

Work Package 3: "Modeling"

openETCS Architecture and Design Specification

Software Component Design and Internal Interface Specification

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Work Package 3: “Modeling”

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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 |
|---------|----------|--|----------------|------------|
| 0.1 | all | Initial document providing structure | Peter Mahlmann | 27.05.2015 |
| 0.2 | 2 | New template for design descriptions | Peter Mahlmann | 10.06.2015 |
| 0.3 | all | Transferred existing documentation to new template | Peter Mahlmann | 22.06.2015 |
| 0.4 | 5 | Updated component hierarchy to match current SCADE model | Peter Mahlmann | 15.09.2015 |

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Todo list

| | |
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| links need to be corrected, in particular links to the API documentation..... | 1 |
| list has to be completed..... | 1 |
| list and descriptions have to be checked for completeness..... | 1 |
| Hashtag has to be updated once the model and document are ready for release..... | 2 |
| Descriptions should be improved | 4 |
| Component descriptions need to be completed..... | 5 |
| to be completed..... | 8 |
| Chapter needs to be completed. Will there be more components?..... | 9 |
| section needs to be completed | 9 |
| Figure: [Put SysML diagram of component here] | 10 |
| components should be listed here | 11 |
| to be checked..... | 11 |
| descriptions needs to be improved | 16 |
| to be completed..... | 16 |
| descriptions needs to be improved | 16 |
| reference sections correctly once these are completed..... | 30 |
| Information filter component description needs to be checked, i.e. is the description still up to date? Should more documentation provided for this component in the ADD (please check with Bernd Hekele)? | 53 |
| Section has to be completed..... | 54 |
| To be completed..... | 56 |
| To be completed..... | 57 |
| To be completed..... | 57 |
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| To be completed | 57 |
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| Can we state "start of mission not completed" in case of "false" here? | 63 |

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| If this is a percentage, then the range would probably be 0...100. Maybe we should replace percentage here?..... | 69 |
| needs to be changed to cm/sec | 69 |
| redundant information to status. Needs cleaning..... | 74 |
| needs to be changed to cm/sec | 74 |
| Section needs to be completed..... | 79 |
| section and corresponding subsections have to be completed..... | 168 |
| section and corresponding subsections have to be completed..... | 170 |
| section and corresponding subsections have to be completed..... | 178 |
| section and corresponding subsections have to be completed..... | 181 |

1.1 Introduction

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

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

- 10 • the corresponding SysML model (SCADE System), available at <https://github.com/openETCS/modeling/tree/master/model/system>,
- 11 • the corresponding functional model (SCADE Suite), available at <https://github.com/openETCS/modeling/tree/master/model/Scade/System>,
- 12 • the corresponding functional design description, i.e. D3.6.x, and
- 13 • the documentation of the generic openETCS Application Programming Interface (API), avail-
 14 able at <https://github.com/openETCS/modeling/blob/master/API/description/api-description.pdf>.

15 links need to be corrected, in particular links to the API documentation

16

1.1.19 Input Documents

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

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

26 list has to be completed

27

1.2.29 Software and Tools used for Development

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

31 list and descriptions have to be checked for completeness

- 32 **SCADE System** Version 16.1b of SCADE System has been used for the the generation of
33 SysML models.
- 34 **SCADE Suite** Version 16.1b of SCADE Suite has been used for the functional modelling of the
35 openETCS OBU components. Executable models are generated via the SCADE Suite code
36 generator (KCG), which has been certified for CENELEC EN 50128 at SIL 3/4.
- 37 **SCADE Display** Version 16.1b of SCADE Display has been used for the development of the
38 Driver Machine Interface (DMI).
- 39 **GitHub** The web based Git repository hosting service GitHub has been used for distributed
40 revision control and source code respectively model management.

1.3 ⁴¹ General Remarks on the openETCS OBU Model

- 42 The openETCS OBU model has been developed according the specification given in ERA Subset-
43 026 [1], Version 3.3.0. The software release of the openETCS OBU documented and described
44 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:

46 Hashtag has to be updated once the model and document are ready for release

47 1c06cc2d4a0d8f27569e065e2a9edf924b453ff1

- 48 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
49 is located at <https://github.com/openETCS/modeling/tree/master/model/Scade>.
50
- 51 Note that all components of the openETCS OBU have been developed from scratch, no existing
52 components have been reused.

53

Part I

54

System Architecture and Functional Breakdown

55

2 56 System Architecture

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

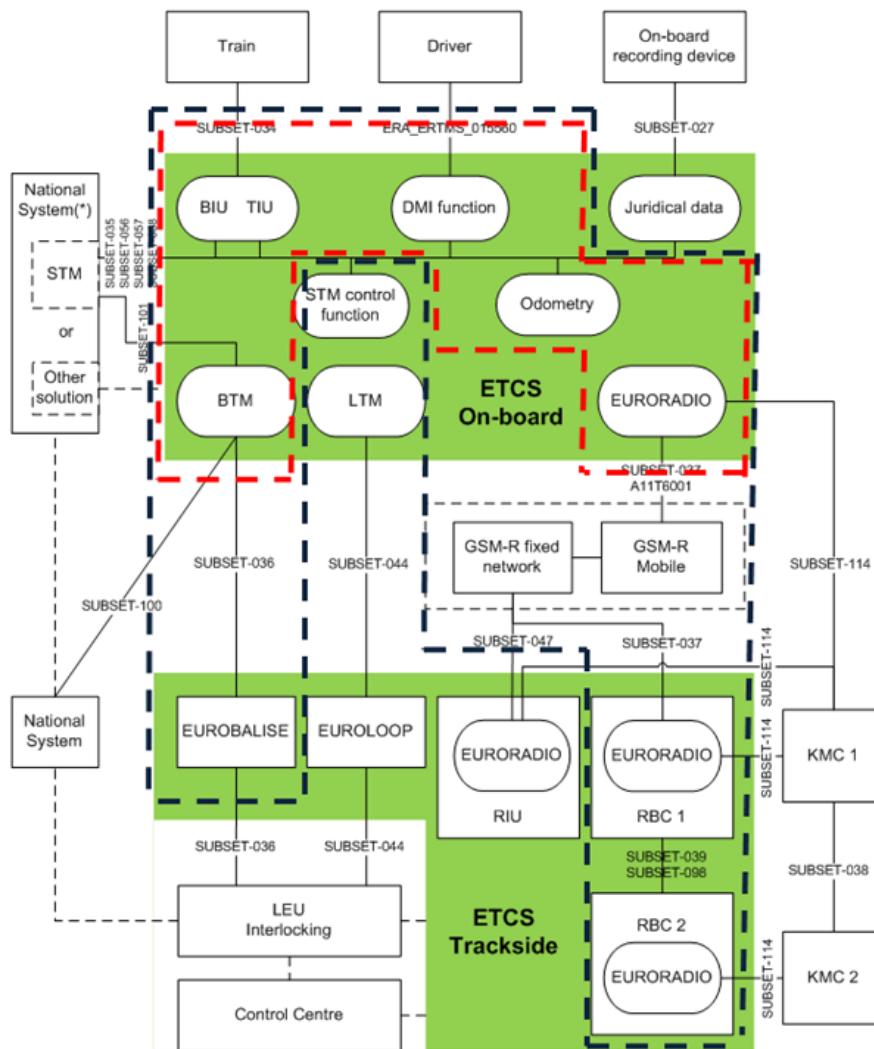


Figure 1. Scope of openETCS OBU model system according to ERA TSI Chapter 2.5. Functional blocks in the scope of openETCS have been marked by the dashed black line. The dashed red line shows the OBU blocks in the scope of openETCS.

2.1 62 Top Level Architecture and External Interfaces

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

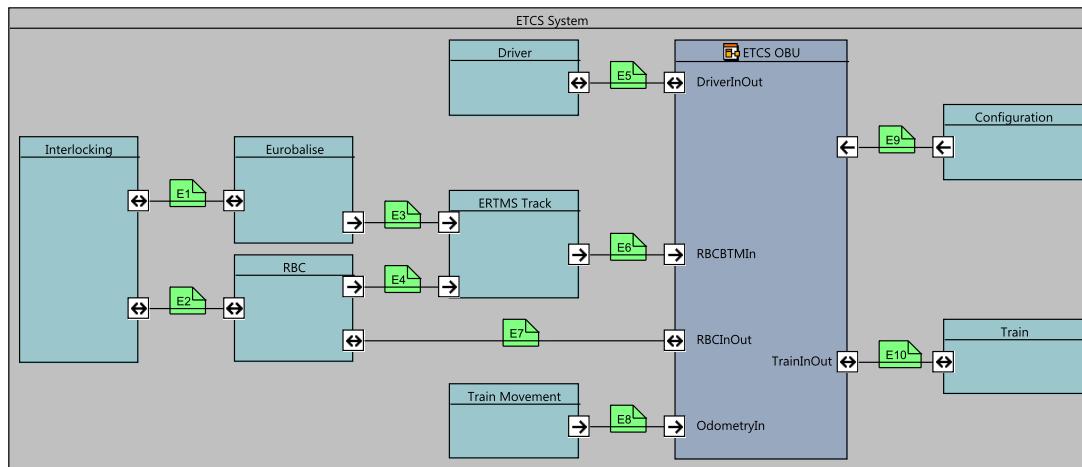


Figure 2. Top level architecture with external interfaces E1 to E10.

Descriptions should be improved

67

68 **E1:** In- and out flow between the Interlocking and the Eurobalise. Only relevant for controlled
69 Eurobalises.

70 **E2:** Input and output interface between the Interlocking and Radio Block Center (RBC).

71 **E3:** Input interface from the Eurobalise to the ERTMS Track module.

72 **E4:** Input interface from the RBC to the ERTMS Track module.

73 **E5:** This interface is used for the interaction between the driver and the display (Driver Machine
74 Interface, DMI).

75 **E6:** This interface is a compound structure and combines the interfaces E3 and E4 to send track
76 side messages from Eurobalises or RBC to the ETCS OBU.

77 **E7:** Input and output interface between RBC and ETCS OBU. This interface is used for the
78 management of radio communication, e.g. session management, and sending radio messages
79 from the ETCS OBU to the RBC. Note that the ETCS OBU receives radio messages via
80 interface E6.

81 **E8:** Input interface to the odometry subsystem of the ETCS OBU. Used for sending information
82 to the train if there is any movement outside the ETCS system, e.g. "cold movement".

83 **E9:** Input interface to the ETCS OBU to set configuration data such as fixed values, system
84 values, national values and train configuration.

85 **E10:** Input and output interface between the ETCS OBU and the train. This interface is used for
86 the interaction between the train and the ETCS OBU such as brake control, traction control,
87 door control, etc.

2.2 88 Functional breakdown of the ETCS OBU

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

91 Component descriptions need to be completed

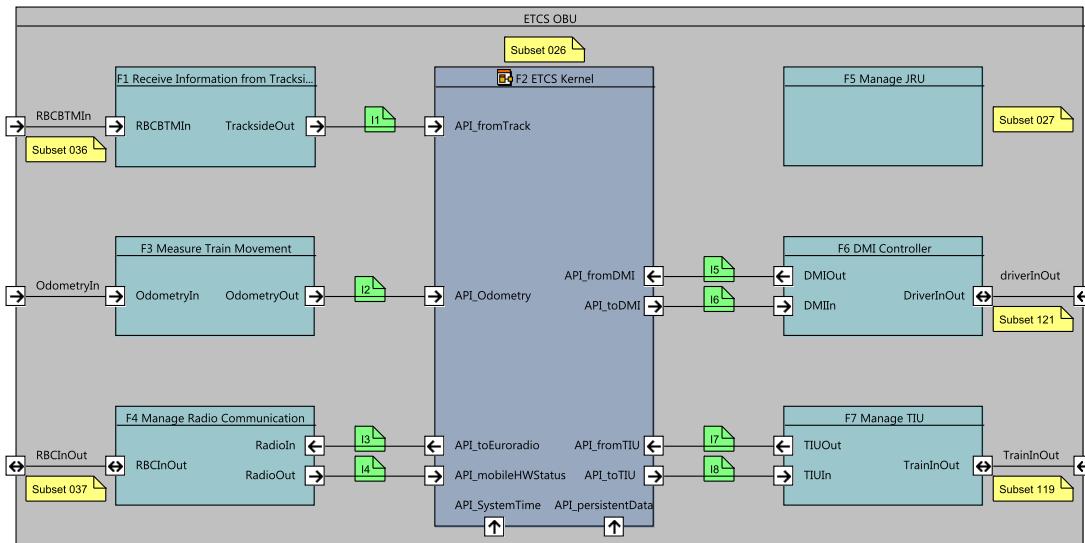


Figure 3. ETCS OBU system architecture view with internal interfaces I1 to I8.

92 **F1 Receive Information from Trackside** This module is responsible for receiving RBC and
93 BTM messages and passing these to the F2 ETCS Kernel module. A detailed description is
94 given in Chapter 4.

95 **F2 ETCS Kernel** This module represents core component of the openETCS OBU. A detailed
96 description is given in Chapter 5.

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

99 **F4 Manage Radio Communication**

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

102 **F6 DMI Controller**

103 **F7 Manage TIU**

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

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

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

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

112 **I4:** Input interface between the F4 Manage Radio Communication module and the F2 ETCS
113 Kernel module.

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

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

116 **I7:** Input interface between the F7 Manage TIU module and the F2 ETCS Kernel module.

117 **I8:** Output interface between the F7 Manage TIU module and the F2 ETCS Kernel module.

118

Part II

119

Design Description

3₁₂₀ General Design Decisions

to be completed

121

4₁₂₂ F1: Receive Information from Trackside

₁₂₃ Chapter needs to be completed. Will there be more components?

4.1₁₂₄ ETCS Messaging: TrackMessages

₁₂₅ section needs to be completed

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 Adjı, 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. |

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?]

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.

| | |
|------------------------|---|
| Input documents | Subset-026, Chapter 6 Subset-026, Chapter 7 Subset-026, Chapter 8 |
| | The objective of this component (the full TrackMessages library) is to provide a full formalisation of above chapters in Subset-026 |
| 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 |

¹²⁷ **4.1.2 Interface**

¹²⁸ An overview of the interface of component TrackMessages is shown in Figure 4. The inputs and ¹²⁹ outputs are described in detail in Section 4.1.2.1 respectively 4.1.2.2.

¹³⁰ **4.1.2.1 Inputs**

¹³¹ **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 |

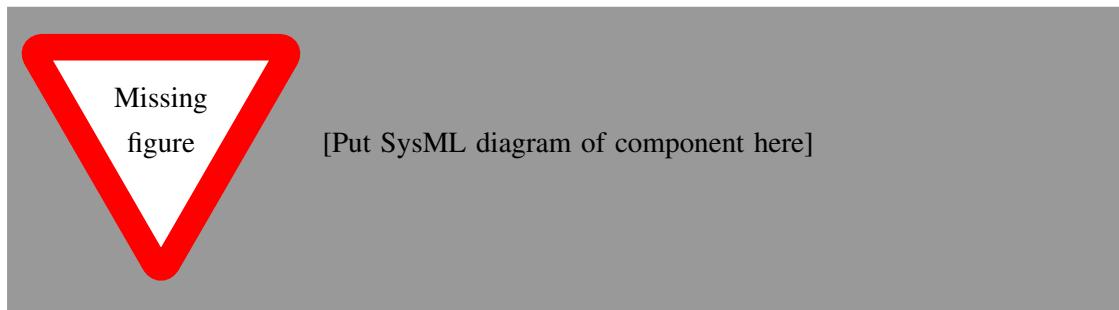


Figure 4. TrackMessages SysML diagram

| | |
|---|--|
| 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 at boundary | n/a |
| 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. |

¹³² **4.1.2.2 Outputs**

¹³³ **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. components should be listed here |
| Type | bool |
| Valid range of values | to be checked |
| | 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 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 |

¹³⁴ **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 | <p>TM::P005_OBU_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] • 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) (<i>Remark: start section from the original packet is integrated into the list of sections</i>) <p>The structured element sections is an array of type P005_section_enum_T. For each element, the valid range of values is as follows:</p> <ul style="list-style-type: none"> • bool valid: [true false] (<i>Remark: Check for consistency with the value of n_iter</i>) • 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) <p><i>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".</i></p> |
| Behaviour when value is at boundary | n/a |

| | |
|---|---|
| Behaviour for values out of valid range | <p>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.</p> <p>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:</p> <ul style="list-style-type: none"> • 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) | n/a |

¹³⁵ **4.1.3 Subcomponents**

¹³⁶ **4.1.3.1 Read_Packets**

¹³⁷ **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 | Subset-026, Chapter 7 This function is not directly traceable to Subset-026, but is built from derived requirements. |
| Safety integrity level | 4 |
| Time constraints | n/a |
| 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. |

¹³⁸ 4.1.3.1.2 Interface

¹³⁹ For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

¹⁴¹ 4.1.3.2 Extract Packet 5

¹⁴² 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](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 |

¹⁴³ **4.1.3.2.2 Interface**

¹⁴⁴ For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.
¹⁴⁵

5₁₄₆ F2: ETCS Kernel

₁₄₇ In this chapter we describe the main components of the openETCS OBU model. Section [5.1](#) gives
₁₄₈ an overview of the external interfaces of this functional block and gives a brief overview of its
₁₄₉ components and their interaction. The following Sections [5.2](#) to [5.14](#) give a detailed description
₁₅₀ for each of the components in F2: ETCS Kernel.

