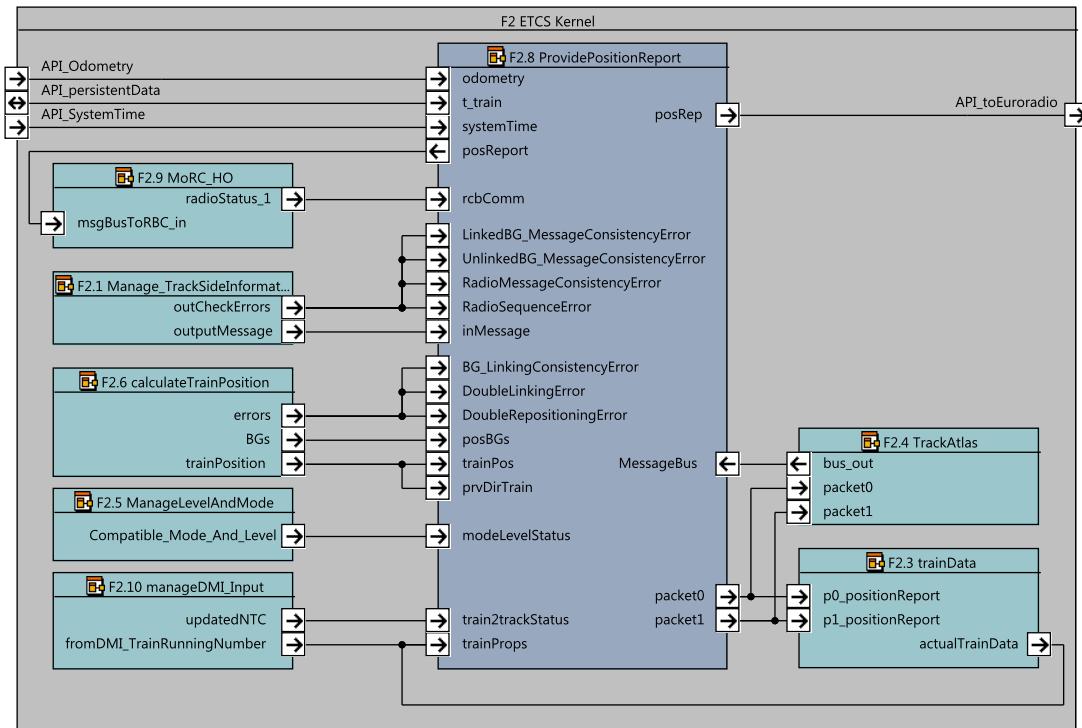


Figure 11. F2: ETCS Kernel SysML diagram with focus on F2.8 Provide_Position_Report component.

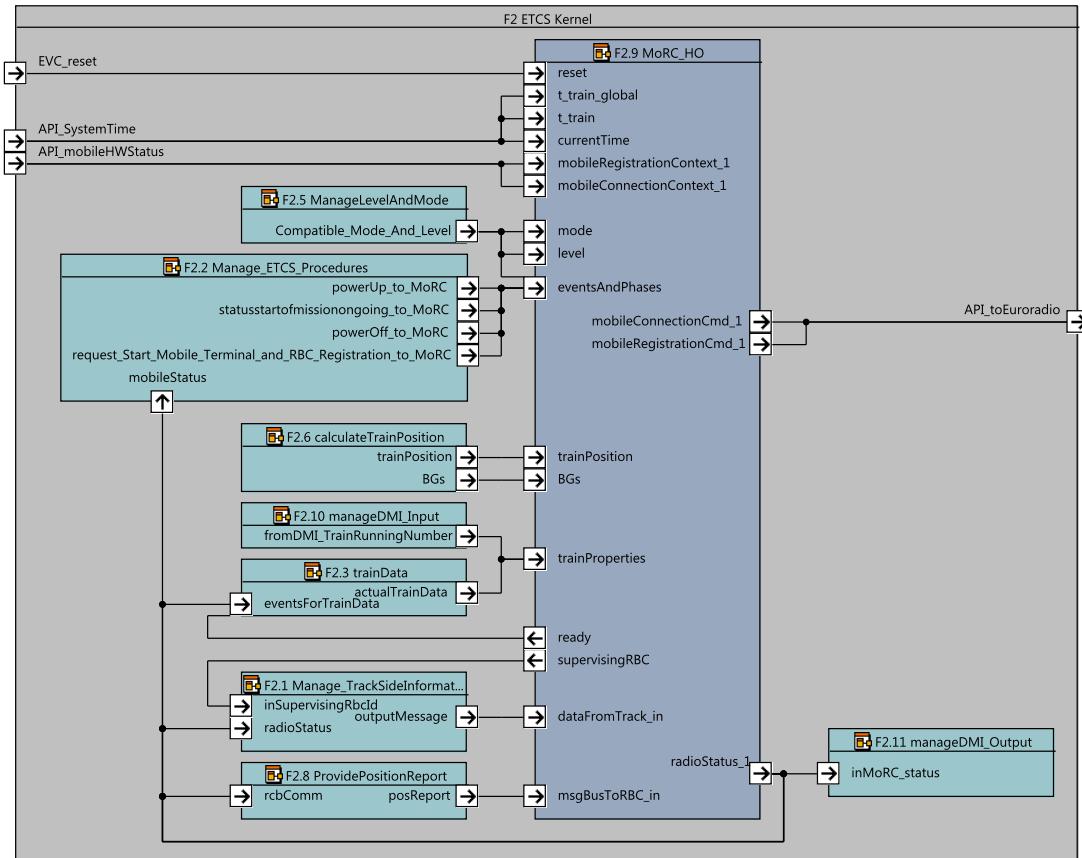


Figure 12. F2: ETCS Kernel SysML diagram with focus on F2.9 Manage_Radio_Communication component.

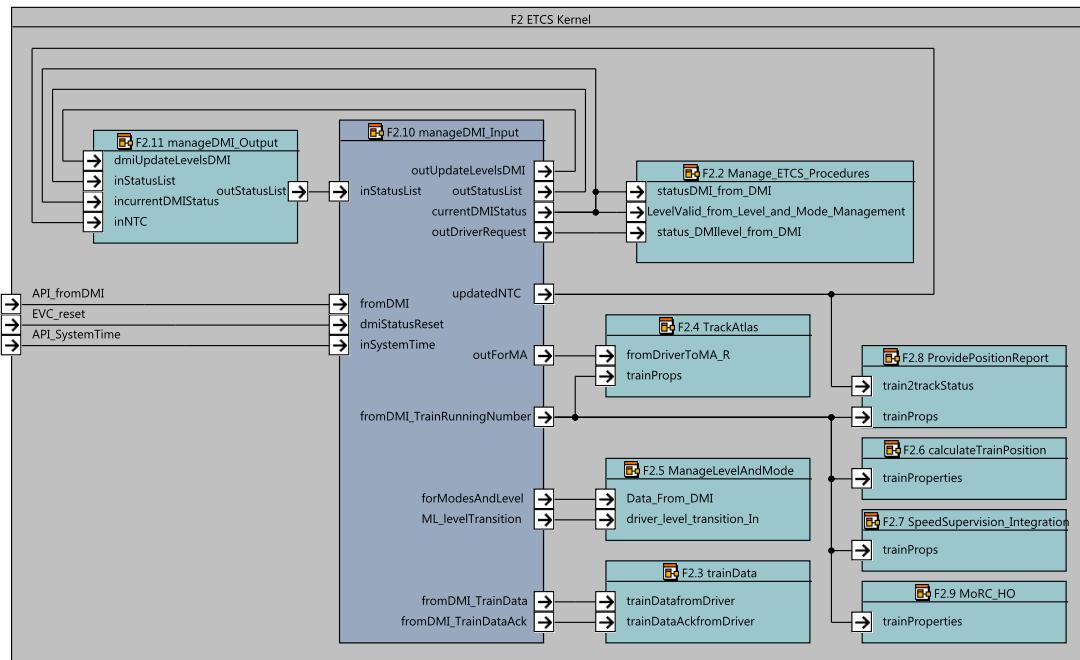


Figure 13. F2: ETCS Kernel SysML diagram with focus on F2.10 ManageDMIInput component.

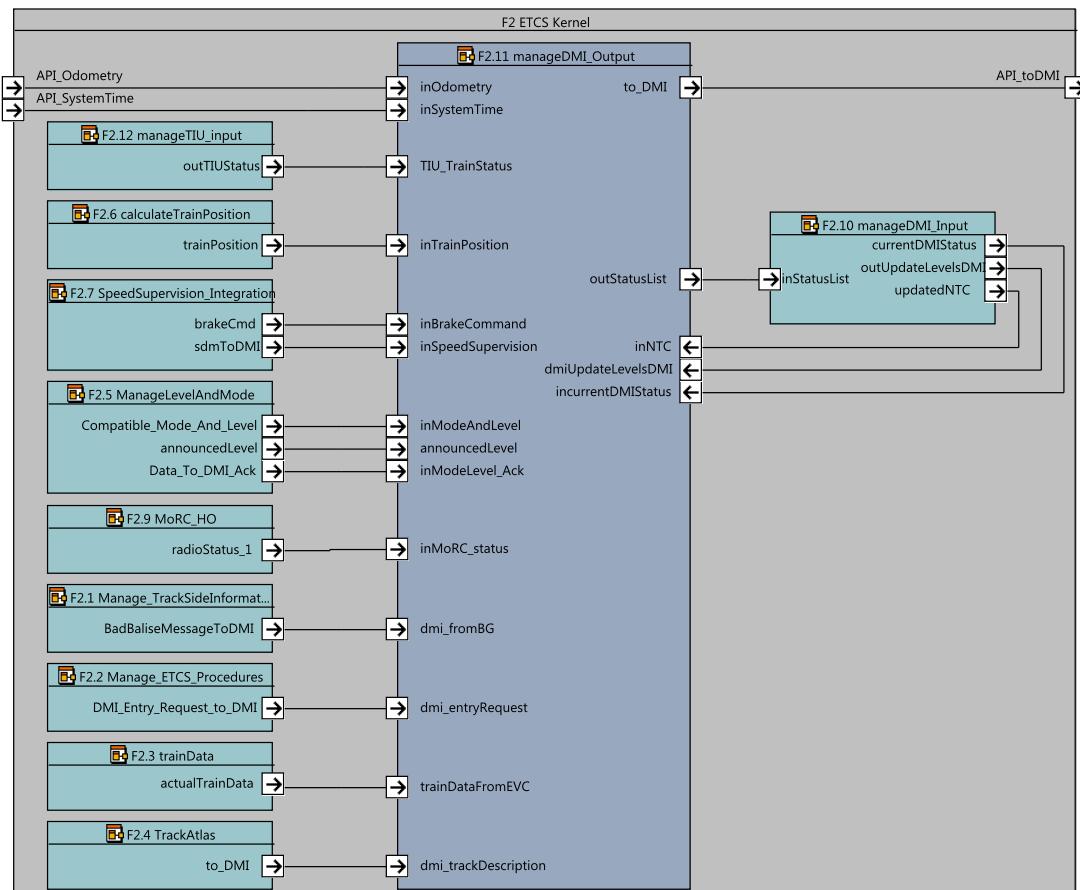


Figure 14. F2: ETCS Kernel SysML diagram with focus on F2.11 ManageDMIOutput component.

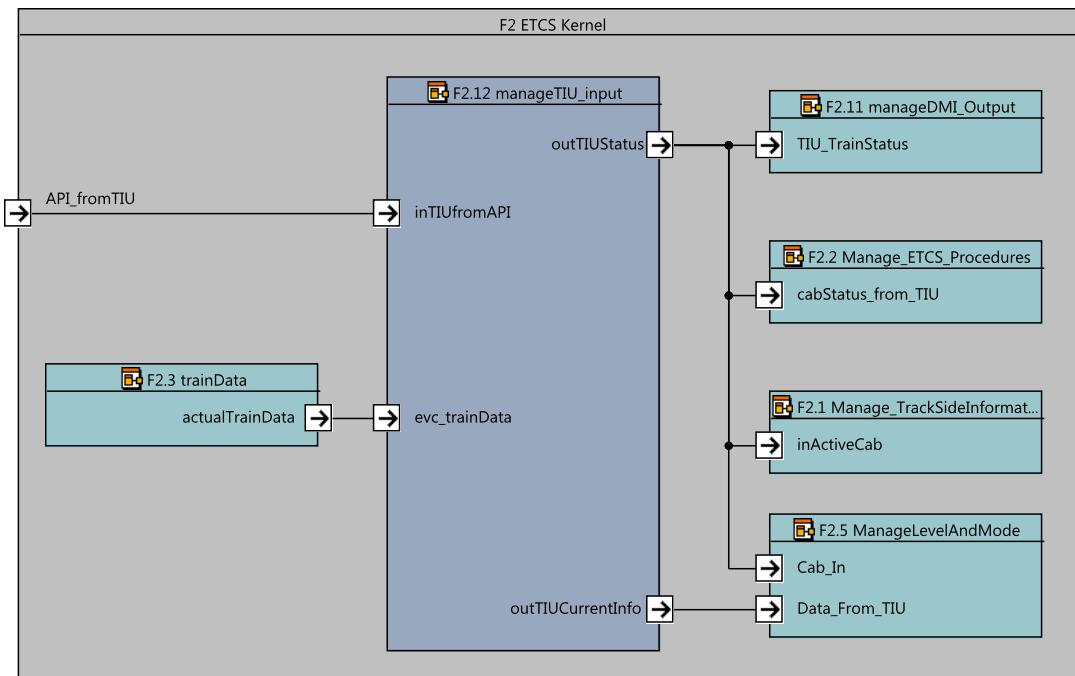


Figure 15. F2: ETCS Kernel SysML diagram with focus on F2.12 ManageTIUInput component.

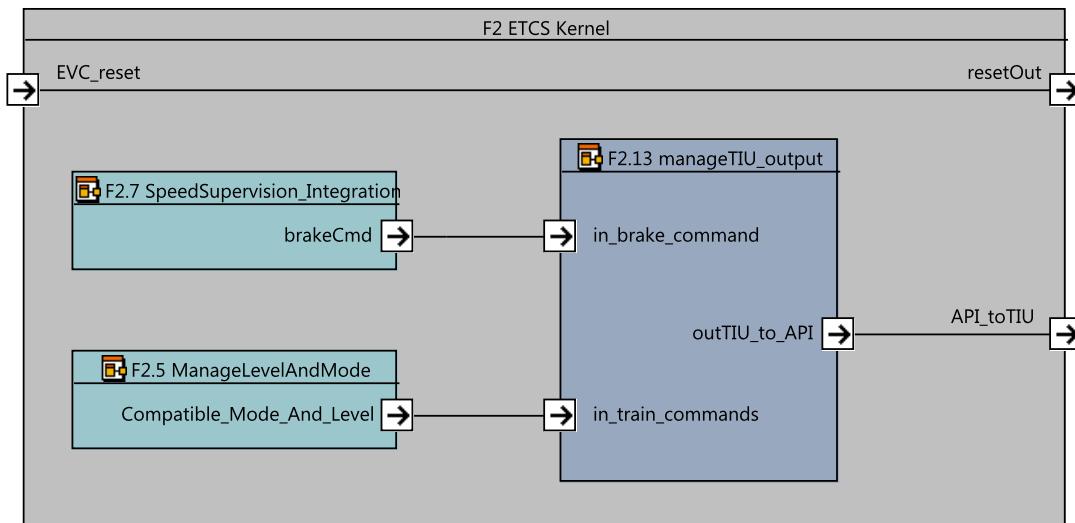


Figure 16. F2: ETCS Kernel SysML diagram with focus on F2.13 ManageTIUOutput component.

Input name	EVC_reset
Description	The reset input is used to delete all data stored in the connected components inside F2 (e.g. collected balise telegrams). If the input is set to true, all data kept in the components is deleted and no input is accepted. The reset option is to be used when the EVC is started or in system error scenarios.
Source	System Startup and Recovery
Type	bool
Valid range of values	<p>true EVC needs to be reset. All stored data of subcomponents get reset by there functions. evc needs to restart with a start of mission procedure.</p> <p>false no reset of the unit.</p>
Behaviour when value is n/a at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.1.1.1.2 API_Odometry

Input name	API_Odometry
Description	Odometry data provided by the external odometry module of the train.
Source	Odometer Unit
Type	structure
Valid range of values	n/a
Behaviour when value is n/a at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.1.1.1.3 API_SystemTime

Input name	API_SystemTime
Description	System time as defined by the runtime system.
Source	EVC operating system
Type	int
Valid range of values	positive range of int
Behaviour when value is at boundary	reset of the time.
Behaviour for values out of valid range	May result in loss of RBC messages due to sequencing errors and finally to the loss of an active radio connection. As a result train may go into standstill caused by emergency brake.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	see above

5.1.1.1.4 API_fromTrack

Input name	API_fromTrack
Description	Messages and Telegrams from trackside.
Source	BTM resp. RTM
Type	structure
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.1.1.1.5 API_fromDMI

Input name	API_fromDMI
Description	Input message from DMI
Source	API respectively F6 DMI Controller
Type	structure

Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.1.1.6 API_fromTIU

Input name	API_fromTIU
Description	Input message from the TIU
Source	API respectively F7 TIU Controller
Type	structure
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.1.1.7 API_mobileHWStatus

Input name	API_mobileHWStatus
Description	Current status of the connected radio module. This implementation is based on a single radio module. The upgrade to a system with two mobiles is in preparation.
Source	RTM
Type	structure
Valid range of values	n.a.
Behaviour when value is at boundary	n/a

Behaviour for values out of valid range n/a

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) n/a

5.1.1.1.8 API_persistentData

Input name	API_persistentData
Description	Storage of data which need to be loaded in order to be able to start the start of mission procedure. The data has to be saved as a part of the end of mission procedure.
Source	EVC-Storage
Type	structure
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.1.1.2 External Outputs

5.1.1.2.1 resetOut

Output name	resetOut
Description	Indicator for the successful execution of the reset function for the EVC.
Destination	System Startup and Recovery
Type	bool
Valid range of values	<p>true ok</p> <p>false not ok</p>
Behaviour when value is at boundary	n/a

Behaviour for values out of valid range n/a

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) n/a

5.1.1.2.2 API_toEuroradio

Output name	API_toEuroradio
Description	Radio messages to be sent to the RBC. The output is dedicated to a sending RTM module. In addition to the messages, commands for controlling the radio module are implemented in this interface.
Destination	Radio Transmission Module (RTM)
Type	structure
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.1.1.2.3 API_toDMI

Output name	API_toDMI
Description	Messages to be sent to the DMI
Destination	API respectively F6 DMI Controller
Type	structure
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.1.1.2.4 API_toTIU

Output name	API_toTIU
Description	Interface to the train Interface Unit (TIU) including Brake Interface Unit (BIU).
Destination	API respectively F7 TIU Controller
Type	structure
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.2 F2.1: Manage_TrackSideInformation_Integration

5.2.1 Component Requirements

Component name	Manage_TrackSideInformation_Integration
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/Manage_TrackSideInformation_Integration/Manage_TrackSideInformation_Integration.etc
SCADE designer	Bernd Hekele, DB Netz AG

Description	<p>The functional block “Manage_TrackSideInformation_Integration” is responsible for receiving Eurobalise telegrams and Euroradio messages from the API and performs several consistency checks on the inputs.</p> <p>The block collects the telegrams of balises in order to build balise group messages. Euroradio messages are always delivered as a whole message. On each message, a consistency check is performed, before the data is validated according to the driving direction of the train. In general, messages not designated for the current driving direction of the train are not forwarded for further processing. After applying consistency checks, the data direction is validated. Finally, the received message is handled in the InformationFilter subcomponent. The InformationFilter may, depending on level, mode and announced level transitions and radio handover scenarios, let information pass immediately, reject information, or buffer information for some cycles until certain conditions apply and the information will be passed. Information in this sense is packets in the context of messages.</p>
Input documents	See subcomponents.
Safety integrity level	4
Time constraints	The component has to be able to receive balise telegrams and radio messages according to the ETCS performance requirements, c.f. [?]. In highspeed traffic, a group of 8 balises must be read in about 250 msec. In addition, 1 message per sec. on the radio interface is to be expected.
API requirements	Interfaces to this unit are defined in the API sections [BTM], [EU-RORADIO], [ODO]. In these sections, also a detailed definition of the concepts implemented on those interfaces is documented.

5.2.2 Interface

An overview of the interface of component Manage_TrackSideInformation_Integration is shown in Figure 17. The inputs and outputs are described in detail in Section 5.2.2.1 respectively 5.2.2.2. Subcomponents are described in Section 5.2.3.

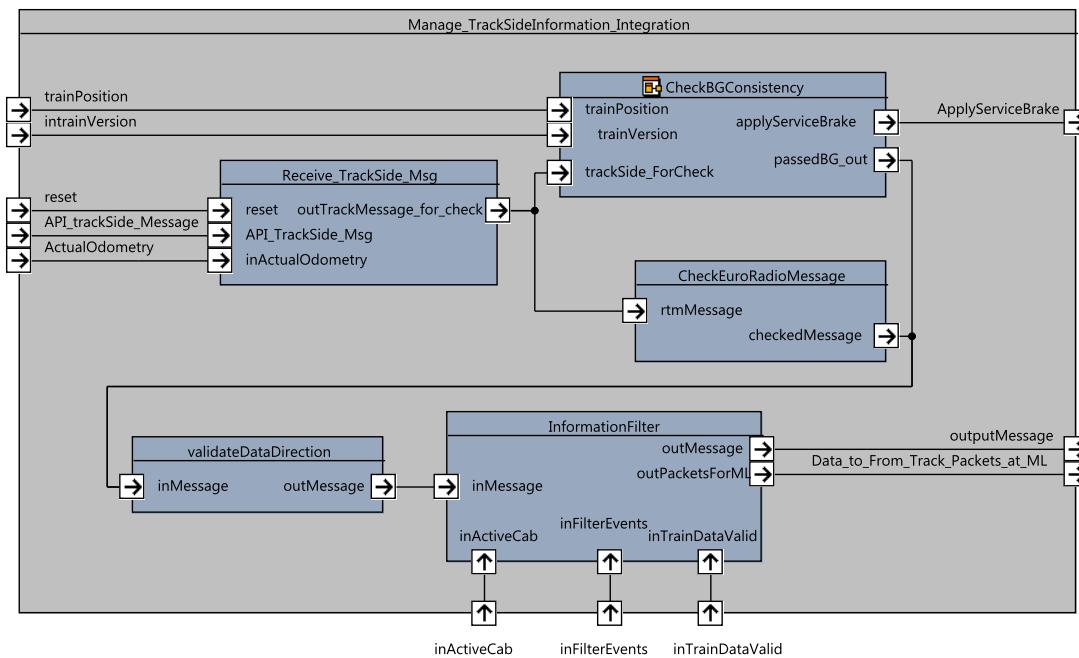


Figure 17. Manage_TrackSideInformation_Integration component SysML diagram.

5.2.2.1 Inputs

5.2.2.1.1 fullChecks

Input name	fullChecks
Description	Indicates, if all checks on the message should be performed. This parameter is for testing purposes only and has to be replaced by a constant in real operation.
Source	This item is only relevant in verification phases. In a real system checks are always activated.
Type	bool
Valid range of values	<p>true All checks are performed.</p> <p>false Component InformationFilter is deactivated.</p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.2.2.1.2 API_trackSide_Message

Input name	API_trackSide_Message
Description	<p>Track side message received from the API. The API performs pre-processing of RTM and BTM messages and delivers a maximum of a single message per cycle. The structure of this message is defined in the API [BTM] and [EURORADIO] sections. The input consists of the following main components:</p> <p>valid (bool) Indicates the information has been refreshed in the cycle. true : Information is updated in this cycle. false : Information is unchanged.</p>

systemTimeMsgReceived (Obu_BasicTypes_Pkg::T_internal_Type):

Timestamp when the system (i.e. the train) has received the message. The parameter is set either by RTM or by BTM modules.

msg_type (Common_Types_Pkg::MsgSource_T) source of this information.

msrc_undefined indicates the information is not defined. This input is expected when valid flag is false.

msrc_Euroradio indicates the information is a euroradio message.

msrc_Eurobalise indicates the information is a balise telegram.

