

Work Package 3: "Modeling"

openETCS Architecture and Design Specification

Software Component Design and Internal Interface Specification

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Work Package 3: “Modeling”**OETCS/WP3/D3.5.3
September 2015**

openETCS Architecture and Design Specification

Software Component Design and Internal Interface Specification

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Architecture and Design Specification

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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| 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 |
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| Clarify detail for documentation with the trackMessages concept..... | 20 |
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| 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)? | 41 |

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| exact name of component in the SCADE model has be used | 52 |
| Figure: [Put SysML diagram of component here] | 56 |
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| Figure: [Put SysML diagram of component here] | 62 |
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| Please use exact component name from SCADE model. | 74 |

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| Description of outputs needs to be completed | 74 |
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| section has to be completed. The level of this component in final architecture has been fixed. | 125 |
| Figure: [Put SysML diagram of component here] | 126 |
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| Maybe more subcomponents have to be added. Please check this..... | 128 |
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| Figure: [Put SysML diagram of component here] | 131 |
| section and corresponding subsections have to be completed..... | 132 |
| Figure: [Put SysML diagram of component here] | 133 |
| section and corresponding subsections have to be completed..... | 139 |
| Figure: [Put SysML diagram of component here] | 140 |
| section and corresponding subsections have to be completed..... | 143 |
| Figure: [Put SysML diagram of component here] | 144 |
| This chapter needs to be completed and a responsible developer has to be identified..... | 150 |

1 Introduction

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

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

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

1.1 Input Documents

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

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

list has to be completed

1.2 Software and Tools used for Development

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

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

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

list and descriptions have to be checked for completeness

- 32 **SCADE Display** Version 16.1b of SCADE Display has been used for the development of the
33 Driver Machine Interface (DMI).
- 34 **GitHub** The web based Git repository hosting service GitHub has been used for distributed
35 revision control and source code respectively model management.

1.3 36 General Remarks on the openETCS OBU Model

- 37 The openETCS OBU model has been developed according the specification given in ERA Subset-
38 026 [1]. The software release of the openETCS OBU documented and described in this document
39 is publicly available at <https://github.com/openETCS/modeling/tree/master/model>
40 and refers to the commit corresponding to the following hashtag:

41 1c06cc2d4a0d8f27569e065e2a9edf924b453ff1

- 42 In particular, the root of the SCADE System SysML model is located at [https://github.com/](https://github.com/openETCS/modeling/tree/master/model/system)
43 [openETCS/modeling/tree/master/model/system](https://github.com/openETCS/modeling/tree/master/model/system) and the root of the functional SCADE
44 Suite model is located at [https://github.com/openETCS/modeling/tree/master/model/](https://github.com/openETCS/modeling/tree/master/model/Scade)
45 [Scade](https://github.com/openETCS/modeling/tree/master/model/Scade).

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

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

48

Part I

49

System Architecture and Functional Breakdown

50

2 System Architecture

has to be completed

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

2.1 Top Level Architecture and External Interfaces

Figure 2 shows the top level architecture with external interfaces E1, E2, ..., E9. The external interfaces are used for the communication between the openETCS OBU (dashed red line) and systems out of the scope of the openETCS project and the ETCS Onboard Unit System. In the following we give brief overview of the interfaces:

paragaphoh has to be checked and extended to be more clear

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

E2: In- and out flow between the Interlocking and Radio Block Control. This interface ensures the states or logics directly to the Radio Block Control and the other way back from the train to the interlocking.

E3: Input flow from the Eurobalise to the Balise Transmission Module or Antenna Unit (BTM) into the ETCS OBU.

E4: In- and out flow between the Radio Block Control and the Euroradio modul into the ETCS OBU. This interface is not active in ETCS levels 0 and 1 since there is no ETCS radio interaction between track and train in these levels.

E5: This interface is used for the interaction between the driver and the display (Driver Machine Interface, DMI), cf. Figure 3.

check if figure is correct. Do we need this figure anyway? If so, make it more appealing.

E6: This interface is a compound structure and combines the interfaces E3 and E4.

E7: Input interface to the odometry subsystem of the ETCS OBU. Used for sending information to the train if there is any movement outside the ETCS System, e.g. "cold movement".

E8: Input interface to the ETCS OBU to set configuration data such as fixed values, system values, national values and train configuration.

E9: In- and Out flow between the ETCS OBU and the train. This interface is used for the interaction between the Train and the ETCS OBU such as brake control, traction control, door control, etc.

2.2 Functional breakdown of the ETCS OBU

Figure 4 depicts the functional breakdown of the ETCS OBU block shown in Figure 2. The internal interfaces

Figure is incomplete and erroneous... F2 is not connected, F2 exists twice

Should this block be described using the new compo-

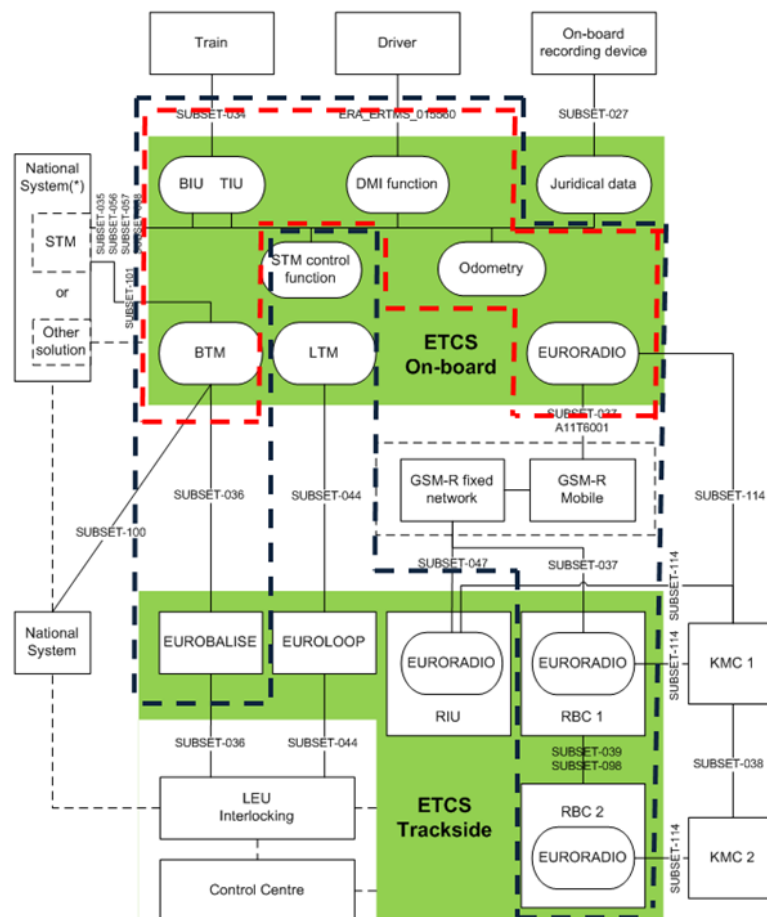


Figure 1. Scope of openETCS OBU model system according to ERA TSI Chapter 2.5. Functional blocks in the scope of openETCS have been marked by the dashed blue line. The dashed red line shows the OBU blocks in the scope of openETCS.

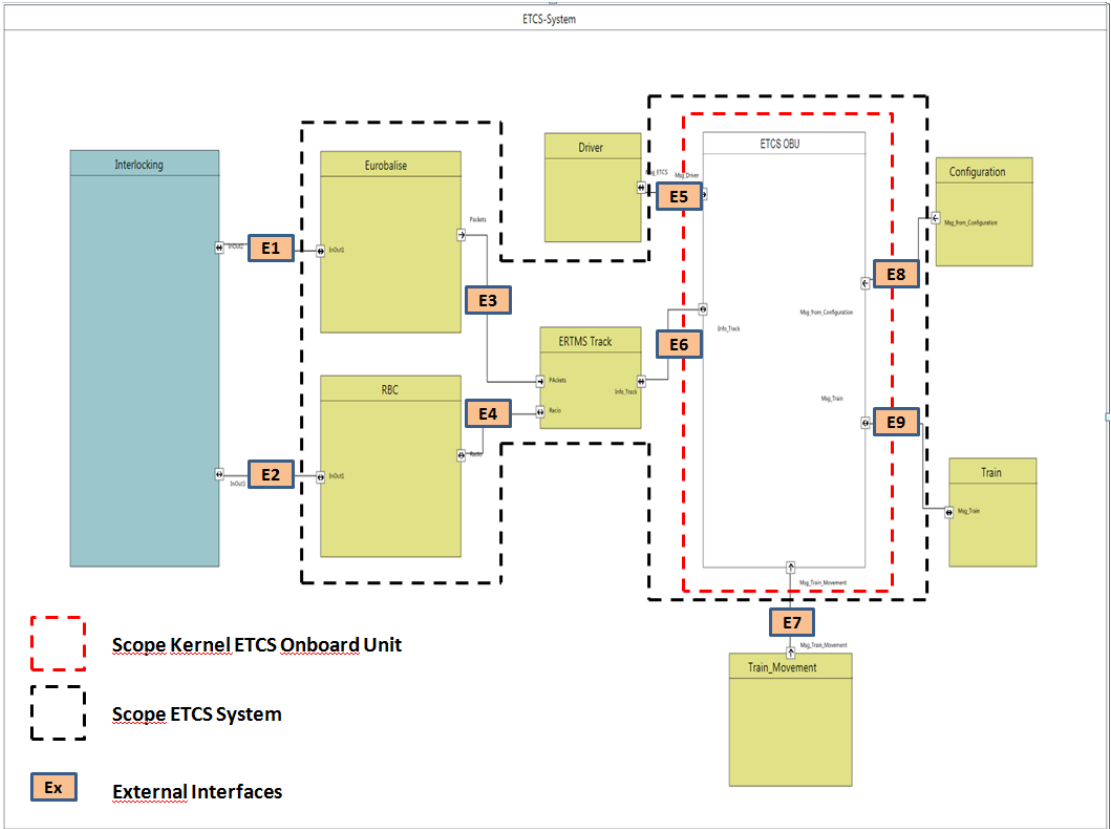


Figure 2. Top level architecture with external interfaces.

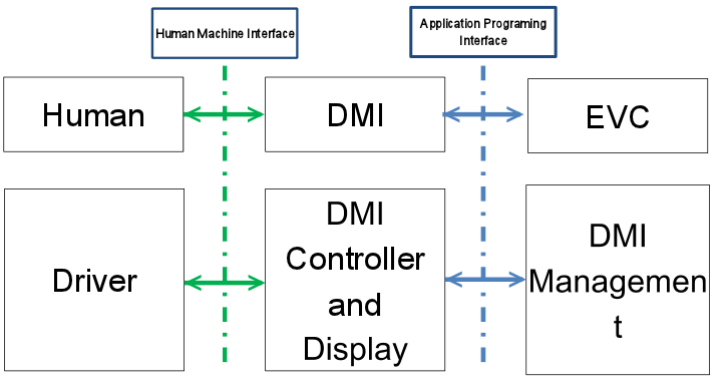


Figure 3. DMI Interfaces.