5.1₁₅₁ ETCS Kernel Overview

₁₅₂ The ETCS Kernel module consists of the 13 functional components, i.e. F2.1 to F2.13 as depicted
₁₅₃ in Figures [5](#) to [17](#). Note that due to the complexity of the Kernel module the SysML diagram has
₁₅₄ been splitted into 13 figures. Each of the figures shows one of the subcomponents F2.1 to F2.13
₁₅₅ and its connections to the other components in F2 and the inputs respectively outputs of F2. In
₁₅₆ the following we briefly describe the functionality of these components.

₁₅₇ **F2.1: Manage_TrackSideInformation_Integration** This component is responsible for receiving
₁₅₈ Eurobalise telegrams and Euroradio messages from the API and performs several consistency
₁₅₉ checks on the inputs. The corresponding SysML diagram is shown in Figure [5](#). For further details we refer to Section [5.2](#).

₁₆₁ **F2.2: Manage_ETCS_Procedures** This component describes the Start of Mission procedure
₁₆₂ of the train until the current status will change to another mode, level or other procedure.
₁₆₃ The corresponding SysML diagram is shown in Figure [6](#). For further details we refer to Section [5.3](#).

₁₆₅ **F2.3: trainData** Implementation of the train data with the corresponding interfaces to track,
₁₆₆ driver and RBC. The corresponding SysML diagram is shown in Figure [7](#). For further details we refer to Section [5.4](#).

₁₆₈ descriptions needs to be improved

₁₆₉ **F2.4: TrackAtlas** t.b.d. The corresponding SysML diagram is shown in Figure [8](#). For further details we refer to Section [5.5](#).

₁₇₁ to be completed

₁₇₂ **F2.5: ManageLevelAndMode** Defines the status of the ETCS regarding on-board functional
₁₇₃ status and track infrastructure. The corresponding SysML diagram is shown in Figure [9](#). For further details we refer to Section [5.6](#).

₁₇₅ descriptions needs to be improved

₁₇₆ **F2.6: calculateTrainPosition** The purpose of this component is to calculate the locations of
₁₇₇ linked and unlinked balise groups and the current train position while the train is running
₁₇₈ along the track. The corresponding SysML diagram is shown in Figure [10](#). For further details we refer to Section [5.7](#).

₁₈₀ **F2.7: SpeedSupervision_Integration** This component monitors the current speed of the train
₁₈₁ and its location to ensure that the speed remains within the given speed and distance limits.
₁₈₂ The corresponding SysML diagram is shown in Figure [11](#). For further details we refer to Section [5.8](#).

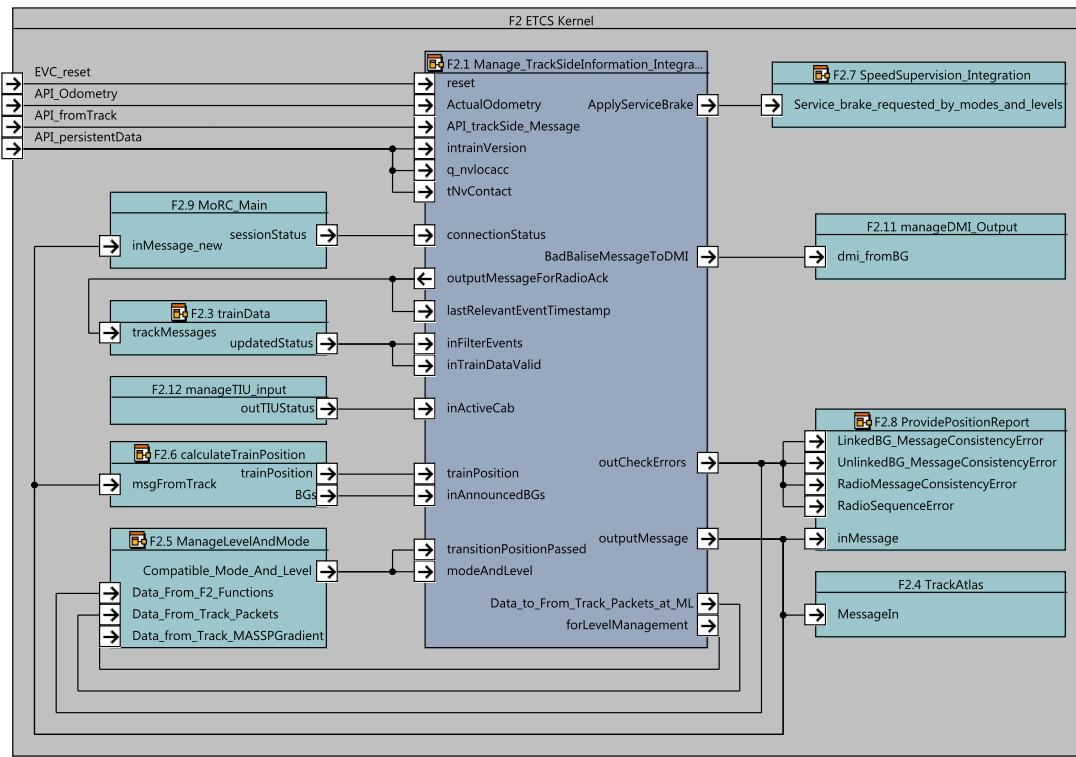


Figure 5. F2: ETCS Kernel SysML diagram with focus on F2.1 Manage_TrackSideInformation_Integration component.

184 **F2.8: Provide_Position_Report** The component builds a position report for the RBC, i.e.,
 185 message 132, and provides it as an output. The corresponding SysML diagram is shown in
 186 Figure 12. For further details we refer to Section 5.9.

187 **F2.9: Manage_Radio_Communication** This component implements the onboard management
 188 of a single communication session with the track, i.e. a single RBC. It controls the estab-
 189 lishment, maintenance and termination process of a radio communication session and steers
 190 the underlying communication safety layer as well as the mobile device. Those and the data
 191 transfer itself are not part of this component. The corresponding SysML diagram is shown in
 192 Figure 13. For further details we refer to Section 5.10.

193 **F2.10: manageDMI_input** This component handles messages respectively data coming from
 194 the Driver Machine Interface (DMI) to the ETCS OBU. The corresponding SysML diagram
 195 is shown in Figure 14. For further details we refer to Section 5.11.

196 **F2.11: manageDMI_output** This component handles messages respectively data being send
 197 from the ETCS OBU to the DMI. The corresponding SysML diagram is shown in Figure 15.
 198 For further details we refer to Section 5.12.

199 **F2.12: manageTIU_input** This component handles messages respectively data coming from
 200 the Train Interface Unit (TIU) to the ETCS OBU. The corresponding SysML diagram is
 201 shown in Figure 16. For further details we refer to Section 5.13.

202 **F2.13: manageTIU_output** This component handles messages respectively data being send
 203 from the ETCS OBU to the TIU. The corresponding SysML diagram is shown in Figure 17.
 204 For further details we refer to Section 5.14.

205 5.1.1 External Interfaces

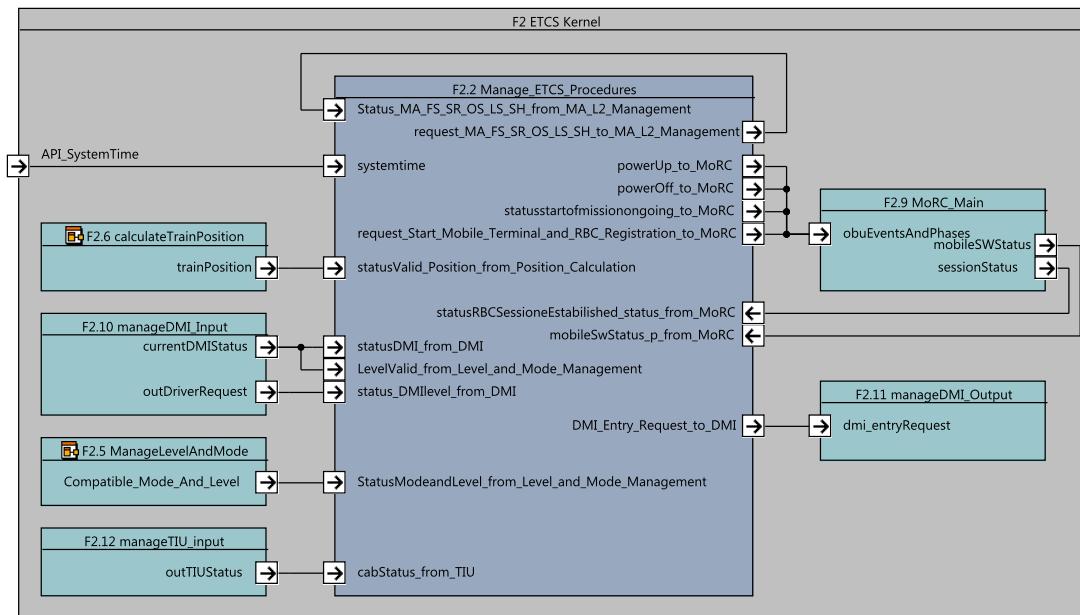


Figure 6. F2: ETCS Kernel SysML diagram with focus on F2.2 Manage_ETCS_Procedures component.

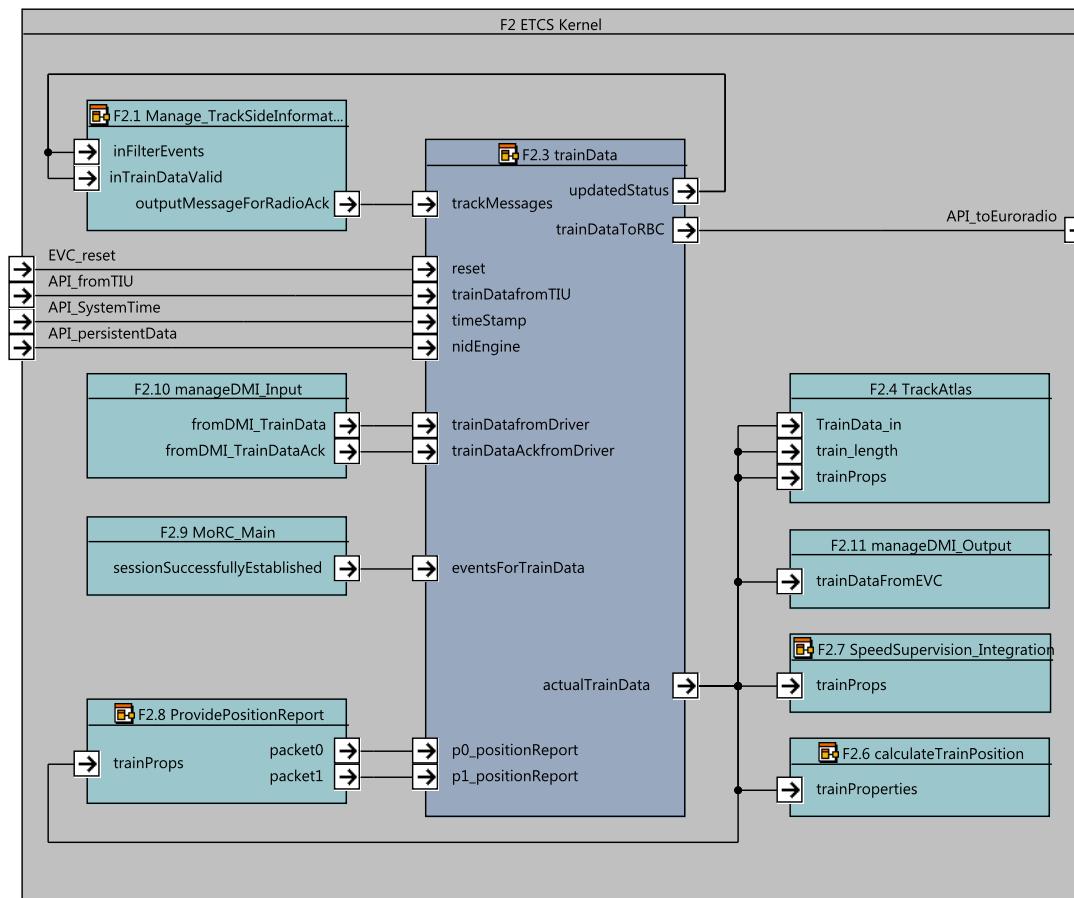


Figure 7. F2: ETCS Kernel SysML diagram with focus on F2.3 trainData component.

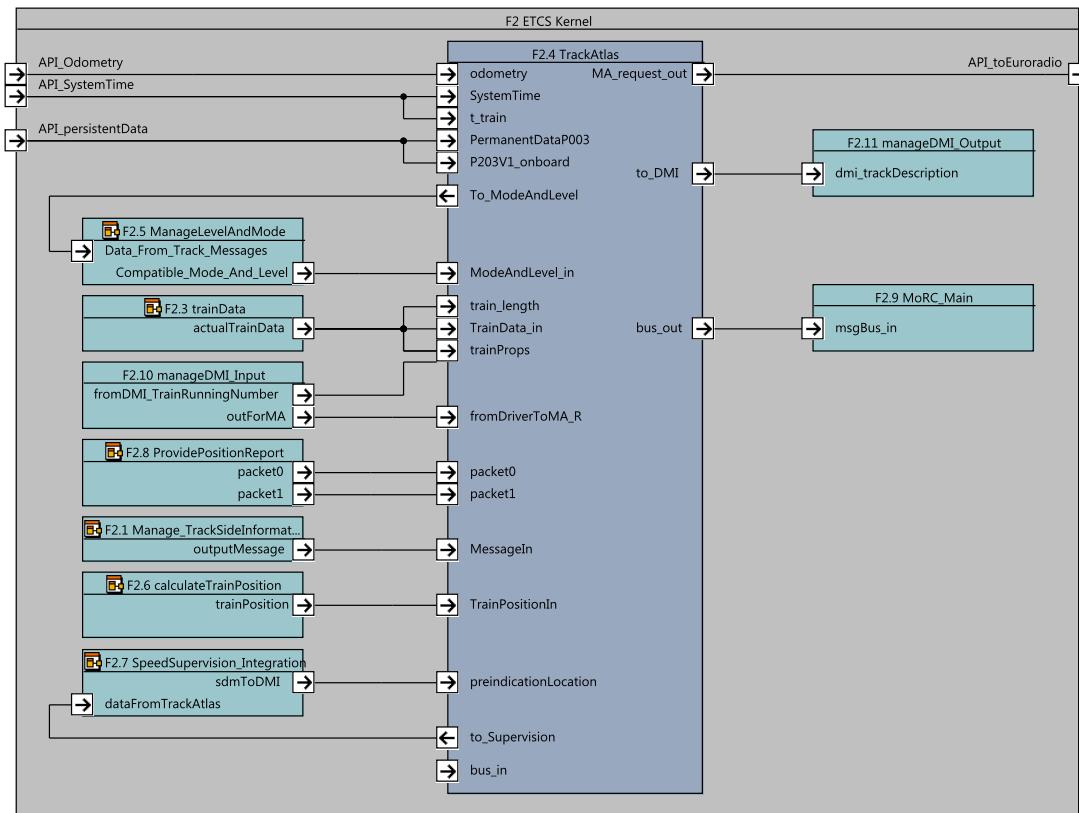


Figure 8. F2: ETCS Kernel SysML diagram with focus on F2.4 TrackAtlas component.

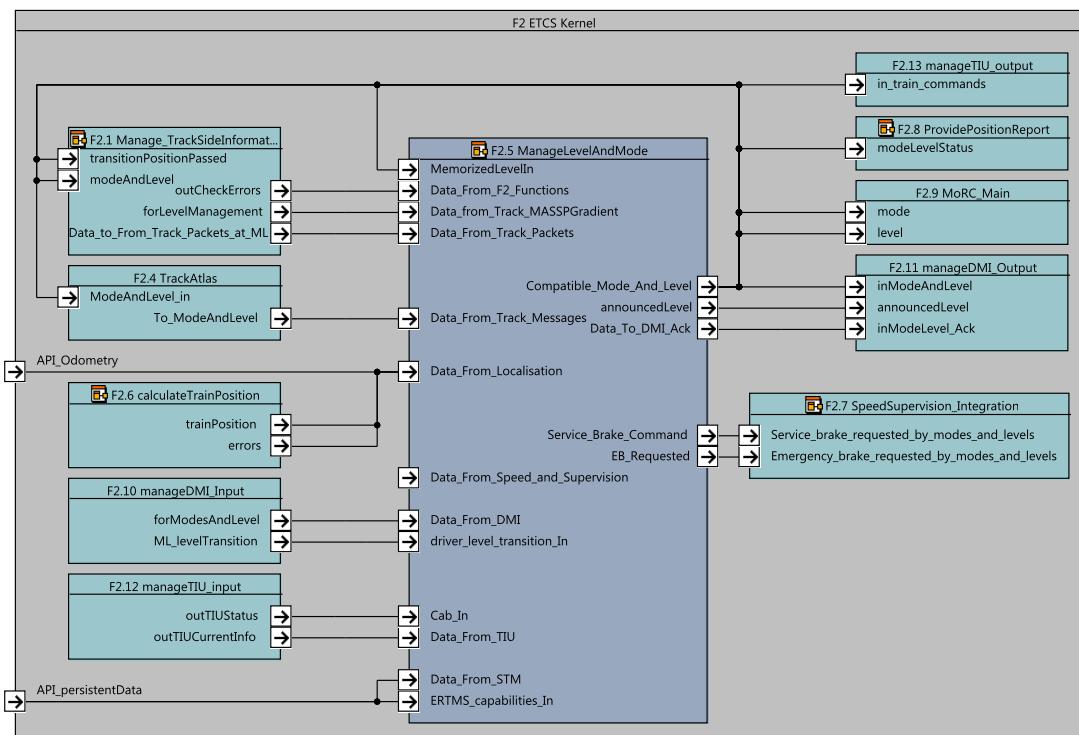


Figure 9. F2: ETCS Kernel SysML diagram with focus on F2.5 Mode_and_Level component.