Other values of this enumeration are not expected in this model.

btm_msg (API_Msg_Pkg::API_TelegramHeader_T) Telegram header with some additional information provided by the btm-module. The header is structured as follows:

present (bool) Telegram information has been received via BTM and the information of this telegram is present.

checkResult (bool) The telegram is checked after reception at the BTM. Typical checks are checksum-tests or checks at conversion of the types from bit-layout to the presentation in the evc. If checkResult is false the information may not be used. The information is evaluated in the checkBGConsistency component of this model.

api_bad_balise_received (bool) The telegram reception was disturbed. Again, the information related to this telegram may not be used in the EVC.

api_header (API_Msg_Pkg::API_TelegramHeader_T) Header of the telegram similar to Subset 026, Section 8.4.2.1. The information in the telegram is not packed on bit-boundaries.

centerOfBalisePosition (BG_Types_Pkg::centerOfBalisePosition_T) Location of the balise as determined by the antenna of the train. The information is extended with inaccuracies of the measurement given by the BTM.

rtm_msg (API_Msg_Pkg::API_RadioMsgHeader_T) Radio message header with some additional information added by the RTM module. The information is structured as follows:

present (bool) Radio message has been received via rtm and the information of this message is present.

apiConsistencyError (bool) The message is checked after reception at the btm. Typical checks are checksum-tests or checks at conversion of the types from bit-layout to the presentation in the evc. If apiConsistencyError is false the information may not be used. The information is evaluated in the checkRadioMessage component of this model.

Radio_Common_Header (Radio_Types_Pkg::Radio_TrackTrain_Header_T) Header of the radio-message as defined in Subset-026, Section 8.4.4.6.1. In the SRS, depending on the concrete message, some optional variables are defined. In our implementation all optional variables are foreseen. In order to indicate the availability of variables the component radioMetadata is used (see below).

radioMetadata (Common_Types_Pkg::RadioMetadata_T) Metadata for optional variables in the common radio message header. For each optional component a presence indicator of type bool is in the list.

sendingRBC_Id (Common_Types_Pkg::RBC_Id_T) Identifies the RBC as it is known at the RTM. Information is added to the interface in the RTM.

packets (Common_Types_Pkg::CompressedPackets_T) Packets as received as a part of the telegram or radio message. The structure is set-up and can be accessed by library routines of the trackMessages component of the system. In the manage_trackside_Messages component packets may be changed to being absent (e.g., by the function validateDataDirection or by the InformationFilter.). If packets have to be treated only this valid indicator is changed. No other parts of the packets are accessed.

Source	F2 input API_fromTrack
Type	API_Msg_Pkg::API_TrackSideInput_T
Valid range of values	Access to the information has to be guarded by the valid flag and similar flags deeper in the structure of the interface. Checks on individual values of message components, telegrams and packets are part of the decoding function. We assume information to be valid in this part of the system.

Behaviour when value is n/a (structure)
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.2.2.1.3 ActualOdometry

Input name	ActualOdometry
Description	Odometry data provided by the external odometry module of the train. It contains relative location information with inaccuracies. In this model only information related to the position of the train is used (ODO component). A valid flag of the odometer input indicates the hardware is working and the parameter may be used.
Source	F2 input API_Odometry
Type	Obu_BasicTypes_Pkg::odometry_T
Valid range of values	From the ODO component the nominal position is used. No plausibility checks on the component are done. Any integer value is allowed.
Behaviour when value is at boundary	Boundary value may lead to jump of the calculation in negative ranges. As a result the train may not be able to complete the reading of a balise group. In consequence, this results in a balise group error and in a service brake reaction of the train.
Behaviour for values out of valid range	Same as description at boundary.
Behaviour when value is erroneous, absent or un- wanted (i.e. spurious)	Same as description at boundary.

5.2.2.1.4 reset

Input name	reset
Description	The reset input is used to delete all data stored in the module (e.g. collected balise telegrams, which do not yet form a complete message). If the input is set to true, all data kept in the module is deleted and no input is accepted. The reset option is to be used when the EVC is started or in system error scenarios.
Source	F2 input EVC_reset

Type bool

Valid range of values

true All data kept in the module is deleted and no input is accepted.

false No action. Data at input is accepted.

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.2.2.1.5 trainPosition

Input name	trainPosition
Description	Contains the current position of the train. This input is used for validation of the direction of packets and for checks of balise groups. Most important information in this input is the LRBG and the pre-vLRBG component. This identifies the last two balise group passed by the train.
Source	F2.6 calculateTrainPosition
Type	TrainPosition_Types_Pck::trainPosition_T
Valid range of values	A valid flag is used in this input to indicate data is provided correctly.
Behaviour when value is n/a at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.2.2.1.6 modeAndLevel

Input name	modeAndLevel
Description	Provides the current level and mode of the EVC. Mode and Level are used by the InformationFilter subcomponent.
Source	F2.5 ManageLevelAndMode
Type	BG_Types_Pkg::ModeAndLevelStatus_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.2.2.1.7 tNvContact

Input name	tNvContact
------------	------------

Description	For monitoring the safe radio connection, this national value is needed as an input. This parameter is used in the radioCheck component of this model.
Source	F2 input API_persistentData
Type	Obu_BasicTypes_Pkg::T_internal_Type
Valid range of values	Positive integer.
Behaviour when value is at boundary	When boundary is reached the input will jump to 0.
Behaviour for values out of valid range	If negative, this parameter will result in a radio message sequence error. Connection to the rbc will be closed.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	See above.

5.2.2.1.8 intrainVersion

Input name	intrainVersion
Description	For monitoring the safe radio connection, this national value is needed as an input. This parameter is used in the radioCheck component of this model.
Source	F2 input API_persistentData
Type	M_VERSION
Valid range of values	Enumerated values.
Behaviour when value is at boundary	Value check will reject radio message resp. balise telegram. In the consequence train will stop respectively the session will be rejected.
Behaviour for values out of valid range	Value check will reject radio message resp. balise telegram. In the consequence train will stop respectively the session will be rejected.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	See above.

5.2.2.1.9 lastRelevantEventTimestamp

Input name	lastRelevantEventTimestamp
------------	----------------------------

Description	For monitoring the safe radio connection, it is necessary that the time between two packets is less than the value of T_NVCONTACT. In situations like level changes or announced radio holes, not the timestamp of the last message is relevant for comparison, but the timestamp of the last relevant event. This can for example be the timestamp of the level change or the timestamp of the moment, when the train was passing the end of the radiohole. For performing this check, the timestamp of the last relevant event is provided to the model as an T_internal_Type-type.
Source	F2.1 Manage_TracksidesInformation_Integration
Type	Obu_BasicTypes_Pkg::T_internal_Type
Valid range of values	Positive integer.
Behaviour when value is at boundary	Once the largest possible timestamp is exceeded, the next timestamps will start from 0 again. This may result in calculations of durations with negative result. As a consequence, the train will react with the loss of the communication session.
Behaviour for values out of valid range	See above.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	See above.

5.2.2.1.10 connectionStatus

Input name	connectionStatus
Description	Status information about the radio connection. The information is needed to perform the timing check, which depends on the connection state in the radioCheck component.
Source	F2.9 MoRC_Main
Type	Radio_Types_Pkg::sessionStatus_Type
Valid range of values	<p>DISCONNECTED The OBU is currently not connected to a RBC.</p> <p>CONNECTING The OBU is currently connecting to the RBC. Received messages belong to the process of establishing a connection.</p> <p>CONNECTION_ESTABLISHED The connection to the RBC is established.</p>
Behaviour when value is at boundary	n/a

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.2.2.1.11 inSupervisingRbcId

Input name	inSupervisingRbcId
Description	For the InformationFilter subcomponent, the information which radio messages are sent by the supervising RBC is needed. To recognize these messages, the identifier of the supervising RBC is needed.
Source	F2.9 MoRC_Main
Type	int
Valid range of values	0, 1, 2
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	Is interpreted as non valid radio connection.
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	Is interpreted as non valid radio connection.

5.2.2.1.12 inAnnouncedBGs

Input name	inAnnouncedBGs
Description	Provides information about balise groups as known in the EVC. This information is generated by the CalculateTrainPosition component based on the linking information received from track side and on the balise groups passed by the train.
Source	F2.6 calculateTrainPosition
Type	TrainPosition_Types_Pck::positionedBGs_T
Valid range of values	Each balise group entry is identified by an valid flag.
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.2.2.1.13 q_nvlocacc

Input name	q_nvlocacc
Description	This national value determines the location accuracy. Needed as input for checkBGConsistency.
Source	F2 input API_persistentData
Type	Q_NVLOCACC
Valid range of values	Integers in the range 0, ..., 63
Behaviour when value is at boundary	No impact.
Behaviour for values out of valid range	Will result in wrong calculation of inaccuracy of the train.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	See above.

5.2.2.1.14 inActiveCab

Input name	inActiveCab
Description	Indicates the cab is active. This input is used by the InformationFilter subcomponent.
Source	F2.12 manageTIU_input
Type	bool
Valid range of values	<p>true Cab is active. false Cab is inactive.</p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.2.2.1.15 inTrainDataValid

Input name	inTrainDataValid
Description	Indicates train data have been validated by the RBC. This input is used by the InformationFilter subcomponent.
Source	F2.3 trainData
Type	bool
Valid range of values	
<p>true Train data has been validated.</p> <p>false Train data has not been validated.</p>	
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.2.2.1.16 inFilterEvents

Input name	inFilterEvents
Description	A set of events needed for controlling the InformationFilter subcomponent. For details see valid range of values row in this table.
Source	F2.3 trainData
Type	Common_Types_Pkg::filterRelatedEvents_T

Valid range of values	This input is a complex structure consisting out of the following components: pendingL1Transition (bool) Indicates if an announced LEVEL 1 transition is present. Used for Level filter exception [1]. The information is indicating the status. Note: this indication can be evaluated based on information available in the Information-Filter. The input is not used from outside the main component Manage_TrackSide_Information. pendingL2L3Transition (bool) Indicates if an announced LEVEL 2 or Level 3 transition is present. Used for Level Filter exception [2]. The information is indicating the status. Note: this indication can be evaluated based on information available in the InformationFilter. The input is not used from outside the main component Manage_TrackSide_Information. pendingAckOfTrainDataFromRBC (bool) Indicates if the acknowledgement of train data is pending. Used for Level filter exception [3]. emergencyStopAccepted (bool): Indicate if the train performs an emergency brake. Used for Level filter exception [5]. lastAckTextMessageId (int) The ID of the last acknowledged text message ID. Used for Level filter exception [12]. The SRS requires text messages to restrict from double sending to the DMI when handled in the filter. This function is currently not implemented. pendingNTCTransition (bool) Indication if an announced LEVEL NTC transition is present. Used for Level filter exception [6,7]. SPPAndGradientOnBoard (bool) Speed Profile and Gradient Profile received and available on board. This information may be part of the actual incoming message. MACoverNotFullLength (bool) MA does not cover full length of the trip. Information from trackAtlas.
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Behaviour when value is n/a
at boundary

Behaviour for values out of valid range

Behaviour when value is n/a
erroneous, absent or unwanted (i.e. spurious)

5.2.2.1.17 transitionPositionPassed

Input name	transitionPositionPassed
------------	--------------------------

Description	The position of the requested level transition has been passed. This information is used by InformationFilter subcomponent to clean data after level management reactions.
Source	F2.5 ManageLevelAndMode
Type	bool
Valid range of values	
	<p>true The position of the requested level transition has been passed.</p> <p>false The position of the requested level transition has not been passed.</p>
Behaviour when value is n/a at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.2.2.2 Outputs

5.2.2.2.1 outputMessage

Output name	outputMessage
Description	Combines both balise and radio messages to one common datatype. This datatype contains all variables and packets, which are possible for the given scenario. In each cycle at most one valid message is put to the output. The InformationFilter subcomponent might take the last processed one or a message from stack - depending on the information stored and on the status of the evc. The component consists of the following building blocks:
<p>valid Information about the status of this message.</p> <p>true The information is valid, a new message is now visible at the output. The valid flag (and the message as such) will only be present for one cycle.</p> <p>false No valid message is available.</p>	

source (Common_Types_Pkg::MsgSource_T) Source of this information.

msrc_undefined Indicates the information is not defined. This input is expected when valid flag is false.

msrc_Euroradio Indicates the information is a euroradio message.

msrc_Eurobalise Indicates the information is a balise telegram.

Other values of this enumeration are not expected in this model.

radioMetadata (Common_Types_Pkg::RadioMetadata_T) Metadata for optional variables in the common radio message header. For each optional component a presence indicator of type bool is in the list.

BG_Common_Header (BG_Types_Pkg::BG_Header_T) Balise group message header with some additional information. This header collects information from the balise telegram headers together with the location and orientation of the balise group related to the driving direction.

Radio_Common_Header (Radio_Types_Pkg::Radio_TrackTrain_Header_T) Radio message header with some additional information added by the RTM module. Variables of messages which are not present in all messages are available in the header, but controlled by the radio metadata.

packets (Common_Types_Pkg::CompressedPackets_T) Packets as received as a part of the telegram or radio message. The structure is set-up and can be accessed by library routines of the trackMessages component of the system. In the manage_trackside_Messages component packets may be changed to being absent (e.g., by the function validateDataDirection or by the InformationFilter.). If packets have to be treated only this valid indicator is changed. No other parts of the packets are changed.

Destination	F2.4 TrackAtlas F2.6 calculateTrainPosition F2.8 ProvidePositionReport F2.9 MoRC_Main
Type	Common_Types_Pkg::ReceivedMessage_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.2.2.2.2 ApplyServiceBrake

Output name	ApplyServiceBrake
Description	Indicates if the balise group the train just passed could not be processed correctly. The check results in the request for a service break.
Destination	F2.7 SpeedSupervision_Integration
Type	bool
Valid range of values	<p>true Request for service break. false No request for service break.</p>

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.2.2.2.3 BadBaliseMessageToDMI

Output name	BadBaliseMessageToDMI
Description	Information to be passed to the DMI to indicate the reception of a “bad balise” to the driver.
Destination	F2.11 manageDMI_output
Type	bool
Valid range of values	<p>true Reception of “bad balise” should be indicated to the driver. false Reception of “bad balise” should not be indicated to the driver.</p>
Behaviour when value is n/a at boundary	

Behaviour for values out of valid range n/a

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) n/a

5.2.2.2.4 outCheckErrors

Output name	outCheckErrors
Description	Error flags for errors found during the message check procedures. For details see valid range of values row of this table.
Destination	F2.5 ManageModeAndLevel F2.8 ProvidePositionReport
Type	Common_Types_Pkg::MSG_Errors_T
Valid range of values	<p>This output is a complex structure mainly consisting out of boolean values. The boolean variables are set true if an error in the particular parameter has been detected and false otherwise.</p> <p>linkedBGError (bool) Reported by checkBGConsistency. Error in a linked BGH - Message has been detected.</p> <p>unlinkedBGError (bool) Reported by checkBGConsistency. Error in an unlinked BGH - Message has been detected.</p> <p>BG_versionIncompatible (bool) Reported by checkBGConsistency. Version of received Balises is not compliant with the train. Balises cannot be used.</p> <p>radioSequenceError (bool) Reported by checkEuroRadioMessage. The sequence of messages in the input channel is not correct. This check is based in t_train of the incoming radio messages.</p> <p>tNvContactError (bool) Reported by checkEuroRadioMessage. The time for receiving the next radio message has been exceeded. This indicates lost radio messages.</p> <p>otherTimingError (bool) Reported by checkEuroRadioMessage. Other timing errors.</p> <p>radioMessageConsistencyError (bool) Reported by checkEuroRadioMessage. Inconsistencies in the contents of radio messages have been detected.</p> <p>nid_c (NID_C) Reported by checkBGConsistency. If known id of the erroneous balise group.</p> <p>nid_errorbg (NID_ERRORBG) Reported by checkBGConsistency. If known id of the erroneous balise group.</p>

Behaviour when value is n/a at boundary

Behaviour for values out of valid range n/a

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) n/a

5.2.2.2.5 forLevelManagement

Output name	forLevelManagement
Description	<p>The InformationFilter subcomponent has to provide information to the EVC components according to the actual level and radio state. In order to trigger the level change level management needs to know about availability of track profiles and other components in order to select the correct mode and level. This output provides information relevant to trigger level transitions. The data will be accumulated in the InformationFilter until the position for the level change has been reached. The output structure consists of the following components:</p> <p>P41 (Packet_Types_Pkg::P41_LevelTransistionOrders_T) Packet 41 (level transition order).</p> <p>P46 (Packet_Types_Pkg::P46_LevelTransistionOrders_T) Packet 46 (conditional level transition order).</p> <p>LRBG (NID_LRBG) Reference LRBG for the level transition order..</p> <p>referenceLocation (Obu_BasicTypes_Pkg::L_internal_Type) Location of the reference LRBG. This location has to be used as reference for calculating the level transition position.</p> <p>P12_received (bool) Packet 12 (Level 1 Movement Authority) has been received at the InfomationFilter subcomponent in the context of this level transition.</p> <p>P15_received (bool) Packet 15 (Level 2/3 Movement Authority) has been received at the InfomationFilter subcomponent in the context of this level transition.</p> <p>P21_received (bool) Packet 21 Gradient Profile) has been received at the InfomationFilter subcomponent in the context of this level transition.</p> <p>P27_received (bool) Packet 27 (International Static Speed Profile) has been received at the InfomationFilter subcomponent in the context of this level transition.</p>
Destination	F2.5 ModesAndLevels
Type	Level_And_Mode_Types_Pkg::T_Data_From_TrackForLevelChange

Valid range of values

true An error in a unlinked balise group was detected.

false No error in a unlinked balise group was detected.

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.2.2.2.6 outputMessageForRadioAck

Output name	outputMessageForRadioAck
Description	Even if an incoming radio message is rejected or kept for some time in the buffer of the InformationFilter subcomponent, some information needs to be made available for maintaining the communication session with the RBC, e.g., the timestamp of the received message and acknowledgment of message reception based on the ACK flag. No other information of this message is to be used in the EVC. This concept might be improved when radio management functions are rearranged.
Destination	F2.3 trainData
Type	Common_Types_Pkg::ReceivedMessage_T
Valid range of values	
true An error in a unlinked balise group was detected.	
false No error in a unlinked balise group was detected.	
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.2.3 Subcomponents

5.2.3.1 Receive_TrackSide_Msg

5.2.3.1.1 Component Requirements

Component name	Receive_TrackSide_Msg
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/Receive_TrackSide_Msg
SCADE designer	Bernd Hekele, DB Netz AG
Description	<p>This function defines the interface of the OBU model to the openETCS generic API for Eurobalise and Euroradio messages. On the interface, either a valid telegram/message is provided or a telegram/message is indicated which could not be received correct when passing the balise or receiving the radio message. The function passes a balise telegram without major changes of the information to the next entity for collecting the balise group information. This entity collects telegrams received via the interface into Balise Group Information. In case of a radio message, the message is converted to an internal format for further processing and passed without changing the information contained.</p> <ul style="list-style-type: none"> • The decoding of balises is done at the API. Also, packets received via the interface are already transformed into a usable shape. • Only packets used inside the current model are passed via the interface. • Treatment of Packet 5: Linking Information. Linking Information is added to the linking array starting from index 0 without gaps. Used elements are marked as valid. Elements are sorted according to the order given by the telegram sequence. • Telegrams received as invalid are passed to the “Check-Function” to process errors in communication with the track side according to the requirements and in a single place. Telegrams are added to the telegram array starting from index 0 without gaps. Used elements are marked as valid. Elements are stored according to the order given by the telegram sequence. • This function does not process information from the packets. The information is passed to the check without further processing of the values.
Input documents	<p>Subset-026, Chapter 7 and 8: Definition of the Balise Telegram Subset-026, Chapter 4.2.2, 4.2.4, 4.2.9: Interface to the BTM Subset-026, Chapter 3.4.1 - 3.4.3, 3.16.2: Handling of Balise Telegrams Subset-026, Chapter 3.16.2: Check of the balise group Subset-026, Chapter 3.4.2: Determining the orientation Subset-026, Chapter 4.5.2: Active Functions Table Subset-026, Chapter 8.4.4: Rules for Euroradio messages</p>
Safety integrity level	4

Time constraints	n/a
API requirements	n/a

5.2.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.2.3.2 CheckBGConsistency

5.2.3.2.1 Component Requirements

Component name	CheckBGConsistency
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/CheckBGConsistency
SCADE designer	Peyman Farhangi, DB Netz AG
Description	<p>The function "Receive_TrackSide_Msg" collects the telegrams in an array. If one or more telegrams are received multiple times, either the whole array or single telegram should be deleted.(e.g.if the train moves back.) The balises in a group are to be expected in a certain distance from each other. The function "Receive_TrackSide_Msg" checks if the telegrams has been received in due time and at the right expected location.</p> <p>The function "CheckBGConsistency" verifies the completeness and correctness of the received telegrams from balise groups and composes the balise message from the received telegram array (input from "Receive_TrackSide_Msg"). A balise message is built from at least one telegram and a maximum of 8 telegrams. When linking information is used on-board, only balise groups marked as linked and included in the linking information and balise groups marked as unlinked shall be taken into account.</p>

- A message is still complete and correct, if a telegram is missing (or not decoded or incompletely decoded), and this telegram is duplicated within the balise group and the duplicating one is correctly read.
- In case of multiple telegrams, the order of N_PIG of telegrams must be either ascending (nominal) or descending (reverse). And the all telegrams must have the same NID_BG and NID_C.
- A message is not correct, if a message counters (M_MCOUNT) equals 254 (that means: The telegram never fits any message of the group). A message counter can equal 255 (that means: The telegram fits with all telegrams of the same balise group) and all other values must be the same.

The orientation of the BG and the running direction of the train are calculated in this block. When linking information is used on-board, the check, if the message of linked balise group has been received in due time and at the expected location, will be performed in "Calculate Train Position". The checks on the validity of the data in the packets and the validity with respect to the direction of motion will be performed in other modules, e.g. "ValidateDataDirection".

Input documents	Subset-026, Chapter 7 and 8: Definition of the Balise Telegram Subset-026, Chapter 3.4.1-3, 3.16.2: Handling of Balise Telegrams Subset-026, Chapter 3.16.2: Check of the balise group Subset-026, Chapter 4.5.2: Active Functions Table
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.2.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.2.3.3 CheckEuroradioMessage

5.2.3.3.1 Component Requirements

Component name	CheckEuroradioMessage
Link to SCADE model	https://github.com/openETCS/modeling/tree/b9c31ce6fdf702b412bbeab3032a8a4dc7c92e5c/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/CheckEuroRadioMessage
SCADE designer	Stefan Karg, LEA Railergy

Description	<p>The component “CheckEuroradioMessage” performs consistency and timing checks on the received radio message. These checks are:</p> <ul style="list-style-type: none"> • Checking the message sequence. • Check if the message violates timing constraints (T_NVCONTACT). • Check if all mandatory elements are included. • Check if no elements are included, which are forbidden for the given message id. <p>Messages, which violate one or more of these criteria are marked as invalid in the message header and the component signals the reason for the invalidation via different flags as described in the SCADE model.</p>
Input documents	Subset-026, Chapter 3.16 Subset-026, Chapter 8.4.4
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.2.3.3.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.2.3.4 ValidateDataDirection

5.2.3.4.1 Component Requirements

Component name	ValidateDataDirection
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/ValidateDataDirection
SCADE designer	Stefan Karg, LEA Railergy
Description	The component filters an input message in order to mark all elements as invalid, which are not designated for the current driving direction of the train.

- The operator contains two processing paths for different message types. Radio messages and balise group messages are handled in a different way. For validating the data direction of a radio message, the check is performed using the balise group referenced in the radio message header as relevant balise group. For balise group message, the LRBG is used.
- The metadata of packets, which are recognized as not valid for the current driving direction, is invalidated.