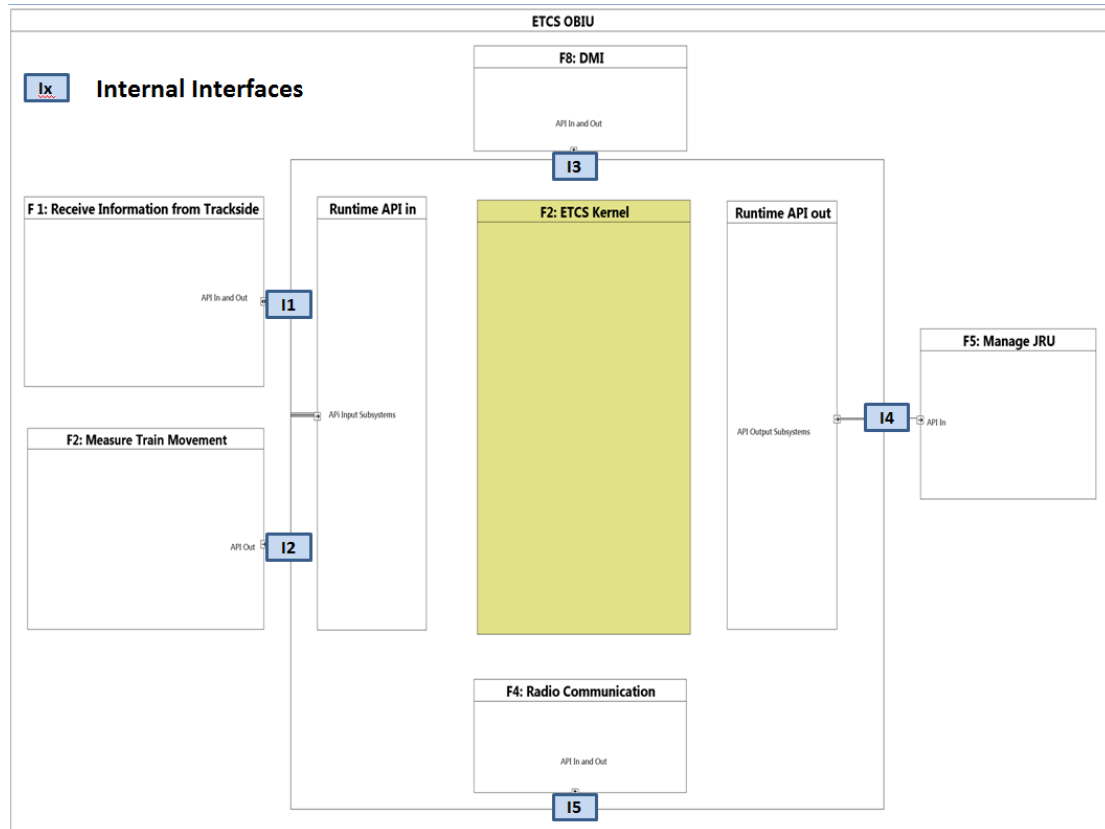


Figure 4. 2nd level system architecture view.


- 86 **I1:** In flow from the Balise Transmission Module (BTM or Antenna) to the "F2 ETCS Kernel"
 87 through Runtime API in. Transmitted data are information from the Eurobalise.
- 88 **I2:** In flow from the Odometrie (ODO) to the "F2 ETCS Kernel" through Runtime API in.
 89 Transmitted data are information from the movement of the train.
- 90 **I3:** In- and Out flow between the DMI Controller and the "F2 ETCS Kernel" through Runtime
 91 API in and out. Transmitted data are information of driver action and display. See description
 92 in figure of "External Interface E5".
- 93 **I4:** Out flow from "F2 ETCS Kernel" to the JRU manager through Runtime API out. Transmitted
 94 data are all necessary information for a juridical recorder unit "black box".
- 95 **I5:** In- and Out flow between the Euroradio and "F2 ETCS Kernel" through Runtime API in and
 96 out. Transmitted data are radio track information (RBC) and information to the track (RBC).

Part II

Design Description

3⁹⁹ General Design Decisions

100

to be completed

4 F1: Receive Information from Trackside

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

4.1 ETCS Messaging: TrackMessages

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 Adj, LEA Railergy |
| Description | <p>TrackMessages is a library containing functionality to:</p> <ul style="list-style-type: none">• Transport TrainToTrack and TrackToTrain messages and packets using a compressed format which is conceptually close to the ETCS language as defined in Subset-026• Compress trackside information and decompress it in the on-board unit, taking into account different baseline versions and providing transparent translation.• Compress trainside information and decompress it in the track-side simulation models, taking into account different baseline versions and providing transparent translation. <p>As TrackMessages is a library with various components supporting all packets and messages defined in Subset-026, we have selected one exemplary function to document the concept. As only the packet/ message- related functionality is specific, this approach will allow a first understanding of the concept and the related interfaces. For a full discussion of the library, refer to the [specific chapter? document?]</p> <p>The function Read_P005 extracts a packet 5 (Gradient Profile) from the compressed packets data flow, if present. It translates the integer-coded compressed data with the help of the metadata in the header section of the CompressedPackets_T formatted data flow. After performing variable-level translation and exception detection, a baseline-3 conformat packet 5 is available for use within the relevant OBU functions.</p> |

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

106 **4.1.2 Interface**

107 An overview of the interface of component TrackMessages is shown in Figure 5. The inputs and
108 outputs are described in detail in Section 4.1.2.1 respectively 4.1.2.2.

109 **4.1.2.1 Inputs**

110 **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 |

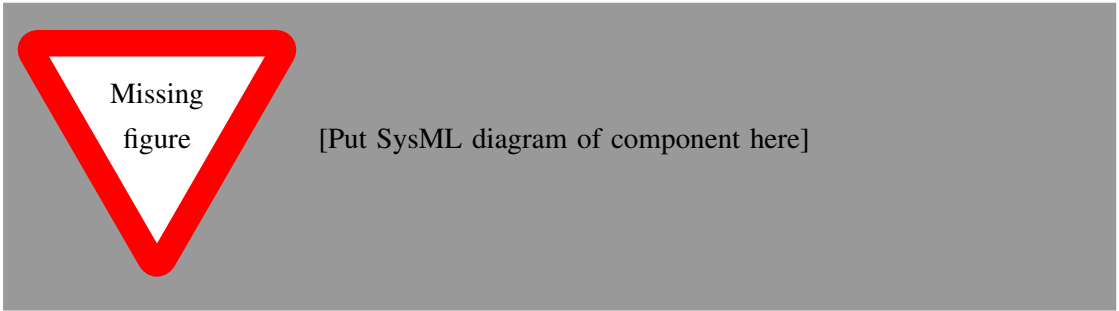


Figure 5. TrackMessages SysML diagram

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

111 4.1.2.2 Outputs

112 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 |

113 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

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

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

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

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

114 4.1.3 Subcomponents

115 4.1.3.1 Read_Packets

116 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. <p>The operator TM_lib_internal::RECV_ReadPackets takes a set of parameter data to:</p> <ol style="list-style-type: none"> 1. Search the metadata of the compressed packets data flow using the provided parameters to determine if a matching packet is contained in any given cycle. 2. Output the flag "received" exactly in any cycle a matching packet is found 3. Output an array of compressed packet data that is filled with the data from the identified packet. |
|-------------|--|

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

117 4.1.3.1.2 Interface

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

120 4.1.3.2 Extract Packet 5

121 4.1.3.2.1 Component Requirements

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

122 4.1.3.2.2 Interface

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

5 F2: ETCS Kernel

In this chapter we describe the main components of the openETCS OBU model. Section 5.1 gives an overview of the external interfaces of this functional block and briefly describes the subcomponents. A detailed description of the subcomponents is given in Sections 5.2 to 5.14.

5.1 ETCS Kernel Overview

The ETCS Kernel module consists of the 13 subcomponents F1.1 to F1.13 as depicted in Figure 6. In the following we briefly describe the functionality of these subcomponents (for a more detailed description we refer to Sections 5.2 to 5.14)

F2.1: Manage_TrackSideInformation_Integration This component is responsible for receiving Eurobalise telegrams and Euroradio messages from the API and performs several consistency checks on the inputs.

to be checked

F2.2: Manage_ETCS_Procedures This component describes the Start of Mission procedure of the train until the current status will change to another mode, level or other procedure.

descriptions needs to be improved

F2.3: trainData Implementation of the train data with the corresponding interfaces to track, driver and RBC.

descriptions needs to be improved

F2.4: TrackAtlas t.b.d.

to be completed

F2.5: Mode_and_Level Defines the status of the ETCS regarding on-board functional status and track infrastructure.

descriptions needs to be improved

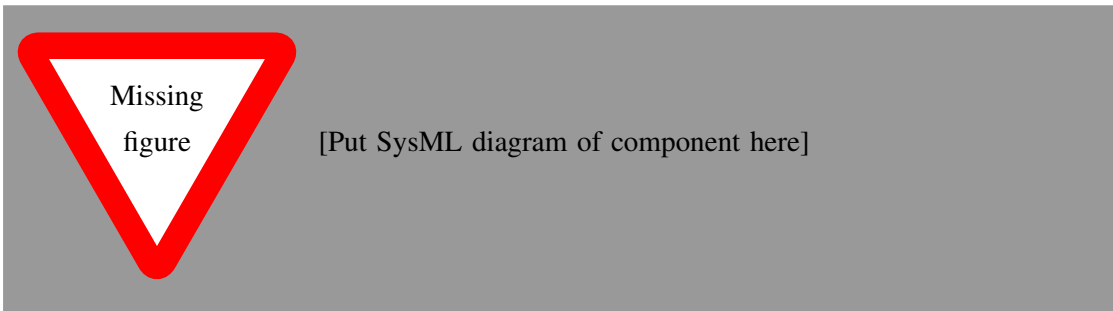


Figure 6. F2: ETCS Kernel SysML diagram

148 **F2.6: calculateTrainPosition** The purpose of this component is to calculate the locations of
 149 linked and unlinked balise groups (BGs) and the current train position while the train is
 150 running along the track.

151 **F2.7: SpeedSupervision_Integration** This component monitors the speed of the train and the
 152 train location to ensure that the speed remains within the given speed and distance limits.

153 to be checked

154 **F2.8: Provide_Position_Report** The component builds a position report for the RBC, i.e.,
 155 message 132, and provides it as an output.

156 to be checked

157 **F2.9: Manage_Radio_Communication** This component implements the onboard management
 158 of a single communication session with the track, i.e. a single RBC. It controls the estab-
 159 lishment, maintenance and termination process of a radio communication session and steers
 160 the underlying communication safety layer as well as the mobile device. Those and the data
 161 transfer itself are not part of this component.

162 **F2.10: ManageDMIInput** t.b.d.

163 to be completed

164 **F2.11: ManageDMIOutput** t.b.d.

165 to be completed

166 **F2.12: ManageTIUInput** t.b.d.

167 to be completed

168 **F2.13: ManageTIUOutput** t.b.d.

169 to be completed

170 5.1.1 External Interfaces

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

173 5.1.1.1 External Inputs

174 5.1.1.1.1 [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 bound-ary] |

| | |
|---|---|
| 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)] |

175 **5.1.1.1.2 [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)] |

176 **5.1.1.2 External Outputs**

177 **5.1.1.2.1 [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)] |

178 5.1.1.2.2 [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)] |

5.2₁₇₉ F2.1: Manage_TrackSideInformation_Integration

180 5.2.1 Component Requirements

181 Clarify detail for documentation with the trackMessages concept

| | |
|---------------------|--|
| 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 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 to the further processing. After applying consistency checks, the data direction is validated.</p> |

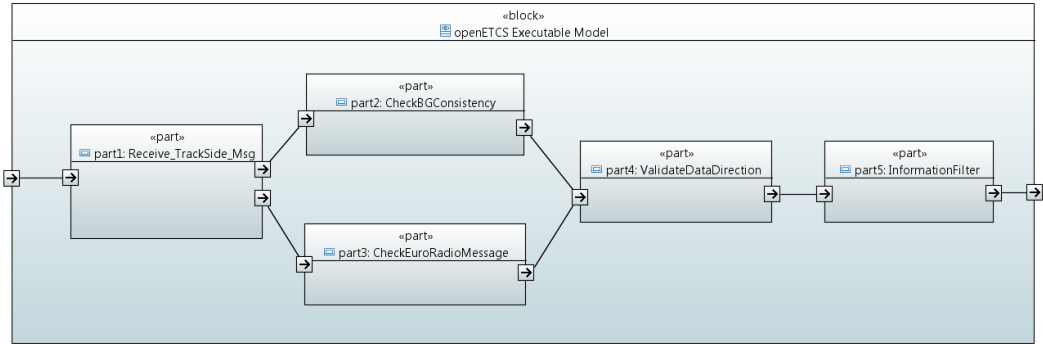


Figure 7. Manage_TrackSideInformation_Integration component SysML diagram.

| | |
|------------------------|---|
| 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). In highspeed traffic, a group of 8 balises must be read in about 250 msec. In addition, 1 message per sec. on the radio interface is to be expected. |
| API requirements | Interfaces to this unit are defined in the API sections [BTM], [EU-RORADIO], [ODO].In these sections, also a detailed definition of the concepts implemented on those interfaces is documented. |

5.2.2 Interface

Manage_TrackSideInformation_Integration SysML diagram needs to be updated.