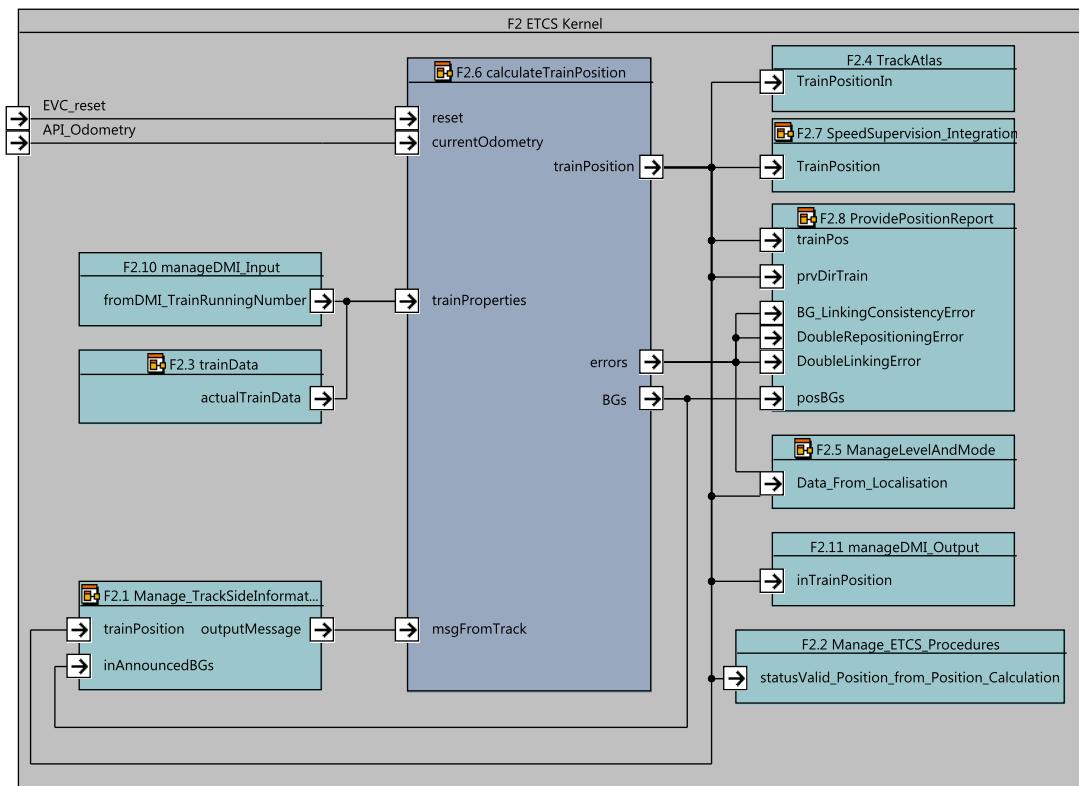


Figure 10. F2: ETCS Kernel SysML diagram with focus on F2.6 calculateTrainPosition component.

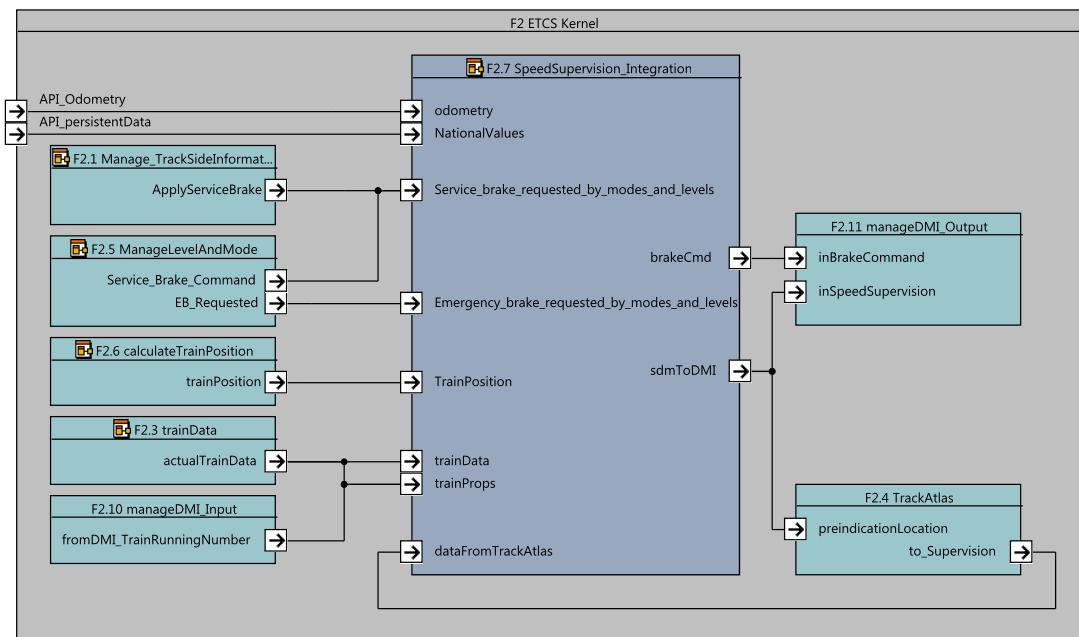


Figure 11. F2: ETCS Kernel SysML diagram with focus on F2.7 SpeedSupervision_Integration component.

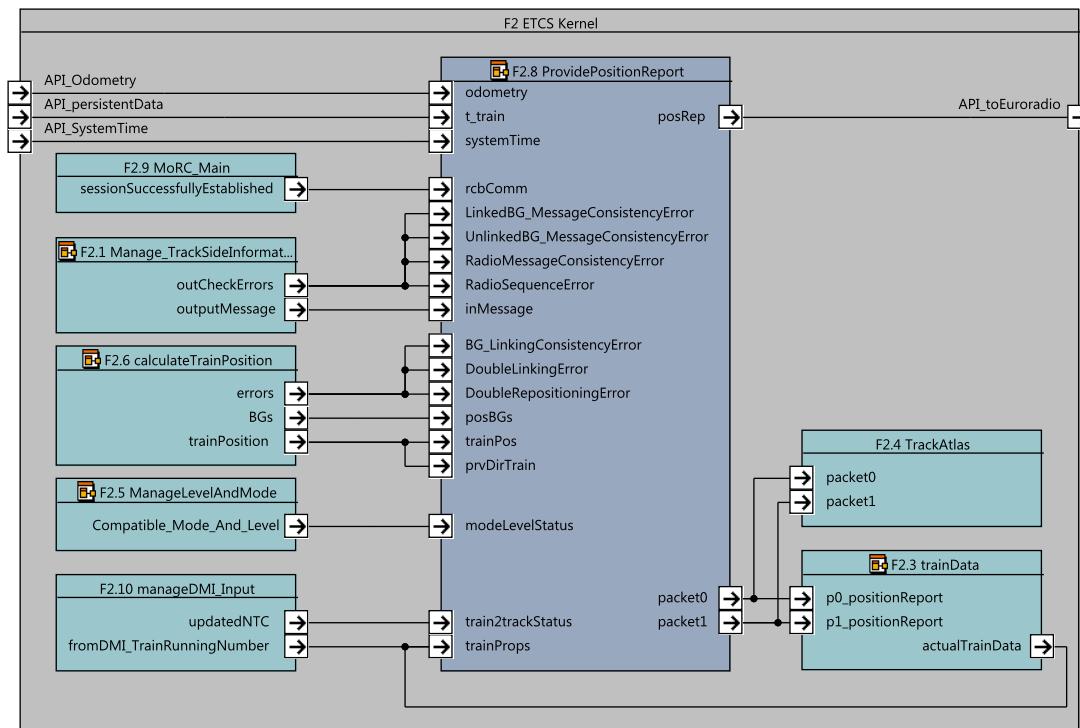


Figure 12. F2: ETCS Kernel SysML diagram with focus on F2.8 Provide_Position_Report component.

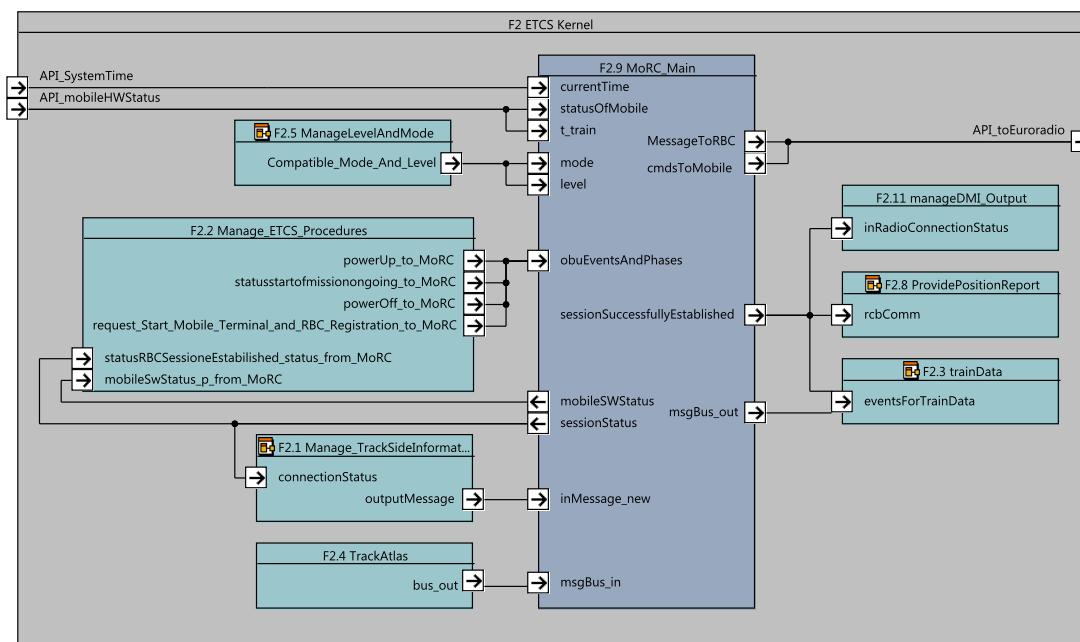


Figure 13. F2: ETCS Kernel SysML diagram with focus on F2.9 Manage_Radio_Communication component.

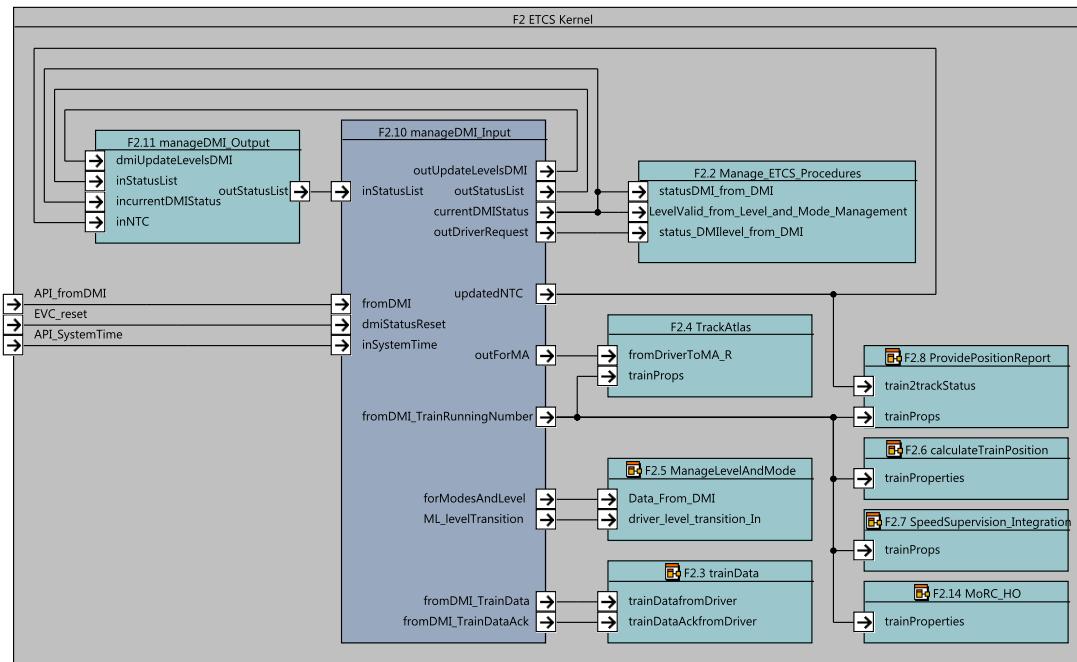


Figure 14. F2: ETCS Kernel SysML diagram with focus on F2.10 ManageDMIInput component.

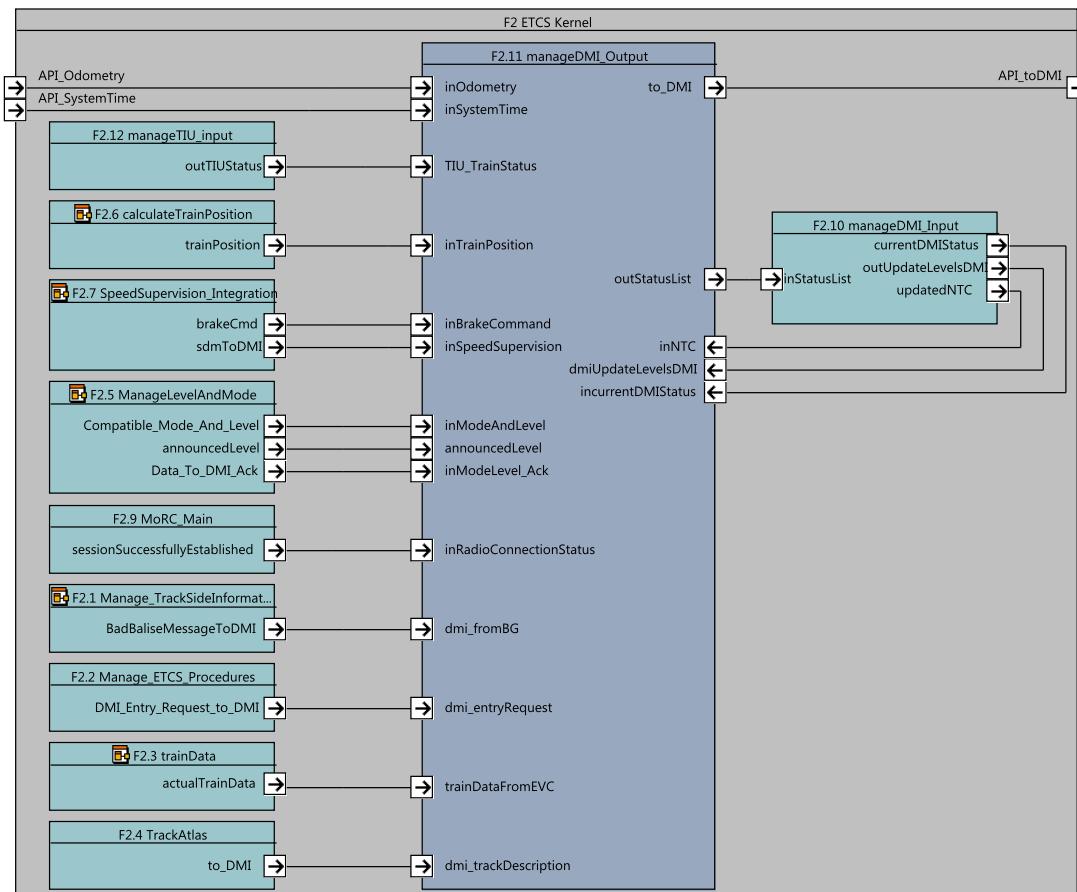


Figure 15. F2: ETCS Kernel SysML diagram with focus on F2.11 ManageDMIOOutput component.