Input documents	Subset-026, Chapter 3.6.3
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.2.3.4.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.2.3.5 InformationFilter

5.2.3.5.1 Component Requirements

Component name	InformationFilter
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/InformationFilter
SCADE designer	Christian Stahl, TWT Alexander Stante, FhG

Description	The filter receives track information (balise and radio) and filters them depending of the mode, level and source of the message. Only messages that pass the filter are valid and should be considered by other ETCS subsystems. The filter consists of four subcomponents: FirstFilter, SecondFilter, ThirdFilter and TransitionBuffer. FirstFilter This filter performs filtering of messages based on the current ETCS level. The decisions taken process is described via a big decision table which contains rows for every packet and columns for every ETCS level. This table encodes also if certain additional information is necessary to filter a message like pending ETCS Level transitions. Based on this filter packets of an incoming message is either rejected, accepted or the whole message is put in the TransitionBuffer. Messages are put in the TransitionBuffer if there is an announced level transition and the received message is only valid for the upcoming level. SecondFilter The SecondFilter mainly considers messages that are received via Euroradio. Certain messages are directly rejected while other may be stored in the TransitionBuffer. The buffer is used to store messages that are received from non supervising RBCs, but will be reevaluated after a RBC transition. ThirdFilter The last filter is functionally very similar the the FirstFilter, however it filters depending on the mode. It also contains a decision table with rows for every packet but the columns are modes. TransitionBuffer The InformationFilter uses two TransitionBuffers. One is used to store up to three messages for the ETCS level transition and the other buffer is used for RBC transitions. The buffer is designed as a ring buffer and message are read in FIFO order.
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Input documents	Subset-026, Chapter 4.8
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.2.3.5.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.3 F2.2: Manage_ETCS_Procedures

5.3.1 Component Requirements

Component name	Manage_ETCS_Procedures
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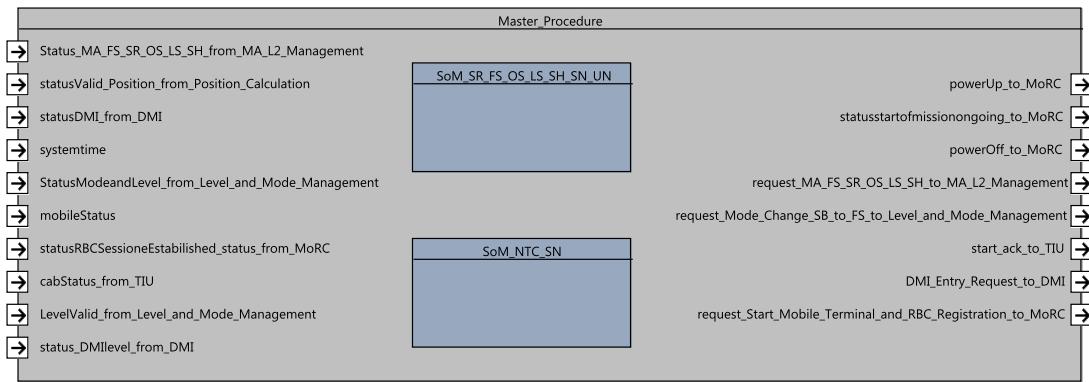


Figure 18. Manage_ETCS_Procedures component SysML diagram.

Link to SCADE model <https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/Procedures>

SCADE designer Baseliyos Jacob, DB Netz AG

Description This function describes the Start of Mission procedure of the train until the current status will change to another mode, level or other procedure.

Input documents Subset-026, Chapter 5.4

Safety integrity level 4

Time constraints n/a

API requirements n/a

5.3.2 Interface

An overview of the interface of component Manage_ETCS_Procedures is shown in Figure 18. The inputs and outputs are described in detail in Section 5.3.2.1 respectively 5.3.2.2. Subcomponents are described in Section 5.3.3.

5.3.2.1 Inputs

5.3.2.1.1 statusDMI_from_DMI

Input name	statusDMI_from_DMI
Description	Input interface of DMI Controller status.
Source	F2.10 manageDMI_input
Type	DMI_Types_Pkg::DMI_EVC_status_T
Valid range of values	See SCADE generated documentation respectively SCADE Suite functional model.
Behaviour when value is at boundary	n/a

Behaviour for values out of valid range Function will not be triggered.

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) Function will not be triggered.

5.3.2.1.2 Status_MA_FS_SR_OS_LS_SH_from_MA_L2_Management

Input name	Status_MA_FS_SR_OS_LS_SH_from_MA_L2_Management
Description	Status of MA, Mode and Level from Level and Mode Management.
Source	F2.2 Manage_ETCS_Procedures
Type	bool

Valid range of values

true Movement Authority for Level 2 FS is valid

false Movement Authority for Level 2 FS is not valid

Behaviour when value is n/a at boundary

Behaviour for values out of valid range n/a

Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)

5.3.2.1.3 systemtime

Input name	systemtime
Description	Standardized system time used for all internal calculations.
Source	F2 input API_Systemtime
Type	Obu_BasicTypes_Pkg::T_internal_Type
Valid range of values	[0, maximum positive int value of target platform]
Behaviour when value is at boundary	System time is assumed to be valid.
Behaviour for values out of valid range	System time is assumed to be valid.

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) System time is assumed to be valid.

5.3.2.1.4 StatusModeandLevel_from_Level_and_Mode_Management

Input name	StatusModeandLevel_from_Level_and_Mode_Management
Description	Status of Mode and Level.
Source	F2.10 ManageLevelAndMode
Type	Level_And_Mode_Types_Pkg::T_Mode_Level
Valid range of values	See SCADE generated documentation respectively SCADE Suite functional model.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.3.2.1.5 mobileSwStatus_p_from_MoRC

Input name	mobileSwStatus_p_from_MoRC
Description	Information about SW status from Management of Radio Communication function.
Source	F2.9 MoRC_HO
Type	MoRC_Pck::mobileSWStatus_Type
Valid range of values	See SCADE generated documentation respectively SCADE Suite functional model.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.3.2.1.6 statusRBCSessionEstablished_status_from_MoRC

Input name	statusRBCSessionEstablished_status_from_MoRC
Description	Information about RBC Session status from the Management of Radio Communication function.
Source	F2.9 MoRC_HO
Type	Radio_Types_Pkg::sessionStatus_Type
Valid range of values	See SCADE generated documentation respectively SCADE Suite functional model.
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.3.2.1.7 cabStatus_from_TIU

Input name	cabStatus_from_TIU
Description	Information about cab desk status from Train Interface Unit function.
Source	F2.12 manageTIU_input
Type	TIU_Types_Pkg::TIU_trainStatus_T
Valid range of values	See SCADE generated documentation respectively SCADE Suite functional model.
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.3.2.1.8 statusValid_Position_from_Position_Calculation

Input name	statusValid_Position_from_Position_Calculation
Description	Information about validity status of the train position calculation.

Source	F2.6 calculateTrainPosition
Type	bool
Valid range of values	
	true Calculated train position is valid.
	false Calculated train position is not valid.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.3.2.1.9 status_DMIlevel_from_DMI

Input name	status_DMIlevel_from_DMI
Description	Information about the status of DMI menu and level request from DMIController function.
Source	F2.10 manageDMI_input
Type	DMI_Messages_DMI_to_EVC_Pkg::DMI_Driver_Request_T
Valid range of values	See SCADE generated documentation respectively SCADE Suite functional model.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.3.2.1.10 LevelValid_from_Level_and_Mode_Management

Input name	LevelValid_from_Level_and_Mode_Management
Description	Information about the validity status of the StatusModeandLevel_from_Level_and_Mode_Management input.
Source	F2.5 ManageModeAndLevel

Type	bool
Valid range of values	
	true Level and Mode information are valid.
	false Level and Mode information are not valid.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or un- wanted (i.e. spurious)	n/a

5.3.2.2 Outputs

5.3.2.2.1 DMI_Entry_Request_to_DMI

Output name	DMI_Entry_Request_to_DMI
Description	Information about input request to the driver.
Destination	F2.11 manageDMI_output
Type	DMI_Messages_EVC_to_DMI_Pkg::DMI_Entry_Request_T
Valid range of values	See SCADE generated documentation respectively SCADE Suite functional model.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or un- wanted (i.e. spurious)	n/a

5.3.2.2.2 request_Start_Mobile_Terminal_and_RBC_Registration_to_MoRC

Output name	request_Start_Mobile_Terminal_and_RBC_Registration_to_MoRC
Description	This output is a trigger to start the mobile terminal and RBC session registration within the Management of Radio Communication function.
Destination	F2.9 MoRC_HI

Type	Common_Types_Pkg::radioManagementMessage_T
Valid range of values	See SCADE generated documentation respectively SCADE Suite functional model.
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/A

5.3.2.2.3 powerUp_to_MoRC

Output name	powerUp_to_MoRC
Description	This output is the trigger to activate the Management of Radio Communication function.
Destination	F2.9 MoRC_HO
Type	bool
Valid range of values	<p>true MoRC will be activated.</p> <p>false No action.</p>
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.3.2.2.4 statusstartofmissionongoing_to_MoRC

Output name	statusstartofmissionongoing_to_MoRC
Description	This output gives the information about the start of mission status procedure to the Management of Radio Communication function.
Destination	F2.9 MoRC_HO
Type	bool

Valid range of values

true Start of mission procedure is currently ongoing.

false Start of mission procedure is currently not ongoing.

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.3.2.2.5 powerOff_to_MoRC

Output name	powerOff_to_MoRC
Description	This output is the trigger to de-activate the Management of Radio Communication function.
Destination	F2.9 MoRC_HO
Type	bool

Valid range of values

true MoRC will be deactivated.

false no action.

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.3.2.2.6 start_ack_to_TIU

Output name	start_ack_to_TIU
Description	This output indicates that the start of mission procedure is completed.
Destination	Output is currently not used in the model.

Type	bool
Valid range of values	
	true Start of mission procedure is completed.
	false Not defined.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.3.3 Subcomponents

5.3.3.1 Awakness_of_Train

5.3.3.1.1 Component Requirements

Component name	Awakness_of_Train
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/Procedures/ManageProcedure_Pkg.xscade
SCADE designer	Baseliyos Jacob, DB Netz AG
Description	This component describes the Start of Mission procedure of the train until the status of the awakening is completed. From this point on the train will be able to switch to further modes, levels and procedures.
Input documents	Subset-026, Chapter 5, § 5.4
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.3.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.3.3.2 NP

5.3.3.2.1 Component Requirements

Component name	NP
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/Procedures/ManageProcedure_Pkg.xscade
SCADE designer	Baseliyos Jacob, DB Netz AG
Description	This component implements the No Power status of the train before the driver opens the cab desk.
Input documents	Subset-026, Chapter 5, § 5.4
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.3.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.3.3.3 SoM_L2_3_FS_SR_OS_LS_SH

5.3.3.3.1 Component Requirements

Component name	SoM_L2_3_FS_SR_OS_LS_SH
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/Procedures/ManageProcedure_Pkg.xscade
SCADE designer	Baseliyos Jacob, DB Netz AG
Description	This component switch to Level 2 or 3 and Mode FS, SR, OS, LS and SH after completion of the awakening of the train.
Input documents	Subset-026, Chapter 5, § 5.4
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.3.3.3.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.3.3.4 SoM_NTC_SN

5.3.3.4.1 Component Requirements

Component name	SoM_NTC_SN
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/Procedures/ManageProcedure_Pkg.xscade
SCADE designer	Baseliyos Jacob, DB Netz AG
Description	This component switch to Level NTC and Mode SN after completion of the awakening of the train.
Input documents	Subset-026, Chapter 5, § 5.4
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.3.3.4.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.4 F2.3: trainData

5.4.1 Component Requirements

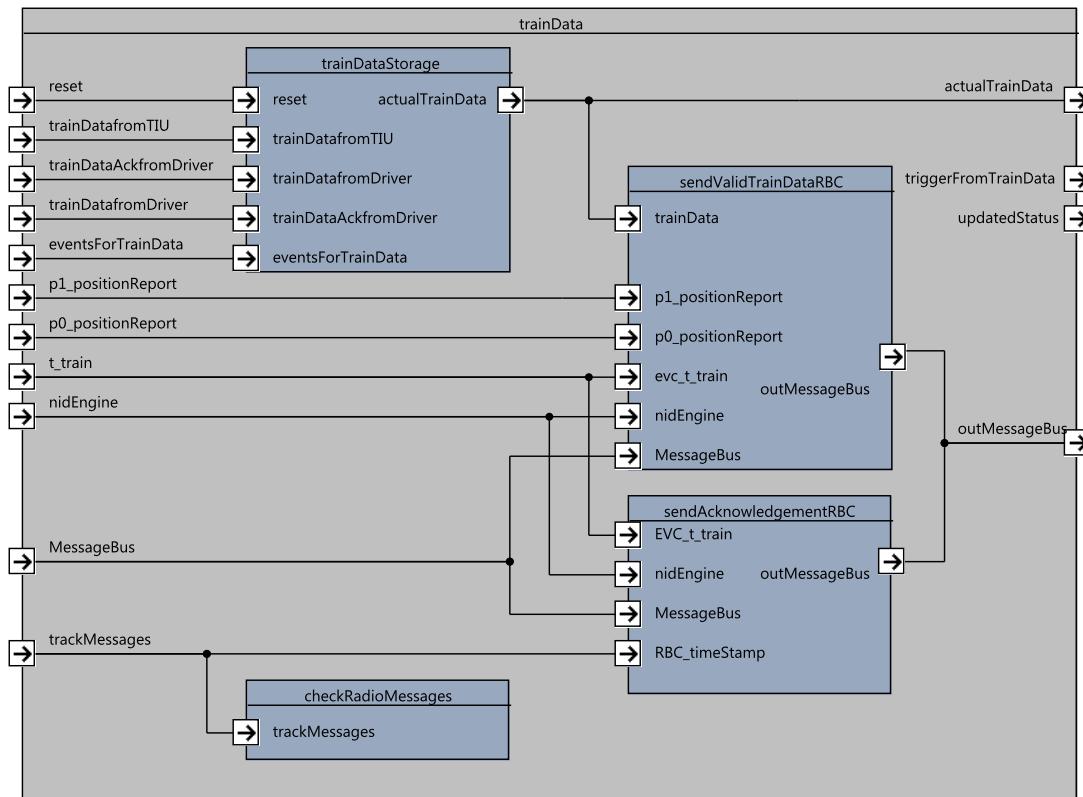
Component name	trainData
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/manageData/trainData/trainData.etp
SCADE designer	Bernd Hekele, DB Netz AG

Description	<p>Implementation of the train data with the corresponding interfaces to track, driver and RBC.</p> <p>This component provides the storage of train data and the procedures necessary for updating data and controlling interfaces for validating train data at the DMI and to the RBC.</p> <p>The scope of train data is defined in Section 3.18.3 of the SRS. Train data are qualifying some safety relevant properties of the train like the length of the train, maximal speed and brake behaviour.</p> <p>During startup of the EVC a first definition of the train data is received from the train interface unit (TIU). During Start of Mission the data is updated respectively validated by the driver via the Driver Machine Interface (DMI). The driver may also change some of the data and has to confirm the set of data before being able to push the start button.</p> <p>When setting up a radio session to an RBC the EVC has to send the actual train data to the RBC for validation. here, the message flow is as follows:</p> <ul style="list-style-type: none"> • sending Message 129 (Validated Train Data) • receiving Message 8 (Acknowledgment of Train Data) is processed as apart of the validation procedure with the RBC. • sending Message 146 (Acknolwedement) in the context of this message flow. T_TRAIN parameter of the messages is used to confirm the association of the messages. <p>The trainData component uses a dedicated state for controlling the reception of the acknowledgement.</p>
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Input documents	Subset-026, Chapter 3.18.3
Safety integrity level	4
Time constraints	n/a
API requirements	Train Data needs system time for stamping messages, access to input from the track messages and access to the output of RBC messages.

5.4.2 Interface

An overview of the interface of component trainData is shown in Figure 19. The inputs and outputs are described in detail in Section 5.4.2.1 respectively 5.4.2.2. Subcomponents are described in Section 5.4.3.

Figure 19. `trainData` component SysML diagram.

5.4.2.1 Inputs

5.4.2.1.1 `reset`

Input name	<code>reset</code>
Description	Triggers the reset of the train data and the train data status data.
Source	F2 input reset
Type	bool
Valid range of values	
<p>true Perform reset of train data and train data status.</p> <p>false No reset of data in this cycle.</p>	
Behaviour when value is at boundary	
Behaviour for values out of valid range	
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	

5.4.2.1.2 trainDatafromTIU

Input name	trainDatafromTIU
Description	<p>Train data received via TIU. The availability of data is indicated with the valid flag. This data is expected to be received in the first place. In the current implementation it is not supported to change data after a mission has been started. The structure covers the following components:</p> <p>valid (bool): valid indicator for this component. In this structure valid means the data has been received from train. Addition states like validated by driver or validated by RBC are maintained in the status structure for train data.</p> <p>other components : Other components are defined according to Section 3.18.3.2 of Subset-026.</p>
Source	F2 input API_fromTIU
Type	TIU_Types_Pkg::trainData_T
Valid range of values	Input with valid information is indicated with the valid flag set to true.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	When valid flag indicates false the data to be used is assumed to be default values. The component is not used when valid flag is false.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Information is only expected during the Start of Mission Procedure. Once the information is successfully received it is not considered any more. Change of train data by train during mission is not supported by this version of the openETCS OBU model.

5.4.2.1.3 trainDatafromDriver

Input name	trainDatafromDriver
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Description	<p>Train data received via DMI from the driver. The availability of data is indicated with the valid flag. The data is expected as a mandatory parameter during start of mission. In the current implementation it is not supported to change data after a mission has been started. The structure consists of the following components:</p> <ul style="list-style-type: none"> valid (bool): valid indicator for this component. The data has been received from DMI. The flag is set to TRUE for a single cycle. systemTime (Obu_BasicTypes_Pkg::T_internal_Type): timestamp set by the DMI. The component is not used by trainData. trainCtcategory (NC_TRAIN): Train category used for the static speed profile calculation. Thanks to NC_TRAIN, the train knows the SSP it must obey. Each bit represents one category. A train can belong to various categories. l_train (Obu_BasicTypes_Pkg::L_internal_Type): Length of the train [cm]. m_brakeperct (int): brake percentage. range from 0 to 300. <div style="border: 1px solid green; padding: 5px; background-color: #e0ffe0; margin-top: 5px;"> If this is a percentage, then the range would probably be 0...100. Maybe we should replace percentage here? </div> v_maxtrain (Obu_BasicTypes_Pkg::V_internal_Type): maximum speed of the train in km/h. <div style="border: 1px solid green; padding: 5px; background-color: #e0ffe0; margin-top: 5px;"> needs to be changed to cm/sec </div> m_axleLoad (M_AXLELOADCAT): axle load category according to Subset-026, Section 3.18.3.2. m_airTight (M_AIRTIGHT): airtight system presence according to Subset-026, Section 3.18.3.2. m_loadingGauge (M_LOADINGGAUGE): loading gauge category according to Subset-026, Section 3.18.3.2.
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Source	F2.10 manageDMI_input
Type	DMI_Messages_Bothways_Pkg::DMI_Train_Data_T
Valid range of values	Input with valid information is indicated with the valid flag.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	When valid flag indicates false the data to be used is assumed to be default values. The component is not used when valid flag is false.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	No checks on individual values is done in this part of the openETCS EVC. We assume - if necessary - appropriate checks are part of the interface layer (e.g., CRC checks) This type of checks is not in the scope of the openETCS project.

5.4.2.1.4 trainDataAckfromDriver

Input name	trainDataAckfromDriver
Description	<p>During start of mission the driver has to validate the train data. The confirmation is visible based on this input. The structure looks like:</p> <p>valid (bool): valid indicator for this component. The data has been received from DMI. The flag is set to TRUE for a single cycle.</p> <p>systemTime (Obu_BasicTypes_Pkg::T_internal_Type): timestamp set by the DMI. The component is not used by trainData.</p> <p>acknowledged (bool): Result of the driver's acknowledgment.</p>
Source	F2.10 manageDMI_input
Type	DMI_Messages_DMI_to_EVC_Pkg::DMI_Train_Data_Ack_T
Valid range of values	Input with valid information is indicated with the valid flag. In addition, the ack parameter has to be evaluated in order to recognise the decision of the driver.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	When valid flag is false the component will not be used and default values will be used instead.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	No checking on individual values is done in this part of the openETCS EVC. We assume - if necessary - appropriate checks are part of the interface layer (e.g., CRC checks) This type of checks is not in the scope of the openETCS project.

5.4.2.1.5 trackMessages

Input name	trackMessages
Description	Information carries the message received from RBC. Information is only used when the valid flag is true and the message source is Radio. Other information is not relevant. Information is evaluated as long as the validation procedure is not completed and a validation request with the RBC is pending.
Source	F2.1 Manage_TracksidesInformation_Integration
Type	Common_Types_Pkg::ReceivedMessage_T
Valid range of values	Input with valid information is indicated with the valid flag.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	When valid flag indicates false the data to be used is assumed to be default values. The component is not used when valid flag is false.

Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	No checking on individual values is done in this part of the openETCS EVC. We assume - if necessary - appropriate checks are part of the interface layer (e.g., CRC checks) This type of checks is not in the scope of the openETCS project.
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5.4.2.1.6 timeStamp

Input name	timeStamp
Description	Timestamp for messaging to the RBC.
Source	F2 input API_SystemTime
Type	T_TRAIN
Valid range of values	Positive non-zero real
Behaviour when value is at boundary	Parameter is not used for computation or addressing. No impact in this model.
Behaviour for values out of valid range	No impact in the EVC. Communication to the RBC will be broken.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Communication to the RBC will be broken. No safety issue in the EVC since RBC connection errors are covered by the EVC function.

