

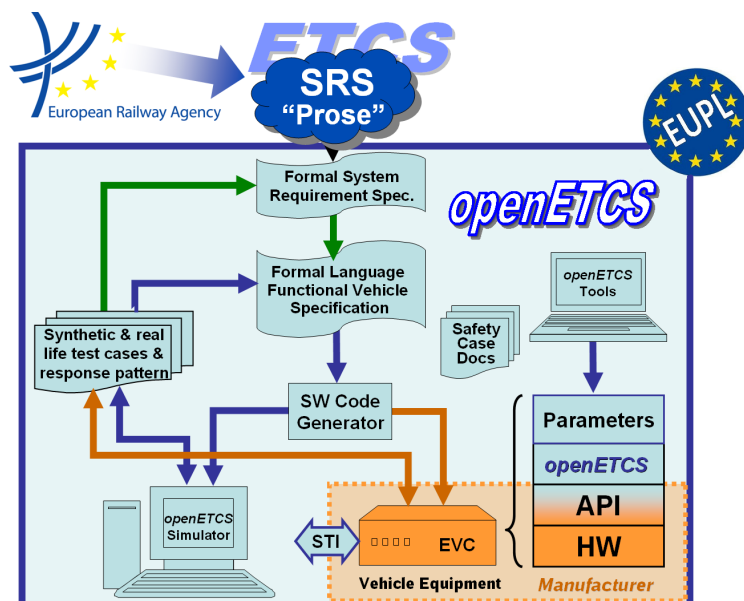
Work Package 3: "Modeling"

openETCS Design Specification

Software Component Design and Internal Interface Specification

Baseliyos Jacob, Peter Mahlmann, Bernd Hekele, Peyman Farhangi, Stefan Karg, Valerio D'Angelo, Uwe Steinke, Christian Stahl, Jakob Gärtner, Jos Holtzer, Jan Welvaarts, Vincent Nuhaan, Benjamin Beichler, Thorsten Schulz, Marielle Petit-Doche, Matthias Gudemann, Vernique Gontier, Ghristian Giraud, Fausto Cochetti and Alexander Stante

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Work Package 3: “Modeling”**OETCS/WP3/D3.5.2
June 2015**

openETCS Design Specification

Software Component Design and Internal Interface Specification

Document approbation

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Architecture and Design Specification

Abstract: This document describes the architecture and design specification of openETCS onboard 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.

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| 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 |

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1 Introduction

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

- 5 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. It should be considered as a complement to the following project outcomes respectively deliverables:
- 10 • 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>.
- 15

Part I

Functional Breakdown

2 openETCS API Runtime System and Input to the EVC)