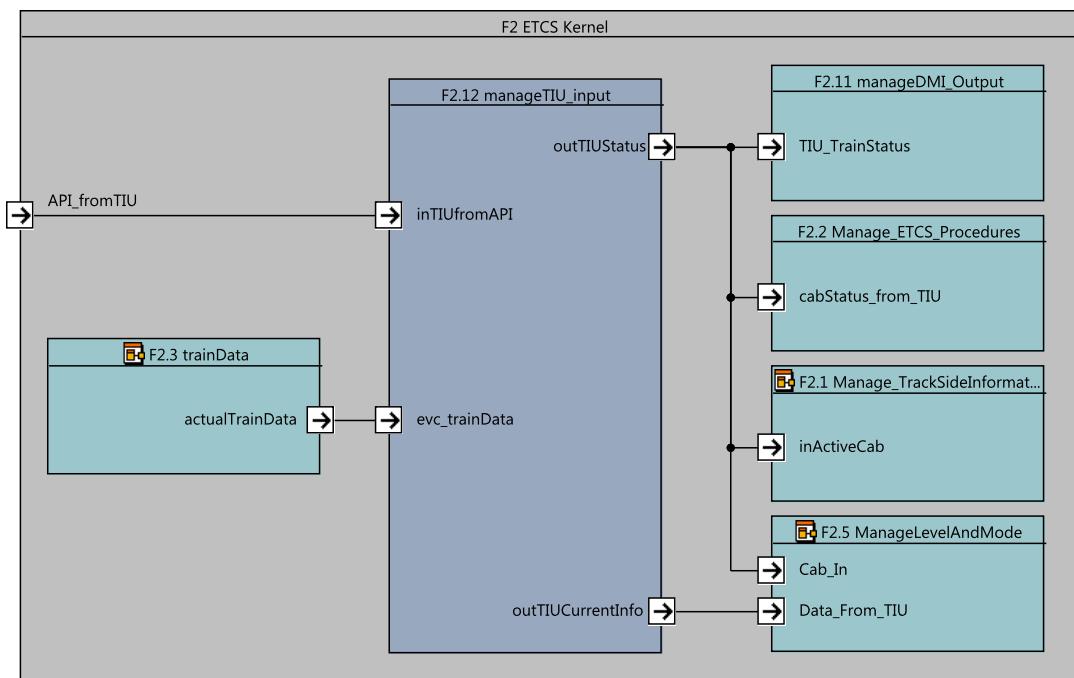


Figure 16. F2: ETCS Kernel SysML diagram with focus on F2.12 ManageTIUInput component.

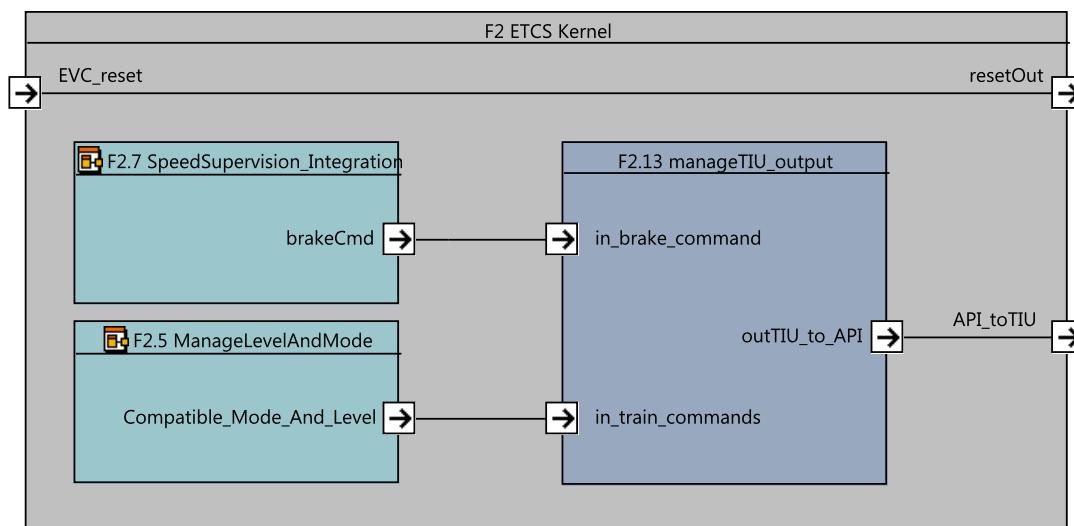


Figure 17. F2: ETCS Kernel SysML diagram with focus on F2.13 ManageTIUOutput component.

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

208 **5.1.1.1 External Inputs**

209 **5.1.1.1.1 EVC_reset**

| | |
|---|---|
| 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 | [Name of the source component] |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

210 **5.1.1.1.2 API_Odometry**

| | |
|---|---|
| Input name | API_Odometry |
| Description | Odometry data provided by the external odometry module of the train. |
| Source | API |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

²¹¹ **5.1.1.1.3 API_SystemTime**

| | |
|---|---|
| Input name | API_SystemTime |
| Description | [Brief description of the input] |
| Source | API |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

²¹² **5.1.1.1.4 API_fromTrack**

| | |
|---|---|
| Input name | API_fromTrack |
| Description | [Brief description of the input] |
| Source | API respectively F1 Receive Information from Trackside |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

²¹³ **5.1.1.1.5 API_fromDMI**

| | |
|-------------|------------------------------------|
| Input name | API_fromDMI |
| Description | [Brief description of the input] |
| Source | API respectively F6 DMI Controller |
| Type | [Type of the input] |

| | |
|---|---|
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

²¹⁴ **5.1.1.1.6 API_fromTIU**

| | |
|---|---|
| Input name | API_fromTIU |
| Description | [Brief description of the input] |
| Source | API respectively F7 Manage TIU Interface |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

²¹⁵ **5.1.1.1.7 API_mobileHWStatus**

| | |
|---|--|
| Input name | API_mobileHWStatus |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |

| | |
|---|---|
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |
|---|---|

²¹⁶ **5.1.1.1.8 API_persistentData**

| | |
|---|---|
| Input name | API_persistentData |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

²¹⁷ **5.1.1.2 External Outputs**

²¹⁸ **5.1.1.2.1 resetOut**

| | |
|---|---|
| Output name | resetOut |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

²¹⁹ **5.1.1.2.2 API_toEuroradio**

| | |
|---|---|
| Output name | API_toEuroradio |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

²²⁰ **5.1.1.2.3 API_toDMI**

| | |
|---|---|
| Output name | API_toDMI |
| Description | [Brief description of the output] |
| Destination | API respectively F6DMI Controller |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

²²¹ **5.1.1.2.4 API_toTIU**

| | |
|-----------------------|--|
| Output name | API_toTIU |
| Description | [Brief description of the output] |
| Destination | API respectively F7 Manage TIU Interface |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |

| | |
|---|---|
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

5.2₂₂₂ F2.1: Manage_TrackSideInformation_Integration

223 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.etp |
| 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.

reference sections correctly once these are completed

224 5.2.2 Interface

225 An overview of the interface of component `Manage_TrackSideInformation_Integration` is shown
226 in Figure 18. The inputs and outputs are described in detail in Section 5.2.2.1 respectively 5.2.2.2.
227 Subcomponents are described in Section 5.2.3.

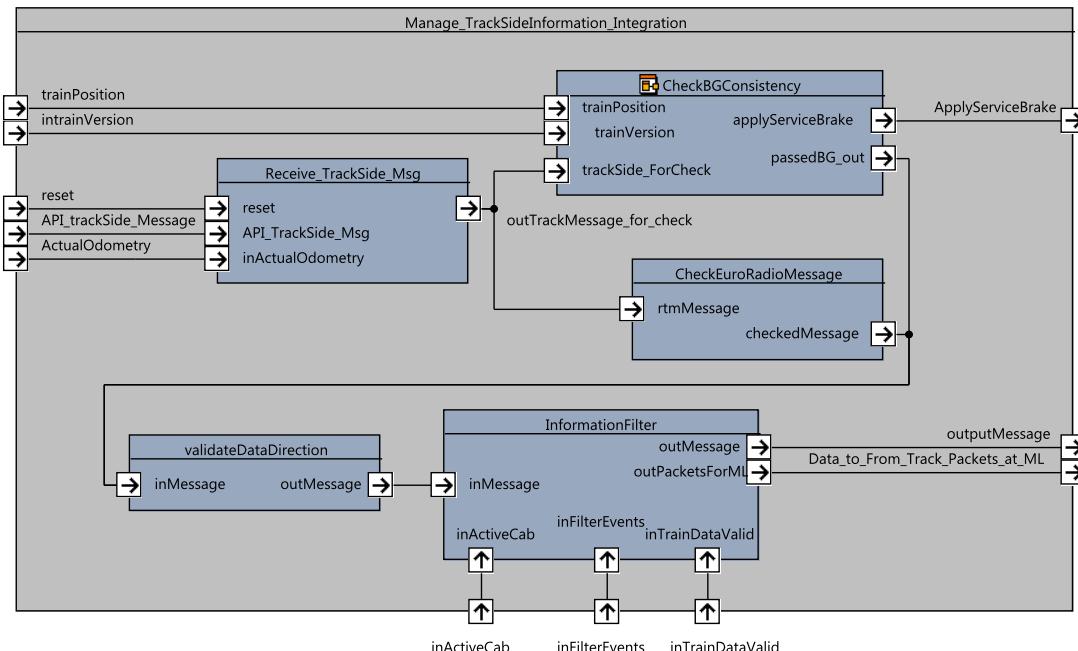


Figure 18. Manage TrackSideInformation Integration component SysML diagram.

228 5.2.2.1 Inputs

229 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

true All checks are performed.

false Component InformationFilter is deactivated.

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)

230 **5.2.2.1.2 API_trackSide_Message**

| | |
|-------------|---|
| Input name | API_trackSide_Message |
| Description | 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: valid (bool) Indicates the information has been refreshed in the cycle. true : Information is updated in this cycle. false : Information is unchanged. |

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)

²³¹ **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. |

²³² **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)

²³³ **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 |

²³⁴ **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 |

²³⁵ **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. |

²³⁶ **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. |

²³⁷ **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. |

²³⁸ **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 of valid range n/a

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

²³⁹ **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 at boundary | n/a |
| Behaviour for values out of valid range | Is interpreted as non valid radio connection. |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | Is interpreted as non valid radio connection. |

²⁴⁰ **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 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)

²⁴¹ **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. |

²⁴² **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 |

²⁴³ 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) | |

²⁴⁴ 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. |
|-----------------------|--|

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)

245 **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 |

²⁴⁶ **5.2.2.2 Outputs**

²⁴⁷ **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)

²⁴⁸ **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)

²⁴⁹ **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

250 **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

²⁵¹ **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)

252 **5.2.2.6 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)

253 **5.2.3 Subcomponents**

254 **5.2.3.1 Receive_TrackSide_Msg**

255 **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 |

256 **5.2.3.1.2 Interface**

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

259 **5.2.3.2 CheckBGConsistency**

260 **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 |

²⁶¹ 5.2.3.2.2 Interface

²⁶² For an overview of the interface of this internal component we refer to the SCADE model (cf. link
²⁶³ above) respectively the SCADE generated documentation.

²⁶⁴ 5.2.3.3 CheckEuroradioMessage

²⁶⁵ 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 |

²⁶⁶ **5.2.3.3.2 Interface**

²⁶⁷ For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

²⁶⁹ **5.2.3.4 ValidateDataDirection**

²⁷⁰ **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 |

²⁷¹ **5.2.3.4.2 Interface**

²⁷² For an overview of the interface of this internal component we refer to the SCADE model (cf. link
²⁷³ above) respectively the SCADE generated documentation.

²⁷⁴ **5.2.3.5 InformationFilter**

²⁷⁵ **5.2.3.5.1 Component Requirements**

Information filter component description needs to be checked, i.e. is the description still up to date? Should more documentation provided for this component in the ADD (please check with Bernd Hekele)?

| | |
|---------------------|---|
| 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 | <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> |
|-------------|---|

| | |
|------------------------|-------------------------|
| Input documents | Subset-026, Chapter 4.8 |
| Safety integrity level | 4 |
| Time constraints | n/a |
| API requirements | n/a |

²⁷⁷ 5.2.3.5.2 Interface

²⁷⁸ For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

²⁸⁰ 5.3 F2.2: Manage_ETCS_Procedures

Section has to be completed

²⁸² 5.3.1 Component Requirements

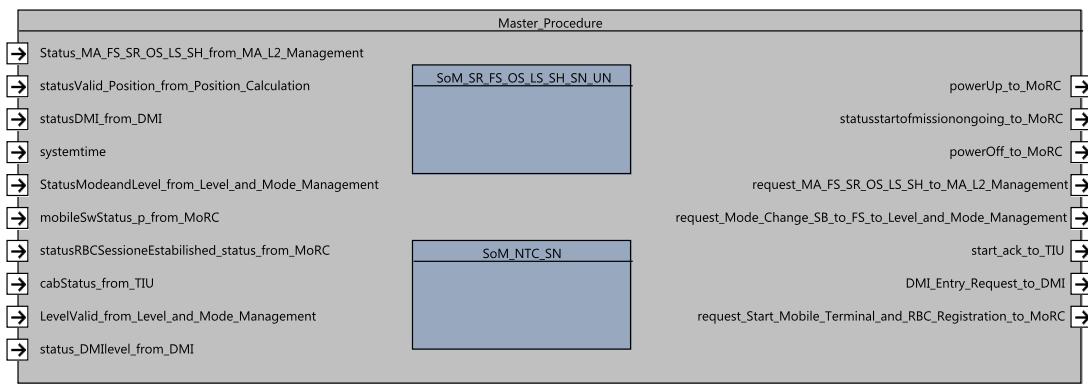


Figure 19. Manage_ETCS_Procedures component SysML diagram.

| | |
|------------------------|---|
| Component name | Manage_ETCS_Procedures |
| 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 |

283 5.3.2 Interface

284 An overview of the interface of component Manage_ETCS_Procedures is shown in Figure 19.
 285 The inputs and outputs are described in detail in Section 5.3.2.1 respectively 5.3.2.2. Subcompo-
 286 nents are described in Section 5.3.3.

287 5.3.2.1 Inputs

288 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

To be completed

Behaviour when value is n/a
at boundary

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.

²⁸⁹ **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 erroneous, absent or unwanted (i.e. spurious) n/a

²⁹⁰ **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.

²⁹¹ **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 | To be completed |

Behaviour when value is at boundary To be completed

Behaviour for values out of valid range To be completed

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

²⁹² **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_Main |
| Type | MoRC_Pck::mobileSWStatus_Type |
| Valid range of values | To be completed |

| | |
|-------------------------------------|-----------------|
| Behaviour when value is at boundary | To be completed |
|-------------------------------------|-----------------|

| | |
|---|-----------------|
| Behaviour for values out of valid range | To be completed |
|---|-----------------|

| | |
|---|-----------------|
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | To be completed |
|---|-----------------|

²⁹³ **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_Main |
| Type | Radio_Types_Pkg::sessionStatus_Type |

| | |
|-----------------------|-----------------|
| Valid range of values | To be completed |
|-----------------------|-----------------|

| | |
|-------------------------------------|-----------------|
| Behaviour when value is at boundary | To be completed |
|-------------------------------------|-----------------|

| | |
|---|-----------------|
| Behaviour for values out of valid range | To be completed |
|---|-----------------|

| | |
|---|-----------------|
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | To be completed |
|---|-----------------|

²⁹⁴ **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

To be completed

Behaviour when value is at boundary

To be completed

Behaviour for values out of valid range

To be completed

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

To be completed

²⁹⁵ **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 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)

²⁹⁶ **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

To be completed

Behaviour when value is at boundary

To be completed

Behaviour for values out of valid range

To be completed

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

To be completed

²⁹⁷ 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 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)

²⁹⁸ 5.3.2.2 Outputs

²⁹⁹ 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 | To be completed |
| Behaviour when value is at boundary | To be completed |
| Behaviour for values out of valid range | To be completed |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | To be completed |

³⁰⁰ **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_Main |
| Type | Common_Types_Pkg::radioManagementMessage_T |
| Valid range of values | To be completed |
| Behaviour when value is at boundary | To be completed |
| Behaviour for values out of valid range | To be completed |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | To be completed |

³⁰¹ **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_Main |
| 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 | |
| Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious) | |

302 **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_Main |
| Type | bool |
| Valid range of values | |
| <p>true Start of mission procedure is currently ongoing.</p> <p>false Start of mission procedure is currently not ongoing.</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) | |

³⁰³ **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_Main |
| 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)

³⁰⁴ **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.

Can we state "start of mission not completed" in case of "false" here?

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)

305 **5.3.3 Subcomponents**

306 **5.3.3.1 Awakness_of_Train**

307 **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 |

308 **5.3.3.1.2 Interface**

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

311 **5.3.3.2 NP**

312 **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 |

313 **5.3.3.2.2 Interface**

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

316 **5.3.3.3 SoM_L2_3_FS_SR_OS_LS_SH**

317 **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 |

318 **5.3.3.3.2 Interface**

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

321 **5.3.3.4 SoM_NTC_SN**

322 **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 |

323 **5.3.3.4.2 Interface**

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

5.4₃₂₆ F2.3: trainData

327 **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.etc |
| 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> |
| 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. |

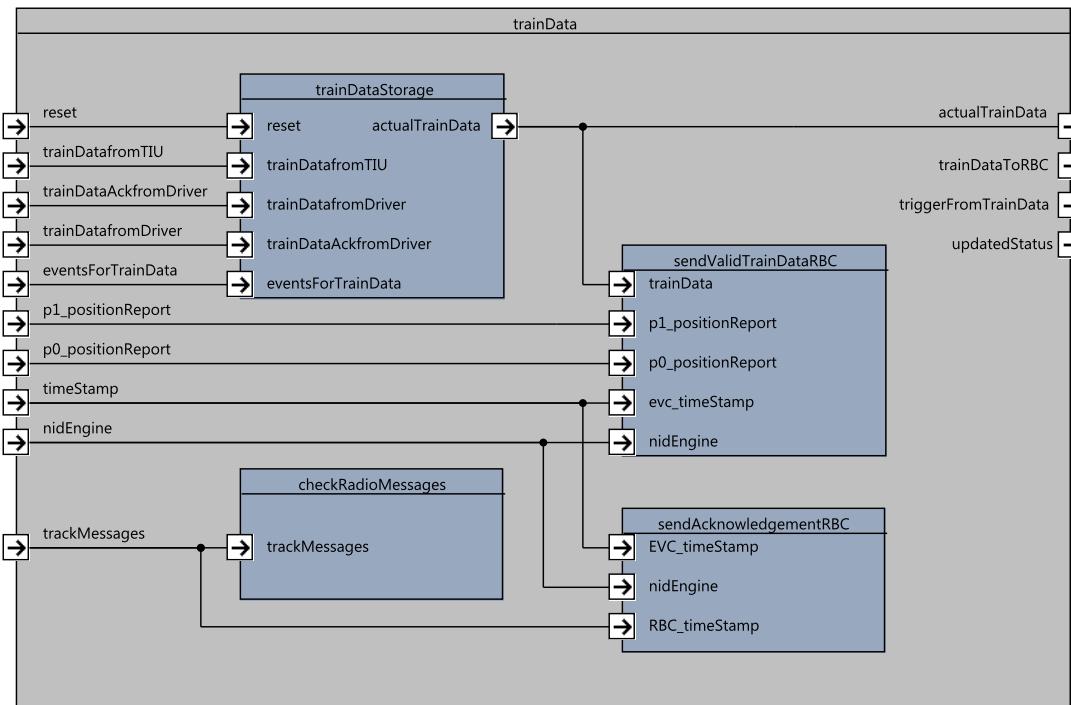


Figure 20. `trainData` component SysML diagram.