An overview of the interface of component Manage_TrackSideInformation_Integration is shown in Figure 7. The inputs and outputs are described in detail in Section 5.2.2.1 respectively 5.2.2.2. Subcomponents are described in Section 5.2.3.

5.2.2.1 Inputs

5.2.2.1.1 fullChecks

| | |
|-------------|--|
| Input name | fullChecks |
| Description | Indicates, if all checks on the message should be performed. |
| 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 at boundary

n/a

Behaviour for values out of valid range

n/a

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)]

To be completed

189 5.2.2.1.2 Receive_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.

Source

API

Type

API_Msg_Pkg::API_TrackSideInput_T

Valid range of values

[Complete list of valid values]

To be completed

Behaviour when value is at boundary

[Description of components behaviour when input value is at boundary]

To be completed

Behaviour for values out of valid range

[Description of components behaviour when input value is out of valid range]

To be completed

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)]

To be completed

190 **5.2.2.1.3 ActualOdometry**

| | |
|---|--|
| Input name | ActualOdometry |
| Description | Provided by the external odometry module of the train. It contains relative location information with inaccuracies. |
| Source | Odometer |
| Type | Obu_BasicTypes_Pkg::odometry_T |
| Valid range of values | [Complete list of valid values] To be completed |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] To be completed |
| 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)] To be completed |

191 **5.2.2.1.4 reset**

| | |
|-----------------------|---|
| Input name | reset |
| Description | To delete all data stored in the module (e.g. collected balise telegrams, which do not yet form a complete message), a reset input can be used. If the input is set to true, all data kept in the module is deleted and no input is accepted. |
| Source | Environment |
| 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 at boundary | [Description of components behaviour when input value is at boundary] |
| | To be completed |

| | |
|---|--|
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| | To be completed |

| | |
|---|---|
| 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)] |
| | To be completed |

192 5.2.2.1.5 trainPosition

| | |
|-----------------------|---|
| Input name | trainPosition |
| Description | Contains the current position of the train. |
| Source | CalculateTrainPosition |
| Type | TrainPosition_Types_Pck::trainPosition_T |
| Valid range of values | To be completed |

| | |
|-------------------------------------|---|
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| | To be completed |

| | |
|---|--|
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| | To be completed |

| | |
|---|---|
| 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)] |
| | To be completed |

193 5.2.2.1.6 modeAndLevel

| | |
|-------------|---|
| Input name | modeAndLevel |
| Description | Provides the current level and mode of the EVC. |

| | |
|---|--|
| Source | ModeAndLevel |
| Type | BG_Types_Pkg::ModeAndLevelStatus_T |
| Valid range of values | [Complete list of valid values] To be completed |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] To be completed |
| 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)] To be completed |

194

5.2.2.1.7 tNvContact

| | |
|---|---|
| Input name | tNvContact |
| Description | For monitoring the safe radio connection, this national value is needed as an input. |
| Source | Database |
| Type | Obu_BasicTypes_Pkg::T_internal_Type |
| Valid range of values | [Complete list of valid values] To be completed |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] To be completed |

| | |
|---|--|
| 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)] To be completed |
|---|--|

195 5.2.2.1.8 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 | Database |
| Type | Obu_BasicTypes_Pkg::T_internal_Type |
| Valid range of values | [Complete list of valid values] To be completed |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] To be completed |
| 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)] To be completed |

196 5.2.2.1.9 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. |

| | |
|---|---|
| Source | ManageRadioCommunication |
| 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 | <p>[Description of components behaviour when input value is at boundary]</p> <p>To be completed</p> |
| Behaviour for values out of valid range | <p>[Description of components behaviour when input value is out of valid range]</p> <p>To be completed</p> |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | <p>[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]</p> <p>To be completed</p> |

197 5.2.2.1.10 inSupervisingRbcId

| | |
|-----------------------|---|
| Input name | inSupervisingRbcId |
| Description | For the subcomponent InformationFilter, 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 | <p>Database</p> <p>consider using the exact component name in the SCADE model</p> |
| Type | int |
| Valid range of values | <p>[Complete list of valid values]</p> <p>To be completed</p> |

| | |
|-------------------------------------|---|
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] |
| | To be completed |

| | |
|---|--|
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |
| | To be completed |

| | |
|---|---|
| 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)] |
| | To be completed |

198 5.2.2.1.11 inAnnouncedBGs

| | |
|---|--|
| Input name | inAnnouncedBGs |
| Description | Provides information about balise groups which will be passed by the train soon. This information is generated by Calculate Train Position based on the linking information received from trackside. |
| Source | CalculateTrainPosition |
| Type | TrainPosition_Types_Pck::positionedBGs_T |
| Valid range of values | [Complete list of valid values] To be completed |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] To be completed |
| 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)] To be completed |

199 5.2.2.1.12 q_nvlocacc

| | |
|---|--|
| Input name | q_nvlocacc |
| Description | The national value determines the location accuracy. |
| Source | Database consider using the exact component name in the SCADE model |
| Type | Q_NVLOCACC |
| Valid range of values | [Complete list of valid values] To be completed |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] To be completed |
| 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)] To be completed |

200 5.2.2.2 Outputs

201 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. |
| Destination | [Name of the destination component(s)] To be completed |
| Type | Common_Types_Pkg::ReceivedMessage_T |
| Valid range of values | [Complete list of valid values] To be completed |

| | |
|---|--|
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] To be completed |
| 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)] To be completed |

202 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 | [Name of the destination component(s)] To be completed |
| Type | bool |
| Valid range of values | [Complete list of valid values] To be completed |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] To be completed |
| 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)] To be completed |

203 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 | DMI |
| Type | bool |
| Valid range of values | <p>true ???</p> <p>false ???</p> <p>To be completed</p> |
| Behaviour when value is at boundary | <p>[Description of components behaviour when output value is at boundary]</p> <p>To be completed</p> |
| Behaviour for values out of valid range | <p>[Description of components behaviour when output value is out of valid range]</p> <p>To be completed</p> |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | <p>[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]</p> <p>To be completed</p> |

204 5.2.2.2.4 errorLinkedBG

| | |
|-------------|--|
| Output name | errorLinkedBG |
| Description | <p>[Brief description of the output]</p> <p>To be completed</p> |
| Destination | <p>[Name of the destination component(s)]</p> <p>To be completed</p> |
| Type | <p>[Type of the output]</p> <p>To be completed</p> |

Valid range of values

true An error in a linked balise group was detected.

false No error in a linked balise group was detected.

| | |
|-------------------------------------|--|
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] |
|-------------------------------------|--|

To be completed

| | |
|---|---|
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |
|---|---|

To be completed

| | |
|---|---|
| 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)] |
|---|---|

To be completed

205 5.2.2.2.5 errorUnlinkedBG

| | |
|-------------|-----------------|
| Output name | errorUnlinkedBG |
|-------------|-----------------|

| | |
|-------------|-----------------------------------|
| Description | [Brief description of the output] |
|-------------|-----------------------------------|

To be completed

| | |
|-------------|--|
| Destination | [Name of the destination component(s)] |
|-------------|--|

To be completed

| | |
|------|------|
| Type | bool |
|------|------|

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 at boundary | [Description of components behaviour when output value is at boundary] |
|-------------------------------------|--|

To be completed

| | |
|---|--|
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] To be completed |
|---|--|

| | |
|---|--|
| 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)] To be completed |
|---|--|

206 5.2.2.2.6 passedBG

| | |
|---|--|
| Output name | passedBG |
| Description | Provides the received balise group message in a special format needed by the component CalculateTrainPosition. |
| Destination | [Name of the destination component(s)] To be completed |
| Type | BG_Types_Pkg::passedBG_T |
| Valid range of values | [Complete list of valid values] To be completed |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] To be completed |
| 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)] To be completed |

207 5.2.2.2.7 outPositionParams

| | |
|-------------|--|
| Output name | outPositionParams |
| Description | Provides the parameters for the position report in a special format needed by the component ProvidePositionReport. |

| | |
|---|--|
| Destination | [Name of the destination component(s)] To be completed |
| Type | Common_Types_Pkg::PositionReportParameter_T To be completed |
| Valid range of values | [Complete list of valid values] To be completed |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] To be completed |
| 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)] To be completed |

208 5.2.2.2.8 outRadioManagement

| | |
|-----------------------|--|
| Output name | outRadioManagement |
| Description | Provides the messages for radio session management in a special format needed by the component ManagementOfRadioCommunication. |
| Destination | [Name of the destination component(s)] To be completed |
| Type | Common_Types_Pkg::radioManagementMessage_T |
| Valid range of values | [Complete list of valid values] To be completed |

| | |
|---|--|
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] To be completed |
| 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)] To be completed |

209 5.2.2.2.9 radioSequenceError

| | |
|---|---|
| Output name | radioSequenceError |
| Description | [Brief description of the output] To be completed |
| Destination | [Name of the destination component(s)] To be completed |
| Type | bool |
| Valid range of values | <p>true A sequence error or a timeout has been detected in the radio message.</p> <p>false No error in the radio message sequence was detected.</p> |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] To be completed |

| | |
|---|--|
| 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)] To be completed |
|---|--|

210 5.2.2.2.10 radioMessageConsistencyError

| | |
|---|--|
| Output name | radioMessageConsistencyError |
| Description | [Brief description of the output] To be completed |
| Destination | [Name of the destination component(s)] To be completed |
| Type | bool |
| Valid range of values | <p>true A consistency error has been detected in the radio message.</p> <p>false No consistency error in the radio message was detected.</p> |
| Behaviour when value is at boundary | [Description of components behaviour when output value is at boundary] To be completed |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] To be completed |
| 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)] To be completed |

211 5.2.3 Subcomponents

212 5.2.3.1 Receive_TrackSide_Msg

213 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</p> <p>Subset-026, Chapter 4.2.2, 4.2.4, 4.2.9: Interface to the BTM</p> <p>Subset-026, Chapter 3.4.1 - 3.4.3, 3.16.2: Handling of Balise Telegrams</p> <p>Subset-026, Chapter 3.16.2: Check of the balise group</p> <p>Subset-026, Chapter 3.4.2: Determining the orientation</p> <p>Subset-026, Chapter 4.5.2 Active Functions Table</p> <p>Subset-026, Chapter 8.4.4: Rules for Euroradio messages</p> |
| Safety integrity level | 4 |
| Time constraints | n/a |

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

214 **5.2.3.1.2 Interface**

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

217 **5.2.3.2 CheckBGConsistency**

218 **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 whole the 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> <ul style="list-style-type: none"> • 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 balises, the order of the balises must be either ascending (nominal) or descending (reverse). • 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. <p>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. "Validate Data Direction".</p> |
| 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 |

219 5.2.3.2.2 Interface

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

222 5.2.3.3 CheckEuroradioMessage

223 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 |

224 5.2.3.3.2 Interface

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

227 5.2.3.4 ValidateDataDirection

228 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 | <p>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.</p> <ul style="list-style-type: none"> • 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 |

229 5.2.3.4.2 Interface

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

232 5.2.3.5 InformationFilter

233 5.2.3.5.1 Component Requirements

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

Description The filter receives track information (balise and radio) and filters them depending of the mode, level and source of the message. Only messages that pass the filter are valid and should be considered by other ETCS subsystems. Figure 8 shows the highlevel decomposition of the functionality. The filter is consists of four components: FirstFilter, SecondFilter, ThirdFilter and TransitionBuffer.

FirstFilter This filter performs filtering of messages based on the current ETCS level. The decisions taken process is described via a big decision table which contains rows for every packet and columns for every ETCS level. This table encodes also if certain additional information is necessary to filter a message like pending ETCS Level transitions. Based on this filter packets of an incoming message is either rejected, accepted or the whole message is put in the TransitionBuffer. Messages are put in the TransitionBuffer if there is an announced level transition and the received message is only valid for the upcoming level.

SecondFilter The SecondFilter mainly considers messages that are received via Euroradio. Certain messages are directly rejected while other may be stored in the TransitionBuffer. The buffer is used to store messages that are received from non supervising RBCs, but will be reevaluated after a RBC transition.