5.4.2.1.7 eventsForTrainData

Input name	eventsForTrainData
Description	Timestamp for messaging to the RBC. Information of the EVC relevant for train data handling according to Section 3.18.3. In the current state of implementation the following events are evaluated: <ul style="list-style-type: none"> • train stand-still • communication Session established The MoRC ready input is used to indicate the evc:morc function is ready with acknowledgment of the communication session.
Source	F2.9 MoRC_HO
Type	trainData_Types_pkg::trainData_Events_T
Valid range of values	Structure of a set of bool. Each component may be true or false.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.4.2.1.8 nidEngine

Input name	nidEngine
Description	ID of the engine. This ID is used in communication with the RBC in order to uniquely identify the engine.
Source	F2 input API_persistentData
Type	NID_ENGINE
Valid range of values	Structure of a set of bool. Each component may be true or false.
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.4.2.1.9 p0_positionReport

Input name	p0_positionReport
Description	Actual Position Report (packet 0) for communication with the RBC.
Source	F2.8 ProvidePositionReport
Type	Packet_TrainTypes_Pkg::PT0_PositionReport_T
Valid range of values	This packet is administered by a valid flag.
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.4.2.1.10 p1_positionReport

Input name	p1_positionReport
Description	Actual Position Report (packet 1) for communication with the RBC.
Source	F2.8 ProvidePositionReport
Type	Packet_TrainTypes_Pkg::PT1_PositionReport_2BG_T
Valid range of values	This packet is administered by a valid flag.
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.4.2.1.11 inMessageBus

Input name	inMessageBus
Description	The trainData function makes use of communication to the RBC. The input parameter gives access to the communication channel to the RBC.
Source	This component is the starting point of the message bus. Here, the message bus is feed with a constant.
Type	TM_TrainTrack_Bus::M_TrainTrackMessageBus_t
Valid range of values	This component is administered by a valid flag.
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.4.2.2 Outputs

5.4.2.2.1 actualTrainData

Output name	actualTrainData
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Description	<p>Actual train data of the evc. Train data received via DMI from the driver. The availability of data is indicated with the valid flag. The data is expected as a mandatory parameter during start of mission. In the current implementation it is not supported to change data after a mission has been started. The structure consists of the following components:</p> <p>valid (bool): valid indicator for this component. Valid indicates the data are updated after start-up of the system. The actual status of trainData is stored in the updatedStatus information.</p> <p>acknowledgedByDriver (bool): Indicates this component has been validated by the driver.</p> <p>trainCategory (NC_TRAIN): Train category used for the static speed profile calculation.</p> <p>cantDeficiency (NC_CDTRAIN): Cant deficiency train category</p> <p>trainLength (Obu_BasicTypes_Pkg::L_internal_Type): Length of the train [cm].</p> <p>brakePercentage (int): brake percentage. range from 0 to 300.</p> <p>maxTrainSpeed (Obu_BasicTypes_Pkg::V_internal_Type): maximum speed of the train in km/h.</p> <p>loadingGauge (M_LOADINGGAUGE): loading gauge category according to 3.18.3.2</p> <p>axleLoadCategory (M_AXLELOADCAT): axle load category according to Subset-026, Section 3.18.3.2.</p> <p>airTightSystem (M_AIRTIGHT): airtight system presence according to Subset-026, Section 3.18.3.2.</p> <p>axleNumber int): axle number according to Subset-026, Section 3.18.3.2.</p> <p>numberNationalSystems (int): The number of national systems available in the train.</p> <p>nationalSystems (Packet_TrainTypes_Pkg::aNID_NTC_T): National Systems available in the train. The elements 0 .. number-NationalSystems - 1 are carrying the relevant data.</p> <p>numberTractionSystems (int): The number of traction systems available in the train.</p> <p>tractionSystems (Packet_TrainTypes_Pkg::aTractionIdentity_T): Traction Systems available in the train. The elements 0 ... numberTractionSystems - 1 are carrying the relevant data.</p>
Destination	<p>F2.4 TrackAtlas</p> <p>F2.6 calculateTrainPosition</p> <p>F2.7 SpeedSupervision_Integration</p> <p>F2.8 ProvidePositionReport</p> <p>F2.9 MoRC_HO</p> <p>F2.11 manageDMI_Output</p>

Type	TIU_Types_Pkg::trainData_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.4.2.2.2 outMessageBus

Output name	outMessageBus
Description	Messages for communicating with the RBC. Messages 129 (Validated Train Data) and 146 (Acknowledgement) are sent by this function. The presence of the message is indicated by a valid flag.
Destination	F2.4 TrackAtlas. The bus collects outgoing messages to an output to RTM
Type	TM_TrainTrack_Bus::M_TrainTrackMessageBus_t
Valid range of values	Indicated by valid flag.
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.4.2.2.3 triggerFromTrainData

Output name	triggerFromTrainData
Description	For a full implementation of ETCS trainData has additional tasks described in the standard but not implemented in openETCS. For those extensions the triggers are pre-defined.
Destination	evc
Type	trainData_Types_pkg::trainData_Trigger_T
Valid range of values	n/a

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.4.2.2.4 updatedStatus

Output name	updatedStatus
Description	<p>Detailed definition of the trainData status. The following components are defined:</p> <p>valid (bool): Data is initialised based on data received from the TIU.</p> <p>validatedByDriver (bool): Data has been validated by the Driver.</p> <p>validatedbyRBC (bool): Data has been validated by the RBC.</p> <p>waitingForRBCResponse (bool): 3.18.3.4.1 Train is waiting for ack to validation command.</p> <p>driverIsModificationTrainData (bool): 3.18.3.3.1 Driver is Modifying / Revalidating train data.</p> <p>timeStampValidateToRBC (T_TRAIN): 8.7.4 This label is used in communication with the RBC to identify the communication entity. Train data is acknowledged.</p>
Destination	F2.1 Manage_TracksidesInformation_Integration
Type	trainData_Types_pkg::trainDataStatus_T
Valid range of values	Indicated by valid flag.
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.4.3 Subcomponents

5.4.3.1 trainDataStorage

5.4.3.1.1 Component Requirements

Component name	trainDataStorage
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/manageData/trainData/trainData.etc
SCADE designer	Bernd Hekele, DB Netz AG
Description	Storage of trainData information. The format of the data kept is described above. Data can be stored or merged depending on the source of data. A reset function is foreseen for initialisation of data.
Input documents	Subset-026, Chapter 3.18.3
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.4.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.4.3.2 checkRadioMessages

5.4.3.2.1 Component Requirements

Component name	checkRadioMessages
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/manageData/trainData/trainData.etc
SCADE designer	Bernd Hekele, DB Netz AG
Description	The function checks an incoming radio message for relevance in the trainData context. Result is whether the message requests an acknowledgement and whether the radio message is a response to an outstanding validation request.
Input documents	Subset-026, Chapter 3.18.3
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.4.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.4.3.3 sendValidTrainDataRBC

5.4.3.3.1 Component Requirements

Component name	sendValidTrainDataRBC
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/manageData/trainData/trainData.etc
SCADE designer	Bernd Hekele, DB Netz AG
Description	This function send the validate data request of the RBC an updates trainData States with the relevant information.
Input documents	Subset-026, Chapter 3.18.3
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.4.3.3.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.4.3.4 sendAcknowledgementRBC

5.4.3.4.1 Component Requirements

Component name	sendAcknowledgementRBC
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/manageData/trainData/trainData.etc
SCADE designer	Bernd Hekele, DB Netz AG
Description	This function prepares the Information for acknowledgement message. It is assumed it used with an boolean activator.
Input documents	Subset-026, Chapter 3.18.3
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.4.3.4.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.4.3.5 checkAcknowledgementGeneral

5.4.3.5.1 Component Requirements

Component name	checkAcknowledgementGeneral
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/manageData/trainData/trainData.etc
SCADE designer	Bernd Hekele, DB Netz AG
Description	This function implements the acknowledgment to ma request and general message. It is actually an extension of the trainData function and needs to be moved to radio management functions.
Input documents	Subset-026, Chapter 3.18.3
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.4.3.5.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.5 F2.4: TrackAtlas

5.5.1 Component Requirements

Component name	TrackAtlas
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/TrackAtlas
SCADE designer	Jakob Gärtner, LEA Railergy

Description	<p>TrackAtlas collects, processes, stores and distributes the information received from trackside or built from onboard data which are the basis for train supervision, driver machine interface, mode and level and other processes in the EVC. Essential information provided to train and speed supervision includes:</p> <ul style="list-style-type: none"> • Gradient Profile • Most Restrictive Speed Profile • Movement Authority <p>In a more abstract sense, TrackAtlas maintains all the information the EVC needs in order to fulfil its essential tasks. This functional block relies on some onboard functions for <i>preprocessing of the information received from track</i> such as</p> <ul style="list-style-type: none"> • ReceiveTrackside Information for reception of the information • Information Filter for selection of the relevant information • CalculateTrainPosition for referencing the information to the correct coordinate system <p>At the output side, information is being reformatted for the different components requiring access to the data maintained by TrackAtlas.</p>
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Input documents	Subset-026, Chapter 3
Safety integrity level	4
Time constraints	TrackAtlas assumes to be cyclically called in a 50ms cycle, changing the scheduling will require adaptation of some parameters
API requirements	TrackAtlas relies on the Track to Train and Train to Track communication libraries provided in the TrackMessages package

5.5.2 Interface

An overview of the interface of component TrackAtlas is shown in Figure 20. The inputs and outputs are described in detail in Section 5.5.2.1 respectively 5.5.2.2. Subcomponents are described in Section 5.5.3.

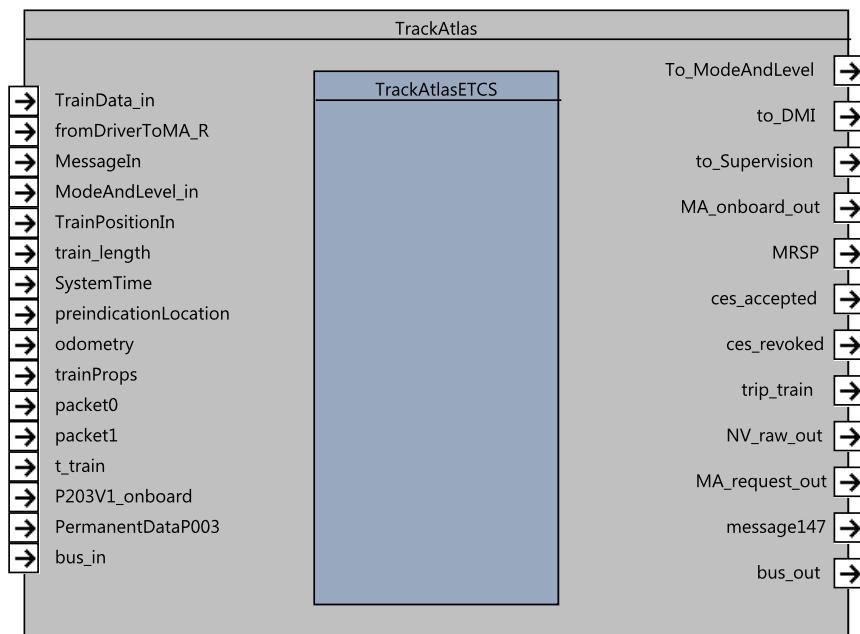


Figure 20. TrackAtlas component SysML diagram.

5.5.2.1 Inputs

5.5.2.1.1 MessageIn

Input name	MessageIn
Description	Track to train message (as defined in Subset 026, chapter 8) with containing packets (as defined in Subset 026, chapter 7)
Source	F2.1 Manage_TracksidInformation_Integration
Type	Common_Types_Pkg::ReceivedMessage_T
Valid range of values	valid combinations of Messages and Packets as implemented in the package TrackMessages
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Invalid messages/ packets are ignored.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	The messages are only seen as valid if they are present.

5.5.2.1.2 ModeAndLevel_in

Input name	ModeAndLevel_in
Description	Status data on mode and level

Source	F2.5 ManageModeAndLevel
Type	Level_And_Mode_Types_Pkg::T_Mode_Level
Valid range of values	n/a, as this is a type based on enumerations which can not reach invalid state in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.5.2.1.3 TrainData_in

Input name	TrainData_in
Description	Data received from TIU
Source	F2.3 trainData
Type	TrackAtlasTypes::FromTIU_tl
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	
Remark	This input is unused at the moment

5.5.2.1.4 TrainPositionIn

Input name	TrainPositionIn
Description	Structured Information about all aspects of the current state of the train with respect to the coordinate system, balise positioning and integrity information and the train position
Source	F2.6 calculateTrainPosition
Type	TrainPosition_Types_Pck::trainPosition_T

Valid range of values	as defined by CalculateTrainPosition
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.5.2.1.5 train_length

Input name	train_length
Description	Train length
Source	TIU
Type	Obu_BasicTypes_Pkg::L_internal_Type
Valid range of values	not checked at the moment
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	
Remark	This input shall be removed as soon as the input <i>TrainData_in</i> will be defined and used

5.5.2.1.6 SystemTime

Input name	SystemTime
Description	Reference time of the EVC
Source	F2 input API_SystemTime
Type	Obu_BasicTypes_Pkg::T_internal_Type
Valid range of values	n/a
Behaviour when value is n/a at boundary	

Behaviour for values out of valid range n/a

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) n/a

5.5.2.1.7 preindicationLocation

Input name	preindicationLocation
Description	Preindication location for speed or target supervision
Source	F2.7 SpeedSupervision_Integration
Type	Obu_BasicTypes_Pkg::L_internal_Type
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.5.2.1.8 odometry

Input name	odometry
Description	Odometry Data
Source	F2 input API_Odometry
Type	Obu_BasicTypes_Pkg::odometry_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.5.2.1.9 fromDriverToMA_R

Input name	fromDriverToMA_R
Description	Data sent from DMI to MA Request function
Source	DMI interface
Type	MA_Request::Driver2MAR_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.5.2.1.10 trainProps

Input name	trainProps
Description	Train Characteristics as provided by CalculateTrainPosition
Source	F2.3 trainData F2.10 manageDMI_Input
Type	TrainPosition_Types_Pck::trainProperties_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.5.2.1.11 packet0

Input name	packet0
Description	Train Position Report packet 0
Source	F2.8 ProvidePositionReport

Type	Packet_TrainTypes_Pkg::PT0_PositionReport_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.5.2.1.12 packet1

Input name	packet1
Description	Train Position Report based on two balise groups (Packet 1)
Source	F2.8 ProvidePositionReport
Type	Packet_TrainTypes_Pkg::PT1_PositionReport_2BG_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.5.2.1.13 t_train

Input name	t_train
Description	Time reference of the EVC
Source	F2 input API_SystemTime
Type	T_TRAIN
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.5.2.1.14 bus_in

Input name	bus_in
Description	Train to track message bus
Source	F2.3 trainData
Type	TM_TrainTrack_Bus::M_TrainTrackMessageBus_t
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.5.2.1.15 P203V1_onboard

Input name	P203V1_onboard
Description	Default values for track to train packet 203 as stored onboard. In case of a baseline 2 track, these data are used to build a baseline 3-conformal packet 3.
Source	F2 input API_persistentData
Type	TM_baseline2::P203V1_OBU_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.5.2.1.16 PermanentDataP003

Input name	PermanentDataP003
Description	Default values for track to train packet 3 (baseline 2) as stored onboard. In case of a baseline 2 track, these data are used to build a baseline 3- conformal packet 3.
Source	F2 input API_persistentData
Type	TM_baseline2::P003_permanent_data_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.5.2.2 Outputs

5.5.2.2.1 NV_raw_out

Output name	NV_raw_out
Description	National values as received from the track (in case of a baseline 3 trackside, or national values as calculated by TrackAtlas (in case of reception of a baseline 2 trackside)
Destination	Various recipients: SDM, Mode and Levels
Type	TM::P003_OBU_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.5.2.2.2 To_ModeAndLevel

Output name	To_ModeAndLevel
-------------	-----------------

Description	Aggregated status information concerning the data maintained by TrackAtlas, for usage by Mode and Levels Management Module
Destination	F2.5 ManageLevelAndMode
Type	TrackAtlasTypes::DataForModeAndLevel_t
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.5.2.2.3 to_DMI

Output name	to_DMI
Description	Aggregated information concerning Movement Authority (MA information, Gradient Profile Information, MRSP information; formatted for use by DMI
Destination	F2.11 manageDMI_Output
Type	TrackAtlasTypes::DataForDMI_t
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.5.2.2.4 MRSP

Output name	MRSP
Description	Aggregated information concerning Movement Authority (MA information, Gradient Profile Information, MRSP information; formatted for use by SDM.
Destination	Output is currently not used in the model.

Type	TrackAtlasTypes::DataForSupervision_nextGen_t
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.5.2.2.5 to_Supervision

Output name	to_Supervision
Description	Most restrictive speed profile
Destination	F2.7 SpeedSupervision_Integration
Type	TrackAtlasTypes::MRSP_Profile_t
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.5.2.2.6 MA_onboard_out

Output name	MA_onboard_out
Description	Movement authority information extracted from Packet 15 or 16, normalised to train coordinate system
Destination	Output is currently not used in the model.
Type	TrackAtlasTypes::MovementAuthority_t
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.5.2.2.7 bus_out

Output name	bus_out
Description	Train to track message bus containing train to track messages with optional packets
Destination	F2.8 ProvidePositionReport
Type	TM_TrainTrack_Bus::M_TrainTrackMessageBus_t
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.5.2.2.8 ces_accepted

Output name	ces_accepted
Description	Flag to indicate that a conditional emergency stop has been accepted in the current cycle
Destination	Output is currently not used in the model.
Type	bool
Valid range of values	true/ false
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.5.2.2.9 ces_revoked

Output name	ces_revoked
Description	Flag to indicate that a conditional emergency stop has been revoked in the current cycle
Destination	Output is currently not used in the model.
Type	bool
Valid range of values	true/ false
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.5.2.2.10 trip_train

Output name	trip_train
Description	Flag to indicate that the train must be tripped
Destination	Output is currently not used in the model.
Type	bool
Valid range of values	true/ false
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.5.3 Subcomponents

5.5.3.1 StoreRaw_NV

5.5.3.1.1 Component Requirements

Component name	StoreRaw_NV
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Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/TrackAtlas/TA_Storage
SCADE designer	Jakob Gärtner, LEA Railergy
Description	Receives National Values from the track. Stores them "as-is" onboard. If Subset_026 chapter 6 is applicable, baseline 3 conformal information is calculated based on packet 3 and packet 203 (according to older versions). Missing trackside information is complemented through default onboard values.
Input documents	Subset-026, Chapter 6 Subset-026, Chapter 7 Subset-026, Chapter 8
Safety integrity level	4
Time constraints	n/a
API requirements	Based on data formats and functions defined by TrackMessages package

5.5.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.5.3.2 Build_GradientProfile

5.5.3.2.1 Component Requirements

Component name	Build_GradientProfile
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/TrackAtlas/TA_Gradient.xscade
SCADE designer	Jakob Gärtner, LEA Railergy
Description	Receives Track to Train Packet 21 (Gradient Profile). References the data to the train coordinate system. Converts incremental distances to absolute distances in the train's coordinate system. Merges the information from sequentially received packets into a continuous Gradient Profile. Truncates the profile as required
Input documents	Subset-026, Chapter 3.11.12 Subset-026, Chapter 7
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.5.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.5.3.3 Build_MA

5.5.3.3.1 Component Requirements

Component name	Build_MA
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/TrackAtlas/TA_MA.xscade
SCADE designer	Jakob Gärtner, LEA Railergy
Description	Received Packet 15 or Packet 16 from Trackside. References the information to the train's coordinate system. Converts all relative and incremental distances to absolute distances in the train's coordinate system. Evaluates and supervises MA timers [TODO]. Replaces, deletes, or shortens MA as required
Input documents	Subset-026, Chapter 3.8
Safety integrity level	4
Time constraints	[n/a]
API requirements	n/a

5.5.3.3.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.5.3.4 Build_MRSP

5.5.3.4.1 Component Requirements

Component name	Build_MRSP
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/TrackAtlas/TA_MRSP
SCADE designer	Jakob Gärtner, LEA
Description	Reduces the various Speed Profiles to Most Restrictive Speed Profile information
Input documents	Subset-026, Chapter 3.11
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.5.3.4.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.5.3.5 Manage_EmergencyStop

5.5.3.5.1 Component Requirements

Component name	Manage_EmergencyStop
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/TrackAtlas/TA_EmergencyS_top.xscade
SCADE designer	Johannes Kastner, ICS AG; Jakob Grtner, LEA Railergy
Description	Manages Emergency Stop Messages
Input documents	Subset-026, Chapter 3
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.5.3.5.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.5.3.6 Manage_MA_Request

5.5.3.6.1 Component Requirements

Component name	Manage_MA_Request
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/TrackAtlas/TA_MA_Request
SCADE designer	Christian Stahl, TWT GmbH
Description	Manages reception of MA request parameters and sends MA request as specified
Input documents	Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ???
Safety integrity level	4
Time constraints	n/a
API requirements	n/a]

5.5.3.6.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.6 F2.5: ManageLevelAndMode

5.6.1 Component Requirements

Component name	ManageLevelAndMode
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes
SCADE designer	Marielle Petit-Duche, Systerel Matthias Gudemann, Systerel
Description	Modes and levels define the status of the ETCS regarding on-board functional status and track infrastructure.
Input documents	Subset-026, Chapter 4 Subset-026, Chapter 5
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.6.2 Interface

An overview of the interface of component ManageLevelAndMode is shown in Figure 21 and Figure 22. The inputs and outputs are described in detail in Section 5.6.2.1 respectively 5.6.2.2. Subcomponents are described in Section 5.6.3.

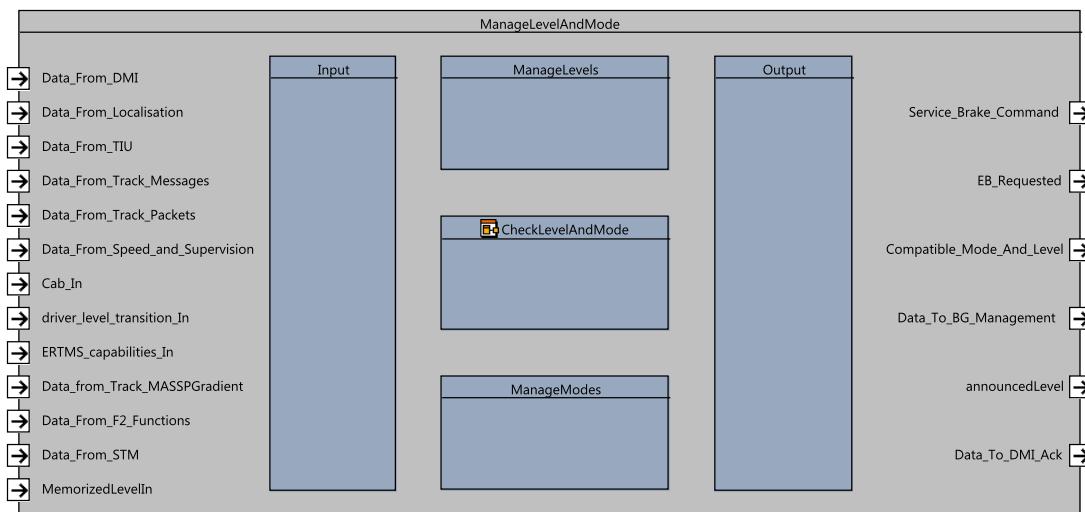


Figure 21. ManageLevelAndMode component SysML diagram.

For a detail description of the interface and contents of the Scade model see <https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes/ModesAndLevels/ModesAndLevels.pdf>, for types definition see : https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes/Level_And_Mode_Types/Level_And_Mode_Types.pdf

5.6.2.1 Inputs

5.6.2.1.1 Data_From_DMI

Input name	Data_From_DMI
Description	Set of data transmitted from DMI (driver acknowledgements and requests to switch modes and level)
Source	F2.10 manageDMI_Input
Type	DMI_Types_Pkg::DMI_To_Modes_T
Valid range of values	<p>It is a complex type :</p> <ul style="list-style-type: none"> • valid : bool, flag to inform of the freshness of the information • DriverAck : DMI_DriverAck_T, indicate which mode is acknowledged • DriverRequest : DMI_DriverRequest_T, table of boolean values for all the driver request related to mode changes. • LevelAck : bool, indication of Level change acknowledgement
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.6.2.1.2 Data_From_Localisation

Input name	Data_From_Localisation
Description	Set of data on position and speed of the train
Source	F2.6 calculateTrainPosition F2 input API_Odometry
Type	Level_And_Mode_Types_Pkg::T_Data_From_Localisation
Valid range of values	<p>It is a complex type:</p> <ul style="list-style-type: none"> • BG_In_List_Expected_BG_In_SR : bool, • BG_In_List_Expected_BG_In_SH : bool, • PositionErrors : TrainPosition_Types_Pck::positionErrors_T, • Train_Position : TrainPosition_Types_Pck::trainPosition_T, • Train_Speed : Obu_BasicTypes_Pkg::Speed_T, • Train_Standstill : bool
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.6.2.1.3 Data_From_TIU

Input name	Data_From_TIU
Description	Set of data providing by TIU
Source	F2.12 manageTIU_input
Type	TIU_Types_Pkg::Message_Train_Interface_to_EVC_T
Valid range of values	It is a complex type defined in the TIU package.
Behaviour when value is n/a at boundary	

Behaviour for values out of valid range n/a

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) n/a

5.6.2.1.4 Data_From_Track_Messages

Input name	Data_From_Track_Messages
Description	Messages received from trackside containing information for modes and levels switches
Source	F2.4 TrackAtlas
Type	Level_And_Mode_Types_Pkg::T_Data_From_Track_Messages
Valid range of values	It is a complex type containing the information of messages : 2, 6, 15, 16, 27 and 28
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.6.2.1.5 Data_From_Track_Packets

Input name	Data_From_Track_Packets
Description	Packets received from trackside containing information for modes and levels switches.
Source	F2.1 Manage_TrackSideInformation_Integration
Type	Level_And_Mode_Types_Pkg::T_Data_From_Track_Packet
Valid range of values	It is a complex type containing the information of packets : 12, 15, 21, 27, 41, 46, 63, 80, 135, 137, 138, and 139.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.6.2.1.6 Data_From_speed_and_Supervision

Input name	Data_From_speed_and_Supervision
Description	Data provided by the speed and supervision function
Source	F2.7 SpeedSupervision_Integrator
Type	Level_And_Mode_Types_Pkg::T_Data_From_Speed_Supervision
Valid range of values	<p>Input type is a complex type:</p> <ul style="list-style-type: none"> • <i>Estim_front_End_overpass_SR_Dist : bool</i>: the train overpass the SR distance with its estimated front end (from SR to trip mode condition 42) • <i>Estim_Front_End_Rear_SSP : bool</i>: estimated front end is rear of the start location of either SSP or gradient profile stored on-board (from FS, LS, OS to trip mode condition 69) • <i>Override_Function_Active</i>: boolean to indicate the state of the activation function • <i>EOA_Antenna_Overpass : bool</i>: the train overpasses the EOA with min safe antenna position Level 1 (from FS, LS, OS to trip mode condition 12) • <i>EOA_Front_End : bool</i> the train overpasses the EOA with min safe front end, Level 2 or 3 (from FS, LS, OS to trip mode condition 16) • <i>Train_Speed_Under_Override_Limit : bool</i> supervision when override function is active (to SR mode condition 37)

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.6.2.1.7 driver_level_transition_in

Input name	driver_level_transition_in
Description	Request of level transition given by the driver for example at start of mission

Source	F2.10 manageDMI_Input
Type	Level_And_Modes_Types_Pkg::T_LevelTransition
Valid range of values	<p>It is a complex type:</p> <ul style="list-style-type: none"> • is_set : bool, • transition : Level_And_Mode_Types_Pkg::T_LevelTransitionInfo, • LRBG : NID_LRBG, • referenceLocation : Obu_BasicTypes_Pkg::L_internal_Type
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.6.2.1.8 Cab_In

Input name	Cab_In
Description	Identification of the cabine where the EVC is implemented.
Source	F2.12 manageTIU_input
Type	TIU_Types_Pkg::cab_ID_T
Valid range of values	[CabUndefined, CabA, CabB]
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.6.2.1.9 ERTMS_Capabilities

Input name	ERTMS_Capabilities
Description	Identification of the capabilities of the train in regards of ERTMS levels

Source	F2 input API_persistentData
Type	T_ERTMS_Capabilities
Valid range of values	<p>It is a complex type:</p> <ul style="list-style-type: none"> • NTC : bool, • L0 : bool, • L1 : bool, • L2 : bool, • L3 : bool
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.6.2.1.10 Data_From_Track_MASSPGradient

Input name	Data_From_Track_MASSPGradient
Description	Information that some packets have been received from trackside c
Source	F2.1 Manage_TrackSideInformation_Integration
Type	Level_And_Mode_Types_Pkg::T_Data_From_Track_MASSPGradient
Valid range of values	It is a complex type containing the information of packets : 12, 15, 21, 27
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.6.2.1.11 Data_From_F2_Functions

Input name	Data_From_F2_Functions
Description	Information received from other F2 functions.