328 5.4.2 Interface

329 An overview of the interface of component `trainData` is shown in Figure 20. The inputs and
330 outputs are described in detail in Section 5.4.2.1 respectively 5.4.2.2. Subcomponents are
331 described in Section 5.4.3.

332 5.4.2.1 Inputs

333 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 <code>reset</code> |
| Type | <code>bool</code> |
| Valid range of values | |

true Perform reset of train data and train data status.

false No reset of data in this 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 un-
wanted (i.e. spurious)

³³⁴ **5.4.2.1.2 trainDatafromTIU**

| | |
|---|--|
| Input name | trainDatafromTIU |
| Description | 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: valid (bool): valid indicator for this component. In this structure valid means the data has been received from train. Additional states like validated by driver or validated by RBC are maintained in the status structure for train data. other components : Other components are defined according to Section 3.18.3.2 of Subset-026. |
| 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 n/a at boundary | |
| 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 un- wanted (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. |

³³⁵ **5.4.2.1.3 trainDatafromDriver**

| | |
|------------|---------------------|
| Input name | trainDatafromDriver |
|------------|---------------------|

| | |
|-------------|--|
| 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> <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>trainCtategory (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.</p> <p>l_train (Obu_BasicTypes_Pkg::L_internal_Type): Length of the train [cm].</p> <p>m_brakeperct (int): brake percentage. range from 0 to 300.</p> <div style="border: 1px solid green; padding: 5px;"> <p>If this is a percentage, then the range would probably be 0...100. Maybe we should replace percentage here?</p> </div> <p>v_maxtrain (Obu_BasicTypes_Pkg::V_internal_Type): maximum speed of the train in km/h.</p> <div style="border: 1px solid green; padding: 5px;"> <p>needs to be changed to cm/sec</p> </div> <p>m_axleLoad (M_AXLELOADCAT): axle load category according to Subset-026, Section 3.18.3.2.</p> <p>m_airTight (M_AIRTIGHT): airtight system presence according to Subset-026, Section 3.18.3.2.</p> <p>m_loadingGauge (M_LOADINGGAUGE): loading gauge category according to Subset-026, Section 3.18.3.2.</p> |
|-------------|--|

| | |
|---|--|
| 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. |

336 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. |

337 **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. |
|---|--|

338 **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. |

339 **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 |
| 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 unwanted (i.e. spurious)

³⁴⁰ **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 of valid range | n/a |
| Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious) | |

³⁴¹ **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 of valid range | n/a |
| Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious) | |

³⁴² **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 |

³⁴³ **5.4.2.2 Outputs**

³⁴⁴ **5.4.2.2.1 actualTrainData**

| | |
|-------------|-----------------|
| Output name | actualTrainData |
|-------------|-----------------|

| Description | |
|-------------|---|
| | 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: |
| | 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. |
| | acknowledgedByDriver (bool): Indicates this component has been validated by the driver. |
| | redundant information to status. Needs cleaning |
| | trainCategory (NC_TRAIN): Train category used for the static speed profile calculation. |
| | cantDeficiency (NC_CDTRAIN): Cant deficiency train category |
| | trainLength (Obu_BasicTypes_Pkg::L_internal_Type): Length of the train [cm]. |
| | brakePercentage (int): brake percentage. range from 0 to 300. |
| | maxTrainSpeed (Obu_BasicTypes_Pkg::V_internal_Type): maximum speed of the train in km/h. |
| | needs to be changed to cm/sec |
| | loadingGauge (M_LOADINGGAUGE): loading gauge category according to 3.18.3.2 |
| | axleLoadCategory (M_AXLELOADCAT): axle load category according to Subset-026, Section 3.18.3.2. |
| | airTightSystem (M_AIRTIGHT): airtight system presence according to Subset-026, Section 3.18.3.2. |
| | axleNumber int): axle number according to Subset-026, Section 3.18.3.2. |
| | numberNationalSystems (int): The number of national systems available in the train. |
| | nationalSystems (Packet_TrainTypes_Pkg::aNID_NTC_T): National Systems available in the train. The elements 0 .. number-NationalSystems - 1 are carrying the relevant data. |
| | numberTractionSystems (int): The number of traction systems available in the train. |
| | tractionSystems (Packet_TrainTypes_Pkg::aTractionIdentity_T): Traction Systems available in the train. The elements 0 ... numberTractionSystems - 1 are carrying the relevant data. |

| | |
|---|---|
| Destination | F2.4 TrackAtlas F2.6 calculateTrainPosition F2.7 SpeedSupervision_Integration F2.8 ProvidePositionReport F2.11 manageDMI_Output |
| 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) | |

³⁴⁵ **5.4.2.2.2 trainDataToRBC**

| | |
|---|---|
| Output name | trainDataToRBC |
| 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 output API_toEuroradio |
| Type | Radio_Types_Pkg::Radio_TrainTrack_Message_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) | |

³⁴⁶ **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 of valid range | n/a |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | n/a |

³⁴⁷ **5.4.2.2.4 updatedStatus**

| | |
|-------------|---|
| Output name | updatedStatus |
| Description | Detailed definition of the trainData status. The following components are defined: valid (bool): Data is initialised based on data received from the TIU. validatedByDriver (bool): Data has been validated by the Driver. validatedbyRBC (bool): Data has been validated by the RBC. waitingForRBCResponse (bool): 3.18.3.4.1 Train is waiting for ack to validation command. driverIsModificationTrainData (bool): 3.18.3.3.1 Driver is Modifying / Revalidating train data. timeStampValidateToRBC (T_TRAIN): 8.7.4 This label is used in communication with the RBC to identify the communication entity. Train data is acknowledged. |

| | |
|---|---|
| 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 of valid range | n/a |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | n/a |

348 **5.4.3 Subcomponents**

349 **5.4.3.1 trainDataStorage**

350 **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 |

351 **5.4.3.1.2 Interface**

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

354 **5.4.3.2 checkRadioMessages**

355 **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 |

356 **5.4.3.2.2 Interface**

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

359 **5.4.3.3 sendValidTrainDataRBC**

360 **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 |

361 **5.4.3.3.2 Interface**

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

364 **5.4.3.4 sendAcknowledgementRBC**

365 **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 |

366 **5.4.3.4.2 Interface**

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

369 **5.4.3.5 checkAcknowledgementGeneral**

370 **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 acknowledgement 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 |

371 **5.4.3.5.2 Interface**

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

5.5₃₇₄ **F2.4: TrackAtlas**

375 Section needs to be completed

376 **5.5.1 Component Requirements**

| | |
|------------------------|--|
| Component name | TrackAtlas |
| Link to SCADE model | ??? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | ??? |
| Input documents | Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

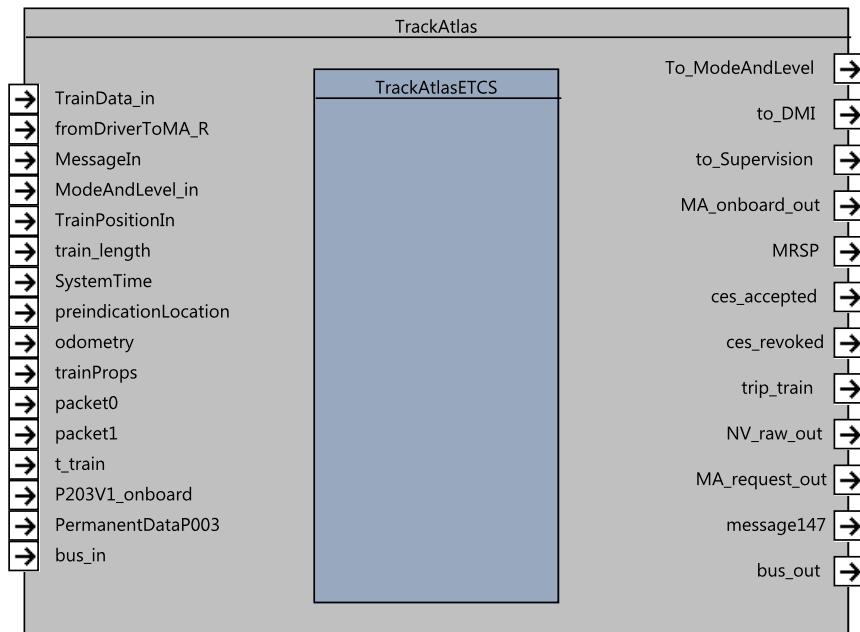


Figure 21. TrackAtlas component SysML diagram.

377 5.5.2 Interface

378 An overview of the interface of component TrackAtlas is shown in Figure 21. The inputs
 379 and outputs are described in detail in Section 5.5.2.1 respectively 5.5.2.2. Subcomponents are
 380 described in Section 5.5.3.

381 5.5.2.1 Inputs

382 5.5.2.1.1 [Input 1 name]

| | |
|---|---|
| Input name | [Name of the input] |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

383 5.5.2.1.2 [Input 2 name]

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| | |
|-------------|----------------------------------|
| Input name | [Name of the input] |
| Description | [Brief description of the input] |

³⁸⁴ **5.5.2.2 Outputs**

³⁸⁵ **5.5.2.2.1 [Output 1 name]**

| | |
|---|---|
| Output name | [Name of the output] |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

³⁸⁶ **5.5.2.2.2 [Output 2 name]**

| | |
|---|---|
| Output name | [Name of the output] |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

³⁸⁷ **5.5.3 Subcomponents**

³⁸⁸ **5.5.3.1 StoreRaw_NV**

³⁸⁹ **5.5.3.1.1 Component Requirements**

| | |
|----------------|-------------|
| Component name | StoreRaw_NV |
|----------------|-------------|

| | |
|------------------------|---|
| Link to SCADE model | http://??? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

390 **5.5.3.1.2 Interface**

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

393 **5.5.3.2 Build_GradientProfile**

394 **5.5.3.2.1 Component Requirements**

| | |
|------------------------|---|
| Component name | Build_GradientProfile |
| Link to SCADE model | http://??? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

395 **5.5.3.2.2 Interface**

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

398 **5.5.3.3 Build_MA**

399 **5.5.3.3.1 Component Requirements**

| | |
|------------------------|---|
| Component name | Build_MA |
| Link to SCADE model | http://??? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

400 **5.5.3.3.2 Interface**

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

403 **5.5.3.4 Build_MRSP**

404 **5.5.3.4.1 Component Requirements**

| | |
|------------------------|---|
| Component name | Build_MRSP |
| Link to SCADE model | http://??? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

405 **5.5.3.4.2 Interface**

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

408 **5.5.3.5 Manage_EmergencyStop**

⁴⁰⁹ **5.5.3.5.1 Component Requirements**

| | |
|------------------------|---|
| Component name | Manage_EmergencyStop |
| Link to SCADE model | http://??? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

⁴¹⁰ **5.5.3.5.2 Interface**

⁴¹¹ For an overview of the interface of this internal component we refer to the SCADE model (cf. link
⁴¹² above) respectively the SCADE generated documentation.

⁴¹³ **5.5.3.6 C_P003V1_OBU_P003_OBU**

⁴¹⁴ **5.5.3.6.1 Component Requirements**

| | |
|------------------------|---|
| Component name | C_P003V1_OBU_P003_OBU |
| Link to SCADE model | http://??? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

⁴¹⁵ **5.5.3.6.2 Interface**

⁴¹⁶ For an overview of the interface of this internal component we refer to the SCADE model (cf. link
⁴¹⁷ above) respectively the SCADE generated documentation.

⁴¹⁸ **5.5.3.7 GradientProfile_to_DMI**

⁴¹⁹ **5.5.3.7.1 Component Requirements**

| | |
|------------------------|--|
| Component name | GradientProfile_to_DMI |
| Link to SCADE model | http://??? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ???? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

⁴²⁰ **5.5.3.7.2 Interface**

⁴²¹ For an overview of the interface of this internal component we refer to the SCADE model (cf. link
⁴²² above) respectively the SCADE generated documentation.

⁴²³ **5.5.3.8 Manage_MA_Request**

⁴²⁴ **5.5.3.8.1 Component Requirements**

| | |
|------------------------|--|
| Component name | Manage_MA_Request |
| Link to SCADE model | http://??? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ???? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

⁴²⁵ **5.5.3.8.2 Interface**

⁴²⁶ For an overview of the interface of this internal component we refer to the SCADE model (cf. link
⁴²⁷ above) respectively the SCADE generated documentation.

⁴²⁸ **5.5.3.9 TA_to_ML**

⁴²⁹ **5.5.3.9.1 Component Requirements**

| | |
|------------------------|---|
| Component name | TA_to_ML |
| Link to SCADE model | http://?? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

⁴³⁰ **5.5.3.9.2 Interface**

⁴³¹ For an overview of the interface of this internal component we refer to the SCADE model (cf. link
⁴³² above) respectively the SCADE generated documentation.

⁴³³ **5.5.3.10 SSP_to_MRSP**

⁴³⁴ **5.5.3.10.1 Component Requirements**

| | |
|------------------------|---|
| Component name | SSP_to_MRSP |
| Link to SCADE model | http://?? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

⁴³⁵ **5.5.3.10.2 Interface**

⁴³⁶ For an overview of the interface of this internal component we refer to the SCADE model (cf. link
⁴³⁷ above) respectively the SCADE generated documentation.

⁴³⁸ **5.5.3.11 MRSP_to_MRSP_to_DMI**

⁴³⁹ **5.5.3.11.1 Component Requirements**

| | |
|------------------------|---|
| Component name | MRSP_to_MRSP_to_DMI |
| Link to SCADE model | http://?? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

⁴⁴⁰ **5.5.3.11.2 Interface**

⁴⁴¹ For an overview of the interface of this internal component we refer to the SCADE model (cf. link above) respectively the SCADE generated documentation.

5.6⁴⁴³ F2.5: ManageLevelAndMode

⁴⁴⁴ **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 and Matthias Güdemann, 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 |

⁴⁴⁵ **5.6.2 Interface**

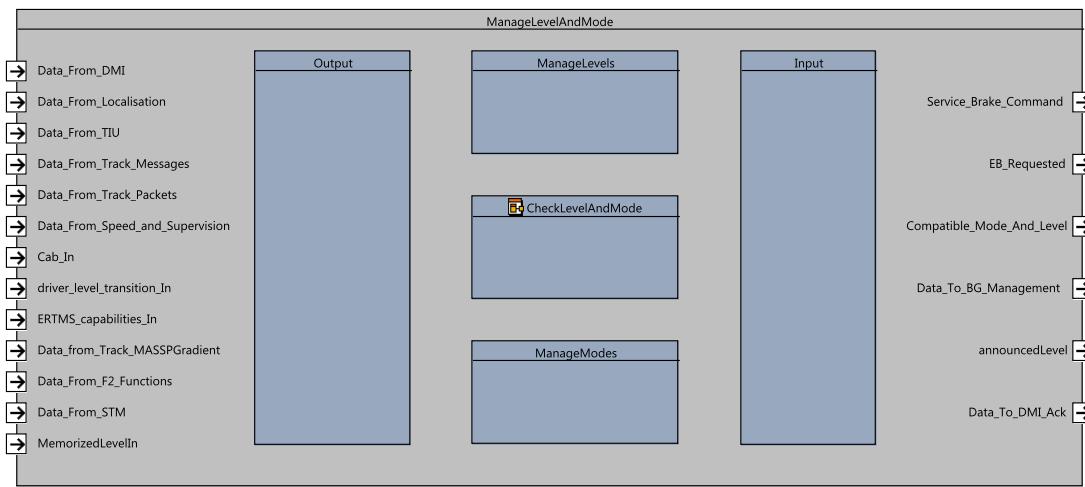


Figure 22. ManageLevelAndMode component SysML diagram.

446 An overview of the interface of component ManageLevelAndMode is shown in Figure 22 and
 447 Figure 23. The inputs and outputs are described in detail in Section 5.6.2.1 respectively 5.6.2.2.
 448 Subcomponents are described in Section 5.6.3.