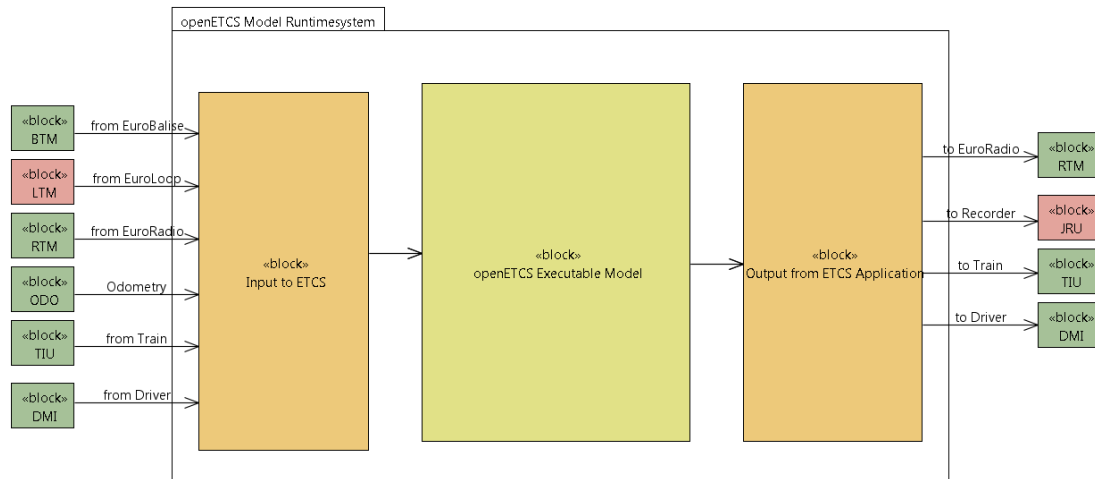


Figure 1. openETCS API Highlevel View

- Figure 1 shows the structure of API with respect to the software architecture. Note that red input and output modules were not yet implemented and thus are not part of the openETCS OBU model. The system covers functions for processing inputs from other units, functions for processing outputs to other functions and a basic runtime system. Inputs are used to feed the input to the executable model before calling it, outputs are used for collecting information provided by the executable model to be passed to the relevant interfaces after the execution cycle has finished.

2.1 Principles for Interfaces (openETCS API)

Information is exchanged via asynchronous *messages*. A message is a set of information corresponding to an event of a particular unit, e.g. a balise message received from the BTM. For possible types of messages please refer to Chapter ??.

- The information is passed to the executable model as parameters to the synchronous call of a procedure (Interface to the executable model). Since the availability of input messages to the application is not guaranteed the parts of the interfaces are defined with a "present" flag. In addition, fields of input arrays quite often are of variable size. Implementation in the concrete interface in this use-case is the use of a "size" parameter and a "valid"-flag.

2.2 openETCS Model Runtime System

The openETCS model runtime system also provides:

Input Functions From other Units In this entity messages from other connected units are received.

Output Functions to other Units The entity writes messages to other connected units.

40 **Conversation Functions for Messages (Bitwalker)** The conversion function are triggered by Input and Output Functions. The main task is to convert input messages from an bit-packed format into logical ETCS messages (the ETCS language) and Output messages from Logical into a bit-packed format. The logical format of the messages is defined for all used types in the openETCS data dictionary.

45 Variable size elements in the Messages are converted to fixed length arrays with an used elements indicator. Optional elements are indicated with an valid flag.

The conversion routines are responsible for checking the data received is valid. If faults are detected the information is passed to the openETCS executable model for further reaction.

Model Cycle The version management function is part of the message handling. This implies, conversions from other physical or logical layouts of messages are mapped onto a generic format used in the EVC. Information about the origin version of the message is part of the messages.

The executable model is called in cycles. In the cycle

- First the received input messages are decoded
- 55 • The input data is passed to the executable model in a predefined order. **(Details for the interface to be defined).**
- Output is encoded according to the SRS and passed to the buffers to the units.

2.3 Input Interfaces of the openETCS API From other Units of the OBU

Interfaces are defined in the Scade project APITypes (package API_Msg_Pkg.xscade).

60 In the interfaces the following principles for indicating the quality of the information is used:

| Indicator | Type | Purpose |
|-----------|------|--|
| present | bool | True indicates the component has been changed compared to the previous call of the routine |
| valid | bool | True indicates the component is valid to be used. |

In the next table we can see the interfaces being used in the openETCS system. Details on the interfaces are defined further down.

| Unit | Name | Processing Function |
|-------------|--------------------------|--------------------------|
| BTM | Balise Telegram | Receive Messages |
| DMI | Driver Machine Interface | DMI Manager |
| EURORADIO | Communication Management | Communication Management |
| EURORADIO | Radio Messages | Receive Messages |
| ODO | Odometer | All Parts |
| System TIME | Time system of the OBU | All Parts |
| TIU | Train Data | All Parts |

65 Information in the following sections gives an more detailed overview of the structure of the interfaces.

2.4 Message based interface (BTM, RTM)

Balise Message (Track to Train)

| Message Name | Optional Packets | Restrictions in the current scope |
|-----------------|---|-----------------------------------|
| Balise Telegram | 3: National Values 41: Level Transition Order 42: Session Management 45: Radio Network registration 46: Conditional Level Transition Order 65: Temporary Speed Restriction 66: Revoke Temporary Speed Restriction 72: Packet for sending plain text messages 137: Stop if in Staff Responsible 255: End of Information | Used in Scenario |
| Balise Telegram | 0, 2, 3, 5, 6, 12, 16, 21, 27, 39, 40, 41, 42, 44, 45, 46, 49, 51, 52, 65, 66, 67, 68, 69, 70, 71, 72, 76, 79, 80, 88, 90, 131, 132, 133, 134, 135, 136, 137, 138, 139, 141, 145, 180, 181, 254 | Not Used in Scenario |