ThirdFilter The last filter is functionally very similiar the the FirstFilter, however it filters depending on the mode. It also contains a decision table with rows for every packet but the columns are modes.

TransitionBuffer The InformationFilter uses two TransitionBuffers. One is used to store up to three messages for the ETCS level transition and the other buffer is used for RBC transitions. The buffer is designed as a ring buffer and message are read in FIFO order.

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

235 5.2.3.5.2 Interface

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

5.3₂₃₈ F2.2: Manage_ETCS_Procedures

239 5.3.1 Component Requirements

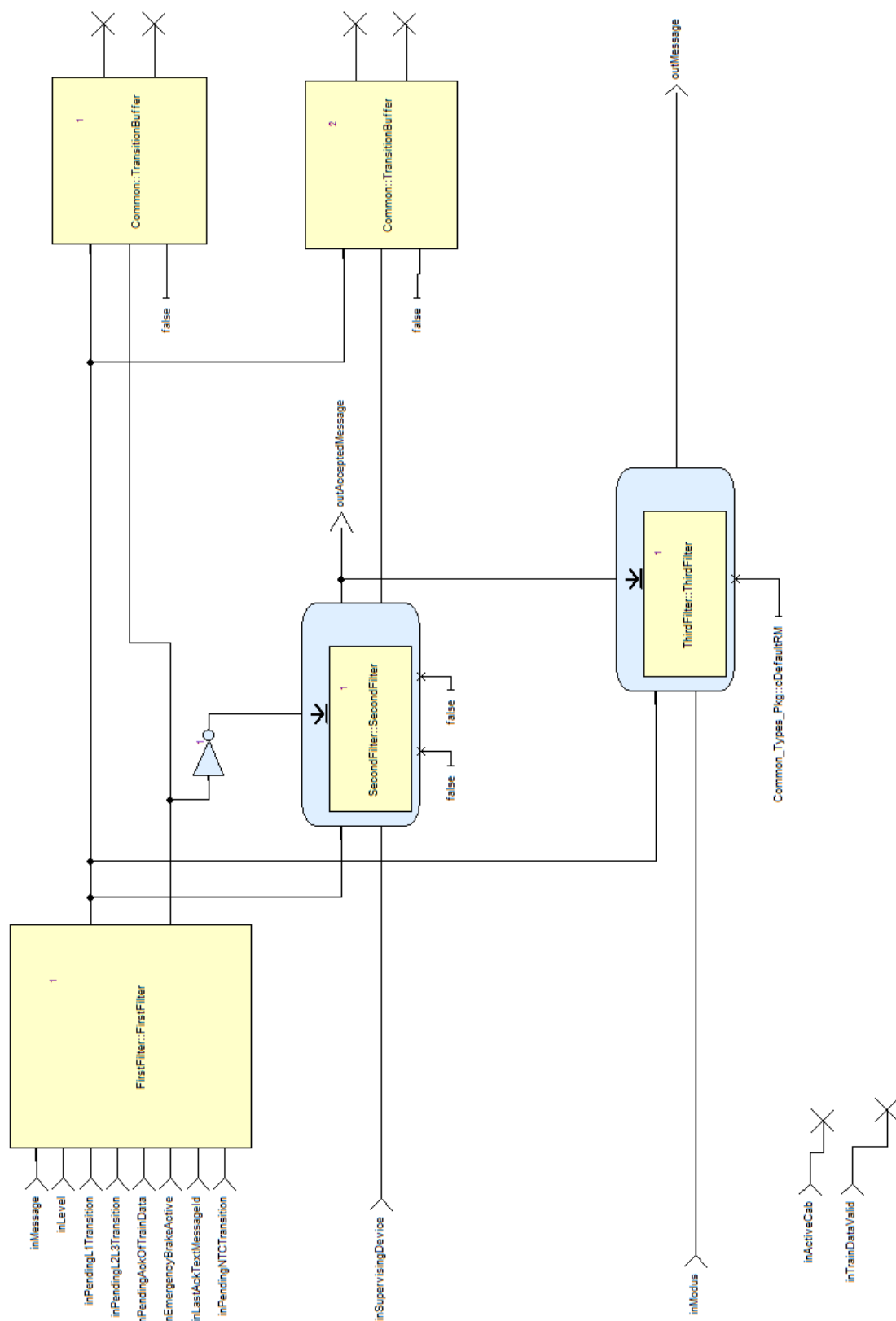


Figure 8. High level overview of the InformationFilter components.



Figure 9. 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 |

5.3.2 Interface

An overview of the interface of component Manage_ETCS_Procedures is shown in Figure 9. The inputs and outputs are described in detail in Section 5.3.2.1 respectively 5.3.2.2. Subcomponents are described in Section 5.3.3.

5.3.2.1 Inputs

5.3.2.1.1 statusDMI_from_DMI

| | |
|-----------------------|---|
| Input name | statusDMI_from_DMI |
| Description | Input interface of DMI Controller status. |
| Source | manageDMI |
| Type | DMI_Types_Pkg::DMI_EVC_status_T |
| Valid range of values | To be completed |

| | |
|-------------------------------------|-----|
| Behaviour when value is at boundary | n/a |
|-------------------------------------|-----|

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

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

246 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 | ManageLevelsAndModes |
| 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 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 |
|---|-----|

247 5.3.2.1.3 systemtime

| | |
|-------------------------------------|--|
| Input name | systemtime |
| Description | Standardized system time used for all internal calculations. |
| Source | Obu_BasicTypes |
| 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.

248 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 | ManageLevelsAndModes |
| 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 |

249 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 | MoRC |
| 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

250 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 | MoRC exact name of component in the SCADE model has be used |
|--------|--|

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

251 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 | manageTIUInput |
|--------|----------------|

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

252

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 | TrainPosition exact name of component in the SCADE model has be used |
| Type | bool |
| Valid range of values | <p>true Calculated train position is valid</p> <p>false Calculated train position is not valid</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 |

253

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 | ManageDMIInput |
| 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 |

254

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 | ManageLevelsAndModes exact name of component in the SCADE model has be used |
| Type | bool |
| Valid range of values | true Level and Mode information are valid false Level and Mode information are not valid |
| Behaviour when value is at boundary | n/a |
| Behaviour for values out of valid range | n/a |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | n/a |

255 5.3.2.2 Outputs

256 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 | ManageDMIOutput |
| 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 |

257 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 | MoRC exact name of component in the SCADE model has be used |
| 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

258 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 | MoRC exact name of component in the SCADE model has be used |
| Type | bool |
| Valid range of values | true MoRC will be activated false no action |
| 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 |

259 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 | MoRC exact name of component in the SCADE model has be used |
| Type | bool |

Valid range of values

true Start of mission procedure is currently ongoing

false Start of mission procedure is currently not ongoing

Behaviour when value is 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

260 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 MoRC
exact name of component in the SCADE model has be used

Type bool

Valid range of values

true MoRC will be deactivated

false no action

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

261 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 | ManageTIUOutput |
| Type | bool |
| Valid range of values | true Start of mission procedure is completed |
| 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 |

262 5.3.3 Subcomponents

263 5.3.3.1 Awakness_of_Train

264 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 |

265 5.3.3.1.2 Interface

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

268 5.3.3.2 NP

269 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 |

270 5.3.3.2.2 Interface

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

273 5.3.3.3 SoM_L2_3_FS_SR_OS_LS_SH

274 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 |

275 5.3.3.3.2 Interface

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

278 5.3.3.4 SoM_NTC_SN

279 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 |

280 5.3.3.4.2 Interface

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

5.4₂₈₃ F2.3: trainData

284 5.4.1 Component Requirements

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



Figure 10. trainData component SysML diagram

| | |
|------------------------|---|
| Description | <p>Implementation of the train data with the corresponding interfaces to track, driver and RBC.</p> <div>descriptions needs to be improved to be more comprehensive</div> <p>Data first is received from the train (TIU). Second step: train data is sent to the driver (DMI). The part relevant for driver interface is confirmed by the driver and sent back to the EVC. Data received via this interface is merged with the data received via TIU. Message Flow:</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 systemtime for stamping messages, access to input from the track messages and access to the output of RBC messages. |

285 **5.4.2 Interface**

286 An overview of the interface of component trainData is shown in Figure 10. The inputs and
287 outputs are described in detail in Section 5.4.2.1 respectively 5.4.2.2. Subcomponents are
288 described in Section 5.4.3.

289 **5.4.2.1 Inputs**

290 **5.4.2.1.1 reset**

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

291 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. |
| Source | Train Interface Unit (TIU) |
| Type | TIU_Types_Pkg::trainData_T |
| Valid range of values | <p>Input with valid information is indicated with the valid flag.</p> <p>Looking at this input this seems to be a complex structure. Consider describing the structure instead of referring to the valid flag only.</p> |
| Behaviour when value is at boundary | n/a |
| Behaviour for values out of valid range | When valid flag indicates false the data to be used is assumed to be default values. The component is not used when valid flag is false. |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | Information is only expected at 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. |

292 **5.4.2.1.3 trainDatafromDriver**

| | |
|---|---|
| Input name | trainDatafromDriver |
| Description | Train data received via DMI from the driver. 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. |
| Source | Driver Machine Interface (DMI) |
| Type | DMI_Messages_Bothways_Pkg::DMI_Train_Data_T |
| Valid range of values | Input with valid information is indicated with the valid flag. Looking at this input this seems to be a complex structure. Consider describing the structure instead of referring to the valid flag only. |
| 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. |

293 **5.4.2.1.4 trainDataAckfromDriver**

| | |
|---|---|
| Input name | trainDataAckfromDriver |
| Description | During start of mission the driver has to validate the train data. The confirmation is visible based on this input. Presence of the input is indicated with the valid flag. Looking at this input this seems to be a complex structure. Consider describing the structure instead of referring to the valid flag only. |
| Source | Driver Machine Interface (DMI) |
| 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 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. |
|---|--|

294 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 | Radio Transmission Module (RTM) |
| Type | Common_Types_Pkg::ReceivedMessage_T |
| Valid range of values | Input with valid information is indicated with the valid flag. Looking at this input this seems to be a complex structure. Consider describing the structure instead of referring to the valid flag only. |
| 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. |

295 5.4.2.1.6 timeStamp

| | |
|---|---|
| Input name | timeStamp |
| Description | Timestamp for messaging to the RBC. |
| Source | Derived from train time. |
| 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. |
|---|--|

296 5.4.2.1.7 eventsForTrainData

| | |
|---|---|
| Input name | eventsForTrainData |
| Description | <p>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:</p> <ul style="list-style-type: none"> • train stand-still • communication Session established <p>The MoRC ready input is used to indicate the evc:morec function is ready with acknowledgment of the communication session.</p> |
| Source | EVC model. |
| 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 erroneous, absent or unwanted (i.e. spurious) | n/a |

297 5.4.2.2 Outputs

298 section needs to be completed

299 5.4.2.2.1 [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)] |

300 5.4.2.2.2 [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)] |

301 5.4.3 Subcomponents

302 section needs to be completed

5.5₃₀₃ F2.4: TrackAtlas

304 Section needs to be completed

305 5.5.1 Component Requirements

| | |
|---------------------|-------------------------|
| Component name | TrackAtlas |
| Link to SCADE model | ??? |
| SCADE designer | Jakob Gärtner, LEA |
| Description | ??? |
| Input documents | Subset-026, Chapter ??? |



Figure 11. TrackAtlas component SysML diagram

| | |
|------------------------|--|
| 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] |

5.5.2 Interface

An overview of the interface of component TrackAtlas is shown in Figure 11. The inputs and outputs are described in detail in Section 5.5.2.1 respectively 5.5.2.2. Subcomponents are described in Section 5.5.3.