Source	F2.1 Manage_TrackSideInformation_Integration
Type	Level_And_Mode_Types_Pkg::T_Data_From_F2_Functions
Valid range of values	<p>It is a complex type:</p> <ul style="list-style-type: none"> • Common_Errors : Common_Types_Pkg::MSG_Errors_T, • Failure_Occured : bool,, • Continue_Shunting_Active : bool, • Stop_Shunting_Stored : bool
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.6.2.1.12 Data_From STM

Input name	Data_From_STM
Description	Information concerning STM embedded systems.
Source	F2 input API_persistentData
Type	Level_And_Mode_Types_Pkg::T_Data_From_STM
Valid range of values	<p>It is a complex type:</p> <ul style="list-style-type: none"> • Interface_to_National_System : bool,, • National_Trip_Order : bool
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.6.2.2 Outputs

5.6.2.2.1 Compatible_Mode_And_Level

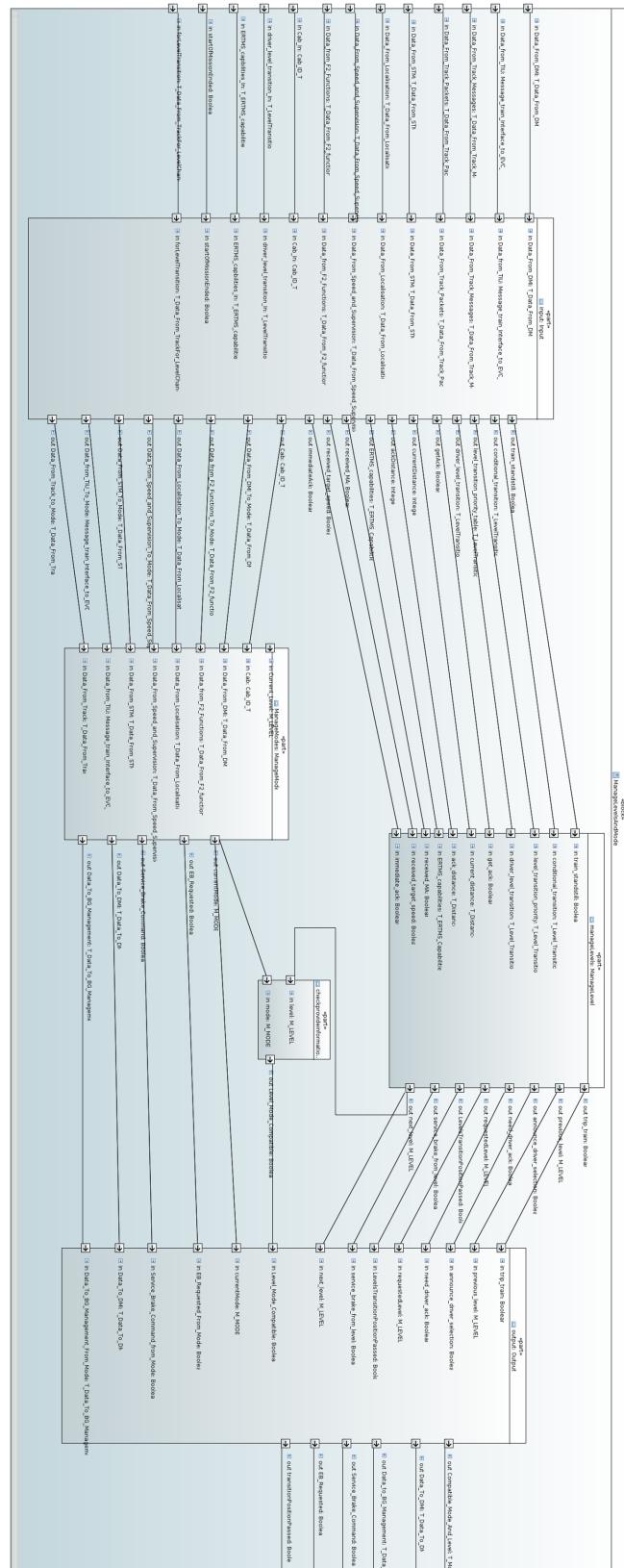


Figure 22. Mode_and_Level data flow SysML diagram

Output name	Compatible_Mode_And_Level
Description	Structure containing mode and level information.
Destination	F2.1 Manage_TrackSideInformation_Integration F2.4 TrackAtlas F2.8 ProvidePositionReport F2.9 MoRC_HO F2.11 manageDMI_output F2.13 manageTIU_output
Type	Level_And_Mode_Types_Pkg::T_Mode_Level
Valid range of values	<p>It is a complex type:</p> <ul style="list-style-type: none"> • CompatibleModeAndLevel : bool, • level : M_LEVEL, • newLevel : bool, • mode : M_MODE, • newMode : bool
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.6.2.2.2 Data_To_DMI_Ack

Output name	Data_To_DMI_Ack
Description	Data information to provided to the driver.
Destination	F2.11 manageDMI_output
Type	DMI_Types_Pkg::DMI_ModesToDMI_T
Valid range of values	It is a complex type defined in the DMI package.
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.6.2.2.3 Data_To_BG_Management

Output name	Data_To_BG_Management
Description	Set of data concerning BG management.
Destination	This output is currently not used in the model.
Type	Level_And_Mode_Types_Pkg::T_Data_To_BG_Management
Valid range of values	<p>It is a complex type:</p> <ul style="list-style-type: none"> • EoM_Procedure_req : bool, • Clean_BG_List_SH_Area : bool, • MA_Req : bool, • Req_for_SH_from_Driver : bool, • Connection_to_RBC_req : bool, • Position_Report_Needed : bool
Behaviour when value is n/a at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	n/a

5.6.2.2.4 Service_Brake_Command

Output name	Service_Brake_Command
Description	Command for the service brake.
Destination	F2.7 SpeedSupervision_Integration
Type	bool
Valid range of values	<p>true Service brake shall be applied. false Service brake shall not be applied.</p>
Behaviour when value is n/a at boundary	n/a

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.6.2.2.5 EB_Request

Output name	EB_Request
Description	Command of the emergency brake
Destination	F2.7 SpeedSupervision_Integration
Type	bool

Valid range of values

true Emergency brake shall be applied.

false Emergency brake shall not be applied.

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.6.2.2.6 announcedLevel

Input name	announcedLevel
Description	Level transition selected for an immediate or future transition.
Destination	F2.7 SpeedSupervision_Integration
Type	Level_And_Modes_Types_Pkg::T_LevelTransition

Valid range of values It is a complex type:

- is_set : bool,
 - transition : Level_And_Mode_Types_Pkg::T_LevelTransitionInfo,
 - LRBG : NID_LRBG,
 - referenceLocation : Obu_BasicTypes_Pkg::L_internal_Type
-

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.6.3 Subcomponents

5.6.3.1 Level_Management

5.6.3.1.1 Component Requirements

Component name	Level_Management
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes/Levels
SCADE designer	Marielle Petit-Doche and Matthias Güdemann, Systerel
Description	<p>The level management subsystem receives level transition order tables and selects the order with the highest probability. It stores the information about the selected transition order and transits to the requested level once the train passes the location of the level transition.</p> <p>If required, the driver is asked to acknowledge the transition, in case of no acknowledgment or if conditions for the level transition are not fulfilled, the train gets tripped.</p> <p>On the most abstract level the design consists of the <i>manage_priorities</i> function which takes the level transition order priority tables as inputs and computes the highest priority transition.</p> <p>This transition order is fed to the <i>computeLevelTransitions</i> operator. This operator consists of three main parts. The <i>ComputeTransitionConditions</i> operator that emits the fulfilled conditions to change from a given level to a new level, the <i>LevelStateMachine</i> that stores the current level and takes the computed change conditions as input for possible level transitions and finally the <i>driverAck</i> operator which contains a state machine that stores the information whether the system is currently waiting for a driver acknowledgement and emits the train trip information if necessary.</p>
Input documents	Subset-026, Chapter 5.10
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.6.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation <https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes/Levels/Levels.rtf>

5.6.3.2 Mode_Management

5.6.3.2.1 Component Requirements

Component name	Mode_Management
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes/Modes
SCADE designer	Marielle Petit-Duche, Systerel
Description	<p>This function is in charge of the computation of new mode to apply according to conditions from inputs (track information, driver interactions, train data,...) and other functions.</p> <p>Three subfunctions are defined:</p> <ul style="list-style-type: none"> Inputs proceeds to inputs check and preparation. ComputeModesCondition performs all specific procedure linked to mode management and defined in [1] sections 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.11, 5.12, 5.13, 5.19 and specifies the conditions to define a mode transition according condition table of section 4.6.3 of [1] SwitchModes performs the mode selection according the conditions and priorities defined in transition table section 4.6.2 of [1] Outputs prepares packet of outputs.
Input documents	Subset-026, Chapter 4.4, 4.6, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.11, 5.12, 5.13, 5.19
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.6.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation <https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes/Modes/Modes.pdf>

5.6.3.3 Check_and_Provide_Mode_and_Level

5.6.3.3.1 Component Requirements

Component name	Check_and_Provide_Mode_and_Level
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes/ModesAndLevels
SCADE designer	Marielle Petit-Duche, Systerel
Description	Checks compatibility between mode and level and provides outputs.
Input documents	Subset-026, Chapter 3.6.5
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.6.3.3.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.7 F2.6: calculateTrainPosition

5.7.1 Component Requirements

Component name	calculateTrainPosition
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/CalculateTrainPosition
SCADE designer	Uwe Steinke, Siemens AG

Description	<p>The main purpose of the function is to calculate the locations of linked and unlinked balise groups (BGs) and the current train position while the train is running along the track. In detail, the calculateTrainPosition function provides a couple of essential subfunctions for the onboard unit. These are mainly:</p> <ul style="list-style-type: none"> • Creating and maintaining an obu internal coordinate system for all types of location based data. • Storing all linked and unlinked balise groups resulting from over passing or from announcements (linking information) from the track. • Calculating and maintaining the locations of all stored balise groups during the train trip, based on odometry and linking information. • Permanently calculating the current train position based on odometry and passed balise group information. • Providing the last recently passed linked balise group as the LRBG. • Providing additional position attribute information. • Deleting stored balise groups, when appropriate. • Detecting linking consistency errors. • Determining, if linking is used on board.
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The calculation algorithms for locations and positions are implemented as specified in https://github.com/openETCS/SRS-Analysis/blob/master/System%20Analysis/WorkingRepository/Group4/SUBSET_26_3-6/DetermineTrainLocationProcedures.pdf

Input documents	Subset-026, Chapter 3.6
Safety integrity level	4
Time constraints	All events at the calculateTrainPosion inputs must be applied strictly in the correct chronological order.
API requirements	The currentOdometry input as well as the odometry stamps within msgFromTrack must be fed with odometry values strictly adhering to https://github.com/openETCS/SRS-Analysis/blob/master/System%20Analysis/WorkingRepository/Group4/SUBSET_26_3-6/DetermineTrainLocationProcedures.pdf , chapt. 3.

5.7.2 Interface

An overview of the interface of component calculateTrainPosition is shown in Figure 23. The inputs and outputs are described in detail in Section 5.7.2.1 respectively 5.7.2.2. Subcomponents are described in Section 5.7.3.

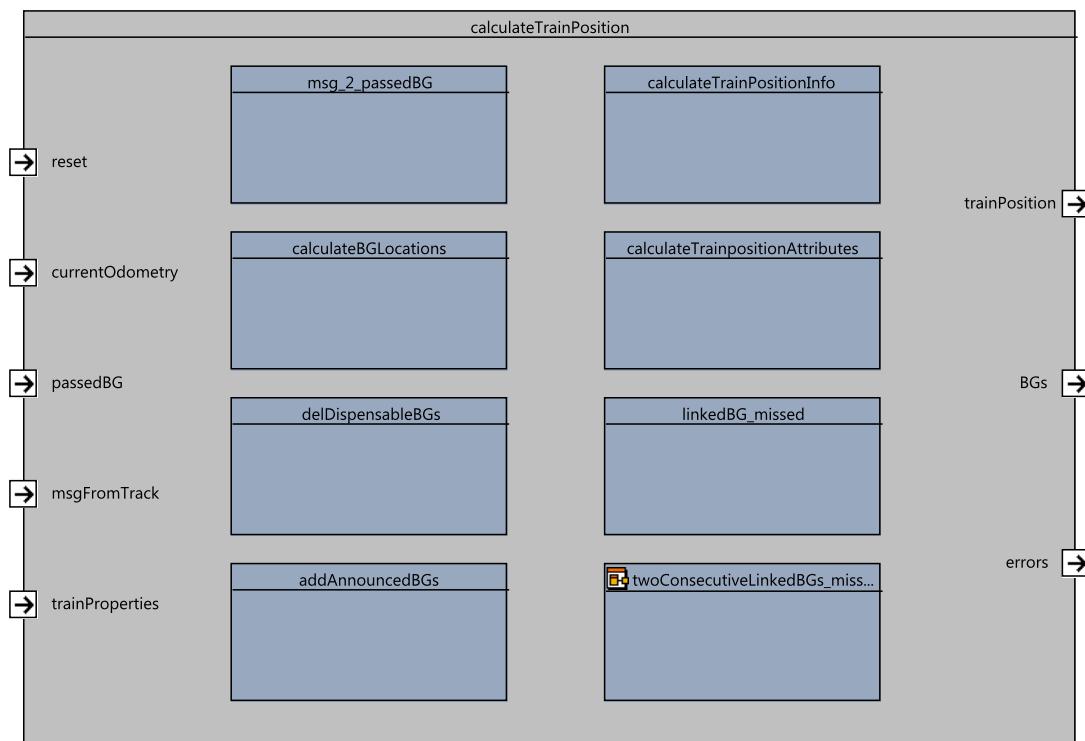


Figure 23. calculateTrainPosition component SysML diagram.

5.7.2.1 Inputs

5.7.2.1.1 currentOdometry

Input name	currentOdometry
Description	currentOdometry is the actual odometry information as known by the whole EVC model and provided by the models external interface.
Source	F2 input API_Odometry
Type	Obu_BasicTypes_Pkg::odometry_T

Valid range of values	<p>Obu_BasicTypes_Pkg::odometry_T is a complex data type. Values are given for each element. Format is: Type Name: range / list of values.</p> <ul style="list-style-type: none"> • bool valid: [true false]. Must be permanently set to "true". • timestamp: (0 - 2147483647). Current time in ms, must be monotonically increasing. • odo: Obu_BasicTypes_Pkg::OdometryLocations_T: current odometry log values with uncertainties; must behave according to https://github.com/openETCS/SRS-Analysis/blob/master/System%20Analysis/WorkingRepository/Group4/SUBSET_26_3-6/DetermineTrainLocationProcedures.pdf [[3.1]]. Members of OdometryLocations_T are: <ul style="list-style-type: none"> – o_nominal: L_internal_Type: nominal value in cm. – o_min: L_internal_Type: min. distance = o_min2 - o_min1 – o_max: L_internal_Type: max distance = o_max2 - o_max1 • speed: Obu_BasicTypes_Pkg::OdometrySpeeds_T: not used by calculateTrainPosition • acceleration: Obu_BasicTypes_Pkg::A_internal_Type: not used by calculateTrainPosition • motionState: [noMotion Motion] • motionDirection: Obu_BasicTypes_Pkg::odoMotionDirection_T [unknownDirection cabAFirst cabBFirst] <p><i>calculateTrainPosition requires consistent value sets of currentOdometry. calculateTrainPosition itself does not check.</i></p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Enumerated values out of range prohibit code generation. In all other cases, calculateTrainPosition does not have the knowledge for out-of-range checks.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Leads to misbehaviour.

5.7.2.1.2 msgFromTrack

Input name	msgFromTrack
Description	With msgFromTrack calculateTrainPosition receives datagrams from balise groups and RBC.
Source	F2.1 Manage_TrackSideInformation_Integration
Type	Common_Types_Pkg::ReceivedMessage_T

Valid range of values	<p>Common_Types_Pkg::ReceivedMessage_T is a complex data type. Values are given for each element. Format is: Type Name: range / list of values.</p> <ul style="list-style-type: none"> • bool valid: [true false]. "true" flags a datagram as received and to be evaluated by calculateTrainPosition. Must be set for exactly 1 clock for each received datagram and stay unset otherwise. • source: Common_Types_Pkg::MsgSource_T: Designates the source of the datagram: (msrc_undefined msrc_Euroradio msrc_Eurobalise msrc_RadioInfillUnit msrc_OBU) • radioMetaData: Common_Types_Pkg::radioMetaData_T: not used by calculateTrainPosition. • BG_Common_Header: BG_Types_Pkg::BG_Header_T: Header information received from balise groups, refer to Manage_TrackSideInformation_Integration_Pkg:: Manage_TrackSideInformation_Integration • Radio_Common_Header: Radio_Types_Pkg::Radio_TrackTrain_Header_T: Header information received from RBC via radio, refer to Manage_TrackSideInformation_Integration_Pkg:: Manage_TrackSideInformation_Integration • packets: Common_Types_Pkg::CompressedPackets_T: datagram packets, refer to Manage_TrackSideInformation_Integration_Pkg:: Manage_TrackSideInformation_Integration. calculateTrainPosition extracts packet 5 (linking information), if available. • sendingRBC: Common_Types_Pkg::RBC_Id_T: designates the origin RBC and the mobile modem channel used onboard, if received via radio. Refer to Manage_TrackSideInformation_Integration_Pkg:: Manage_TrackSideInformation_Integration for more detailed information. <p><i>calculateTrainPosition expects the received information to be consistent and validated before applied to. It does not check, if the information is appropriate due to current EVC mode, level, train or balise orientation. Received balise group or linking information already known by calculateTrainPosition overrides former data. All messages must be applied in the correct chronological order</i></p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Enumerated values out of range prohibit code generation. In all other cases, calculateTrainPosition does not have the knowledge for out-of-range checks.

Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Causes misbehaviour.
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5.7.2.1.3 trainProperties

Input name	trainProperties
Description	Supplies calculateTrainPosition with train specific properties required for position calculation.
Source	F2.3 trainData F2.10 manageDMI_input
Type	TrainPosition_Types_Pck::trainProperties_T
Valid range of values	<p>TrainPosition_Types_Pck::trainProperties_T is a complex data type. Values are given for each element. Format is: Type Name: range / list of values.</p> <ul style="list-style-type: none"> • nid_engine:: NID_ENGINE as defined by subset 026-7. • nid_operational: NID_OPERATIONAL as defined by subset 026-7. • l_train: L_TRAIN as defined by subset 026-7. • d_baliseAntenna_2_frontend: Obu_BasicTypes_Pkg::LocWithInAcc_T: Distance from the trains balise antenna to the trains front end, in cm with uncertainties. • d_frontend_2_rearend: Obu_BasicTypes_Pkg::LocWithInAcc_T: Distance from the trains front end to rear end, in cm with uncertainties. • locationAccuracy_DefaultValue: Obu_BasicTypes_Pkg::LocWithInAcc_T: Default location accuracy of balise groups (subset 026, 3.6.4.3.2), in cm with uncertainties. • centerDetectionAcc_DefaultValue: Obu_BasicTypes_Pkg::LocWithInAcc_T: Default accuracy of balise groups detection of the BTM, in cm with uncertainties. Will be applied, if centerDetectionInaccuracy from BTM is not available, especially for announced and not yet passed BGs. <p><i>calculateTrainPosition expects this information to be consistent and validated before applied to.</i></p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Enumerated values out of range prohibit code generation. In all other cases, calculateTrainPosition does not have the knowledge for out-of-range checks.

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) Causes misbehaviour.

5.7.2.1.4 passedBG

Input name	passedBG
Description	Deprecated alternative input to msgFromTrack. Must not be used any more and is subject to be removed in subsequent releases.

5.7.2.1.5 reset

Input name	reset
Description	Resets and keeps calculateTrainPosition at its initial state and deletes all internally stored data.
Source	F2 input EVC_reset
Type	bool
Valid range of values	[false true]
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Enumerated values out of range prohibit code generation.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Causes misbehaviour.

5.7.2.2 Outputs

5.7.2.2.1 trainPosition

Output name	trainPosition
Description	Provides the current train position and LRBG with its attributes. All distance and location computations of the OBU must be based on this information.

Destination	F2.1 Manage_TracksidesInformation_Integration F2.2 Manage_ETCS_Procedures F2.4 TrackAtlas F2.5 ManageLevelAndMode F2.7 PeedSupervision_Integration F2.8 ProvidePositionReport F2.9 MORC_HO F2.11 manageDMI_Output
Type	TrainPosition_Types_Pck::trainPosition_T
Valid range of values	<p>TrainPosition_Types_Pck::trainPosition_T is a complex data type. Values are given for each element. Format is: Type Name: range / list of values.</p> <ul style="list-style-type: none"> • valid: bool: [true false]. Always true, except for exceptional circumstances. • timestamp: Obu_BasicTypes_Pkg::T_internal_Type: latest time in ms. • trainPositionIsUnknown: bool: true, if the train position is evaluated as "unknonwn" (refer to subset-026, 3.6.3.1.3.1). • noCoordinateSystemHasBeenAssigned: bool: refer to subset 026, 3.4.2, 3.6.3.1.4. • trainPosition: Obu_BasicTypes_Pkg::LocWithInAcc_T: The calculated train position with uncertainties • estimatedFrontEndPosition: Obu_BasicTypes_Pkg::Location_T: Train front end position in cm. • minSafeFrontEndPosition: Obu_BasicTypes_Pkg::Location_T: Train front end position in cm. • maxSafeFrontEndPostion: Obu_BasicTypes_Pkg::Location_T: Train front end position in cm. • LRBG: TrainPosition_Types_Pck::positionedBG_T: the current LRBG. • prvLRBG: TrainPosition_Types_Pck::positionedBG_T: the balise group passed previously to LRBG. For type definition, see below. • nominalOrReverseToLRBG: Q_DLRBG: Orientation of the train in relation to the direction of the LRBG, see subset 026-7. • trainOrientationToLRBG: Q_DIRLRBG: Orientation of the train in relation to the direction of the LRBG, see subset 026-7. • trainRunningDirectionToLRBG: Q_DIRTRAIN: Direction of train movement in relation to the LRBG orientation, see subset 026-7. • linkingIsUsedOnboard: bool: Designates, if at least one announced linked BG is ahead.