⁷⁰ Radio Messages (Track to Train)

| Message Name | Optional Packets | Restrictions in the current scope |
|--------------------------|---|-------------------------------------|
| 2: SR Authorisation | 63: List of Balises in SR Authority | Message Not Supported |
| 3: Movement Authority | 21: Gradient Profile 27: International Static Speed Profile 49: List of balises for SH Area 80: Mode profile plus common optional packets | a |
| 9: Request To Shorten MA | 49: List of balises for SH Area 80: Mode profile | |
| 24: General Message | From RBC: 21: Gradient Profile 27: International Static Speed Profile plus common optional packets From RIU: 44, 45, 143, 180, 254 | Messages from RIU are not supported |

| | | |
|--|---|-----------------------|
| 28: SH authorised | 3, 44, 49 | |
| 33: MA with Shifted Location Reference | 21: Gradient Profile 27: International Static Speed Profile 49: List of balises for SH Area 80: Mode profile plus common optional packets | |
| 37: Infill MA | 5, 21, 27, 39, 40, 41, 44, 49, 51, 52, 65, 66, 68, 69, 70, 71, 80, 88, 138, 139 | Message Not Supported |
| List of common optional parameters | 3, 5, 39, 40, 51, 41, 42, 44, 45, 52, 57, 58, 64, 65, 66, 68, 69, 70, 71, 72, 76, 79, 88, 131, 138, 139, 140, 180 | |

The runtime system is in charge to transfer the messages from its stream mode first to compressed message format.

2.5⁷⁵ Interfaces to the Time System

The interface types are defined in the OBU_Basic_Types_Pkg Package. The system time is defined in the basic software.

The system TIME is provided to the executable model at the begin of the cycle. It is not refreshed during the cycle. The time provided to the application is equal to 0 at power-up of the EVC (it is not a “UTC time” nor a “Local Time”), then must increase at each cycle (unit = 1 msec), until it reaches its maximum value (i.e current EVC limitation = 24 hours)

- TIME (T_internal_Type, 32-bit INT)
Standardized system time type used for all internal time calculations: in ms. The time is defined as a cyclic counter: When the maximum is exceeded the time starts from 0 again.
- 85 • CLOCK (to be implemented)
The clocking system is provided by the JRU. A GPS based clock is assumed to provide the local time.

2.6 Interfaces to the Odometry System

The interface types are defined in the OBU_Basic_Types_Pkg Package. The odometer gives the current information of the positing system of the train. In this section the structure of the interfaces are only highlighted. Details, including the internal definitions for distances, locations speed and time are implemented in the package.

- Odometer (odometry_T)
 - valid (bool)
95 valid flag, i.e., the information is provided by the ODO system and can be used.
 - timestamp (T_internal_Type)
of the system when the odometer information was collected. Please, see also general remarks on the time system.

- Coordinate (odometryLocation_T)
 - * nominal (L_internal_Type) [cm]
 - * min (L_internal_Type) [cm]
 - * max (L_internal_Type) [cm]

The type used for length values is a 32 bit integer. Min and max value give the interval where the train is to be expected. The boundaries are determined by the inaccuracy of the positioning system. All values are set to 0 when the train starts.
- speed (OdometrySpeeds_T) [km/h]
 - * v_safeNominal (speed internal type) [km/h]
The safe nominal estimation of the speed which will be bounded between 98% and 100% of the upper estimation
 - * v_rawNominal (speed internal type) [km/h]
The raw nominal estimation of the speed which will be bounded between the lower and the upper estimations
 - * v_lower (speed internal type) [km/h]
The lower estimation of the speed
 - * v_upper (speed internal type) [km/h]
The upper estimation of the speed

The type used for speed values is a 32 bit integer. Min and max value give the interval where the train is to be expected. The boundaries are determined by the inaccuracy of the positioning system. All values are set to 0 when the train starts.
- acceleration (A_internal_Type)[0.01 m/s²],
Standardized acceleration type for all internal calculations :
- motionState (Enumeration)
indicates whether the train is in motion or in no motion
- motionDirection (Enumeration)
indicates the direction of the train, i.e., CAB-A first, CAB-B first or unknown.