5.5.2.1 Inputs

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)] |

5.5.2.1.2 [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] |

| | |
|---|---|
| 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)] |
|---|---|

313 5.5.2.2 Outputs

314 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)] |

315 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)] |

316 5.5.3 Subcomponents

317 5.5.3.1 StoreRaw_NV

318 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] |

319 5.5.3.1.2 Interface

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

322 5.5.3.2 Build_GradientProfile

323 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] |

324 5.5.3.2.2 Interface

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

327 5.5.3.3 Build_MA

328 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] |

329 5.5.3.3.2 Interface

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

332 5.5.3.4 Build_MRSP

333 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] |

334 5.5.3.4.2 Interface

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

337 5.5.3.5 Manage_EmergencyStop

338 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] |

339 5.5.3.5.2 Interface

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

342 5.5.3.6 C_P003V1_OBU_P003_OBU

343 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] |

344 5.5.3.6.2 Interface

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

347 **5.5.3.7 GradientProfile_to_DMI**

348 **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] |

349 **5.5.3.7.2 Interface**

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

352 **5.5.3.8 Manage_MA_Request**

353 **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] |

354 **5.5.3.8.2 Interface**

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

357 5.5.3.9 TA_to_ML

358 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] |

359 5.5.3.9.2 Interface

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

362 5.5.3.10 SSP_to_MRSP

363 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] |

364 5.5.3.10.2 Interface

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

367 5.5.3.11 MRSP_to_MRSP_to_DMI

368 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] |

369 5.5.3.11.2 Interface

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

5.6₃₇₂ F2.5: Mode_and_Level

373 5.6.1 Component Requirements

| | |
|------------------------|---|
| Component name | Mode_and_Level |
| Link to SCADE model | https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes |
| SCADE designer | Marielle Petit-Doche 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 |

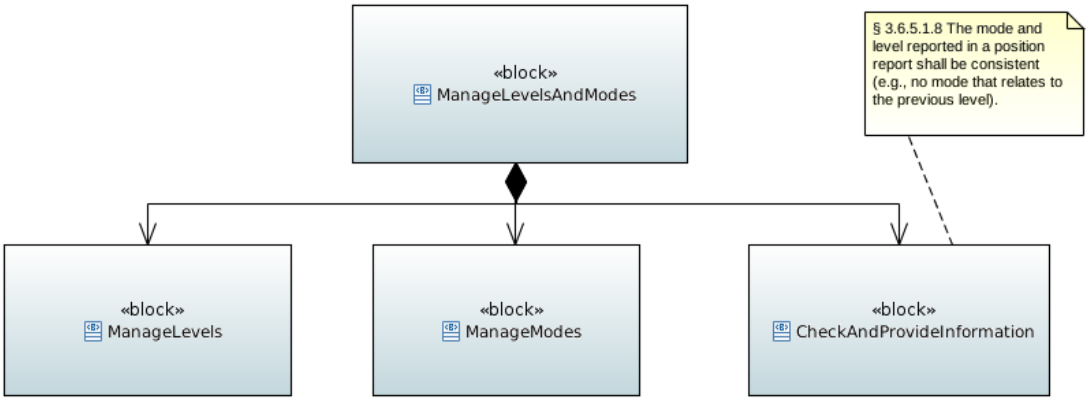


Figure 12. Mode_and_Level component SysML diagram

5.6.2 Interface

An overview of the interface of component Mode_and_Level is shown in Figure 12. The inputs and outputs are described in detail in Section 5.6.2.1 respectively 5.6.2.2. Subcomponents are described in Section 5.6.3.

5.6.2.1 Inputs

5.6.2.1.1 Data_From_TIU

table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a particular input or output.

| | |
|---|---|
| Input name | Data_From_TIU |
| Description | Set of data providing by TIU |
| Source | input_from_TIU_API_Pkg::manageTIU_input |
| Type | TIU_Types_Pkg::Message_Train_Interface_to_EVC_T |
| Valid range of values | It is a complex type more detail should be given here |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] to be completed |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] to be completed |

| | |
|---|--|
| 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)] to be completed |
|---|--|

381 5.6.2.1.2 Cab_In

382 table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a particular input or output.

| | |
|---|--|
| Input name | Cab_In |
| Description | Identification of the cabine where the EVC is implemented |
| Source | ??? to be completed |
| Type | TIU_Types_Pkg::cab_ID_T |
| Valid range of values | [CabUndefined, CabA, CabB] |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] to be completed |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] to be completed |
| 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)] to be completed |

383 5.6.2.1.3 Data_From_DMI

384 table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a particular input or output.

| | |
|-------------|---|
| Input name | Data_From_DMI |
| Description | Set of data transmitted from DMI (driver acknowledgements and requests to switch modes and level) |
| Source | manage_DMI_Input_Pkg::manageDMI_Input |

| | |
|---|--|
| Type | DMI_Types_Pkg::DMI_To_Modes_T |
| Valid range of values | It is a complex type : <ul style="list-style-type: none"> • valid : bool, flag to inform of the freshness of the information • DriverAck : DMI_DriverAck_T, indicate which mode is acknowledged • DriverRequest : DMI_DriverRequest_T, table of boolean values for all the driver request related to mode changes. • LevelAck : bool, indication of Level change acknowledgement |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] to be completed |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] to be completed |
| 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)] to be completed |

385 5.6.2.1.4 driver_level_transition_in

386 table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a particular input or output.

| | |
|-------------------------------------|--|
| Input name | driver_level_transition_in |
| Description | Request of level transition given by the driver for example at start of mission |
| Source | manage_DMI_Input_Pkg::manageDMI_Input |
| Type | Level_And_Modes_Types_Pkg::T_LevelTransition |
| Valid range of values | It is a complex type |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] to be completed |

| | |
|---|---|
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] to be completed |
|---|---|

| | |
|---|--|
| 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)] to be completed |
|---|--|

387 5.6.2.1.5 Data_From_Track_Packets

388 table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a particular input or output.

| | |
|---|--|
| Input name | Data_From_Track_Packets |
| Description | Packets received from trackside containing information for modes and levels switches |
| Source | ???? to be completed |
| Type | Level_And_Mode_Types_Pkg::T_Data_From_Track_Packet |
| Valid range of values | It is a complex type containing the information of packets : 12, 15, 21, 27, 41, 46, 63, 80, 135, 137, 138 and 139 |
| Behaviour when value is at boundary | [Description of components behaviour when input value is at boundary] to be completed |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] to be completed |
| 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)] to be completed |

389 5.6.2.1.6 Data_From_speed_and_Supervision

390 table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a particular input or output.

| | |
|---|---|
| Input name | Data_From_speed_and_Supervision |
| Description | Data provided by the speed and supervision function |
| Source | Speed and Supervision function Please use exact component name from SCADE model. |
| Type | Level_And_Mode_Types_Pkg::T_Data_From_Speed_Supervision |
| Valid range of values | <p>Input type a complex type</p> <ul style="list-style-type: none"> • <i>Estim_front_End_overpass_SR_Dist</i> : <i>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</i> : <i>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</i> : <i>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</i> : <i>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</i> : <i>bool</i> supervision when override function is active (to SR mode condition 37) |
| Behaviour when value is at boundary | <p>[Description of components behaviour when input value is at boundary]</p> <p>to be completed</p> |
| Behaviour for values out of valid range | <p>[Description of components behaviour when input value is out of valid range]</p> <p>to be completed</p> |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | <p>[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]</p> <p>to be completed</p> |

391 5.6.2.2 Outputs

Description of outputs needs to be completed

392

393 5.6.2.2.1 [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)] |

394 5.6.2.2.2 [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)] |

395 5.6.3 Subcomponents

396 5.6.3.1 Level_Management

397 5.6.3.1.1 Component Requirements

| | |
|------------------------|---|
| Component name | Level_Management |
| Link to SCADE model | https://github.com/openETCS/modeling/tree/master/openETCSArchitectureAndDesign/WorkGroups/Group3/SCADE/LevelManagement/ |
| SCADE designer | Marielle Petit-Doche and Matthias Güdemann, Systerel |
| Description | <p>The level management subsystem receives level transition order tables and selects the order with the highest probability. It stores the information about the selected transition order and transits to the requested level once the train passes the location of the level transition.</p> <p>If required, the driver is asked to acknowledge the transition, in case of no acknowledgment or if conditions for the level transition are not fulfilled, the train gets tripped.</p> <p>On the most abstract level the design consists of the <i>manage_priorities</i> function which takes the level transition order priority tables as inputs and computes the highest priority transition.</p> <p>This transition order is the fed to the <i>computeLevelTransitions</i> operator. This operator consists of three main parts. The <i>ComputeTransitionConditions</i> operator that emits the fulfilled conditions to change from a given level to a new level, the <i>LevelStateMachine</i> that stores the current level and takes the computed change conditions as input for possible level transitions and finally the <i>driverAck</i> operator which contains a state machine that stores the information whether the system is currently waiting for a driver acknowledge and emits the train trip information if necessary.</p> |
| Input documents | Subset-026, Chapter 5.10 |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] to be completed |
| API requirements | [If applicable description of API requirements, otherwise n/a] to be completed |

398 5.6.3.1.2 Interface

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

401 5.6.3.2 Mode_Management

402 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-Doche, 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 | [If applicable description of time constraints, otherwise n/a] to be completed |
| API requirements | [If applicable description of API requirements, otherwise n/a] to be completed |

403 5.6.3.2.2 Interface

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

406 5.6.3.3 Check_and_Provide_Mode_and_Level

407 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/Modes |

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

408 5.6.3.3.2 Interface

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

5.7₄₁₁ F2.6: calculateTrainPosition

412 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. |

413 5.7.2 Interface

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

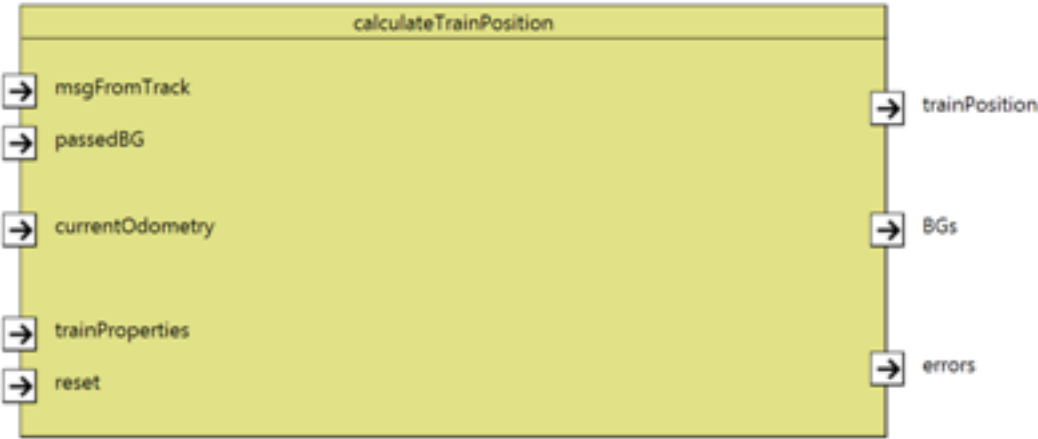


Figure 13. calculateTrainPosition SysML diagram

417 **5.7.2.1 Inputs**

418 **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 | External model interface input |
| 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. |

419 5.7.2.1.2 msgFromTrack

| | |
|-------------|---|
| Input name | msgFromTrack |
| Description | With msgFromTrack calculateTrainPosition receives datagrams from balise groups and RBC. |

| | |
|-----------------------|---|
| Source | Manage_TrackSideInformation_Integration_Pkg:: 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. calculates-TrainPosition 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. |

420 5.7.2.1.3 trainProperties

| | |
|-----------------------|--|
| Input name | trainProperties |
| Description | Supplies calculateTrainPosition with train specific properties required for position calculation. |
| Source | EVC_Support_Pkg::maintainTrainProperties |
| 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. |

calculateTrainPosition expects this information to be consistent and validated before applied to.