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted

5.7.2.2.2 BGs

Output name	BGs
Description	A list of all linked and unlinked balise groups - known to calculate-TrainPosition - in the order they are arranged on the track.
Destination	F2.1 Manage_TracksideInformation_Integration F2.8 ProvidePositionReport F2.9 MoRC_HO
Type	array of TrainPosition_Types_Pck::positionedBG_T
Valid range of values	<p>TrainPosition_Types_Pck::positionedBG_T is a complex data type. Values are given for each array element. Format is: Type Name: range / list of values.</p> <ul style="list-style-type: none"> • valid: bool: [true false]. "true" for every existing balise group. • nid_c: NID_C: refer to subset 026-7. • nid_bg: NID_BG: refer to subset 026-7. • q_link: Q_LINK: refer to subset 026-7. • location: Obu_BasicTypes_Pkg::LocWithInAcc_T: The best known location (with inaccuracies) calculated from linking and from passing information. • seqNoOnTrack: int: Sequence number, specifies the order of the BG passed or expected to be passed. • infoFromLinking: TrainPosition_Types_Pck::infoFromLinking_T: Describes a linked BG as announced from the linking BG. Mainly, this information is taken from the linking packet. • infoFromPassing: BG_Types_Pkg::passedBG_T: If the balise group has been passed already, this is the relevant information received from the BG.

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
errorneous, absent or un-
wanted

5.7.2.2.3 errors

Output name	errors
Description	Provides a collection of error flags, raised by calculateTrainPosition.
Destination	F2.5 ManageLevelAndMode F2.8 ProvidePositionReport
Type	TrainPosition_Types_Pck::positionErrors_T
Valid range of values	<p>TrainPosition_Types_Pck::positionErrors_T is a complex data type. Values are given for each array element. Format is: Type Name: range / list of values.</p> <ul style="list-style-type: none"> • outOfMemSpace: bool: Memory overrun: a passed or announced BG could not be stored. • passedBG_foundNotWhereExpected: bool: The currently passed linked BG location does not match its expectation window. • positionCalculation_inconsistent: A consistency problem arose during position calculation. • linkedBGMissed: bool: The expectation window for an announced BG was passed without detecting the BG. • BGpassedInUnexpectedDirection: bool: The BG was passed in a different orientation than announced via linking. • BG_LinkingConsistencyError: bool: Linking consistency error (ref. subset 026, 3.16.2.3). • twoConsecutiveLinkedBGs_missed: bool: 2 consecutive linked balise groups announced by linking are not detected and the end of the expectation window of the second balise group has been passed (subset 026, 3.16.2.7.1). • doubleRepositioningError: bool: Double repositioning error (3.16.2.7.2). • bg: TrainPosition_Types_Pck::positionedBG_T: The corresponding balise group in the case of an error.

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
errorneous, absent or unwanted

5.7.3 Subcomponents

5.7.3.1 msg_2_passedBG

5.7.3.1.1 Component Requirements

Component name	msg_2_passedBG
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/CalculateTrainPosition
SCADE designer	Uwe Steinke, Siemens AG
Description	Converts msgFromTrack from ReceivedMessage_T to passedBG_T and determines, if the message was received from a just overpassed balise group or if it only announces balise groups via radio.
Input documents	n/a
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.7.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.7.3.2 calculateBGLocations

5.7.3.2.1 Component Requirements

Component name	calculateBGLocations
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/CalculateTrainPosition
SCADE designer	Uwe Steinke, Siemens AG

Description	<p>Calculates the location of a just overpassed balise group related to the list of all so far known balise groups. If the just overpassed balise group has been announced via linking (packet 5) previously, its location is adjusted to the best-of combination of linking and odometry information. If the just overpassed BG is a linked balise group, the locations of all known balise groups ahead and astern are recalculated with the just overpassed balise group as the one with minimized location uncertainties.</p> <p>If the overpassed balise group announces balise groups ahead via linking (packet 5), these balise groups are added to the list of known balise groups.</p>
Input documents	Subset-026, Chapter 3.6 Subset-026, Chapter 3.6.4
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.7.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.7.3.3 delDisposableBGs

5.7.3.3.1 Component Requirements

Component name	delDisposableBGs
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/CalculateTrainPosition
SCADE designer	Uwe Steinke, Siemens AG
Description	Deletes balise groups not needed any more from the list of known balise groups.
Input documents	Subset-026, Chapter 3.6.2.2.c)
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.7.3.3.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.7.3.4 addAnnouncedBGs

5.7.3.4.1 Component Requirements

Component name	addAnnouncedBGs
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/CalculateTrainPosition
SCADE designer	Uwe Steinke, Siemens AG
Description	When balise groups ahead are announced via radio, addAnnouncedBGs adds these balise groups to the list of known balises groups and calculates their locations.
Input documents	Subset-026, Chapter 3.6
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.7.3.4.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.7.3.5 calculateTrainpositionInfo

5.7.3.5.1 Component Requirements

Component name	calculateTrainpositionInfo
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/CalculateTrainPosition
SCADE designer	Uwe Steinke, Siemens AG
Description	Calculates the current train position based on the odometry and the list of known balise groups. Provides the last passed linked balised group and the linked balise group passed previously to the last passed linked balise group. Provides the last passed unlinked balise group. Determines, if linking is used on board.
Input documents	Subset-026, Chapter 3.6
Safety integrity level	4

Time constraints	n/a
API requirements	n/a

5.7.3.5.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (c.f. link above) respectively the SCADE generated documentation.

5.7.3.6 calculateTrainPositionAttributes

5.7.3.6.1 Component Requirements

Component name	calculateTrainPositionAttributes
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/CalculateTrainPosition
SCADE designer	Uwe Steinke, Siemens AG
Description	Enhances the current train position information with additional attributes as if the train position is unknown, if no coordinate system has been assigned, the trains front end position with attributes, determines the LRBG and the previous LRBG, if the train front end is located nominal or reverse to the LRBG, the train orientation and the train movement direction.
Input documents	Subset-026, Chapter 3.6
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.7.3.6.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.7.3.7 linkedBG_missed

5.7.3.7.1 Component Requirements

Component name	linkedBG_missed
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/CalculateTrainPosition
SCADE designer	Uwe Steinke, Siemens AG

Description	Detects, when the range of a linked BG (where it is expected to be found) is left and the BG has not been passed yet. Steadily observes the current train position and detects, when the train leaves the expectation window of any BG. When this happens, checks whether it is a linked BG and has been marked as passed. If not, it was not found within its expectation window.
Input documents	Subset-026, Chapter 3.6 Subset-026, Chapter 3.16.2.3
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.7.3.7.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.7.3.8 twoconsecutiveLinkedBGs_missed

5.7.3.8.1 Component Requirements

Component name	twoconsecutiveLinkedBGs_missed
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/CalculateTrainPosition
SCADE designer	Uwe Steinke, Siemens AG
Description	Detects, if 2 subsequent linked BGs are missed. The criterium is fulfilled, when 2 consecutive linked balise groups announced by linking have not been detected and the end of the expectation window of the second balise group has been passed.
Input documents	Subset-026, Chapter 3.6 Subset-026, Chapter 3.16.2.3
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.7.3.8.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.8 F2.7: SpeedSupervision_Integration

5.8.1 Component Requirements

Component name	SpeedSupervision_Integration
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervision
SCADE designer	Benjamin Beichler, University of Rostock Christian Stahl, TWT Thorsten Schulz, University of Rostock
Description	<p>The task of SDM is to monitor the speed of the train and the train location and as such to ensure that the speed remains within the given speed and distance limits. This block is based on [1, Chapt. 3.13]. The integration node “SpeedSupervision_Integration” takes as input (1) movement related information such as train speed, train position and acceleration, (2) train related information such as brake information and train length, and (3) track related information such as speed and distance limits and national values.</p> <p>Based on this information a speed profile is calculated. Speed restrictions create target speeds (targets) that have to be followed. For each such target braking curves are generated to supervise at which location of the track the train must apply the brake. In case of no target restrictions the train may accelerate to the supervised maximum speed of the speed profile. These calculations lead to commands being sent to the driver and the brake system.</p> <p>The functionality is modeled using eight subcomponents, as shown in Figure 24, which are explained in Section 5.8.3.</p> <p>The current status of the analysis of “SDM” and a functional breakdown can be found in a separate document, SpeedSupervision_analysis.pdf.</p>
Input documents	Subset-026, Chapter 3.13: Speed and distance monitoring
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.8.2 Interface

An overview of the interface of component SpeedSupervision_integration is shown in Figure 24. The inputs and outputs are described in detail in Section 5.8.2.1 respectively 5.8.2.2. Sub components are described in Section 5.8.3.

5.8.2.1 Inputs

5.8.2.1.1 National Values

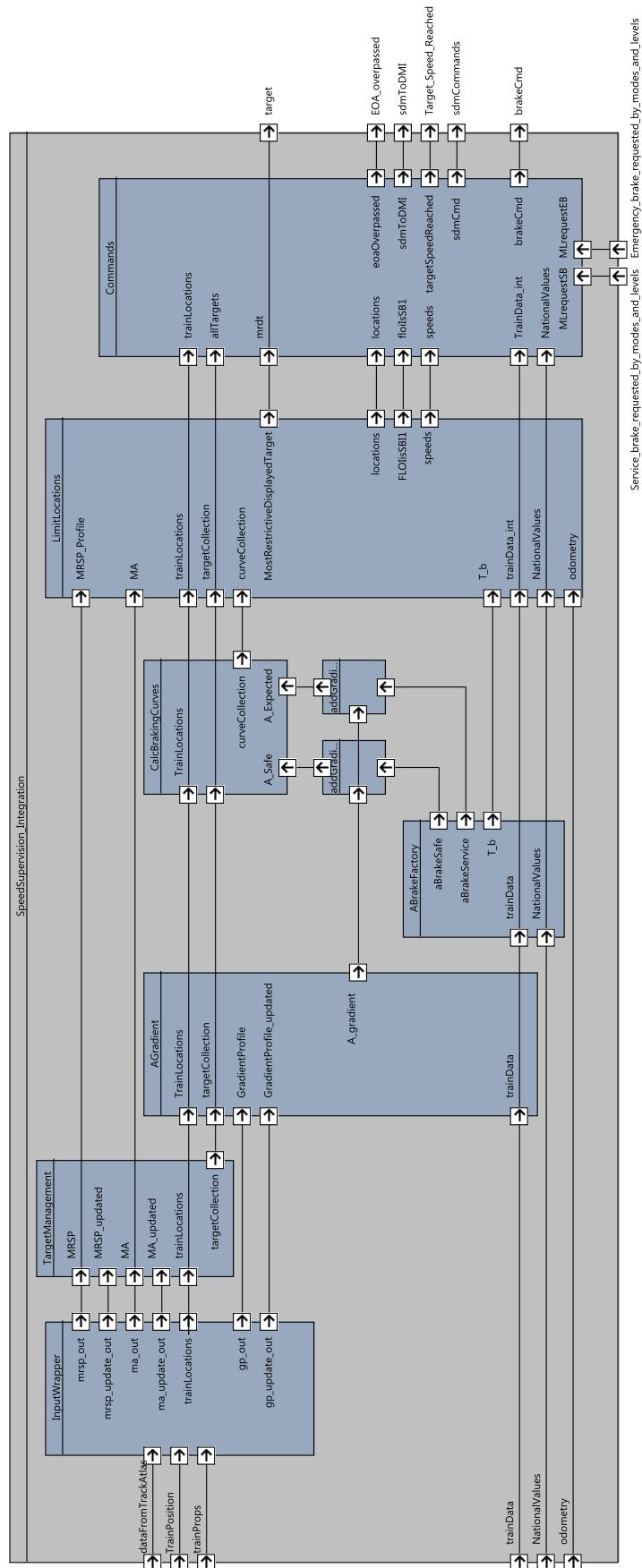


Figure 24. SpeedSupervision_Integration component SysML diagram.

Input name	NationalValues
Description	This input is packet 3 or 203 of [1, Chapt. 8], describing the national values.
Source	F2.4 TrackAtlas; current release, hard wired constant: cP3NationalValuesUtrechtAmsterdam
Type	P3_NationalValues_T
Valid range of values	P3_NationalValues_T is a complex data type, valid ranges are specified in SRS Subset-026-7, no further checks are done here.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Not checked; node must not be called without reasonable National Value.

5.8.2.1.2 Train Position

Input name	TrainPosition
Description	This input is the current train position.
Source	F2.6 calculateTrainPosition
Type	trainPosition_T
Valid range of values	trainPosition_T is a complex data type. Value valid must not be false for proper function and it may not be properly checked in current release. Furthermore, reversing (decreasing positions, reverse flag set) is currently NOT supported and leads to undefined behaviour. No brake will be thrown in this occasion.
Behaviour when value is at boundary	Not checked, may overflow.
Behaviour for values out of valid range	Currently not checked.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Not checked; node must not be called without reasonable position data. Valid flag is not checked (bug), as SDM has not yet implemented exception handling on unacceptable input data.

5.8.2.1.3 Odometry

Input name	odometry
------------	----------

Description	This input is the odometry data.
Source	F2 input API_Odometry
Type	odometry_T
Valid range of values	<p>complex data type used fields are:</p> <ul style="list-style-type: none"> - acceleration: Obu_BasicTypes_Pkg::A_internal_Type. No valid range defined, neither checked. - motionState: [noMotion Motion] (enum type) - motionDirection: is NOT evaluated currently which leads to erroneous behaviour when driving anti-nominal direction.
Behaviour when value is at boundary	Possible overflow not evaluated.
Behaviour for values out of valid range	Not checked.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Not handled, valid data is expected for valid function. Valid flag is not checked (bug), as SDM has not yet implemented exception handling on unacceptable input data.

5.8.2.1.4 Train Properties

Input name	trainProps
Description	This input is a set of train related properties.
Source	F2.3 trainData F2.10 manageDMI_input
Type	trainProperties_T
Valid range of values	trainProperties_T is a complex type but referenced only d_baliseAntenna_2_frontend.nominal: Obu_BasicTypes_Pkg::L_internal_Type. No valid range defined, neither checked.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Value is only evaluated in Level 1. Low values (e.g. invalid-default 0) will lead to early trip, brake and alike. Larger values will lead to late braking, possibly numeric overflow.

5.8.2.1.5 Train Data

Input name	trainData
Description	This input is a set of train related inputs from the TIU.
Source	F2.3 trainData F2.10 manageDMI_input
Type	trainData_T
Valid range of values	trainData_T is a complex type. No valid range defined, neither checked. The source is trusted.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Must be valid for SDM to function. Valid flag is not checked (bug), as SDM has not yet implemented exception handling on unacceptable input data.

5.8.2.1.6 Track Data

Input name	dataFromTrackAtlas
Description	This input is a set of track related input data, containing the MRSP, the Gradient Profile and the Movement Authority. And its associated update flags to optimize data handling.
Source	F2.4 TrackAtlas
Type	DataForSupervision_nextGen_t
Valid range of values	DataForSupervision_nextGen_t is a wrapper the three mentioned complex types. The fresh-flags are seen as an optimization hint. From specification, all three containers must contain valid data for SDM to function. Ranges or sanity are not checked. The source is trusted. MA Must always contain a valid Movement Authority, else the brake is commanded. GradientProfile As per SRS, this must always contain a valid description up to the end of the MA. MRSP Must at least a profile for the train's maximum speed, if no other restriction is known.
Behaviour when value is at boundary	n/a

Behaviour for values out of valid range	If the MA is not valid the brake should be commanded.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Absence of minimal MRSP is not detected but trusted. Validity of MA is not checked up front.

5.8.2.2 Outputs

5.8.2.2.1 sdmToDMI

Output name	sdmToDMI
Description	This output contains information about different speeds and positions and the current supervision status. This information shall be displayed to the driver.
Destination	F2.4 TrackAtlas F2.11 manageDMI_output
Type	speedSupervisionForDMI_T (complex)
Valid range of values	<p>speedSupervisionForDMI_T is a complex data type. Values are given for each element. Format is: Type Name: range/list of value.</p> <ul style="list-style-type: none"> • bool valid: [true, false] true, if internal state of speed monitoring is defined [CSM, TSM, RSM]; false, if it is undefined • V_internal_Type targetSpeed, permittedSpeed, releaseSpeed, interventionSpeed: 0 or above, not internally limited; set to cDMIUnknownSpeed (-1) if not defined • L_internal_Type location_brake_curve_starting_point, locationBrakeTarget, distanceIndicationPoint: calculated locations • M_SupervisionDisplay_T supervisionDisplay: [supDis_normal, supDis_indication, supDis_overspeed, supDis_warning, supDis_intervention] • M_SUPERVISION_STATUS sup_status: [CSM, TSM, RSM, unknown], PIM is not referenced
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Location values may not be meaningful in some situations. This is not directly linked to the specific items but maybe accessible from further context such as supervisionDisplay and sup_status.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Valid can be false in case of initialization. All values must be disregarded then.

5.8.2.2.2 target

Output name	target
Description	This output is the most restrictive displayed target (MRDT).
Destination	n/a, null-sink
Type	Target_T (complex)
Valid range of values	<p>Target_T is a complex data type. Values are given for each element. Format is: Type Name: range/list of value.</p> <ul style="list-style-type: none"> • bool valid: [true, false] true, if targetType is other than invalid • V_internal_Type speed: permitted speed from target location • L_internal_Type distance: location of brake target • TargetType_T targetType: <ul style="list-style-type: none"> EoA End of Authority (speed must be = 0) SvL Supervised Location (speed must be = 0) MRSP Speed Profile, Speed restriction (speed > 0) LoA Limit of Authority (speed > 0) invalid currently no brake target known (e.g. after trip)
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Valid target values of speed and distance are not artificially limited to a sane range and are passed through data from track input.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	.valid may be false if no target is supervised or known, other values of this output must be ignored then.

5.8.2.2.3 sdmCommands

Output name	sdmCommands
Description	This output gives some intermediate results of operator SDM_Commands. It is currently used for test purposes only.
Destination	n/a, null-sink
Type	SDM_Commands_T (complex)
Valid range of values	Containing values are either boolean command-trigger flags, the internal state of the SDM_commands state-machine or speed/distance types with guarding bool valid flag. For in-depth description see generated documentation.

Behaviour when value is n/a
at boundary

Behaviour for values out
of valid range

- Bool are always in range.
- The internal state SupervisionStatus_T is Undefined_Supervision at initialization and renders the output sdmToDMI's valid flag to false.
- Speeds estimatedSpeed, permittedSpeed, releaseSpeed, mrdrd-Speed, sbiSpeed and distance targetDistance must be ignored and contain invalid values if the corresponding valid-flag is false. Valid-marked outputs are not artificially limited to a sane range and rely on correctly specified algorithms.

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) Overall .valid is always set, individual speeds have their corresponding valid flag. Values may not have a valid output depending on the situation.

5.8.2.2.4 brakeCmd

Output name	brakeCmd
Description	This output is the brake command, indicating whether performing the service brake and/or the emergency brake have been commanded.
Destination	F2.11 manageDMI_output
Type	Brake_command_T (complex)
Valid range of values	<p>Brake_command_T is a complex data type. Values are given foreach element. Format is: Type Name: range/list of value</p> <ul style="list-style-type: none"> • bool valid: true (constant) • M_brake_signal_command_T m_servicebrake_cm: brake_signal_command_not_defined No change of brake state requested, keep last. apply_brake service brakes must be applied release_brake service brakes must be released • M_brake_signal_command_T m_emergencybrake_cm: brake_signal_command_not_defined No change of brake state requested, keep last. apply_brake emergency brakes must be applied release_brake emergency brakes must be released <p>Brake commands are edge triggered and may only be defined in a single cycle.</p>

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) brakeCmd is constantly valid, but may not contain a command change.

5.8.2.2.5 EOA_overpassed

Output name	EOA_overpassed
Description	This output is true if the end of authority has been overpassed and false otherwise. In Level 1 this is compensated by the antenna offset.
Destination	n/a, null-sink in current release
Type	bool

Valid range of values

true The train's front end has passed the end of authority

false The end of authority is ahead of the train.

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or unwanted (i.e. spurious)

5.8.2.2.6 Target_Speed_Reached

Output name	Target_Speed_Reached
Description	This output is true if the current speed is greater than or equal the target speed and false otherwise.
Destination	n/a, null-sink in current release
Type	bool

Valid range of values

true The current speed is greater than or equal to the target speed
or target is invalid

false The current speed is less than the target speed

Value must be ignored, if output target (5.8.2.2.2) is invalid.

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.8.3 Subcomponents

5.8.3.1 SDM_InputWrapper

5.8.3.1.1 Component Requirements

Component name	SDM_InputWrapper
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/ Scade/System/ObuFunctions/SpeedSupervision/SpeedSupervision_ Integration
SCADE designer	Benjamin Beichler, University of Rostock Thorsten Schulz, University of Rostock
Description	The motivation for this operator is to convert all inputs of SDM that contain information about length, speed, distance, and acceleration defined as integer into real to allow automatically the highest precision in the calculations by the meaning of floating point operations. In addition, to ease the modeling, inside block “Speed Supervision” only units meters ([m]), seconds([s]), meters per second([$\frac{m}{s}$]), and meters per square second([$\frac{m}{s^2}$]) are used. This operator forwards input messages, takes data from complex data types or transforms inputs messages into an internal type thereby converting int to real.
Input documents	Subset-026, Chapter 3.13, (not specific, helper function)
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.8.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.8.3.2 TargetManagement

5.8.3.2.1 Component Requirements

Component name	TargetManagement
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervision/TargetManagement
SCADE designer	Benjamin Beichler, University of Rostock Thorsten Schulz, University of Rostock
Description	This operator calculates/updates the list of targets to be supervised by SDM. Taking the current movement authority, the most restrictive speed profile and the current maximum safe front end position as an input, the operator outputs a list of MRSP-Targets and a Limit-of-Authority-Target (LoA) or, if an End of Authority is known, the End-of-Authority-Target (EoA) and the Supervised Location (SvL). Since LoA and SvL are mutually exclusive but both result in a trip-target, they use the same flow. Derivation of Targets from Movement Authority The <i>Movement Authority</i> creates three types of targets: Limit of Authority (LoA) if the End of Authority is not yet known to the RBC and is accompanied by a speed limit for the given location. End Of Authority (EoA) requires the train to stop and creates a Service Brake Target Supervised Location (SvL) is derived from the EoA but results in an emergency brake target and on passing in a trip. The SvL may be offset from the EoA to the Overlap (OL) or the Dangerpoint (DP). Derivation of Targets from MRSP According to [1, Chapt. 3.13.8.2], every speed decrease of the MRSP is used to derive a target. Therefore in every cycle in which the MRSP is updated, the operator iterates through the entire MRSP searching for all MRSP targets. For this purpose, every element of the MRSP is compared with its successor. Update of Targets In every cycle the operator monitors whether all targets are already passed. To this end, it iterates over the list of targets comparing the current front end position with the target's location.
Input documents	Subset-026, Chapter 3.13.8.2: Determination of the supervised targets
Safety integrity level	4

Time constraints	n/a
API requirements	n/a

5.8.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.8.3.3 AGradient

5.8.3.3.1 Component Requirements

Component name	AGradient
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervisionSDM_GradientAcceleration
SCADE designer	Benjamin Beichler, University of Rostock
Description	This operator translates the incoming gradient profile from track data to acceleration values under consideration of train length compensation.
Input documents	Subset-026, Chapter 3.13.4: Acceleration / Deceleration due to gradient
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.8.3.3.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.8.3.4 ABrakeFactory

5.8.3.4.1 Component Requirements

Component name	ABrakeFactory
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervision/SDM_Models
SCADE designer	Thorsten Schulz, University of Rostock

Description	This operator implements the braking models. At this stage only the lamda trains (conversion) model is implemented. The output of the conversion model are a location independent, but highly National Values dependent, braking curves. One for the service brake and one for the emergency brake. As a side product, the model related brake build-up times are also generated.
Input documents	Subset-026, Chapter 3.13.2.2.3 Braking Models, Chapter 3.13.2.2.4,5 Brake Position, Percentage, Chapter 3.13.2.3.7 National Values for SDM, Chapter 3.13.3 Conversion Models, 3.13.6 Calculation of the deceleration and brake build-up times
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.8.3.4.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.8.3.5 addGradient