2.7 Interfaces to the Train Interfaces (TIU)

The following information is based on the implementation of the Alstom API. The interface is organised in packets. The packets of the Alstom implementation are listed in the appendix to this document.

- The description of interfaces needed for the current scope will be added according to the use.

2.8 Output Interfaces of the openETCS API TO other Units of the OBU

| From Function | Name | To Unit | Description |
|---------------|--------------------------|-----------|-------------|
| | Radio Output Message | EURORADIO | |
| | Communication Management | EURORADIO | |
| | Driver Information | DMI | |
| | Train Data | TIU | |

Packets: to be completed

Radio Messages to be completed

Part II

Design Description

3 F1: Receive information from Trackside

4 F2: ETCS Kernel

4.1 Manage_TrackSideInformation_Integration

140 4.1.1 Component Requirements

| | |
|------------------------|--|
| Component name | Manage_TrackSideInformation_Integration |
| Link to SCADE model | ??? |
| SCADE designer | [Name, affiliation] |
| 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> |
| Input documents | See sub-components. |
| Safety integrity level | 4 |
| Time constraints | n/a |
| API requirements | n/a |

4.1.2 Interface

An overview of the interface of component Manage_TrackSideInformation_Integration is shown in Figure 2. The inputs and outputs are described in detail in Section 4.1.2.1 respectively 4.1.2.2. Sub components are described in Section 4.1.3.

145 4.1.2.1 Inputs

4.1.2.1.1 fullChecks

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

| | |
|---|--|
| Type | bool |
| Valid range of values | <p>true All checks are performed.</p> <p>false Component InformationFilter is deactivated.</p> |
| Behaviour when value is at boundary | n/a |
| Behaviour for values out of valid range | n/a |

4.1.2.1.2 API_trackSide_Message

| | |
|---|---|
| Input name | API_trackSide_Message |
| Description | Track side message received from the API. The API performs pre-processing of RTM and BTM messages and delivers a maximum of a single message per cycle. |
| Source | API |
| Type | API_Msg_Pkg::API_TrackSideInput_T |
| 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] |

4.1.2.1.3 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] |
| 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] |

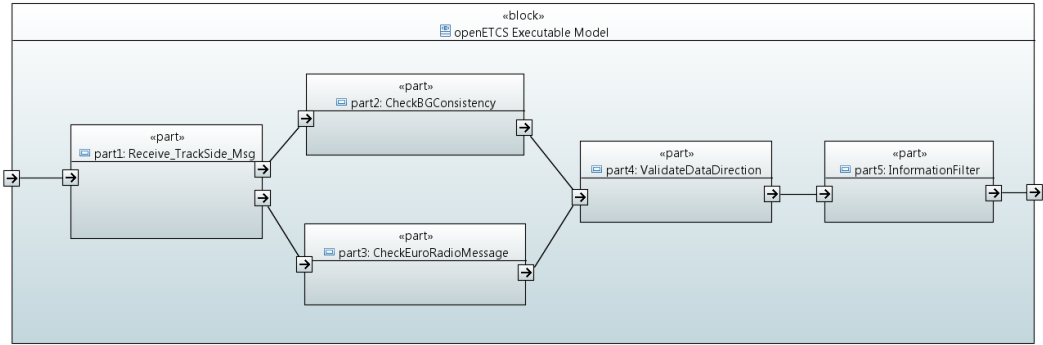


Figure 2. Manage_TrackSideInformation_Integration component SysML diagram.