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

421 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. |

422 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 | To whom it may concern/ |
| 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. |

423 5.7.2.2 Outputs

424 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 | Any drain component which needs the current train position or LRBG. |
| 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 "unknownwn" (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. <p><i>calculateTrainPosition provides the train position to whom it concerns and recalculates it in every clock cycle.</i></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 n/a

425 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 | Any subsequent component which needs the current collection of balises groups. |
| 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. <p><i>calculateTrainPosition provides the list of balise groups to whom it concerns.</i></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 n/a

426 5.7.2.2.3 errors

| | |
|-----------------------|---|
| Output name | errors |
| Description | Provides a collection of error flags, raised by calculateTrainPosition. |
| Destination | Error handlers and components which need to know of common and linking consistency errors. |
| 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 |
|---|-----|

427 5.7.3 Subcomponents

428 5.7.3.1 msg_2_passedBG

429 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 |

430 5.7.3.1.2 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 5.7.3.2 calculateBGLocations

434 5.7.3.2.1 Component Requirements

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

| | |
|------------------------|---|
| Description | 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, it's 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. 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. |
| 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 |

435 5.7.3.2.2 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 5.7.3.3 delDispensableBGs

439 5.7.3.3.1 Component Requirements

| | |
|------------------------|---|
| Component name | delDispensableBGs |
| 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 3.6.2.2.2 c) |
| Safety integrity level | 4 |
| Time constraints | n/a |
| API requirements | n/a |

440 5.7.3.3.2 Interface

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

443 **5.7.3.4 addAnnouncedBGs**

444 **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, addAnnounced-BGs 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 |

445 **5.7.3.4.2 Interface**

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

448 **5.7.3.5 calculateTrainpositionInfo**

449 **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 |

450 5.7.3.5.2 Interface

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

453 5.7.3.6 calculateTrainPositionAttributes

454 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 |

455 5.7.3.6.2 Interface

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

458 5.7.3.7 linkedBG_missed

459 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 |

460 5.7.3.7.2 Interface

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

463 5.7.3.8 twoconsecutiveLinkedBGs_missed

464 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 |

465 5.7.3.8.2 Interface

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

5.8₄₆₈ F2.7: SpeedSupervision_Integration

469 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 14, 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 |

470 5.8.2 Interface

471 An overview of the interface of component SpeedSupervision_integration is shown in Figure 14.
 472 The inputs and outputs are described in detail in Section 5.8.2.1 respectively 5.8.2.2. Sub
 473 components are described in Section 5.8.3.

474 5.8.2.1 Inputs

475 5.8.2.1.1 National Values

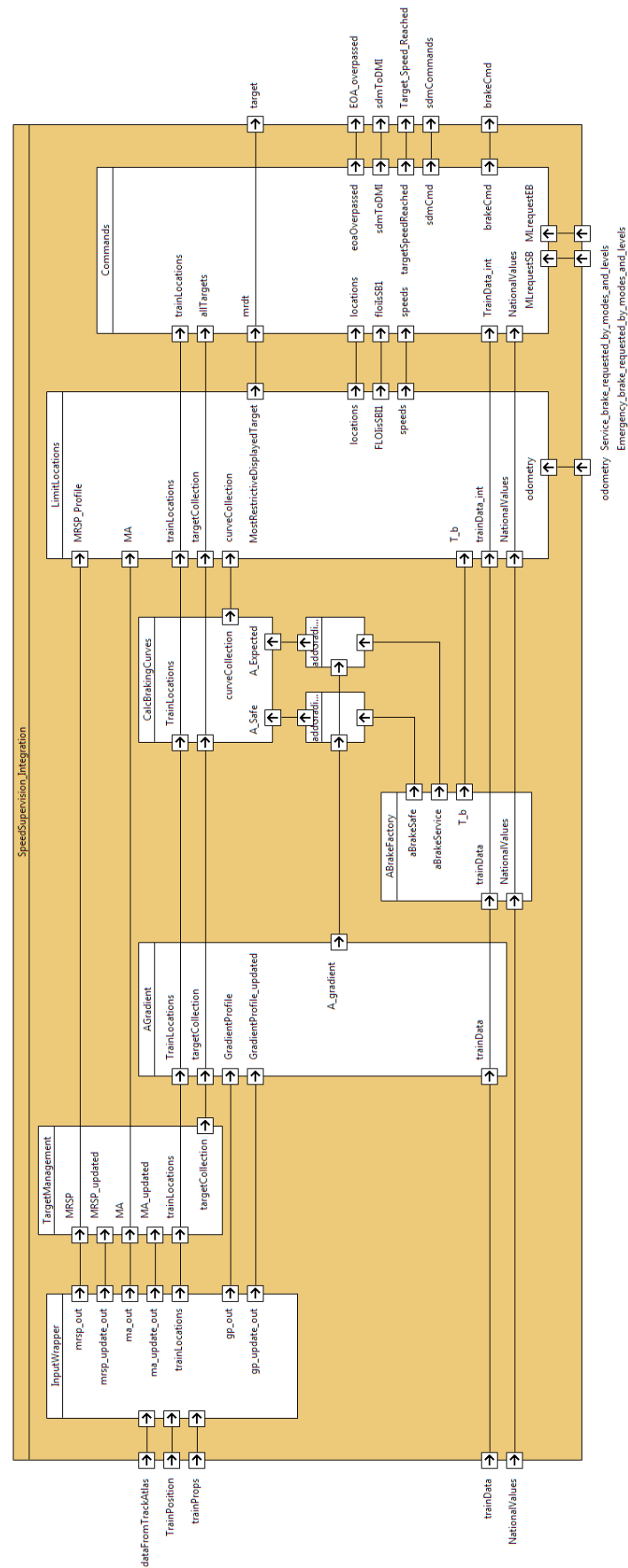


Figure 14. Structure of component SpeedSupervision_Integration.

| | |
|---|--|
| Input name | NationalValues |
| Description | This input is packet 3 or 203 of [1, Chapt. 8], describing the national values. |
| Source | 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. |

476 5.8.2.1.2 Train Position

| | |
|---|--|
| Input name | TrainPosition |
| Description | This input is the current train position. |
| Source | calculateTrainPosition |
| Type | trainPosition_T |
| Valid range of values | <p>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.</p> <div style="background-color: #90EE90; border: 1px solid black; border-radius: 5px; padding: 2px; display: inline-block;">To be completed</div> |
| 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. |

477 **5.8.2.1.3 Odometry**

| | |
|---|---|
| Input name | odometry |
| Description | This input is the odometry data. |
| Source | API_Odometry |
| Type | odometry_T |
| Valid range of values | complex data type used fields are: - 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. |

478 **5.8.2.1.4 Train Properties**

| | |
|---|---|
| Input name | trainProps |
| Description | This input is a set of train related properties. |
| Source | maintainTrainProperties |
| 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. |

479 **5.8.2.1.5 Train Data**

| | |
|---|---|
| Input name | trainData |
| Description | This input is a set of train related inputs from the TIU. |
| Source | manageTrainData |
| 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. |

480 **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 | TrackAtlas |
| Type | DataForSupervision_nextGen_t |
| Valid range of values | <p>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.</p> <p>MA Must always contain a valid Movement Authority, else the brake is commanded.</p> <p>GradientProfile As per SRS, this must always contain a valid description up to the end of the MA.</p> <p>MRSP Must at least a profile for the train's maximum speed, if no other restriction is known.</p> |
| 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. |
|---|--|

481 5.8.2.2 Outputs

482 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 | <ul style="list-style-type: none"> TrackAtlas (5.5.2.1) manageDMI_output (18) ROOT_integration |
| 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, location-BrakeTarget, 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. |
|---|--|

483 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. |

484 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 at boundary | n/a |
| Behaviour for values out of valid range | <ul style="list-style-type: none"> • 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, mrdt-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. |

485 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 | <ul style="list-style-type: none"> • TIU_OutputIntegration (20) • manageDMI_output (18) • ROOT_integration |
| 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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 at boundary | n/a |
| Behaviour for values out of valid range | n/a |
| Behaviour when value is erroneous, absent or unwanted (i.e. spurious) | brakeCmd is constantly valid, but may not contain a command change. |

486 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 | <p>true The train's front end has passed the end of authority</p> <p>false The end of authority is ahead of the train.</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

487 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 | <p>true The current speed is greater than or equal to the target speed or target is invalid</p> <p>false The current speed is less than the target speed</p> <p>Value must be ignored, if output target (5.8.2.2.2) is invalid.</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 |

488 5.8.3 Subcomponents

489 5.8.3.1 SDM_InputWrapper

490 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 | <p>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 <code>real</code> 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.</p> |
| Input documents | Subset-026, Chapter 3.13, (not specific, helper function) |
| Safety integrity level | 4 |
| Time constraints | n/a |
| API requirements | n/a |

491 5.8.3.1.2 Interface

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

494 5.8.3.2 TargetManagement

495 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 *Movement Authority* creates three types of targets:

Limit of Authority (LoA) if the End of Authority is not yet known to the RBC and is accompanied by a speed limit for the given location.

End Of Authority (EoA) requires the train to stop and creates a Service Brake Target

Supervised Location (SvL) is derived from the EoA but results in an emergency brake target and on passing in a trip. The SvL may be offset from the EoA to the Overlap (OL) or the Dangerpoint (DP).

Derivation of Targets from MRSP

According to [1, Chapt. 3.13.8.2], every speed decrease of the MRSP is used to derive a target. Therefore in every cycle in which the MRSP is updated, the operator iterates through the entire MRSP searching for all MRSP targets. For this purpose, every element of the MRSP is compared with its successor.

Update of Targets

In every cycle the operator monitors whether all targets are already passed. To this end, it iterates over the list of targets comparing the current front end position with the target's location.

| | |
|------------------------|---|
| Input documents | Subset-026, Chapter 3.13.8.2: Determination of the supervised targets |
| Safety integrity level | 4 |
| Time constraints | n/a |
| API requirements | n/a |

496 **5.8.3.2.2 Interface**

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

499 **5.8.3.3 AGradient**

500 **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 |

501 **5.8.3.3.2 Interface**

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

504 **5.8.3.4 ABrakeFactory**

505 **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 |

506 **5.8.3.4.2 Interface**

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

509 **5.8.3.5 addGradient**

510 **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 |

511 **5.8.3.5.2 Interface**

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

514 **5.8.3.6 CalcBrakingCurves_Integration**

515 **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 |

516 **5.8.3.6.2 Interface**

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

519 **5.8.3.7 SDMLimitLocations**

520 **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</p> <p>Subset-026, Chapter 5.3.1.2: f_{41} – accuracy of speed known on-board</p> <p>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 |

521 5.8.3.7.2 Interface

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

524 5.8.3.8 SDM_Commands

525 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 | <p>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.</p> <p>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 to 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 stati. 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.</p> |
| 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 |

526 5.8.3.8.2 Interface

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

5.9529 F2.8: Provide_Position_Report

530 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> |

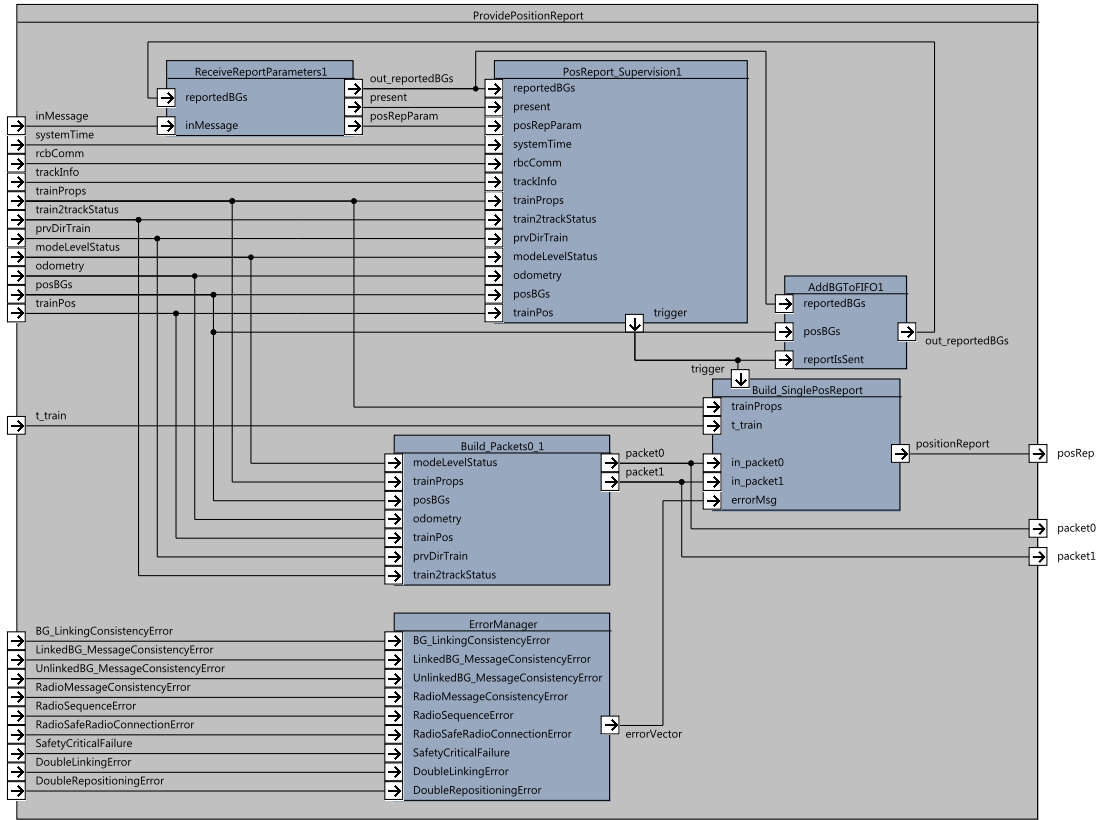


Figure 15. Provide_Position_Report component SysML diagram

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

5.9.2 Interface

An overview of the interface of component **Provide_Position_Report** is shown in Figure 15. The inputs and outputs are described in detail in Section 5.9.2.1 respectively 5.9.2.2. Subcomponents are described in Section 5.9.3.