449 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

454 5.6.2.1 Inputs

455 See Figure 24 for the inputs of the function.

456 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 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)

⁴⁵⁷ **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 It is a complex type:

- 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)

⁴⁵⁸ **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 n/a
of valid range

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

⁴⁵⁹ 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 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) | |

⁴⁶⁰ 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 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

⁴⁶¹ **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 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

⁴⁶² **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 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 |

⁴⁶³ **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 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 |

⁴⁶⁴ **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 n/a at boundary | |
| Behaviour for values out of valid range | |
| Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious) | |

⁴⁶⁵ **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 n/a at boundary | |
| Behaviour for values out of valid range | |
| Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious) | |

⁴⁶⁶ **5.6.2.1.11 Data_From_F2_Functions**

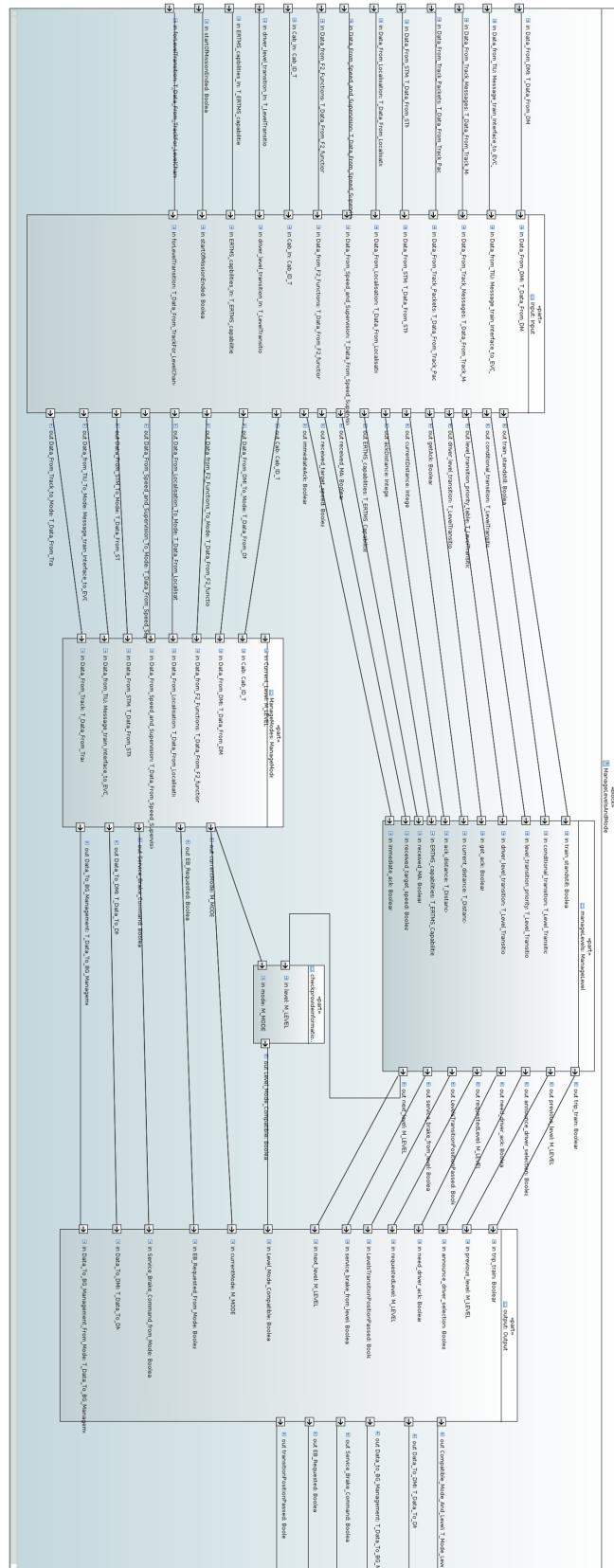


Figure 23. Mode_and_Level data flow SysML diagram

Table 5: Inputs of ManageLevelAndMode

| Name | Type | Comments and Information |
|---------------------------------|--|--------------------------|
| Data_From_DMI | DMI_Types_Pkg::DMI_To_Modes_T | |
| Data_From_Localisation | Level_And_Mode_Type s_Pkg::T_Data_From_Locatisation | |
| Data_From_TIU | TIU_Types_Pkg::Message_Train_Interface_to_EVC_T | |
| Data_From_Track_Messages | Level_And_Mode_Type s_Pkg::T_Data_From_Track_Mess | |
| Data_From_Track_Packets | Level_And_Mode_Type s_Pkg::T_Data_From_Track_Packet | |
| Data_From_Speed_and_Supervision | Level_And_Mode_Type s_Pkg::T_Data_From_Speed_Supervision | |
| Cab_In | TIU_Types_Pkg::cab_ID_T | |
| driver_level_transition_In | Level_And_Mode_Type s_Pkg::T_LevelTransition | |
| ERTMS_capabilities_In | Level_And_Mode_Type s_Pkg::T_ERTMS_capabilities | |
| Data_from_Track_MASSPGradient | Level_And_Mode_Type s_Pkg::T_Data_From_Track_MASSPGradient_Available | |
| Data_From_F2_Functions | Level_And_Mode_Type s_Pkg::T_Data_From_F2_functions | |
| Data_From_STM | Level_And_Mode_Type s_Pkg::T_Data_From_STM | |

Figure 24. Mode_and_Level inputs

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

⁴⁶⁷ **5.6.2.1.12 Data_FromSTM**

| | |
|---|--|
| Input name | Data_FromSTM |
| Description | Information concerning STM embedded systems. |
| Source | F2 input API_persistentData |
| Type | Level_And_Mode_Types_Pkg::T_Data_FromSTM |
| 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 n/a at boundary | |
| Behaviour for values out of valid range | |
| Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious) | |

Table 6: Outputs of ManageLevelAndMode

| Name | Type | Comments and Information |
|-----------------------------|---|--------------------------|
| Compatible_Mode_And_Level | Level_And_Mode_Type s_Pkg::T_Mode_Level | |
| Data_To_DMI | DMI_Types_Pkg::DMI_ModesToDMI_T | |
| Data_To_BG_Management | Level_And_Mode_Type s_Pkg::T_Data_To_BG_Management | |
| Service_Brake_Command | bool | |
| EB_Requested | bool | |
| announcedLevelTransitionOut | Level_And_Mode_Type s_Pkg::T_LevelTransiti on | |
| isAvailableForUseOut | bool | |

Figure 25. Mode_and_Level outputs468 **5.6.2.2 Outputs**469 **5.6.2.2.1 Compatible_Mode_And_Level**

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

470

5.6.2.2.2 Data_To_DMI_Ack

| | |
|-------------|-----------------|
| Output name | Data_To_DMI_Ack |
|-------------|-----------------|

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

⁴⁷¹ **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 | |
| Behaviour for values out n/a of valid range | |
| Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious) | |

⁴⁷² **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

Behaviour for values out n/a
of valid range

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

⁴⁷³ **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)

⁴⁷⁴ **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: <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 |

⁴⁷⁵ **5.6.3 Subcomponents**

⁴⁷⁶ **5.6.3.1 Level_Management**

⁴⁷⁷ **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-Duche and Matthias Gudemann, Systerel |

Description

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.

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.

On the most abstract level the design consists of the *manage_priorities* function which takes the level transition order priority tables as inputs and computes the highest priority transition.

This transition order is fed to the *computeLevelTransitions* operator. This operator consists of three main parts. The *ComputeTransitionConditions* operator that emits the fulfilled conditions to change from a given level to a new level, the *LevelStateMachine* that stores the current level and takes the computed change conditions as input for possible level transitions and finally the *driverAck* 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.

| | |
|------------------------|--------------------------|
| Input documents | Subset-026, Chapter 5.10 |
| Safety integrity level | 4 |
| Time constraints | n/a |
| API requirements | n/a |

478 5.6.3.1.2 Interface

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

483 5.6.3.2 Mode_Management

484 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> <p>Inputs proceeds to inputs check and preparation.</p> <p>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]</p> <p>SwitchModes performs the mode selection according the conditions and priorities defined in transition table section 4.6.2 of [1]</p> <p>Outputs prepares packet of outputs.</p> |
|-------------|--|

| | |
|------------------------|--|
| 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 |

485 5.6.3.2.2 Interface

486 For an overview of the interface of this internal component we refer to the SCADE model (cf. link
 487 above) respectively the SCADE generated documentation <https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes/Modes/Modes.pdf>
 488
 489

490 5.6.3.3 Check_and_Provide_Mode_and_Level

491 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-Doche, 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 |

⁴⁹² **5.6.3.3.2 Interface**

⁴⁹³ For an overview of the interface of this internal component we refer to the SCADE model (cf. link
⁴⁹⁴ above) respectively the SCADE generated documentation.

5.7⁴⁹⁵ F2.6: calculateTrainPosition

⁴⁹⁶ **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. <p>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</p> |
| 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. |

497 **5.7.2 Interface**

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

501 **5.7.2.1 Inputs**

502 **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. |

503 **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.

504 **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 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.

505 **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. |

506 **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. |

507 **5.7.2.2 Outputs**

508 **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 F2.11 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 at boundary | n/a |

Behaviour for values out n/a
of valid range

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

509 **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_TracksidInformation_Integration F2.8 ProvidePositionReport |
| 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
erroneous, 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 at boundary | n/a |
| Behaviour for values out of valid range | n/a |
| Behaviour when value is erroneous, absent or unwanted | n/a |

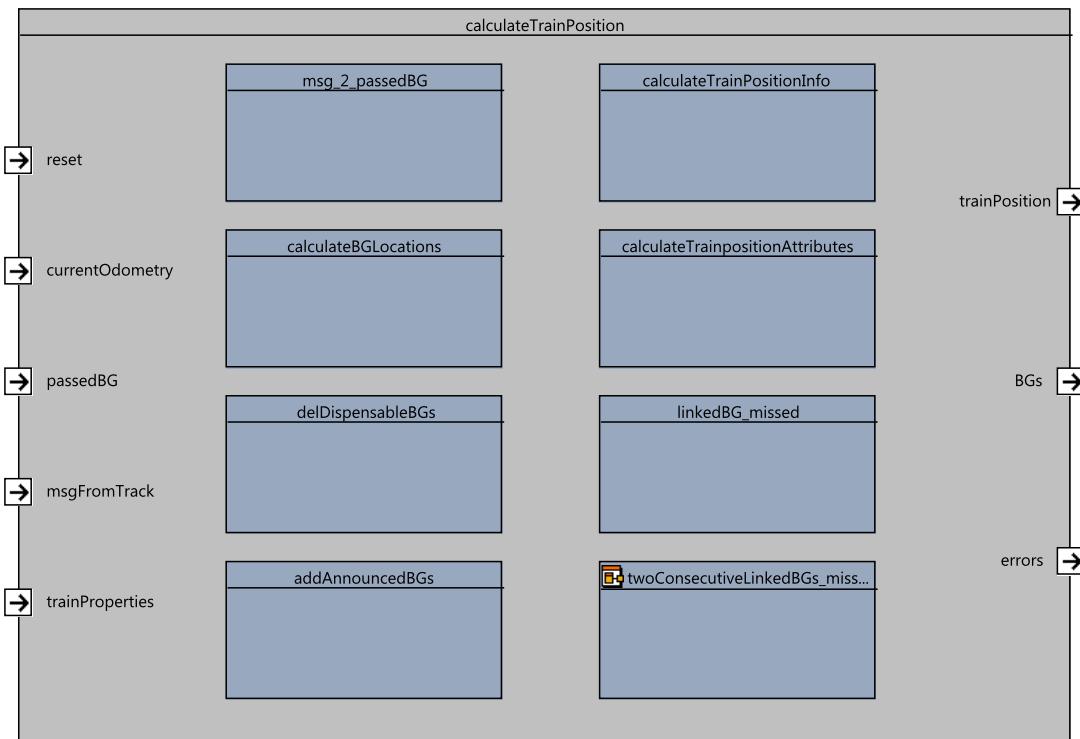


Figure 26. calculateTrainPosition component SysML diagram.

511 **5.7.3 Subcomponents**

512 **5.7.3.1 msg_2_passedBG**

513 **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 |

514 **5.7.3.1.2 Interface**

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

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517 **5.7.3.2 calculateBGLocations**

518 **5.7.3.2.1 Component Requirements**

| | |
|------------------------|---|
| 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 |

⁵¹⁹ **5.7.3.2.2 Interface**

⁵²⁰ For an overview of the interface of this internal component we refer to the SCADE model (cf. link
⁵²¹ above) respectively the SCADE generated documentation.

⁵²² **5.7.3.3 delDisposableBGs**

⁵²³ **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 |

⁵²⁴ **5.7.3.3.2 Interface**

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

527 **5.7.3.4 addAnnouncedBGs**

528 **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 |

529 **5.7.3.4.2 Interface**

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

532 **5.7.3.5 calculateTrainpositionInfo**

533 **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 |

534 **5.7.3.5.2 Interface**

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

537 **5.7.3.6 calculateTrainPositionAttributes**

538 **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 |

539 **5.7.3.6.2 Interface**

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

542 **5.7.3.7 linkedBG_missed**

543 **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 |

544 **5.7.3.7.2 Interface**

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

547 **5.7.3.8 twoconsecutiveLinkedBGs_missed**

548 **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 |

549 **5.7.3.8.2 Interface**

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

5.8₅₅₂ F2.7: SpeedSupervision_Integration

553 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 27, 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 |

554 5.8.2 Interface

- 555 An overview of the interface of component SpeedSupervision_integration is shown in Figure 27.
 556 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.

558 5.8.2.1 Inputs

559 5.8.2.1.1 National Values

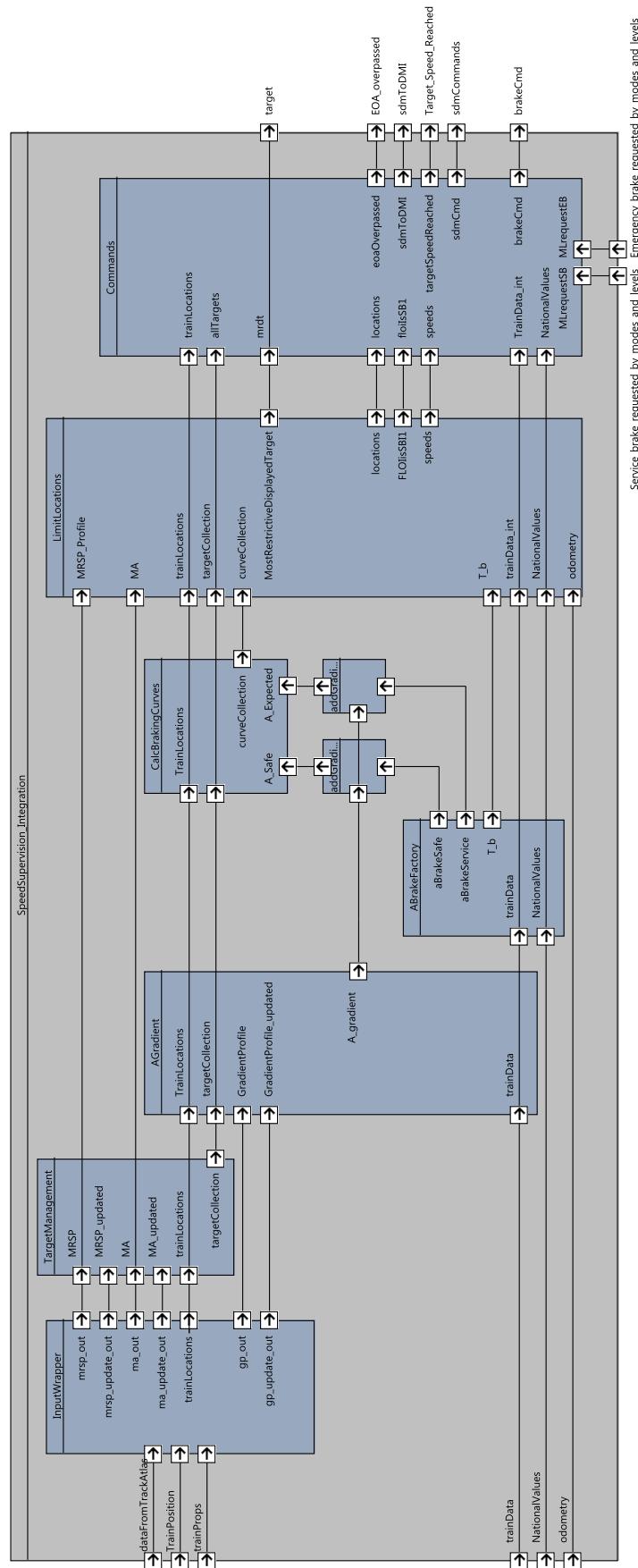


Figure 27. SpeedSupervision_Integration component SysML diagram.

| | |
|---|--|
| 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. |

560 **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. |

561 **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. |

562 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. |

563 **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. |

564 **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. |

565 **5.8.2.2 Outputs**

566 **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. |

567 **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. |

568 **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.

⁵⁶⁹ 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.