4.1.2.1.4 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 | <p>true All data kept in the module is deleted and no input is accepted.</p> <p>false No action. Data at input is accepted.</p> |
| 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] |

4.1.2.1.5 trainPosition

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

4.1.2.1.6 modeAndLevel

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

4.1.2.1.7 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] |
| 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] |

4.1.2.1.8 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] |
| 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] |

4.1.2.1.9 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 | [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] |

155 **4.1.2.1.10 inSupervisingRbcId**

| | |
|---|--|
| Input name | inSupervisingRbcId |
| Description | For the sub component 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 | Database |
| Type | int |
| 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] |

4.1.2.1.11 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] |
| 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] |

4.1.2.1.12 q_nvlocacc

| | |
|---|--|
| Input name | q_nvlocacc |
| Description | The national value determines the location accuracy. |
| Source | Database |
| Type | Q_NVLOCACC |
| 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] |

4.1.2.2 Outputs

4.1.2.2.1 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)] |
| Type | Common_Types_Pkg::ReceivedMessage_T |
| 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] |

160 4.1.2.2.2 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)] |
| Type | bool |
| 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] |

4.1.2.2.3 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> |
| 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] |

4.1.2.2.4 errorLinkedBG

| | |
|--|---|
| Output name | errorLinkedBG |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | [Type of the output] |
| 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] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |

4.1.2.2.5 errorUnlinkedBG

| | |
|--|---|
| Output name | errorUnlinkedBG |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| 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] |
| Behaviour for values out of valid range | [Description of components behaviour when output value is out of valid range] |

4.1.2.2.6 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)] |

| | |
|---|---|
| Type | BG_Types_Pkg::passedBG_T |
| 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] |

165 4.1.2.2.7 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)] |
| Type | Common_Types_Pkg::PositionReportParameter_T |
| 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] |

4.1.2.2.8 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)] |
| Type | Common_Types_Pkg::radioManagementMessage_T |
| 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] |

4.1.2.2.9 radioSequenceError

| | |
|---|---|
| Output name | radioSequenceError |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | bool |
| Valid range of values | |
| | true A sequence error or a timeout has been detected in the radio message. |
| | false No error in the radio message sequence was detected. |
| 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] |

4.1.2.2.10 radioMessageConsistencyError

| | |
|---|---|
| Output name | radioMessageConsistencyError |
| Description | [Brief description of the output] |
| Destination | [Name of the destination component(s)] |
| Type | bool |
| Valid range of values | |
| | true A consistency error has been detected in the radio message. |
| | false No consistency error in the radio message was detected. |
| 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] |

4.1.3 Sub Components

170 4.1.3.1 Receive_TrackSide_Msg

4.1.3.1.1 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 | [Name, affiliation] |
| 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 |
|------------------|-----|

4.1.3.1.2 Interface

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

175 4.1.3.2 CheckBGConsistency

4.1.3.2.1 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 | [Name, affiliation] |
| Description | <p>This function verifies the completeness and correctness of the received messages from balise groups. A message consists of at least a telegram and a maximum of 8 telegrams.</p> <ul style="list-style-type: none"> • A message is still complete and correct, if a telegram is missing (or not decoded or incomplete decoded), and this telegram is duplicated within the balise group and the duplicating one is correctly read. • By more than one telegram, the order of the telegrams must be either ascending (nominal) or descending(reverse). • A message is correct, if all message counters (M MCUNT) do not equal 254 (that means: The telegram never fits any message of the group). A message counter can be 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 will also be calculated in this block. The check, if the message has been received in due time and the right at the right 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 |

4.1.3.2.2 Interface

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

180 4.1.3.3 CheckEuroradioMessage

4.1.3.3.1 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, DB Netz AG |
| Description | The component “CheckEuroradioMessage” performs several checks on the received radio message. These checks include checking of the message sequence, completeness of messages. Invalid messages are marked as invalid in the message header. |
| 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 |

4.1.3.3.2 Interface

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

185 4.1.3.4 ValidateDataDirection

4.1.3.4.1 Component Requirements

| | |
|---------------------|---|
| Component name | CheckEuroradioMessage |
| Link to SCADE model | https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/ValidateDataDirection |
| SCADE designer | ??? |