5.9.2.1 Inputs

5.9.2.1.1 inMessage

| | |
|-------------|--|
| Input name | inMessage |
| Description | Input message from the bus (to extract Packet 58, the position report parameters). |
| Source | Manage_TrackSideInformation_Integration_Pkg:: 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. |

537 5.9.2.1.2 systemTime

| | |
|---|---|
| Input name | systemTime |
| Description | The system time. |
| Source | API |
| 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 |

538 5.9.2.1.3 rbcComm

| | |
|---|---|
| Input name | rbcComm |
| Description | Variables modeling stati regarding the RBC communication. |
| Source | MoRC_Pck::MoRC_Main |
| Type | RBC_Communication_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) | n/a |
|---|-----|

539 **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 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 |

540 **5.9.2.1.5 trainProps**

| | |
|---|--|
| Input name | trainProps |
| Description | The train properties. |
| Source | EVC_Support_Pkg::maintainTrainProperties |
| Type | TrainPosition_Types_Pck::trainProperties_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) | n/a |

541 **5.9.2.1.6 train2trackStatus**

| | |
|---|------------------------------------|
| Input name | train2trackStatus |
| Description | Train to track status information. |
| Source | EVC |
| Type | BG_Types_Pkg::TrainToTrackStatus_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) | n/a |

542 5.9.2.1.7 prvDirTrain

| | |
|---|--|
| Input name | prvDirTrain |
| Description | Train direction of the last clock cycle. |
| Source | CalculateTrainPosition_Pkg::calculateTrainPosition |
| Type | Q_DIRTRAIN |
| 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) | n/a |

543 5.9.2.1.8 modeLevelStatus

| | |
|-----------------------|---|
| Input name | modeLevelStatus |
| Description | Information referring to mode and level status. |
| Source | ManageLevelAndMode |
| Type | ModeLevel2PositionReport_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) | n/a |
|---|-----|

544 5.9.2.1.9 odometry

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

| | |
|-------------|-----------------------|
| Description | Odometry information. |
|-------------|-----------------------|

| | |
|--------|-----|
| Source | API |
|--------|-----|

| | |
|------|--------------------------------|
| Type | Obu_BasicTypes_Pkg::odometry_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) | n/a |
|---|-----|

545 5.9.2.1.10 posBGs

| | |
|------------|--------|
| Input name | posBGs |
|------------|--------|

| | |
|-------------|---|
| Description | Positioned balise groups used for current train position. |
|-------------|---|

| | |
|--------|--|
| Source | CalculateTrainPosition_Pkg::calculateTrainPosition |
|--------|--|

| | |
|------|--|
| Type | TrainPosition_Types_Pck::positionedBGs_T |
|------|--|

| | |
|-----------------------|---------------------|
| Valid range of values | as defined in SCADE |
|-----------------------|---------------------|

| | |
|-------------------------------------|-----|
| Behaviour when value is at boundary | n/a |
|-------------------------------------|-----|

| | |
|---|-----|
| Behaviour for values out of valid range | n/a |
|---|-----|

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

546 5.9.2.1.11 trainPos

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

547 5.9.2.1.12 t_train

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

548 5.9.2.1.13 BG_LinkingConsistencyError

| | |
|------------|----------------------------|
| Input name | BG_LinkingConsistencyError |
|------------|----------------------------|

| | |
|---|---|
| Description | True if respective error has occurred; otherwise false. |
| Source | CalculateTrainPosition_Pkg::calculateTrainPosition |
| Type | bool |
| 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) | n/a |

549 **5.9.2.1.14 LinkedBG_MessageConsistencyError**

| | |
|---|--|
| Input name | LinkedBG_MessageConsistencyError |
| Description | True if respective error has occurred; otherwise false. |
| Source | Manage_TrackSideInformation_Integration_Pkg:: Manage_TrackSideInformation_Integration |
| Type | bool |
| 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) | n/a |

550 **5.9.2.1.15 UnlinkedBG_MessageConsistencyError**

| | |
|-----------------------|--|
| Input name | UnlinkedBG_MessageConsistencyError |
| Description | True if respective error has occurred; otherwise false. |
| Source | Manage_TrackSideInformation_Integration_Pkg:: Manage_TrackSideInformation_Integration |
| Type | bool |
| 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) | n/a |
|---|-----|

551 5.9.2.1.16 RadioMessageConsistencyError

| | |
|---|--|
| Input name | RadioMessageConsistencyError |
| Description | True if respective error has occurred; otherwise false. |
| Source | Manage_TrackSideInformation_Integration_Pkg:: Manage_TrackSideInformation_Integration |
| Type | bool |
| 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) | n/a |

552 5.9.2.1.17 RadioSequenceError

| | |
|---|--|
| Input name | RadioSequenceError |
| Description | True if respective error has occurred; otherwise false. |
| Source | Manage_TrackSideInformation_Integration_Pkg:: Manage_TrackSideInformation_Integration |
| Type | bool |
| 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) n/a

553 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 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 |

554 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 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 |

555 5.9.2.1.20 DoubleLinkingError

| | |
|------------|--------------------|
| Input name | DoubleLinkingError |
|------------|--------------------|

| | |
|---|---|
| Description | True if respective error has occurred; otherwise false. |
| Source | CalculateTrainPosition_Pkg::calculateTrainPosition |
| Type | bool |
| 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) | n/a |

556 5.9.2.1.21 DoubleRepositioningError

| | |
|---|---|
| Input name | DoubleRepositioningError |
| Description | True if respective error has occurred; otherwise false. |
| Source | CalculateTrainPosition_Pkg::calculateTrainPosition |
| Type | bool |
| 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) | n/a |

557 5.9.2.2 Outputs

558 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 | TrackAtlas::TrackAtlas |
| Type | Packet_TrainTypes_Pkg::PT0_PositionReport_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) | n/a |

559 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 | TrackAtlas::TrackAtlas |
| Type | Packet_TrainTypes_Pkg::PT1_PositionReport_2BG_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) | n/a |

560 5.9.2.2.3 posRep

| | |
|---|--|
| Output name | posRep |
| Description | Position report to be send to the RBC, i.e. message 136. |
| Destination | radioOutput_Pkg::collectRadioMessages |
| Type | Radio_Types_Pkg::Radio_TrainTrack_Message_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) | n/a |
|---|-----|

561 5.9.3 Subcomponents

562 5.9.3.1 ReceiveReportParameters

563 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 |

564 5.9.3.1.2 Interface

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

567 5.9.3.2 PosReport_Supervision

568 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 |

569 5.9.3.2.2 Interface

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

572 5.9.3.3 ErrorManager

573 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 |

574 5.9.3.3.2 Interface

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

577 5.9.3.4 Build_Packets0_1

578 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 |

579 5.9.3.4.2 Interface

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

582 5.9.3.5 Build_PosReport

583 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 |

584 5.9.3.5.2 Interface

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

587 5.9.3.6 AddBGToFIFO

588 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 |

589 5.9.3.6.2 Interface

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

5.10₂ F2.9: Manage_Radio_Communication and RBC_Handover

593 section has to be completed. The level of this component in final architecture has been fixed.

594 5.10.1 Component Requirements

| | |
|---------------------|-------------------------|
| Component name | MoRC_HO |
| Link to SCADE model | ??? |
| SCADE designer | Uwe Steinke, Siemens AG |



Figure 16. Manage_Radio_Communication component SysML diagram

Description

to be checked

The management of radio communication MoRC 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. The kernel function of the MoRC component is *managementOfRadioCommunication* (figure ???). The implementation is kept close to the prose of Subset-026, chap. 3.5. Since chap. 3.5 rarely refers to terms, variable types, packets and messages of the ETCS language as specified in Subset-026, chap. 7 and 8, *managementOfRadioCommunication* does neither. To be capable of being integrated with other OBU software components, *MoRC* had to be wrapped with a transformer between the ETCS and the "chap. 3.5" language. This is the purpose of the main function of *MoRC*, *MoRC_Main*.

| | |
|------------------------|--|
| Input documents | Subset-026, Chapter 4 Subset-026, Chapter 5 |
| 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] |

595 5.10.2 Interface

596 An overview of the interface of component Manage_Radio_Communication is shown in Figure 16.
597 The inputs and outputs are described in detail in Section 5.10.2.1 respectively 5.10.2.2. Sub
598 components are described in Section 5.10.3.

599 5.10.2.1 Inputs

600 5.10.2.1.1 [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)] |

601 5.10.2.1.2 [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)] |

602 5.10.2.2 Outputs

603 5.10.2.2.1 [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)] |

604 5.10.2.2.2 [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)] |

605 5.10.3 Subcomponents

606 Maybe more subcomponents have to be added. Please check this.

607 5.10.3.1 Management_of_Radio_Communication

608 5.10.3.1.1 Component Requirements

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

to be checked

The function *managementOfRadioCommunication* implements the session states establishing, maintaining and termination as described in Subset-026, chap. 3.5. A SCADE state machine reflects this state model (Figure ???) accurately. Within each of the states, the activities needed as long as the state is active, are performed. When there is no communication session (state *NoSession*) currently, the state machine waits for events that initiate a session (subfunction *initiate_a_Session*). When the appropriate conditions are fulfilled, the state machine moves to the *Establishing* state. Here in, it runs through the sequence required fore establishing a session (subfunction *establish_a_Session*. Dependent on the results, the state machine changes over to the *Maintaining* or *Terminating* state. While in *Maintaining*, the communication connection is monitored. When an event triggering the session termination occurs, the state machine switches to the state *Terminating* with the subfunction *terminating_a_CommunicationSession* and performs the session termination sequence.

In parallel to the main state machine, *managementOfRadioCommunication* monitors all the time whether the session has to be terminated (subfunction *initiateTerminatingASession*) or if the session has the be terminated and subsequently established (subfunction *terminateAndEstablishSession*). *registeringToTheRadioNetwork* is responsible for connection to the radio network. *safeRadioConnectionIndication* controls the radio connection indication for the driver.

| | |
|------------------------|--|
| Input documents | Subset-026, Chapter 3.5 |
| 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] |

609 5.10.3.1.2 Interface

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

612 5.10.3.2 genMSGToRBC

613 5.10.3.2.1 Component Requirements

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

Description

to be completed

| | |
|------------------------|--|
| Input documents | Subset-026, Chapter 3.5 |
| 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] |

614 5.10.3.2.2 Interface

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

5.11 F2.10: ManageDMIInput

section and corresponding subsections have to be completed

619 5.11.1 Component Requirements

| | |
|------------------------|---|
| Component name | ManageDMIInput |
| 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] |

620 5.11.2 Interface

621 An overview of the interface of component ManageDMIInput is shown in Figure 17. The inputs
622 and outputs are described in detail in Section 5.11.2.1 respectively 5.11.2.2. Subcomponents are
623 described in Section 5.11.3.