5.8.3.5.1 Component Requirements

Component name	addGradient
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervision/SDM_Models
SCADE designer	Thorsten Schulz, University of Rostock
Description	This operator is part of SDM_Models and is merging the gradient acceleration into the curve brake model curve, producing a location dependent braking curve. It twice, for the emergency curve and the service braking curve respectively
Input documents	Subset-026, Chapter 3.13.6.2.1.3 and 3.13.6.4.3 Calculation of the deceleration and brake build-up times
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.8.3.5.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.8.3.6 CalcBrakingCurves_Integration

5.8.3.6.1 Component Requirements

Component name	CalcBrakingCurves_Integration
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervision/CalcBrakingCurves
SCADE designer	Benjamin Beichler, University of Rostock
Description	For each type of target a certain braking curve has to be calculated. This curve enables proactive monitoring of the train's speed. A reverse lookup on this braking curve indicates, where the train has to start braking given the current speed. The braking curve does not depend on the actual train status. As a consequence the braking curve stays constant over time. As a legitimate simplification the calculation of the braking curve is not extended past the estimated front end position of the train.
Input documents	Subset-026, Chapter 3.13.8.3: Emergency Brake Deceleration curves (EBD) Subset-026, Chapter 3.13.8.4: Service Brake Deceleration curves (SBD) Subset-026, Chapter 3.13.8.5: Guidance curves (GUI)
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.8.3.6.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.8.3.7 SDMLimitLocations

5.8.3.7.1 Component Requirements

Component name	SDMLimitLocations
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervision/SDM_TargetLimits
SCADE designer	Thorsten Schulz, University of Rostock

Description	<p>This operator calculates the various locations and speeds needed to determine the speed and distance monitoring commands. The current implementation of functionality is stateless and requires a complete recalculation each cycle.</p> <p>This operator gathers all necessary input values and computes some frequently used intermediate values in the operators <code>surplusTractionDeltas</code> and v_{bec}. The other input preparation operator is the <code>TargetSelector</code> whose main task is to dissect the list of targets to find the Most Restrictive Target. The accompanying braking curves are extracted and promoted to trailing location calculations. Also the special values of the EOA are exposed.</p> <p>The operator creates the requested values for the commands package. These are in particular the preindication locations for EBD and SBD based targets, the release speed monitoring start locations, the locations for target speed monitoring of the I-, W-, P- and FLOI-curve, the related FLOI speed and the location of the permitted speed supervision limit. Included in the output are also certain flags for the validity of linked values.</p>
Input documents	<p>Subset-026, Chapter 3.13.9: Supervision Limits Subset-026, Chapter 5.3.1.2: f_{41} – accuracy of speed known on-board Subset-026, Chapter 3.13.10: Monitoring Commands as reference for required outputs of this module</p>
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.8.3.7.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.8.3.8 SDM_Commands

5.8.3.8.1 Component Requirements

Component name	SDM_Commands
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervision/SDM_Commands
SCADE designer	Christian Stahl, TWT Thorsten Schulz, University of Rostock

Description	This operator models the speed and distance monitoring commands. More precisely, it triggers the service or emergency brake and outputs the current supervision status of the OBU together with information on speeds and locations to the driver. The OBU can be in any of three types of speed and distance monitoring modes: ceiling speed monitoring, release speed monitoring and target speed monitoring. We use a state machine to model the switching between the three modes: each state models a mode and a transition between states is enabled if the condition two switch between the two corresponding modes is evaluated to true. In each mode, the OBU can be in up to five different supervision states. The behavior of changing from one status to another is also modeled as a state machine. As a result, the model is a hierarchical state machine.
Input documents	Subset-026, Chapter 3.13.10: Speed and distance monitoring commands
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.8.3.8.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.9 F2.8: Provide_Position_Report

5.9.1 Component Requirements

Component name	Provide_Position_Report
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/ProvidePositionReport/ProvidePositionReport_Pkg.xscade
SCADE designer	Christian Stahl, TWT GmbH
Description	<p>The component builds a position report for the RBC, i.e., message 132, and provides it as an output. There are two triggers for sending message 132:</p> <ol style="list-style-type: none"> 1. at least one of the triggers of the position report parameters (packet 58) holds or 2. one of the events enabling the sending of the report occurs. <p>As the core position report (i.e., packet 0 or 1) is included in other packets, the component also provides this core position report at every clock cycle. At most one of the two packets is valid.</p>

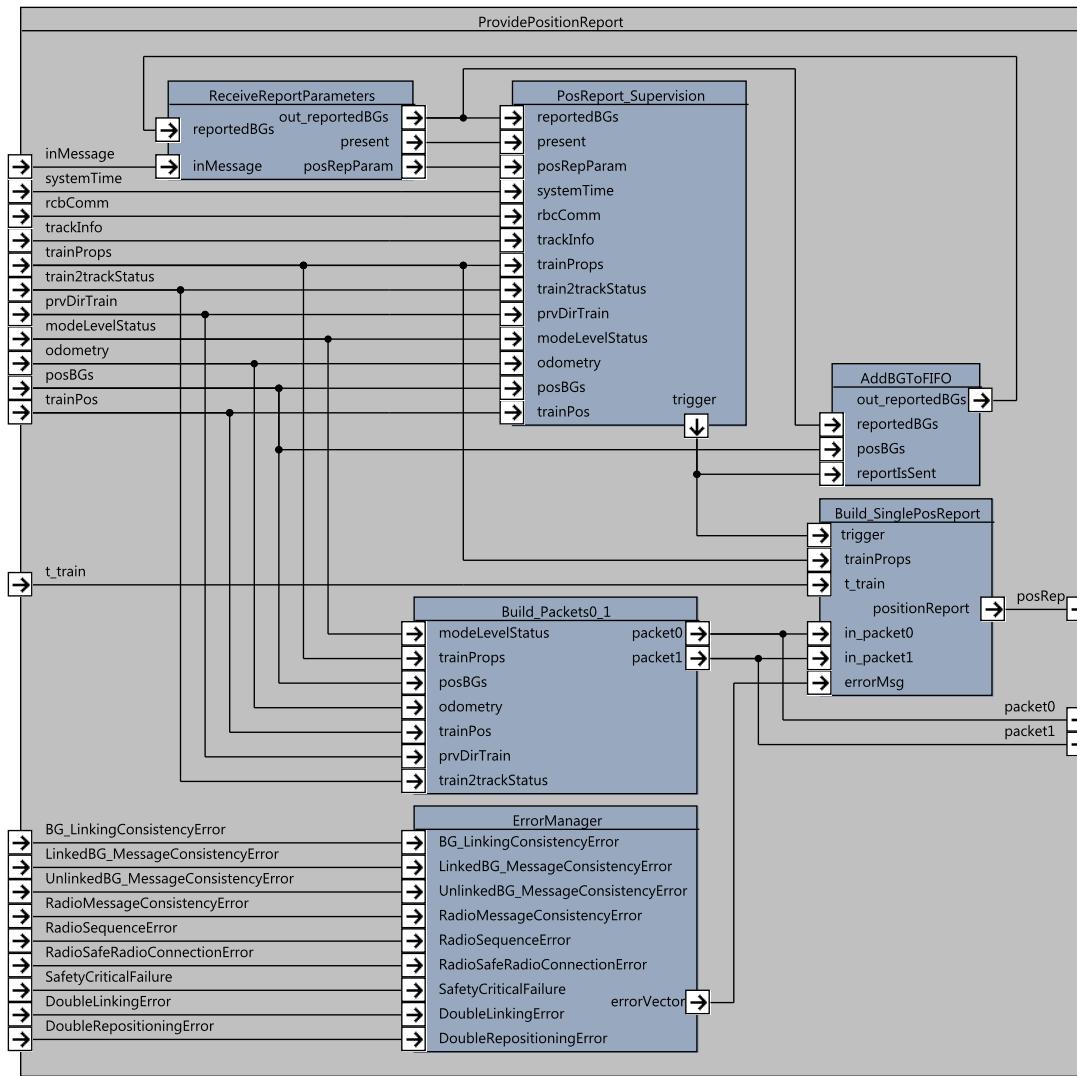


Figure 25. **Provide_Position_Report** component SysML diagram

Input documents	Subset-026, Chapter 3.6.5
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.9.2 Interface

An overview of the interface of component `Provide_Position_Report` is shown in Figure 25. The inputs and outputs are described in detail in Section 5.9.2.1 respectively 5.9.2.2. Subcomponents are described in Section 5.9.3.

5.9.2.1 Inputs

5.9.2.1.1 `inMessage`

Input name	inMessage
Description	Input message from the bus (to extract Packet 58, the position report parameters).
Source	F2.1 Manage_TrackSideInformation_Integration
Type	Common_Types_Pkg::ReceivedMessage_T
Valid range of values	as defined in SCADE
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or un- wanted (i.e. spurious)	If valid is false, then input is ignored.

5.9.2.1.2 systemTime

Input name	systemTime
Description	The system time.
Source	F2 input API_SystemTime
Type	SystemTime_T, i.e., Obu_BasicTypes_Pkg::T_internal_Type
Valid range of values	[0; maximum positive int value of target platform]
Behaviour when value is at boundary	assumed to be valid
Behaviour for values out of valid range	assumed to be valid
Behaviour when value is erroneous, absent or un- wanted (i.e. spurious)	assumed to be valid

5.9.2.1.3 rbcComm

Input name	rbcComm
Description	Variables modeling stati regarding the RBC communication.
Source	F2.9 MoRC_HO
Type	RBC_Communication_T
Valid range of values	as defined in SCADE

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.9.2.1.4 trackInfo

Input name	trackInfo
Description	Location based events.
Source	EVC; currently a constant
Type	LocationBasedEvents_T
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.9.2.1.5 trainProps

Input name	trainProps
Description	The train properties.
Source	F2.10 manageDMI_Input
Type	TrainPosition_Types_Pck::trainProperties_T
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.9.2.1.6 train2trackStatus

Input name	train2trackStatus
Description	Train to track status information.
Source	F2.10 manageDMI_Input
Type	BG_Types_Pkg::TrainToTrackStatus_T
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.9.2.1.7 prvDirTrain

Input name	prvDirTrain
Description	Train direction of the last clock cycle.
Source	F2.6 calculateTrainPosition
Type	Q_DIRTRAIN
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.9.2.1.8 modeLevelStatus

Input name	modeLevelStatus
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Description	Information referring to mode and level status.
Source	F2.5 ManageLevelAndMode
Type	ModeLevel2PositionReport_T
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	n/a

5.9.2.1.9 odometry

Input name	odometry
Description	Odometry information.
Source	F2 input API_Odometry
Type	Obu_BasicTypes_Pkg::odometry_T
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	n/a

5.9.2.1.10 posBGs

Input name	posBGs
Description	Positioned balise groups used for current train position.
Source	F2.6 calculateTrainPosition
Type	TrainPosition_Types_Pck::positionedBGs_T
Valid range of values	as defined in SCADE

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.9.2.1.11 trainPos

Input name	trainPos
Description	Current train position.
Source	F2.6 calculateTrainPosition
Type	TrainPosition_Types_Pck::trainPosition_T
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.9.2.1.12 t_train

Input name	t_train
Description	Current timestamp.
Source	F2 input API_persistentData
Type	T_TRAIN
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.9.2.1.13 BG_LinkedConsistencyError

Input name	BG_LinkedConsistencyError
Description	True if respective error has occurred; otherwise false.
Source	F2.6 calculateTrainPosition
Type	bool
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.9.2.1.14 LinkedBG_MessageConsistencyError

Input name	LinkedBG_MessageConsistencyError
Description	True if respective error has occurred; otherwise false.
Source	F2.1 Manage_TrackSideInformation_Integration
Type	bool
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.9.2.1.15 UnlinkedBG_MessageConsistencyError

Input name	UnlinkedBG_MessageConsistencyError
Description	True if respective error has occurred; otherwise false.
Source	F2.1 Manage_TrackSideInformation_Integration
Type	bool

Valid range of values as defined in SCADE

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.9.2.1.16 RadioMessageConsistencyError

Input name RadioMessageConsistencyError

Description True if respective error has occurred; otherwise false.

Source F2.1Manage_TrackSideInformation_Integration

Type bool

Valid range of values as defined in SCADE

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.9.2.1.17 RadioSequenceError

Input name RadioSequenceError

Description True if respective error has occurred; otherwise false.

Source F2.1 Manage_TrackSideInformation_Integration

Type bool

Valid range of values as defined in SCADE

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.9.2.1.18 RadioSafeRadioConnectionError

Input name	RadioSafeRadioConnectionError
Description	True if respective error has occurred; otherwise false.
Source	none; currently a constant
Type	bool
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.9.2.1.19 SafetyCriticalFailure

Input name	SafetyCriticalFailure
Description	True if respective error has occurred; otherwise false.
Source	EVC; currently a constant
Type	bool
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.9.2.1.20 DoubleLinkingError

Input name	DoubleLinkingError
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Description	True if respective error has occurred; otherwise false.
Source	F2.6 calculateTrainPosition
Type	bool
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	n/a

5.9.2.1.21 DoubleRepositioningError

Input name	DoubleRepositioningError
Description	True if respective error has occurred; otherwise false.
Source	F2.6 calculateTrainPosition
Type	bool
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	n/a

5.9.2.2 Outputs

5.9.2.2.1 packet0

Output name	packet0
Description	Packet 0 – position report based on a single balise – is provided every clock cycle.
Destination	F2.4 TrackAtlas
Type	Packet_TrainTypes_Pkg::PT0_PositionReport_T

Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.9.2.2.2 packet1

Output name	packet1
Description	Packet 1 – position report based on two balise groups – is provided every clock cycle.
Destination	F2.4 TrackAtlas
Type	Packet_TrainTypes_Pkg::PT1_PositionReport_2BG_T
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	

5.9.2.2.3 posRep

Output name	posRep
Description	Position report to be send to the RBC, i.e. message 136.
Destination	F2 output API_toEuroradio
Type	Radio_Types_Pkg::Radio_TrainTrack_Message_T
Valid range of values	as defined in SCADE
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a

Behaviour when value is n/a
erroneous, absent or unwanted (i.e. spurious)

5.9.3 Subcomponents

5.9.3.1 ReceiveReportParameters

5.9.3.1.1 Component Requirements

Component name	ReceiveReportParameters
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/ProvidePositionReport/ProvidePositionReport_Pkg.xscade
SCADE designer	Christian Stahl, TWT
Description	The component reads the position report parameters (i.e., packet 58) from the message bus. When a report is received, the BG information provided is used to update the location of respective BG. This BG is being stored in the list of the last 8 BGs.
Input documents	Subset-026, Chapter 3.6.5
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.9.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.9.3.2 PosReport_Supervision

5.9.3.2.1 Component Requirements

Component name	PosReport_Supervision
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/ProvidePositionReport/ProvidePositionReport_Pkg.xscade
SCADE designer	Christian Stahl, TWT

Description	The component supervises trigger (i.e., position report parameter) and events that trigger the sending of a position report. If the output is true, then a report has to be sent.
Input documents	Subset-026, Chapter 3.6.5
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.9.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.9.3.3 ErrorManager

5.9.3.3.1 Component Requirements

Component name	ErrorManager
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/ProvidePositionReport/PositionReportErrorManager_Pkg.xscade
SCADE designer	Christian Stahl, TWT
Description	The component takes all nine possible error messages as an input and aggregates them to a vector.
Input documents	Subset-026, Chapter 3.6.5
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.9.3.3.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.9.3.4 Build_Packets0_1

5.9.3.4.1 Component Requirements

Component name	Build_Packets0_1
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Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/ProvidePositionReport/ProvidePositionReport_Pkg.xscade
SCADE designer	Christian Stahl, TWT
Description	The component builds packets 0 and 1; at most one of them is valid.
Input documents	Subset-026, Chapter 3.6.5
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.9.3.4.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.9.3.5 Build_PosReport

5.9.3.5.1 Component Requirements

Component name	Build_PosReport
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/ProvidePositionReport/ProvidePositionReport_Pkg.xscade
SCADE designer	Christian Stahl, TWT
Description	This operator builds nine position report messages – there can be up to nine errors, and for each error an individual report has to be sent. The fold operator ensures that the first report is invalid if the first error is not present but there exists an error in the error field. In other words, one valid report will be built. If the errorVector does not contain a single error, then at least one report needs to be built (if the operator is triggered).
Input documents	Subset-026, Chapter 3.6.5
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.9.3.5.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.9.3.6 AddBGToFIFO

5.9.3.6.1 Component Requirements

Component name	AddBGToFIFO
Link to SCADE model	https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/ProvidePositionReport/ProvidePositionReport_Pkg.xscade
SCADE designer	Christian Stahl, TWT
Description	The component adds the current reported BG to the list of BGs for which a report has been sent. Adding of this BG is performed according to the FIFO method.
Input documents	Subset-026, Chapter 3.6.5
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.9.3.6.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.10 F2.9: Manage_Radio_Communication and RBC_Handover

5.10.1 Component Requirements

Component name	MoRC_HO
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/Radio/MoRC_HO
SCADE designer	Uwe Steinke, Siemens AG

Description	<p>The <i>MoRC_HO</i> component implements the handover process between two different RBCs and the session management (<i>MoRC</i> = management of radio communication) with each of them.</p> <p><i>MoRC_HO</i> comprises</p> <ul style="list-style-type: none"> • the <i>processHandingOver</i> subcomponent performing the handover process from the handing over RBC to the accepting RBC, • two instances of <i>MoRC_Main_v2</i> representing the session management with up to two RBCs in parallel • a <i>mobileDataRouter_out</i> subcomponent for routing the OBUs output data stream to both RBCs and switching over from the handing over RBC to the accepting RBC. <p><i>processHandingOver</i> consumes the relevant messages received from track and controls the registration with the radio network, the session termination with the handing over RBC and the session establishment with the accepting RBC. To achieve this, it controls up to two instances of <i>MoRC_Main_v2</i>. Additionally, it monitors the current train position and performs the handing over at the ordered track location. The number of MoRC instances used is configurable and depends on the number of mobile modems (1 or 2) available on board.</p> <p>The management of radio communication <i>MoRC_Main_v2</i> implements the onboard management part of a single communication session with the track, i.e. a single RBC. It controls the establishing, maintaining and termination process of a radio communication session and steers the underlying communication safety layer and the mobile device. Those and the data transfer itself are not part of the function.</p> <p><i>MoRC_HO</i> requests position reports to be sent to the appropriate RBC and cooperates with the <i>InformationFilter</i> component for input data stream filtering and buffering as required by the handover process.</p>
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Input documents	Subset-026, Chapter 3.5 Subset-026, Chapter 3.15 Subset-026, Chapter 5.15
Safety integrity level	4
Time constraints	Function activation has to facilitate the internally implemented time delays
API requirements	Interfaces with the OBUs mobile modems via API

5.10.2 Interface

An overview of the interface of component MoRC_HO is shown in Figure 26. The inputs and outputs are described in detail in Section 5.10.2.1 respectively 5.10.2.2. Sub components are described in Section 5.10.3.

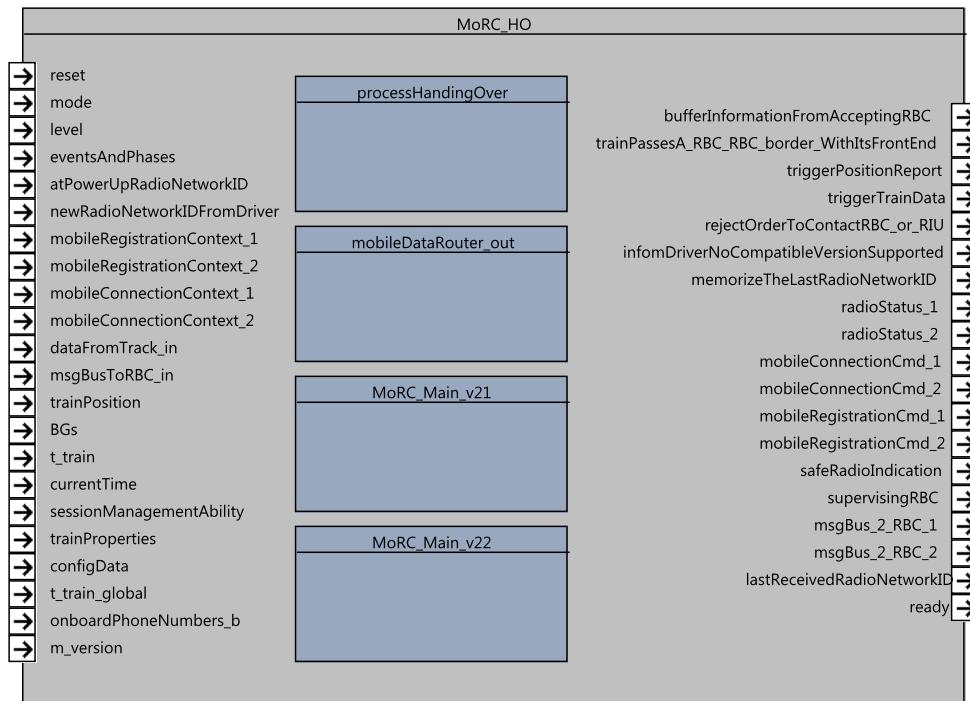


Figure 26. Manage_Radio_Communication component SysML diagram

5.10.2.1 Inputs

5.10.2.1.1 mode

Input name	mode
Description	Current onboard operating mode
Source	F2.5 ManageLevelAndMode
Type	M_MODE
Valid range of values	Defined by M_MODE enumerations
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

5.10.2.1.2 [level]

Input name	level
Description	Current Operating Level
Source	F2.5 ManageLevelAndMode
Type	M_LEVEL
Valid range of values	Defined by M_LEVEL enumerations
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

5.10.2.1.3 eventsAndPhases

Input name	eventsAndPhases
Description	Collection of input events and OBU operating phases
Source	F2.5 ManageLevelAndMode F2.2 Manage_ETCS_Procedures
Type	RCM_Session_Types_Pkg::obuEventsAndPhases_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

5.10.2.1.4 atPowerUpRadioNetworkID

Input name	atPowerUpRadioNetworkID
Description	Radio network ID to be used at power up
Source	Input is a constant currently.
Type	Packet_Types_Pkg::P45_RadioNetworkRegistration_T

Valid range of values	Ref. to NID_MN (Identity of Radio Network)
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	OBUs registers to unwanted radio network
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	OBUs registers to unwanted radio network

5.10.2.1.5 newRadioNetworkIDFromDriver

Input name	newRadioNetworkIDFromDriver
Description	Radio network ID entered by the driver
Source	Input is a constant currently.
Type	Packet_Types_Pkg::P45_RadioNetworkRegistration_T
Valid range of values	Ref. to NID_MN (Identity of Radio Network)
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	OBUs registers to unwanted radio network
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	OBUs registers to unwanted radio network

5.10.2.1.6 mobileRegistrationContext_1

Input name	mobileRegistrationContext_1
Description	Current registration status information from mobile modem 1
Source	F2 input API_mobileHWStatus
Type	RCM_Types_Pkg::mobileRegistrationContext_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	Misbehaviour

Behaviour when value is Misbehaviour
erroneous, absent or un-
wanted (i.e. spurious)

5.10.2.1.7 mobileRegistrationContext_2

Input name	mobileRegistrationContext_2
Description	Current registration status information from mobile modem 2
Source	F2 input API_mobileHWStatus
Type	RCM_Types_Pkg::mobileRegistrationContext_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	Misbehaviour
Behaviour for values out of valid range	Misbehaviour
Behaviour when value is Misbehaviour erroneous, absent or un- wanted (i.e. spurious)	

5.10.2.1.8 mobileConnectionContext_1

Input name	mobileConnectionContext_2
Description	Current connection status information from mobile modem 1
Source	F2 input API_mobileHWStatus
Type	RCM_Types_Pkg::mobileConnectionContext_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	Misbehaviour
Behaviour for values out of valid range	Misbehaviour
Behaviour when value is Misbehaviour erroneous, absent or un- wanted (i.e. spurious)	

5.10.2.1.9 mobileConnectionContext_2

Input name	mobileConnectionContext_2
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Description	Current connection status information from mobile modem 2
Source	F2 input API_mobileHWStatus
Type	RCM_Types_Pkg::mobileConnectionContext_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	Misbehaviour
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