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

4.1.3.4.2 Interface

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

190 4.1.3.5 InformationFilter

4.1.3.5.1 Component Requirements

| | |
|---------------------|---|
| Component name | CheckEuroradioMessage |
| Link to SCADE model | https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/InformationFilter |
| SCADE designer | 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 3 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 First-Filter, 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 Transition-Buffers. 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 |

4.1.3.5.2 Interface

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

4.2¹⁹⁵ Train_Supervision

4.2.1 Component Requirements

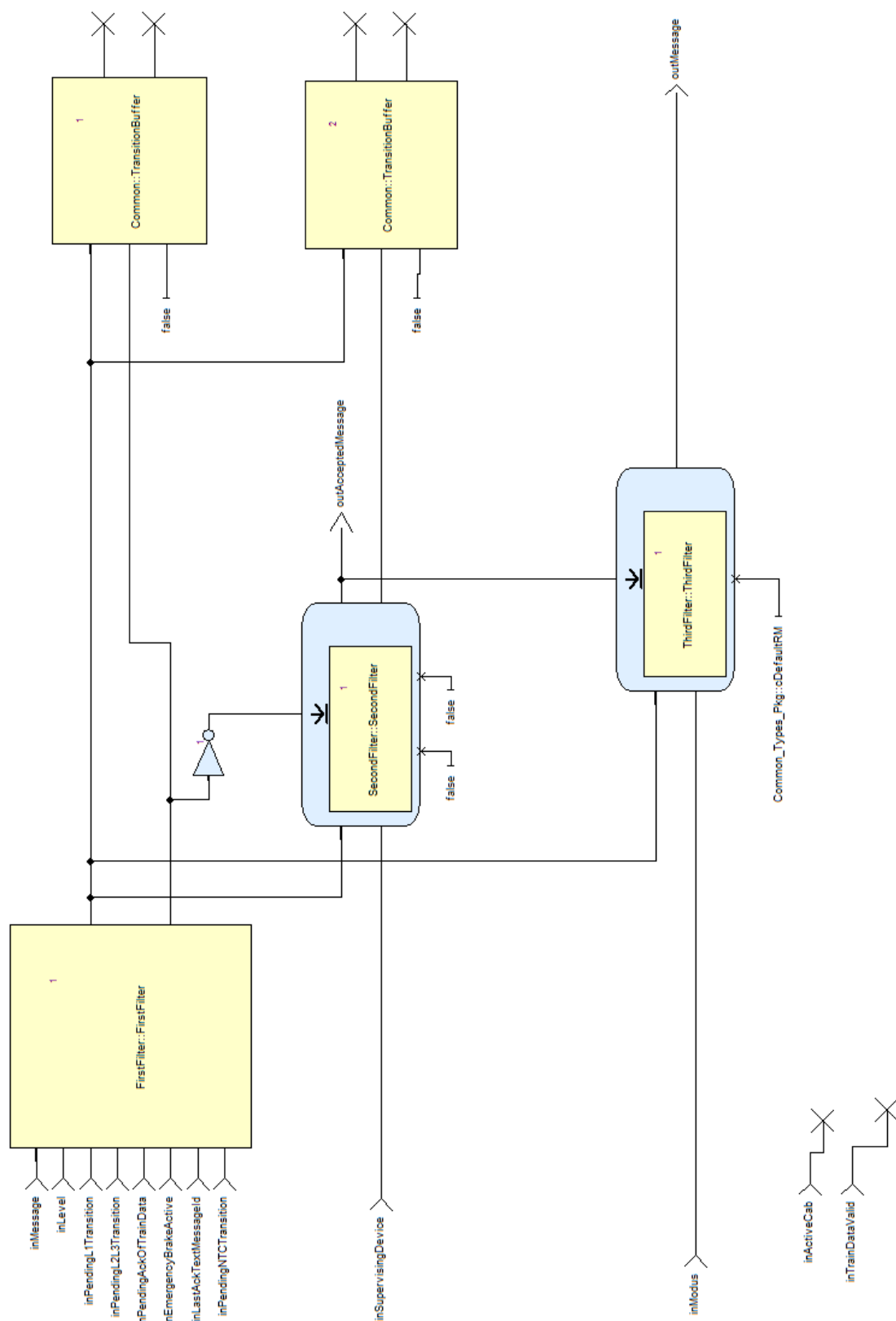


Figure 3. High level overview of the InformationFilter components.