⁵⁷⁰ **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)

⁵⁷¹ **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)

⁵⁷² **5.8.3 Subcomponents**

⁵⁷³ **5.8.3.1 SDM_InputWrapper**

⁵⁷⁴ **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 |

575 **5.8.3.1.2 Interface**

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

578 **5.8.3.2 TargetManagement**

579 **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. |
| <hr/> | |
| 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 |

580 **5.8.3.2.2 Interface**

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

583 **5.8.3.3 AGradient**

584 **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 |

585 **5.8.3.3.2 Interface**

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

588 **5.8.3.4 ABrakeFactory**

589 **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 |

590 **5.8.3.4.2 Interface**

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

593 **5.8.3.5 addGradient**

594 **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 |

595 **5.8.3.5.2 Interface**

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

598 **5.8.3.6 CalcBrakingCurves_Integration**

599 **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 |

600 **5.8.3.6.2 Interface**

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

603 **5.8.3.7 SDMLimitLocations**

604 **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 |

605 5.8.3.7.2 Interface

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

608 5.8.3.8 SDM_Commands

609 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 |

610 **5.8.3.8.2 Interface**

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

5.9₆₁₃ F2.8: Provide_Position_Report

614 **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> |

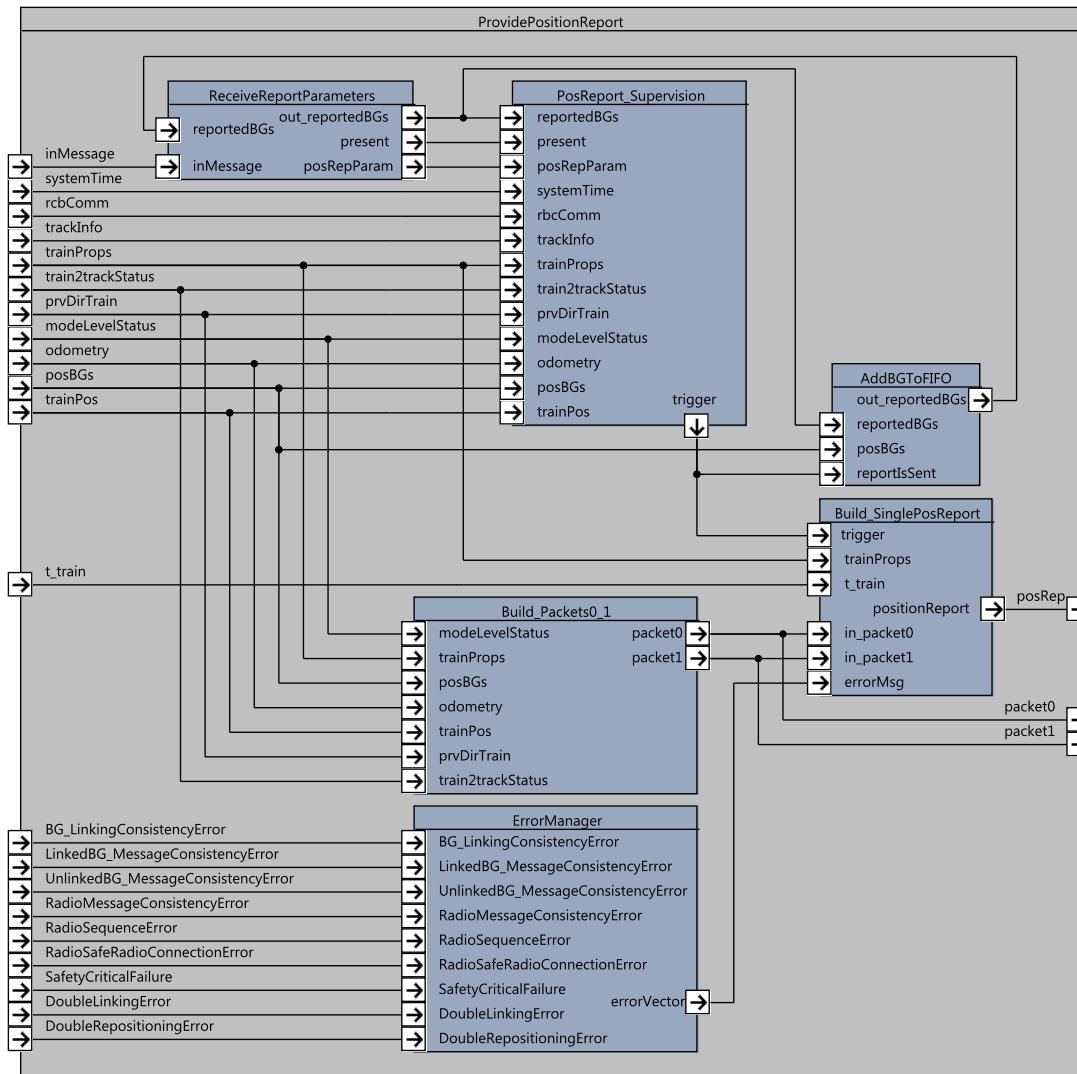


Figure 28. Provide_Position_Report component SysML diagram

| | |
|-----------------|---------------------------|
| Input documents | Subset-026, Chapter 3.6.5 |
|-----------------|---------------------------|

| | |
|------------------------|---|
| Safety integrity level | 4 |
|------------------------|---|

| | |
|------------------|-----|
| Time constraints | n/a |
|------------------|-----|

| | |
|------------------|-----|
| API requirements | n/a |
|------------------|-----|

615 5.9.2 Interface

616 An overview of the interface of component Provide_Position_Report is shown in Figure 28. The
 617 inputs and outputs are described in detail in Section 5.9.2.1 respectively 5.9.2.2. Subcomponents
 618 are described in Section 5.9.3.

619 5.9.2.1 Inputs

620 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 unwanted (i.e. spurious) | If valid is false, then input is ignored. |

621 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 unwanted (i.e. spurious) | assumed to be valid |

622 5.9.2.1.3 rbcComm

| | |
|-----------------------|---|
| Input name | rbcComm |
| Description | Variables modeling stati regarding the RBC communication. |
| Source | F2.9 MoRC_Main |
| 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)

623 **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) | |

624 **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)

625 **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) | |

626 **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) | |

627 **5.9.2.1.8 modeLevelStatus**

Input name modeLevelStatus

| | |
|---|---|
| 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 |

628 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 |

629 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)

630 **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)

631 **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)

⁶³² **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) | |

⁶³³ **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) | |

⁶³⁴ **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)

635 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)

636 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)

⁶³⁷ **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) | |

⁶³⁸ **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) | |

⁶³⁹ **5.9.2.1.20 DoubleLinkingError**

Input name DoubleLinkingError

| | |
|---|---|
| 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 |

640 **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 |

641 **5.9.2.2 Outputs**

642 **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 n/a
of valid range

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

⁶⁴³ **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 n/a
of valid range

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

⁶⁴⁴ **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 n/a
of valid range

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

645 **5.9.3 Subcomponents**

646 **5.9.3.1 ReceiveReportParameters**

647 **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 |

648 **5.9.3.1.2 Interface**

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

651 **5.9.3.2 PosReport_Supervision**

652 **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 |

653 **5.9.3.2.2 Interface**

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

656 **5.9.3.3 ErrorManager**

657 **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 |

658 **5.9.3.3.2 Interface**

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

661 **5.9.3.4 Build_Packets0_1**

662 **5.9.3.4.1 Component Requirements**

| | |
|----------------|------------------|
| Component name | Build_Packets0_1 |
|----------------|------------------|

| | |
|------------------------|---|
| 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 |

663 **5.9.3.4.2 Interface**

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

666 **5.9.3.5 Build_PosReport**

667 **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 |

668 **5.9.3.5.2 Interface**

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

671 **5.9.3.6 AddBGToFIFO**

672 **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 |

673 **5.9.3.6.2 Interface**

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

5.10 F2.9: Manage_Radio_Communication and RBC_Handover

677 **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> |
|-------------|--|

| | |
|------------------------|---|
| 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 |

678 5.10.2 Interface

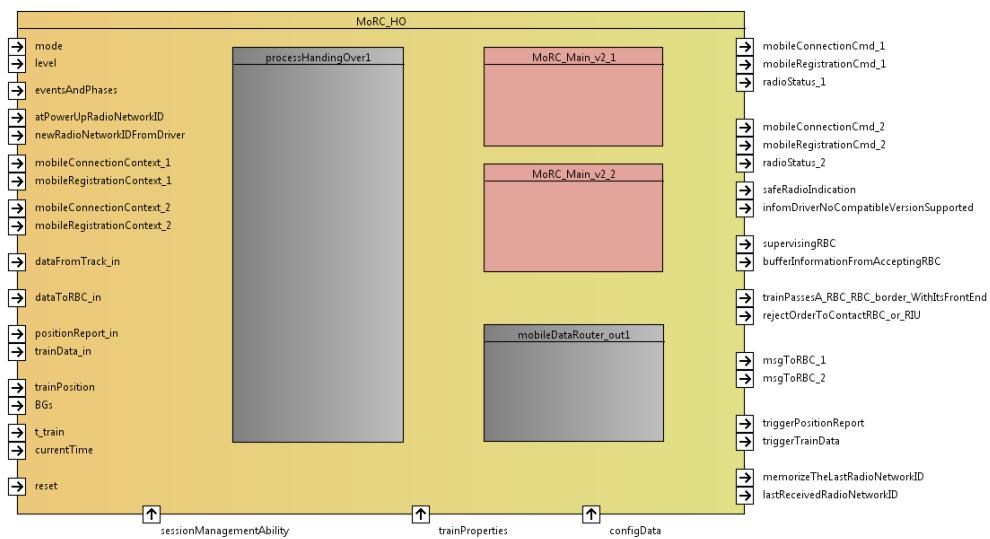


Figure 29. Manage_Radio_Communication component SysML diagram

679 An overview of the interface of component MoRC_HO is shown in Figure 29. The inputs and
 680 outputs are described in detail in Section 5.10.2.1 respectively 5.10.2.2. Sub components are
 681 described in Section 5.10.3.

682 5.10.2.1 Inputs

683 5.10.2.1.1 [mode]

| | |
|---|--------------------------------|
| Input name | mode |
| Description | Current onboard operating mode |
| Source | ??? |
| 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 |

684 5.10.2.1.2 [level]

| | |
|---|---------------------------------|
| Input name | level |
| Description | Current Operating Level |
| Source | ??? |
| Type | M_LEVEL |
| <i>This work is licensed under the "openETCS Open License Terms" (oOLT)</i> | |
| Valid range of values | Defined by M_LEVEL enumerations |
| Behaviour when value is n/a | |

| | |
|---|---|
| Description | Collection of input events and OBU operating phases |
| Source | Collection of source components responsible for the information |
| 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 |

⁶⁸⁶ **5.10.2.1.4 [atPowerUpRadioNetworkID]**

| | |
|---|--|
| Input name | atPowerUpRadioNetworkID |
| Description | Radio network ID to be used at power up |
| Source | ??? |
| 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 | OBU registers to unwanted radio network |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | OBU registers to unwanted radio network |

⁶⁸⁷ **5.10.2.1.5 [newRadioNetworkIDFromDriver]**

| | |
|-----------------------|--|
| Input name | newRadioNetworkIDFromDriver |
| Description | Radio network ID entered by the driver |
| Source | ??? |
| 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 OBU registers to unwanted radio network

Behaviour when value is erroneous, absent or unwanted (i.e. spurious) OBU registers to unwanted radio network

⁶⁸⁸ **5.10.2.1.6 [mobileRegistrationContext_1]**

Input name mobileRegistrationContext_1

Description Current registration status information from mobile modem 1

Source API

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 erroneous, absent or unwanted (i.e. spurious) Misbehaviour

⁶⁸⁹ **5.10.2.1.7 [mobileRegistrationContext_2]**

Input name mobileRegistrationContext_2

Description Current registration status information from mobile modem 2

Source API

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 erroneous, absent or unwanted (i.e. spurious) Misbehaviour

690 **5.10.2.1.8 [mobileConnectionContext_1]**

| | |
|---|---|
| Input name | mobileConnectionContext_2 |
| Description | Current connection status information from mobile modem 1 |
| Source | API |
| 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 |

691 **5.10.2.1.9 [mobileConnectionContext_2]**

| | |
|---|---|
| Input name | mobileConnectionContext_2 |
| Description | Current connection status information from mobile modem 2 |
| Source | API |
| 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 |

692 **5.10.2.1.10 [dataFromTrack_in]**

| | |
|-------------|---|
| Input name | [dataFromTrack_in] |
| Description | Messages received from track |
| Source | Manage_TrackSideInformation_Integration |
| Type | RCM_MsgTypes_Pkg::msgFromTrack_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 erroneous, absent or unwanted (i.e. spurious) | Misbehaviour |

⁶⁹³ **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 at boundary | n/a |
| Behaviour for values out of valid range | Confused RBC communication |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | Confused RBC communication |

⁶⁹⁴ **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 at boundary | n/a |
| Behaviour for values out of valid range | RBC receives faulty position report |

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

695 **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 at boundary | n/a |
| Behaviour for values out of valid range | RBC receives faulty train data |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | RBC receives faulty train data |

696 **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 |

697 **5.10.2.1.15 [BGs]**

| | |
|---|---|
| Input name | BGs |
| Description | Collection of currently known balise groups |
| Source | 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 |

698 **5.10.2.1.16 [t_train]**

| | |
|---|---|
| Input name | t_train |
| Description | Time, according to trainborne clock, at which messages are to be sent |
| Source | ??? |
| Type | T_TRAIN |
| Valid range of values | Refer to Subset 016-7. |
| Behaviour when value is at boundary | n/a |
| 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 |

699 **5.10.2.1.17 [reset]**

| | |
|-----------------------|--|
| Input name | reset |
| Description | Initializes the component and deletes the internal storage |
| Source | The OBUs system start controller |
| 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 unwanted (i.e. spurious)

⁷⁰⁰ **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 n/a at boundary | |
| Behaviour for values out of valid range | Code generation fails |
| Behaviour when value is Misbehaviour erroneous, absent or unwanted (i.e. spurious) | |

⁷⁰¹ **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 | The OBUs configuration manager |
| Type | TrainPosition_Types_Pck::trainProperties_T |
| Valid range of values | n/a |
| Behaviour when value is n/a at boundary | |
| Behaviour for values out of valid range | Faulty parametrization |

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

⁷⁰² **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 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) | |

⁷⁰³ **5.10.2.2 Outputs**

⁷⁰⁴ **5.10.2.2.1 [radioStatus_1]**

| | |
|---|--|
| Output name | radioStatus_1 |
| Description | Radio registration, connection and session status for radio link 1 |
| Destination | All components which need to know the radio status |
| 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 of valid range | n/a |
| Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious) | |

⁷⁰⁵ **5.10.2.2.2 [radioStatus_2]**

| | |
|---|--|
| Output name | radioStatus_2 |
| Description | Radio registration, connection and session status for radio link 2 |
| Destination | All components which need to know the radio status |
| 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 of valid range | n/a |
| Behaviour when value is n/a erroneous, absent or unwanted (i.e. spurious) | |

⁷⁰⁶ **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 unwanted (i.e. spurious) | |

⁷⁰⁷ **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 n/a
of valid range

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

⁷⁰⁸ **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 n/a of valid range | |
| Behaviour when value is n/a erroneous, absent or un- wanted (i.e. spurious) | |

⁷⁰⁹ **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 n/a of valid range | |

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

⁷¹⁰ **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) | |

⁷¹¹ **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 | InformationFilter |
| 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) | |

⁷¹² **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 of valid range | Code generation fails |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | Misbehaviour |

⁷¹³ **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 erroneous, absent or unwanted (i.e. spurious) | Misbehaviour |

⁷¹⁴ **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 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 |

⁷¹⁵ **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 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 |

⁷¹⁶ **5.10.2.2.13 [triggerPositionReport]**

| | |
|-------------------------------------|---|
| Output name | triggerPositionReport |
| Description | Triggers the providePositionReport function to provide a position report at positionReport_in input |
| Destination | providePositionReport |
| 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 position report

⁷¹⁷ **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 | provideTrainData ??? |
| 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 |

⁷¹⁸ **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 | ??? |
| 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 |

⁷¹⁹ **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 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) | Misinformed train driver |

⁷²⁰ **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 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) | Corrupted stored last radio network ID |

⁷²¹ **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 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) | Corrupted stored last radio network ID |

⁷²² **5.10.2.2.19 [ready]**

| | |
|---|---|
| Output name | ready |
| 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 | All components providing inputs for MoRC_HO |
| 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 |

⁷²³ **5.10.3 Subcomponents**

⁷²⁴ **5.10.3.1 RBC_Handover**

⁷²⁵ **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 *processHandingOver* 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 |

726 **5.10.3.1.2 Interface**

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

729 **5.10.3.2 Management_of_Radio_Communication**

730 **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 *MoRC_Main_v2* 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 |

731 **5.10.3.2.2 Interface**

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

734 **5.10.3.3 mobileDataRouter**

735 **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 commuting 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 |

736 **5.10.3.3.2 Interface**

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

5.11 **F2.10: manageDMI_input**

740 section and corresponding subsections have to be completed

741 **5.11.1 Component Requirements**

| | |
|------------------------|--|
| Component name | manageDMI_input |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of the components functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ???? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

742 **5.11.2 Interface**

743 An overview of the interface of component manageDMI_input is shown in Figure 30. The inputs
 744 and outputs are described in detail in Section 5.11.2.1 respectively 5.11.2.2. Subcomponents are
 745 described in Section 5.11.3.