624 5.11.2.1 Inputs

625 5.11.2.1.1 [Input 1 name]



Figure 17. ManageDMIInput SysML diagram

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

626 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 bound-ary] |
| 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 un- wanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

627 5.11.2.2 Outputs

628 5.11.2.2.1 [Output 1 name]

| | |
|---|---|
| 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)] |

629 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)] |

630 5.11.3 Subcomponents

631 Currently ManageDMIInput does not have any subcomponents.

5.12 F2.11: ManageDMIOutput

633 section and corresponding subsections have to be completed

634 5.12.1 Component Requirements

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



Figure 18. ManageDMIOOutput SysML diagram

| | |
|------------------------|---|
| 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] |

5.12.2 Interface

An overview of the interface of component ManageDMIOOutput is shown in Figure 18. The inputs and outputs are described in detail in Section 5.12.2.1 respectively 5.12.2.2. Subcomponents are described in Section 5.12.3.

5.12.2.1 Inputs

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)] |

5.12.2.1.2 [Input 2 name]

| | |
|------------|---------------------|
| Input name | [Name of the input] |
|------------|---------------------|

| | |
|---|---|
| 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)] |

642 5.12.2.2 Outputs

643 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)] |

644 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)] |
|---|---|

645 5.12.3 Subcomponents

646 5.12.3.1 cyclicReportToDMI

647 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] |

648 5.12.3.1.2 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 5.12.3.2 ManageTextMessages

652 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] |
|------------------|--|

653 5.12.3.2.2 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 5.12.3.3 copyTrackDescription

657 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] |

658 5.12.3.3.2 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 5.12.3.4 toEntryRequest

662 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] |

663 5.12.3.4.2 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 5.12.3.5 sendBrakesToDMI

667 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] |

668 5.12.3.5.2 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 5.12.3.6 manageDMI_Output

672 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] |

673 5.12.3.6.2 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.

676 5.12.3.7 sendTrainData

677 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] |

678 5.12.3.7.2 Interface

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

681 5.12.3.8 sendVersion

682 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] |

683 5.12.3.8.2 Interface

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

686 5.12.3.9 sendLevelListPkg

687 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] |

688 5.12.3.9.2 Interface

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

5.13₁ F2.12: ManageTIUInput

692 section and corresponding subsections have to be completed

693 5.13.1 Component Requirements

| | |
|---------------------|-------------------------------------|
| Component name | ManageTIUInput |
| 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] |

5.13.2 Interface

An overview of the interface of component ManageTIUInput is shown in Figure 19. The inputs and outputs are described in detail in Section 5.13.2.1 respectively 5.13.2.2. Subcomponents are described in Section 5.13.3.

5.13.2.1 Inputs

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 bound-ary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |

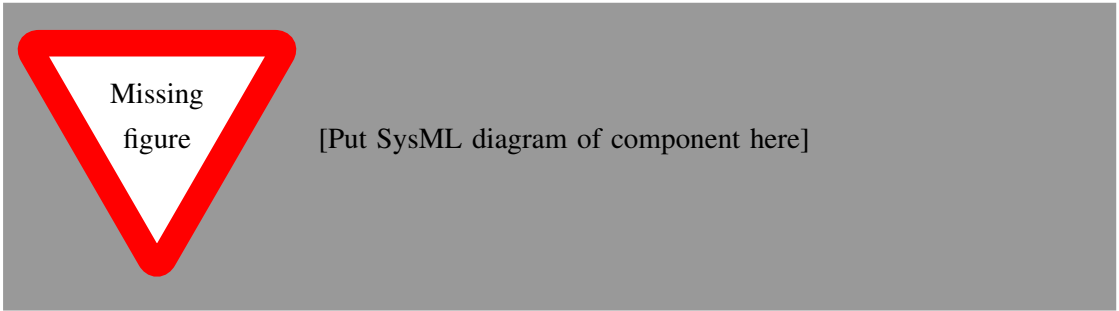


Figure 19. ManageTIUInput SysML diagram

| | |
|---|---|
| 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)] |
|---|---|

700 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] |
| 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)] |

701 5.13.2.2 Outputs

702 5.13.2.2.1 [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)] |

703 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)] |

704 5.13.3 Subcomponents

705 5.13.3.1 mergeTIU_Info

706 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] |

707 5.13.3.1.2 Interface

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

710 5.13.3.2 getTIUStatusFromData

711 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] |

712 5.13.3.2.2 Interface

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

5.14₅ F2.13: ManageTIUOutput

716 section and corresponding subsections have to be completed

717 5.14.1 Component Requirements

| | |
|------------------------|---|
| Component name | ManageTIUOutput |
| 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] |

718 5.14.2 Interface



Figure 20. ManageTIUOutput SysML diagram

719 An overview of the interface of component ManageTIUOutput is shown in Figure 20. The inputs
720 and outputs are described in detail in Section 5.14.2.1 respectively 5.14.2.2. Subcomponents are
721 described in Section 5.14.3.

722 **5.14.2.1 Inputs**

723 **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 bound-ary] |
| 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 un-wanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

724 **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 bound-ary] |

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

| | |
|---|---|
| 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)] |

727 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)] |

728 5.14.3 Subcomponents

729 5.14.3.1 handleTraction

730 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] |

731 5.14.3.1.2 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 5.14.3.2 manageTIU_output

735 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] |

736 5.14.3.2.2 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.

6⁷³⁹ F3: Measure Train Movement

⁷⁴⁰ This component is not part of the openETCS OBU currently and therefore no detailed description
⁷⁴¹ is provided here.

7⁷⁴² F4: Manage Radio Communication

⁷⁴³ This component is not part of the openETCS OBU currently and therefore no detailed description
⁷⁴⁴ is provided here.

8 ⁷⁴⁵ F5: Manage JRU

⁷⁴⁶ This component is not part of the openETCS OBU currently and therefore no detailed description
⁷⁴⁷ is provided here.

9 F6: DMI Controller

This chapter needs to be completed and a responsible developer has to be identified.

9.1 DMI

9.1.1 Component Requirements

| | |
|------------------------|--|
| Component name | DMI |
| Link to SCADE model | https://github.com/openETCS/modeling/tree/master/model/Scade/System/DMI_Control |
| SCADE designer | Valerio D'Angelo, DB Netz AG |
| Description | The DMI controller interacts with the DMI display and is responsible for all procedures between the DMI display and Driver. Furthermore, the DMI controller will interact with the DMI Management to compute the received information (e.g. driver number request, ...) and send, if necessary, data or reports to the DMI Management (acknowledge, text messages...). The DMI Controller is a passive module, this means that all the processing are performed EVC-side, therefore the DMI Controller simply responds to the requests of the EVC or Driver and performs some checks according with the information received from EVC. |
| Input documents | ERA_ERTMS_015560 |
| 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] |

9.1.2 Interface

An overview of the interface of component DMI is shown in Figure 21. The inputs and outputs are described in detail in Section 9.1.2.1 respectively 9.1.2.2.

9.1.2.1 Inputs

9.1.2.1.1 DMI_entry_request

| | |
|-------------|---|
| Input name | DMI_entry_request |
| Description | Request to input data (e.g. driver id, Train running number etc.) |
| Source | DMI Management |

| | |
|---|---|
| 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)] |

757 **9.1.2.1.2 DMI_identifier_request**

| | |
|---|---|
| Input name | DMI_identifier_request |
| Description | Request of the DMI informations |
| Source | DMI Management |
| 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)] |

758 **9.1.2.1.3 DMI_menu_request**

| | |
|---|--|
| Input name | DMI_menu_request |
| Description | Request to enable or disable buttons |
| Source | DMI Management |
| 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)] |
|---|---|

759 **9.1.2.1.4 DMI_dynamic**

| | |
|---|---|
| Input name | DMI_dynamic |
| Description | Contains informations about current speed, current mode etc. |
| Source | DMI Management |
| 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)] |

760 **9.1.2.1.5 DMI_text_message**

| | |
|---|---|
| Input name | DMI_text_message |
| Description | Contains predefined or plain text messages |
| Source | DMI Management |
| 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)] |

761 **9.1.2.1.6 DMI_icons**

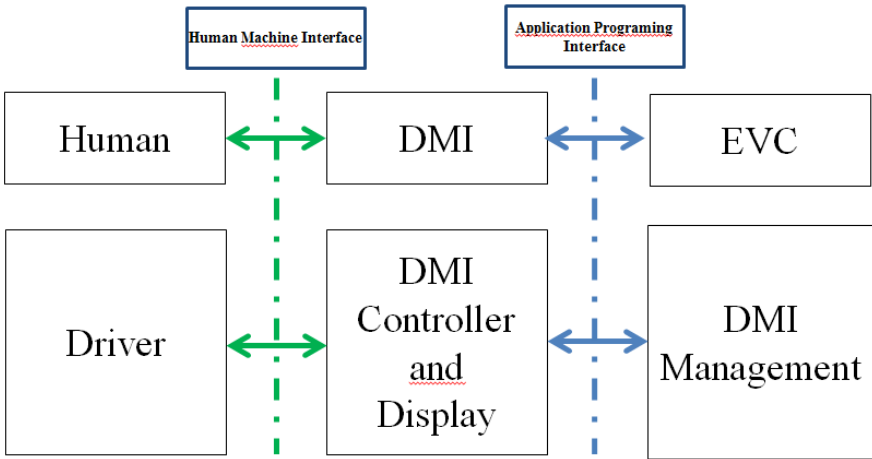


Figure 21. DMI component SysML diagram

| | |
|---|---|
| Input name | DMI_icons |
| Description | Request to display one or more icons in any area |
| Source | DMI Management |
| 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 bound-ary] |
| 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 un- wanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

762 9.1.2.1.7 DMI_driver_identifier

| | |
|---|---|
| Input name | DMI_driver_identifier |
| Description | Contains the default or entered driver identifier |
| Source | DMI Management |
| 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 bound-ary] |
| 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 un- wanted (i.e. spurious) | [Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] |

| | |
|---|---|
| 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 **9.1.2.1.9 DMI_train_data**

| | |
|---|---|
| Input name | DMI_train_data |
| Description | Contains the default or entered train data |
| Source | DMI Management |
| 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)] |

765 **9.1.2.1.10 TIU_trainStatus**

| | |
|---|--|
| Input name | TIU_trainStatus |
| Description | Open/close Desk signal |
| Source | TIU |
| 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)] |
|---|---|

766 9.1.2.2 Outputs

767 9.1.2.2.1 DMI_identifier

| | |
|---|---|
| Output name | DMI_identifier |
| Description | Information about DMI (e.g. version, cabin identifier etc.) |
| Destination | DMI Management |
| 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)] |

768 9.1.2.2.2 DMI_driver_request

| | |
|---|---|
| Output name | DMI_driver_request |
| Description | Driver request or acknowledgement |
| Destination | DMI Management |
| 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)] |

769 9.1.2.2.3 DMI_train_data_ack

| | |
|---|---|
| Output name | DMI_train_data_ack |
| Description | Train data acknowledgement |
| Destination | DMI Management |
| 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)] |

770 9.1.2.2.4 DMI_status_report

| | |
|---|---|
| Output name | DMI_status_report |
| Description | The actual status of DMI (keep alive) |
| Destination | DMI Management |
| 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)] |

771 9.1.2.2.5 DMI_text_message_ack

| | |
|-----------------------|---------------------------------|
| Output name | DMI_text_message_ack |
| Description | Text message acknowledgement |
| Destination | DMI Management |
| 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)] |

772 **9.1.2.2.6 DMI_icons_ack**

| | |
|---|---|
| Output name | DMI_icons_ack |
| Description | Icon acknowledgement |
| Destination | DMI Management |
| 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)] |

773 **9.1.2.2.7 DMI_driver_identifier**

| | |
|---|---|
| Output name | DMI_driver_identifier |
| Description | Contains the default or entered driver identifier |
| Destination | DMI Management |
| 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)] |
|---|---|

774 9.1.2.2.8 DMI_train_running_number

| | |
|---|---|
| Output name | DMI_train_running_number |
| Description | Contains the default or entered train running number |
| Destination | DMI Management |
| 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)] |

775 9.1.2.2.9 DMI_train_data

| | |
|---|---|
| Output name | DMI_train_data |
| Description | Contains the default or entered train data |
| Destination | DMI Management |
| 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)] |

References

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