5.10.2.1.10 dataFromTrack_in

Input name	dataFromTrack_in
Description	Messages received from track
Source	F2.1 Manage_TrackSideInformation_Integration
Type	RCM_MsgTypes_Pkg::msgFromTrack_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	Misbehaviour
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

5.10.2.1.11 dataToRBC_in

Input name	dataToRBC_in
Description	Messages to be routed to the supervising RBC
Source	All components transmitting messages to the RBC
Type	RCM_MsgTypes_Pkg::msgToTrack_T
Valid range of values	n/a

Behaviour when value is n/a
at boundary

Behaviour for values out Confused RBC communication
of valid range

Behaviour when value is Confused RBC communication
erroneous, absent or un-
wanted (i.e. spurious)

5.10.2.1.12 positionReport_in

Input name	positionReport_in
Description	Current positon report to be transmitted to the handing over and/or accepting RBC under control of <i>MoRC_HO</i>
Source	providePositionReport
Type	RCM_MsgTypes_Pkg::msgToTrack_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out RBC receives faulty position report of valid range	
Behaviour when value is RBC receives faulty position report erroneous, absent or un- wanted (i.e. spurious)	

5.10.2.1.13 trainData_in

Input name	trainData_in
Description	Validated train data (packet 11) to be transmitted to the handing over and/or accepting RBC under control of <i>MoRC_HO</i>
Source	???
Type	RCM_MsgTypes_Pkg::msgToTrack_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out RBC receives faulty train data of valid range	

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) RBC receives faulty train data

5.10.2.1.14 trainPosition

Input name	trainPosition
Description	Current train position
Source	calculateTrainPosition
Type	TrainPosition_Types_Pck::trainPosition_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	RBC handover is performed at an unwanted location
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	RBC handover is performed at an unwanted location

5.10.2.1.15 BGs

Input name	BGs
Description	Collection of currently known balise groups
Source	F2.6 calculateTrainPosition
Type	TrainPosition_Types_Pck::positionedBGs_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	RBC handover is performed at an unwanted location
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	RBC handover is performed at an unwanted location

5.10.2.1.16 t_train

Input name	t_train
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Description	Time, according to trainborne clock, at which messages are to be sent
Source	F2 input API_SystemTime
Type	T_TRAIN
Valid range of values	Refer to Subset 016-7.
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	Faulty time information in messages sent to the RBC
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Faulty time information in messages sent to the RBC

5.10.2.1.17 reset

Input name	reset
Description	Initializes the component and deletes the internal storage
Source	F2 input EVC_reset
Type	bool
Valid range of values	true false
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

5.10.2.1.18 sessionManagementAbility

Input name	sessionManagementAbility
Description	Configurable ability to manage one or two sessions and mobile modems onboard
Source	The OBUs configuration manager
Type	Handover_Pkg::abilityToHandleCommunicationSessions

Valid range of values	isAbleToManageOneSession isAbleToManageTwoSessions
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

5.10.2.1.19 trainProperties

Input name	trainProperties
Description	Train parameters used to calculate the handover location and to generate messages to the RBC
Source	F2.3 trainData F2.10 manageDMI_Input
Type	TrainPosition_Types_Pck::trainProperties_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Faulty parametrization
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

5.10.2.1.20 configData

Input name	configData
Description	Session management configuration parameters
Source	The OBUs configuration manager
Type	RCM_Session_Types_Pkg::morc_configData_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Misbehaviour

Behaviour when value is Misbehaviour
erroneous, absent or un-
wanted (i.e. spurious)

5.10.2.2 Outputs

5.10.2.2.1 radioStatus_1

Output name	radioStatus_1
Description	Radio registration, connection and session status for radio link 1
Destination	F2.1 Manage_TrackSideInformation_Integration F2.2 Manage_ETCS_Procedures F2.3 trainData F2.8ProvidePositionReport F2.11 manageDMI_Output
Type	RCM_Session_Types_Pkg::morcStatus_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.10.2.2.2 radioStatus_2

Output name	radioStatus_2
Description	Radio registration, connection and session status for radio link 2
Destination	Output is currently not used in the model.
Type	RCM_Session_Types_Pkg::morcStatus_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.10.2.2.3 mobileConnectionCmd_1

Output name	mobileConnectionCmd_1
Description	Commands to mobile 1 for radio connection control
Destination	API to radio mobile 1
Type	RCM_Types_Pkg::mobileConnectionCmd_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.10.2.2.4 mobileConnectionCmd_2

Output name	mobileConnectionCmd_2
Description	Commands to mobile 2 for radio connection control
Destination	API to radio mobile 2
Type	RCM_Types_Pkg::mobileConnectionCmd_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.10.2.2.5 mobileRegistrationCmd_1

Output name mobileRegistrationCmd_1

Description	Commands to mobile 1 for radio registration control
Destination	API to radio mobile 1
Type	RCM_Types_Pkg::mobileRegistrationCmd_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	n/a

5.10.2.2.6 mobileRegistrationCmd_2

Output name	mobileRegistrationCmd_2
Description	Commands to mobile 2 for radio registration control
Destination	API to radio mobile 2
Type	RCM_Types_Pkg::mobileRegistrationCmd_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious)	n/a

5.10.2.2.7 safeRadioIndication

Output name	safeRadioIndication
Description	Safe radio indication for DMI
Destination	DIM via DMI interface
Type	RCM_Session_Types_Pkg::safeRadioConnectionIndication_T
Valid range of values	srci_noConnection srci_connectionLost_setupFailed srci_connectionUp

Behaviour when value is n/a
at boundary

Behaviour for values out n/a
of valid range

Behaviour when value is n/a
erroneous, absent or un-
wanted (i.e. spurious)

5.10.2.2.8 supervisingRBC

Output name	supervisingRBC
Description	Designates the current supervising RBC for the InformationFilter to support input message filtering and buffering there
Destination	F2.1 Manage_TrackSideInformation_Integragion
Type	Handover_Pkg::connection_ids_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.10.2.2.9 bufferInformationFromAcceptingRBC

Output name	bufferInformationFromAcceptingRBC
Description	Informs the InfomationFilter to buffer messages received from the accepting RBC
Destination	InformationFilter
Type	bool
Valid range of values	true false
Behaviour when value is n/a at boundary	
Behaviour for values out n/a of valid range	Code generation fails

Behaviour when value is Misbehaviour
erroneous, absent or un-
wanted (i.e. spurious)

5.10.2.2.10 trainPassesA_RBC_RBC_border_WithItsFrontEnd

Output name	trainPassesA_RBC_RBC_border_WithItsFrontEnd
Description	Indicates that the train front passes a RBC/RBC border.
Destination	To whom it may concern
Type	bool
Valid range of values	true false
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	Code generation fails
Behaviour when value is Misbehaviour erroneous, absent or un- wanted (i.e. spurious)	

5.10.2.2.11 msgToRBC_1

Output name	msgToRBC_1
Description	Radio message to be transmitted to RBC via mobile modem 1, if session established.
Destination	API: interface to mobile modem 1
Type	RCM_MsgTypes_Pkg::msgToTrack_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious)	

5.10.2.2.12 msgToRBC_2

Output name	msgToRBC_2
Description	Radio message to be transmitted to RBC via mobile modem 2, if session established.
Destination	API: interface to mobile modem 2
Type	RCM_MsgTypes_Pkg::msgToTrack_T
Valid range of values	n/a
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.10.2.2.13 triggerPositionReport

Output name	triggerPositionReport
Description	Triggers the providePositionReport function to provide a position report at positionReport_in input.
Destination	Output is currently not used in the model.
Type	bool
Valid range of values	true false
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Causes a mistimed position report

5.10.2.2.14 triggerTrainData

Output name	triggerTrainData
Description	Triggers the provideTrainData function to provide a train data set (packet 11) at trainData_in input
Destination	Output is currently not used in the model.
Type	bool

Valid range of values	true false
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Causes a mistimed train data set transmission to the RBC

5.10.2.2.15 rejectOrderToContactRBC_or_RIU

Output name	rejectOrderToContactRBC_or_RIU
Description	Informs the OBU that the order to contact an RBC has to be rejected
Destination	Output is currently not used in the model.
Type	bool
Valid range of values	true false
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

5.10.2.2.16 infomDriverNoCompatibleVersionSupported

Output name	infomDriverNoCompatibleVersionSupported
Description	Informs the driver that no compatible version is supported
Destination	DMI via DMI interface and API
Type	bool
Valid range of values	true false
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails

Behaviour when value is erroneous, absent or un- wanted (i.e. spurious)	Misinformed train driver
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5.10.2.2.17 memorizeTheLastRadioNetworkID

Output name	memorizeTheLastRadioNetworkID
Description	Triggers the storage of the last radio network ID.
Destination	External storage via API
Type	bool
Valid range of values	true false
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or un- wanted (i.e. spurious)	Corrupted stored last radio network ID

5.10.2.2.18 lastReceivedRadioNetworkID

Output name	lastReceivedRadioNetworkID
Description	Provides the last received radio network ID.
Destination	External storage via API
Type	Packet_Types_Pkg::P45_RadioNetworkRegistration_T
Valid range of values	Refer to subset 026-7, packet 45
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or un- wanted (i.e. spurious)	Corrupted stored last radio network ID

5.10.2.2.19 ready

Output name	ready
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Description	When false, indicates that MoRC_HO has not finished the current operation and needs at least one more clock before the next input event can be consumed.
Destination	F2.3 trainData
Type	bool
Valid range of values	true false
Behaviour when value is n/a at boundary	
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

5.10.3 Subcomponents

5.10.3.1 RBC_Handover

5.10.3.1.1 Component Requirements

Component name	processHandingOver
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/Radio/Handover/RBC_Handover
SCADE designer	Uwe Steinke, Siemens
Description	The function <i>processHandingOver</i> implements the process of handing over the OBU from one RBC to a subsequent RBC. This process is based upon orders received from balise and radio.

processHandingOver terminates the radio session with the current - the handing over - RBC and establishes a session with the new - the accepting - RBC. Dependent on the availability of one or two mobile modems onboard, *processHandingOver* is able to manage two sessions in parallel or subsequently. For this, it steers two instances of MoRC_Main_v2.

processHandingOver controls the switchover of the OBUs output data stream to track from the handing over RBC to the accepting RBC and provides the InformationFilter with the supervising RBC information for message buffering and filtering.

It in addition, *processHandingOver* monitors the current train position and executes the handover, when the train front passes the appropriate location.

Input documents	Subset-026, Chapter 3.15 Subset-026, Chapter 5.15
Safety integrity level	4
Time constraints	Implements several time delays, therefore appropriate clocking required
API requirements	n/a

5.10.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.10.3.2 Management_of_Radio_Communication

5.10.3.2.1 Component Requirements

Component name	MoRC_Main_v2 (Management_of_Radio_Communication)
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/Radio/MoRC
SCADE designer	Uwe Steinke, Siemens
Description	The function <i>MoRC_Main_v2</i> implements the session states establishing, maintaining and terminating as described in Subset-026, chap. 3.5. A SCADE state machine reflects this state model accurately. Within each of the states, the activities needed as long as the state is active, are performed.

MoRC_Main_v2 is related to exactly one of the radio mobile modems onboard, monitors its status and controls the processes of registration to the radio network, connecting to one RBC and establishing a radio session with the RBC. *MoRC_Main_v2* communicates with its mobile modem directly via the API.

As the OBU is required to manage up to two RBCs, two instances of *MoRC_Main_v2* are used.

In addition, *MoRC_Main_v2* generates the radio connection indication for the driver.

Input documents	Subset-026, Chapter 3.5
Safety integrity level	4
Time constraints	Implements several time delays, therefore appropriate clocking required

API requirements	Interfaces to the OBUs mobile modem hardware via API
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5.10.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.10.3.3 mobileDataRouter

5.10.3.3.1 Component Requirements

Component name	mobileDataRouter_out
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/Radio/Handover/RBC_Handover
SCADE designer	Uwe Steinke, Siemens
Description	The function <i>mobileDataRouter_out</i> represents the change-over switch commutating the OBUs output message data stream from the handing over RBC to the accepting RBC. It is controlled by the processHandingOver subcomponent.
Input documents	Subset-026, Chapter 3.15 Subset-026, Chapter 5.15
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.10.3.3.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.11 F2.10: manageDMI_input

5.11.1 Component Requirements

Component name	manageDMI_input
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/manageData/manageDMI
SCADE designer	Bernd Hekele, DB Netz AG
Description	This component processes the incoming messages from the Driver Machine Interface (DMI) and provides these to other Functions in block F2.

Input documents	ERA ERTMS 015560 ETCS DRIVER MACHINE INTERFACE ERSA API
Safety integrity level	4
Time constraints	Both periodic and sporadic packets will be received.
API requirements	n/a

5.11.2 Interface

An overview of the interface of component manageDMI_input is shown in Figure 27. For the description of inputs and outputs we refer to the SCADE Suite model (cf. link above) respectively the SCADE generated documentation. Subcomponents are described in Section 5.11.3.



Figure 27. manageDMI_input SysML diagram.

5.11.3 Subcomponents

Currently ManageDMIInput does not have any subcomponents.

5.12 F2.11: manageDMI_output

5.12.1 Component Requirements

Component name	manageDMI_output
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/manageData/manageDMI
SCADE designer	Bernd Hekele, DB Netz AG

Description	This component collects and processes outgoing messages to the Driver Machine Interface (DMI).
Input documents	ERA ERTMS 015560 ETCS DRIVER MACHINE INTERFACE ERSA API
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.12.2 Interface

An overview of the interface of component manageDMI_output is shown in Figure 28. For the description of inputs and outputs we refer to the SCADE Suite model (cf. link above) respectively the SCADE generated documentation. Subcomponents are described in Section 5.12.3.

5.12.3 Subcomponents

5.12.3.1 cyclicReportToDMI

5.12.3.1.1 Component Requirements

Component name	cyclicReportToDMI
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/manageData/manageDMI
SCADE designer	Bernd Hekele, DB Netz AG
Description	This subcomponent is responsible for writing and sending Dynamic Packets to the DMI.
Input documents	ERA ERTMS 015560 ETCS DRIVER MACHINE INTERFACE ERSA API
Safety integrity level	4
Time constraints	periodically
API requirements	n/a

5.12.3.1.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.12.3.2 ManageTextMessages

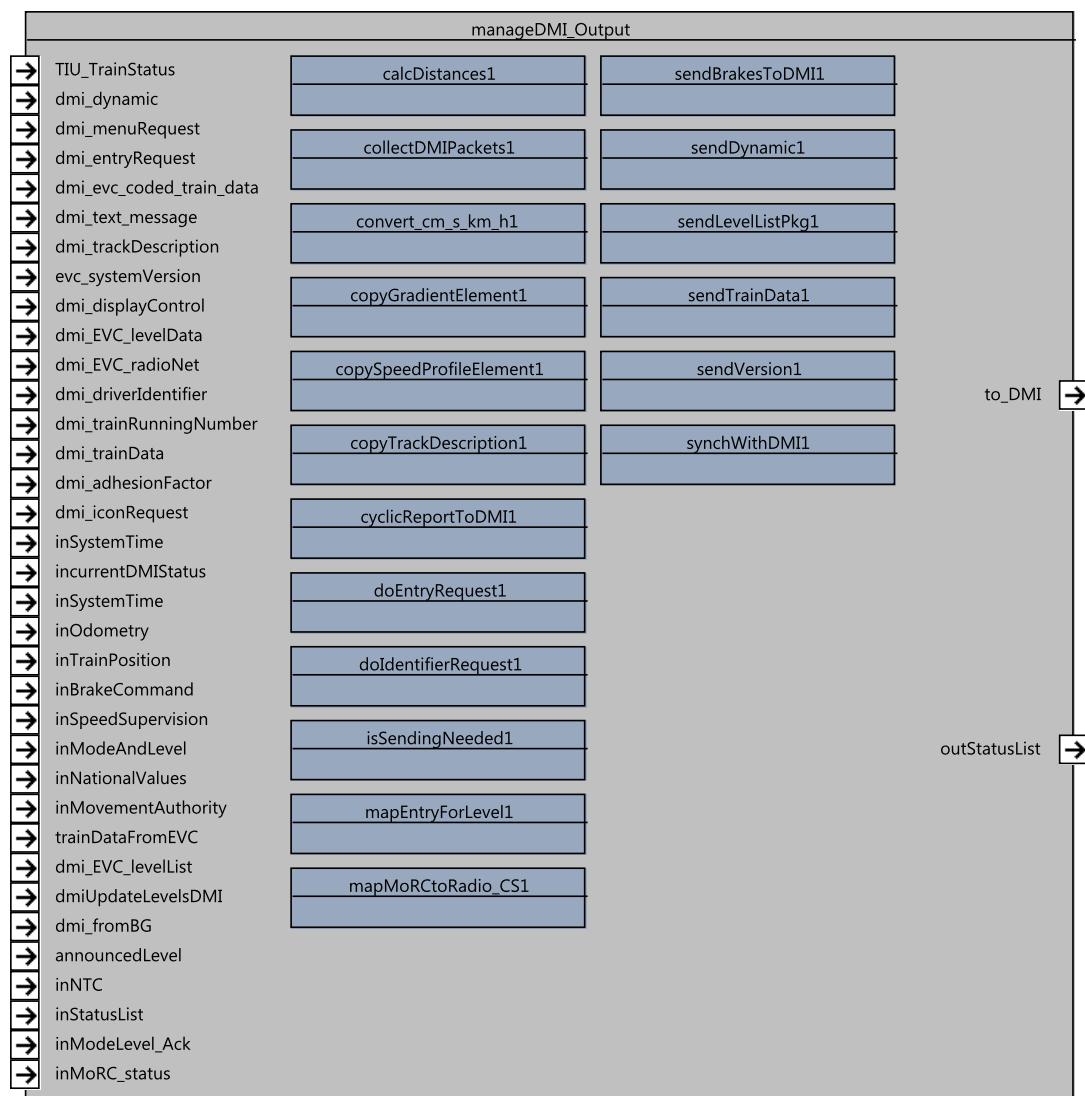


Figure 28. manageDMI_output SysML diagram.

5.12.3.2.1 Component Requirements

Component name	ManageTextMessages
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/manageData/manageDMI
SCADE designer	Bernd Hekele, DB Netz AG
Description	This subcomponent receives available text messages from within the EVC sources, handles messages according to the priority, and provides an output stack for messages.
Input documents	ERA ERTMS 015560 ETCS DRIVER MACHINE INTERFACE ERSA API
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.12.3.2.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.12.3.3 copyTrackDescription

5.12.3.3.1 Component Requirements

Component name	copyTrackDescription
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/manageData/manageDMI
SCADE designer	Bernd Hekele, DB Netz AG
Description	This subcomponent processes and provides the following informations: <ul style="list-style-type: none"> • The point at which the driver needs to start braking to avoid intervention by the ETCS onboard equipment. • The distance that the train has permission to travel. • The maximum speed which the train must not exceed.
Input documents	ERA ERTMS 015560 ETCS DRIVER MACHINE INTERFACE ERSA API
Safety integrity level	4

Time constraints	n/a
API requirements	n/a

5.12.3.3.2 Interface

For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.13 F2.12: manageTIU_input

5.13.1 Component Requirements

Component name	manageTIU_input
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/manageData/manageTIU
SCADE designer	Bernd Hekele, DB Netz AG
Description	This component manages the incoming messages and information that are received from the Train Interface Unit (TIU), e.g. cab status information.
Input documents	Alstom API Subset-034
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.13.2 Interface

An overview of the interface of component manageTIU_input is shown in Figure 29. For the description of inputs and outputs we refer to the SCADE Suite model (cf. link above) respectively the SCADE generated documentation. Subcomponents are described in Section 5.13.3.

5.13.3 Subcomponents

The subcomponents of ManageTIUInput are not documented in this version of the architecture and design description document.

5.14 F2.13: manageTIU_output

5.14.1 Component Requirements

Component name	manageTIU_output
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Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/manageData/manageTIU
SCADE designer	Bernd Hekele, DB Netz AG
Description	This component manages the outgoing messages to the Train Interface Unit (TIU).
Input documents	Alstom API Subset-034
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.14.2 Interface

An overview of the interface of component manageTIU_output is shown in Figure 30. For the description of inputs and outputs we refer to the SCADE Suite model (cf. link above) respectively the SCADE generated documentation. Subcomponents are described in Section 5.14.3.

5.14.3 Subcomponents

The subcomponents of ManageTIUInput are not documented in this version of the architecture and design description document.

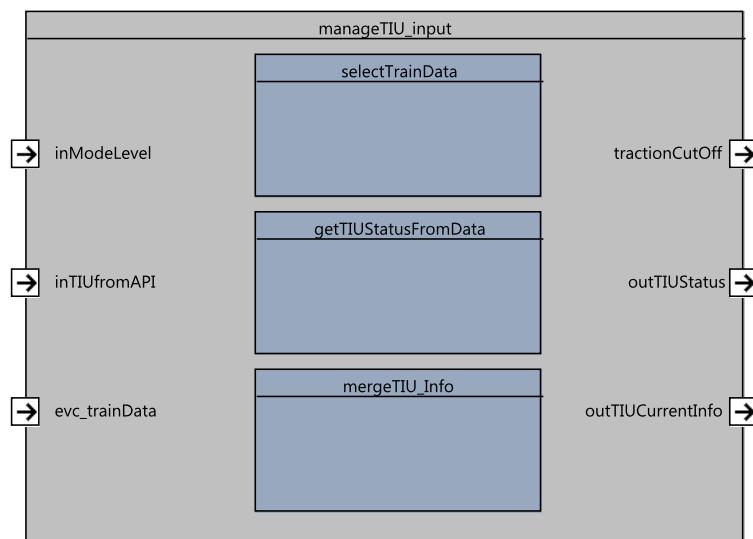


Figure 29. manageTIU_input SysML diagram.

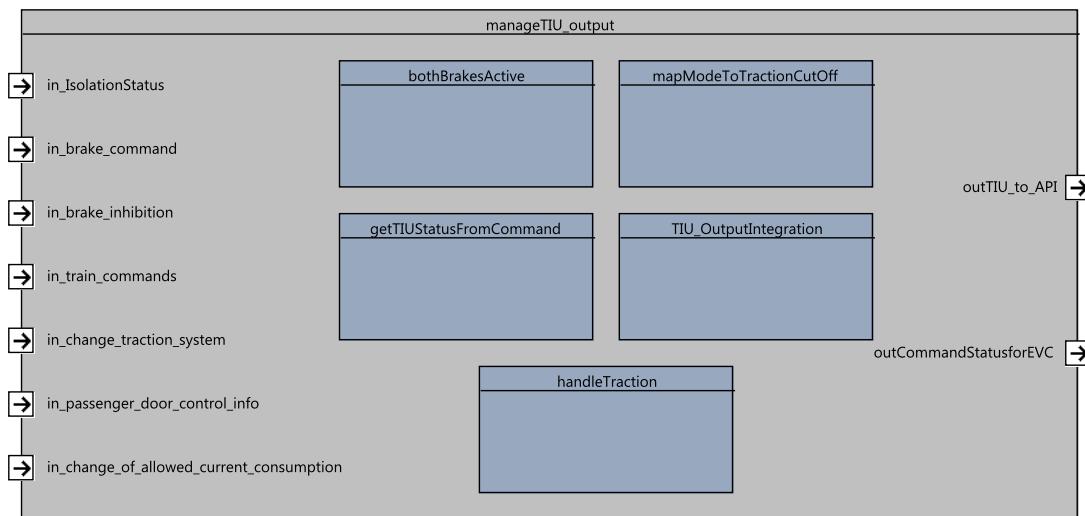


Figure 30. manageTIU_output SysML diagram.

6 F3: Measure Train Movement

This component is not part of the openETCS OBU currently and therefore no detailed description is provided here.

7 F4: Manage Radio Communication

This component is not part of the openETCS OBU currently and therefore no detailed description is provided here.

8 F5: Manage JRU

This component is not part of the openETCS OBU currently and therefore no detailed description is provided here.

9 F6: DMI Controller

This component is not part of the openETCS OBU currently and therefore no detailed description is provided here.

10 F7: Manage TIU

This component is not part of the openETCS OBU currently and therefore no detailed description is provided here.

References

- [1] ERA. *System Requirements Specification, SUBSET-026*, v3.3.0 edition, March 2012.