746 **5.11.2.1 Inputs**

747 **5.11.2.1.1 [Input 1 name]**

| | |
|-------------|----------------------------------|
| Input name | [Name of the input] |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] |

| | |
|---|---|
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

⁷⁴⁸ **5.11.2.1.2 [Input 2 name]**

| | |
|---|---|
| Input name | [Name of the input] |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

⁷⁴⁹ **5.11.2.2 Outputs**

⁷⁵⁰ **5.11.2.2.1 [Output 1 name]**

| | |
|-------------------------------------|--|
| Output name | [Name of the output] |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |

| | |
|---|---|
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

751 **5.11.2.2.2 [Output 2 name]**

| | |
|---|---|
| Output name | [Name of the output] |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

752 **5.11.3 Subcomponents**

753 Currently ManageDMIInput does not have any subcomponents.

5.12.4 F2.11: manageDMI_output

755 section and corresponding subsections have to be completed

756 **5.12.1 Component Requirements**

| | |
|---------------------|---|
| Component name | manageDMI_output |
| Link to SCADE model | http://?? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of the components functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |

Safety integrity level 4

| | |
|------------------|--|
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

757 **5.12.2 Interface**

758 An overview of the interface of component manageDMI_output is shown in Figure 31. The inputs
 759 and outputs are described in detail in Section 5.12.2.1 respectively 5.12.2.2. Subcomponents are
 760 described in Section 5.12.3.

761 **5.12.2.1 Inputs**

762 **5.12.2.1.1 [Input 1 name]**

| | |
|---|---|
| Input name | [Name of the input] |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

763 **5.12.2.1.2 [Input 2 name]**

| | |
|---|--|
| Input name | [Name of the input] |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |

| | |
|---|---|
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |
|---|---|

764 **5.12.2.2 Outputs**

765 **5.12.2.2.1 [Output 1 name]**

| | |
|---|---|
| Output name | [Name of the output] |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

766 **5.12.2.2.2 [Output 2 name]**

| | |
|---|---|
| Output name | [Name of the output] |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

767 **5.12.3 Subcomponents**

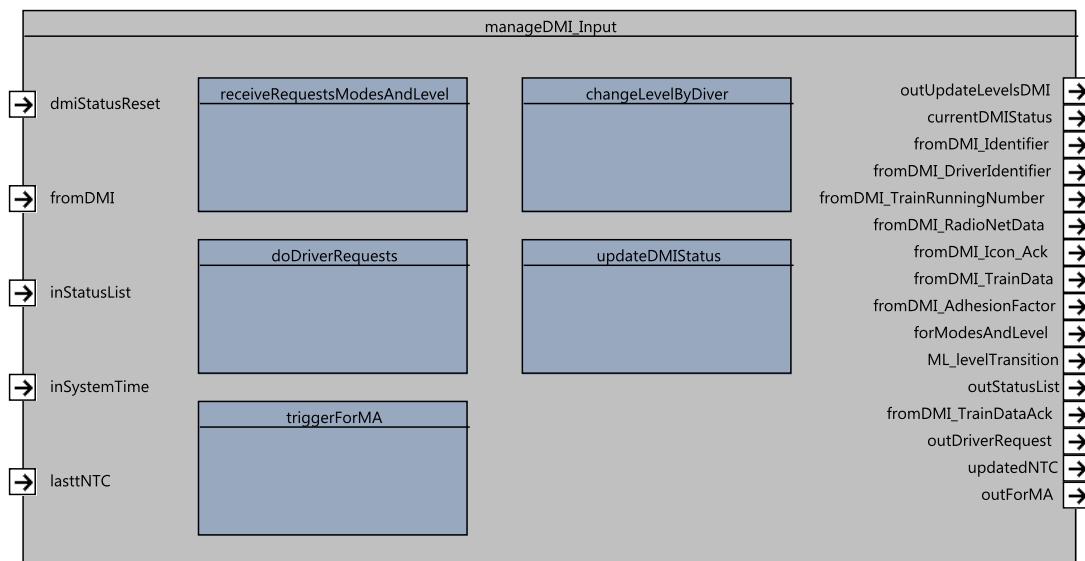


Figure 30. manageDMI_input SysML diagram.

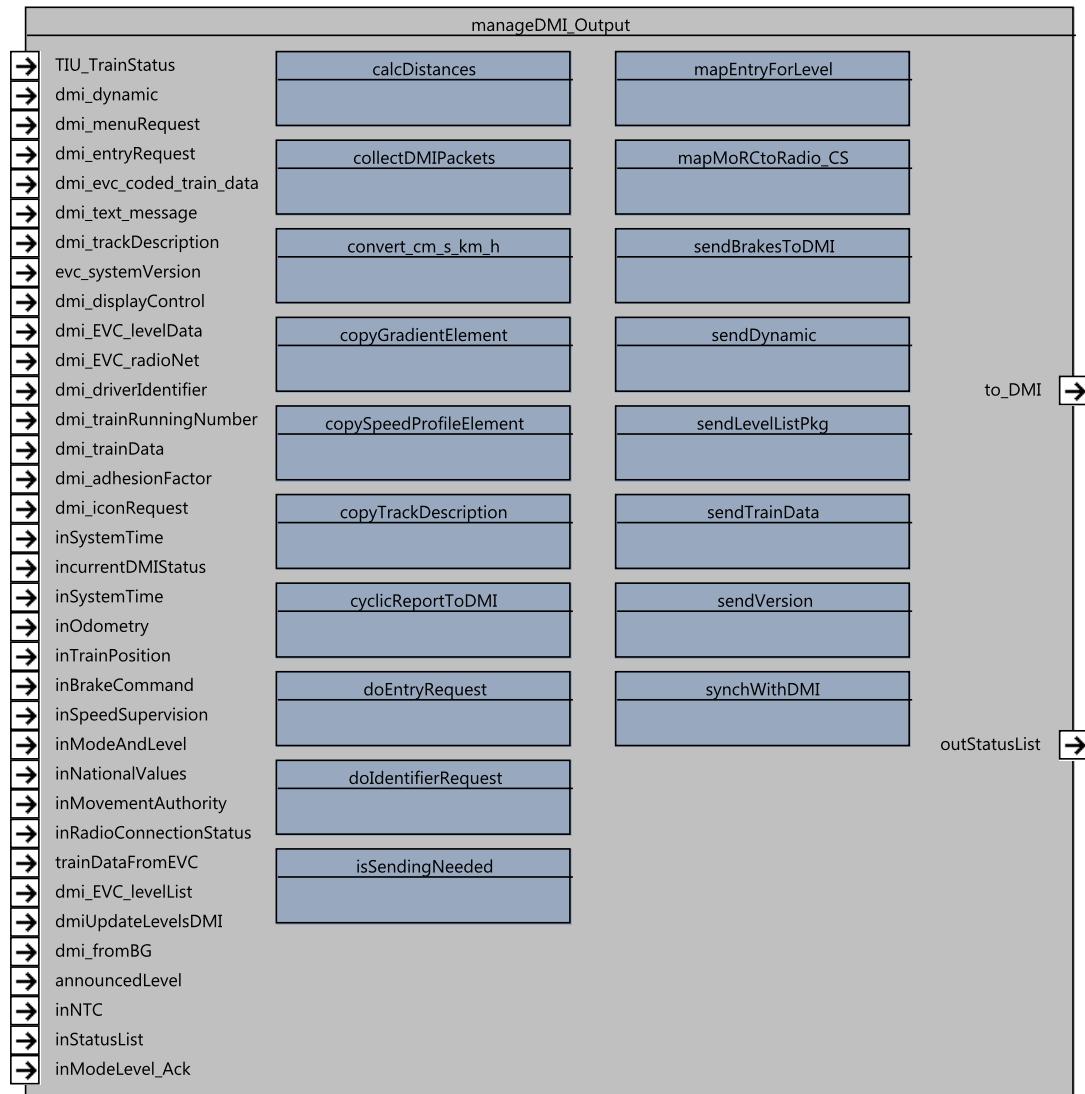


Figure 31. manageDMI_output SysML diagram.

768 **5.12.3.1 cyclicReportToDMI**

769 **5.12.3.1.1 Component Requirements**

| | |
|------------------------|---|
| Component name | cyclicReportToDMI |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

770 **5.12.3.1.2 Interface**

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

773 **5.12.3.2 ManageTextMessages**

774 **5.12.3.2.1 Component Requirements**

| | |
|------------------------|---|
| Component name | ManageTextMessages |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of the components functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

775 **5.12.3.2.2 Interface**

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

778 **5.12.3.3 copyTrackDescription**

779 **5.12.3.3.1 Component Requirements**

| | |
|------------------------|---|
| Component name | copyTrackDescription |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

780 **5.12.3.3.2 Interface**

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

783 **5.12.3.4 toEntryRequest**

784 **5.12.3.4.1 Component Requirements**

| | |
|------------------------|---|
| Component name | toEntryRequest |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

785 **5.12.3.4.2 Interface**

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

788 **5.12.3.5 sendBrakesToDMI**

789 **5.12.3.5.1 Component Requirements**

| | |
|------------------------|---|
| Component name | sendBrakesToDMI |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

790 **5.12.3.5.2 Interface**

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

793 **5.12.3.6 manageDMI_Output**

794 **5.12.3.6.1 Component Requirements**

| | |
|------------------------|---|
| Component name | manageDMI_Output |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

795 **5.12.3.6.2 Interface**

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

798 **5.12.3.7 sendTrainData**

799 **5.12.3.7.1 Component Requirements**

| | |
|------------------------|---|
| Component name | sendTrainData |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

800 **5.12.3.7.2 Interface**

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

803 **5.12.3.8 sendVersion**

804 **5.12.3.8.1 Component Requirements**

| | |
|------------------------|---|
| Component name | sendVersion |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

805 **5.12.3.8.2 Interface**

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

808 **5.12.3.9 sendLevelListPkg**

809 **5.12.3.9.1 Component Requirements**

| | |
|------------------------|---|
| Component name | sendLevelListPkg |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

810 **5.12.3.9.2 Interface**

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

5.13 F2.12: manageTIU_input

814 section and corresponding subsections have to be completed

815 **5.13.1 Component Requirements**

| | |
|------------------------|---|
| Component name | manageTIU_input |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of the components functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

816 **5.13.2 Interface**

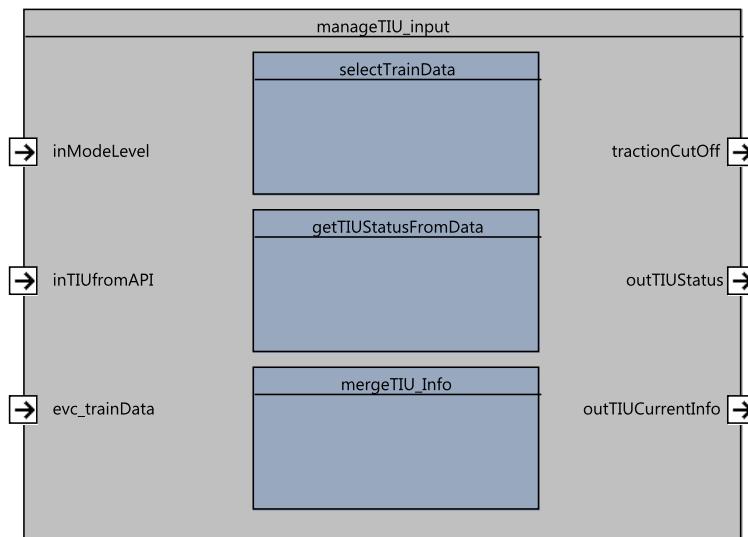


Figure 32. manageTIU_input SysML diagram.

817 An overview of the interface of component manageTIU_input is shown in Figure 32. The inputs
 818 and outputs are described in detail in Section 5.13.2.1 respectively 5.13.2.2. Subcomponents are
 819 described in Section 5.13.3.

820 5.13.2.1 Inputs

821 5.13.2.1.1 [Input 1 name]

| | |
|---|---|
| Input name | [Name of the input] |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

822 5.13.2.1.2 [Input 2 name]

| | |
|-------------------------|---|
| Input name | [Name of the input] |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] <i>This work is licensed under the 'openETCS Open License Terms' (oOLT).</i> |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is | [Description of components behaviour when input value is at bound- |

| | |
|---|---|
| Output name | [Name of the output] |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

825 **5.13.2.2.2 [Output 2 name]**

| | |
|---|---|
| Output name | [Name of the output] |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

826 **5.13.3 Subcomponents**

827 **5.13.3.1 mergeTIU_Info**

828 **5.13.3.1.1 Component Requirements**

| | |
|---------------------|-----------------------------------|
| Component name | mergeTIU_Info |
| Link to SCADE model | http://?? |

| | |
|------------------------|---|
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

829 **5.13.3.1.2 Interface**

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

832 **5.13.3.2 getTIUStatusFromData**

833 **5.13.3.2.1 Component Requirements**

| | |
|------------------------|---|
| Component name | getTIUStatusFromData |
| Link to SCADE model | http://???? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

834 **5.13.3.2.2 Interface**

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

5.14 F2.13: manageTIU_output

838 section and corresponding subsections have to be completed

839 **5.14.1 Component Requirements**

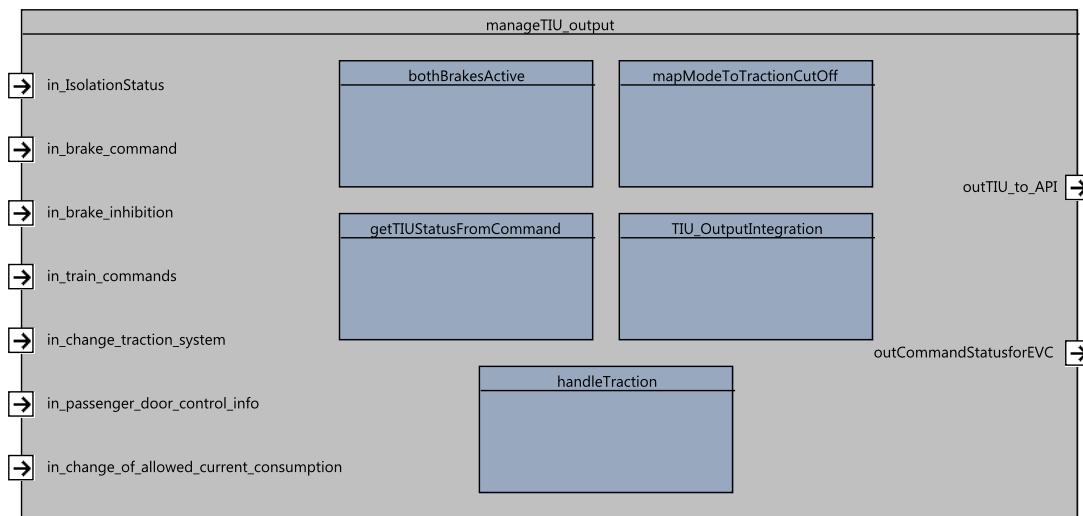


Figure 33. manageTIU_output SysML diagram.

| | |
|------------------------|---|
| Component name | manageTIU_output |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of the components functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

840 5.14.2 Interface

841 An overview of the interface of component manageTIU_output is shown in Figure 33. The inputs
 842 and outputs are described in detail in Section 5.14.2.1 respectively 5.14.2.2. Subcomponents are
 843 described in Section 5.14.3.

844 5.14.2.1 Inputs

845 5.14.2.1.1 [Input 1 name]

| | |
|-------------|----------------------------------|
| Input name | [Name of the input] |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] |

| | |
|---|---|
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

846 **5.14.2.1.2 [Input 2 name]**

| | |
|---|---|
| Input name | [Name of the input] |
| Description | [Brief description of the input] |
| Source | [Name of the source component] |
| Type | [Type of the input] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

847 **5.14.2.2 Outputs**

848 **5.14.2.2.1 [Output 1 name]**

| | |
|-------------------------------------|--|
| Output name | [Name of the output] |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |

| | |
|---|---|
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

849 **5.14.2.2.2 [Output 2 name]**

| | |
|---|---|
| Output name | [Name of the output] |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| Valid range of values | [Complete list of valid values] |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

850 **5.14.3 Subcomponents**

851 **5.14.3.1 handleTraction**

852 **5.14.3.1.1 Component Requirements**

| | |
|------------------------|---|
| Component name | handleTraction |
| Link to SCADE model | http://?? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??..? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

853 **5.14.3.1.2 Interface**

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

856 **5.14.3.2 manageTIU_output**

857 **5.14.3.2.1 Component Requirements**

| | |
|------------------------|---|
| Component name | manageTIU_output |
| Link to SCADE model | http://??? |
| SCADE designer | Bernd Hekele, DB Netz AG |
| Description | [Brief description of functionality] |
| Input documents | Subset-026, Chapter ?? Subset-026, Chapter ?? Subset-026, Chapter ??? |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

858 **5.14.3.2.2 Interface**

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

6⁸⁶¹ F3: Measure Train Movement

⁸⁶² This component is not part of the openETCS OBU currently and therefore no detailed description
⁸⁶³ is provided here.

7⁸⁶⁴ F4: Manage Radio Communication

⁸⁶⁵ This component is not part of the openETCS OBU currently and therefore no detailed description
⁸⁶⁶ is provided here.

8⁸⁶⁷ F5: Manage JRU

⁸⁶⁸ This component is not part of the openETCS OBU currently and therefore no detailed description
⁸⁶⁹ is provided here.

9₈₇₀ F6: DMI Controller

₈₇₁ This component is not part of the openETCS OBU currently and therefore no detailed description
₈₇₂ is provided here.

10⁸⁷³ F7: Manage TIU

⁸⁷⁴ This component is not part of the openETCS OBU currently and therefore no detailed description
⁸⁷⁵ is provided here.

References

- 877 [1] ERA. *System Requirements Specification, SUBSET-026*, v3.3.0 edition, March 2012.