| | |
|------------------------|---|
| Component name | TrainSupervision |
| Link to SCADE model | ??? |
| SCADE designer | Christian Stahl, TWT |
| Description | <p>The task of block “Train Supervision” 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 mainly based on [1, Chapt. 3.13].</p> <p>The block “Train Supervision” 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 perform 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 operators, as shown in Figure 4, which are explained below.</p> <p>The current status of the analysis of “Train Supervision” 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 | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

4.2.2 Interface

An overview of the interface of component [component name] is shown in Figure 4. The inputs and outputs are described in detail in Section 4.2.2.1 respectively 4.2.2.2. Sub components are described in Section 4.2.3.

4.2.2.1 Inputs

4.2.2.1.1 NationalValues

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

| | |
|---|--|
| Type | P3_NationalValues_T |
| 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] |

4.2.2.1.2 TrainPosition

| | |
|---|--|
| Input name | TrainPosition |
| Description | This input is the current train position. |
| Source | Manage Track Data |
| Type | trainPosition_T |
| 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] |

4.2.2.1.3 odometry

| | |
|---|--|
| Input name | odometry |
| Description | This input is the odometry data. |
| Source | Odometry |
| Type | odometry_T |
| 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] |

205 4.2.2.1.4 m_level

| | |
|-------------|---|
| Input name | m_level |
| Description | This input is the current level of the train. |

| | |
|---|--|
| Source | Mode and Level |
| Type | M_LEVEL |
| 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] |

4.2.2.1.5 trainProps

| | |
|---|--|
| Input name | trainProps |
| Description | This input is a set of train related properties. |
| Source | Database |
| Type | trainProperties_T |
| 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] |

4.2.2.1.6 MRSP

| | |
|---|--|
| Input name | MRSP |
| Description | This input is the most restrictive speed profile. |
| Source | ??? |
| Type | MRSP_Profile_t |
| 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] |

4.2.2.1.7 MA

| | |
|------------|----|
| Input name | MA |
|------------|----|

| | |
|---|--|
| Description | This input is a movement authority. |
| Source | ??? |
| Type | MAs_t |
| 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] |

4.2.2.1.8 MA_updated

| | |
|---|---|
| Input name | MA_updated |
| Description | This flag is true if the movement authority has been updated in this clock cycle and false otherwise. |
| Source | internal |
| Type | bool |
| 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] |

210 4.2.2.1.9 MRSP_updated

| | |
|---|---|
| Input name | MRSP_updated |
| Description | This flag is true if the most restrictive speed profile has been updated in this clock cycle and false otherwise. |
| Source | internal |
| Type | bool |
| 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] |

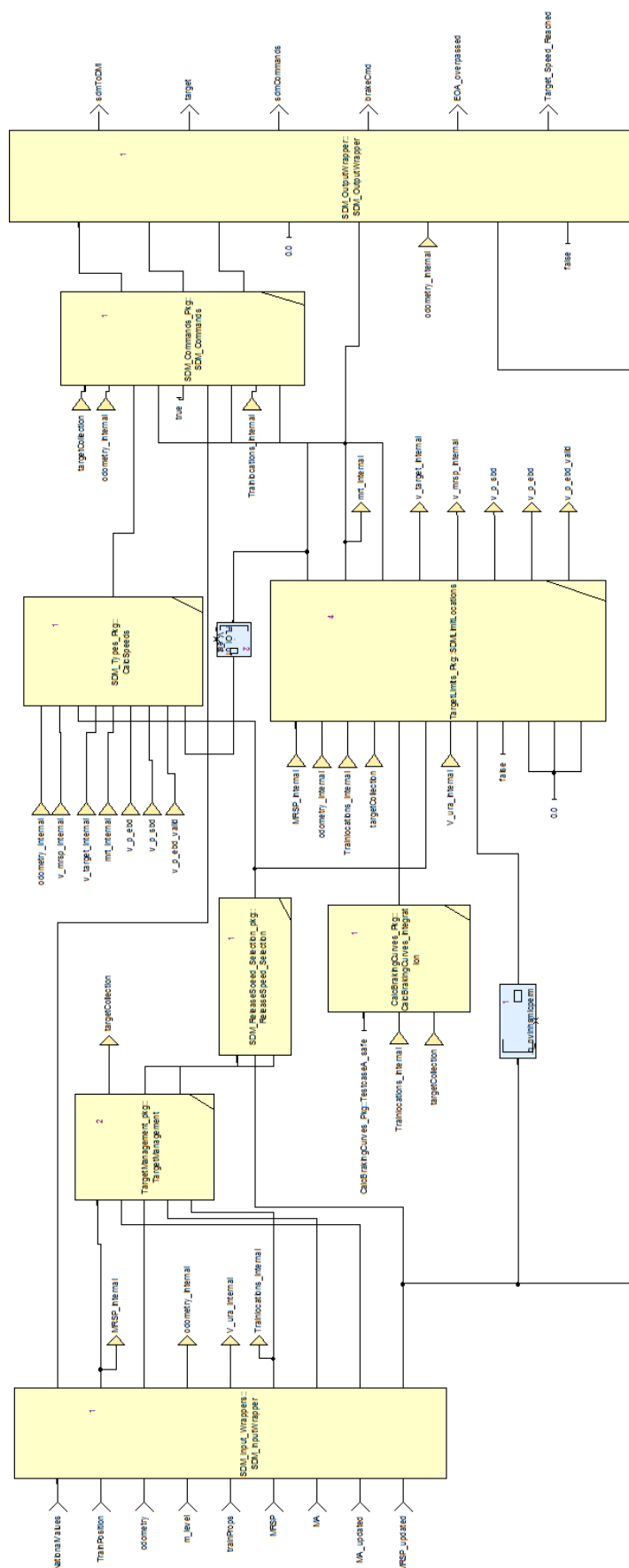


Figure 4. Structure of component ProvidePositionReport.

4.2.2.2 Outputs

4.2.2.2.1 sdmToDMI

| | |
|---|--|
| Output name | sdmToDMI |
| Description | This output contains information about different speeds and positions, on the one hand and the current supervision status, on the other hand. This information shall be displayed to the driver. |
| Destination | [Name of the destination component(s)] |
| Type | speedSupervisionForDMI_T |
| 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] |

4.2.2.2.2 target

| | |
|---|---|
| Output name | target |
| Description | This output is the most restrictive displayed target (MRDT). |
| Destination | [Name of the destination component(s)] |
| Type | Target_T |
| 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] |

4.2.2.2.3 sdmCommands

| | |
|-----------------------|--|
| Output name | sdmCommands |
| Description | This output gives some intermediate results of operator SDM_Commands. It is currently used for test purposes only. |
| Destination | [Name of the destination component(s)] |
| Type | SDM_Commands_T |
| 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] |

215 4.2.2.2.4 brakeCmd

| | |
|---|---|
| Output name | brakeCmd |
| Description | This output is the brake command, indicating whether performing the service brake or the emergency brake have been commanded. |
| Destination | [Name of the destination component(s)] |
| Type | Brake_command_T |
| 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] |

4.2.2.2.5 EOA_overpassed

| | |
|---|--|
| Output name | EOA_overpassed |
| Description | This output is true if the end of authority has been overpassed and false otherwise. |
| Destination | [Name of the destination component(s)] |
| Type | bool |
| 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] |

4.2.2.2.6 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 | [Name of the destination component(s)] |
| Type | bool |
| 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] |

4.2.3 Sub Components

4.2.3.1 Receive_TrackSide_Msg

220 4.2.3.1.1 Component Requirements

| | |
|------------------------|---|
| Component name | SDM_InputWrapper |
| Link to SCADE model | ??? |
| SCADE designer | Christian Stahl, TWT |
| Description | <p>The motivation for this operator is to convert all inputs of block “Speed Supervision” 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.</p> <p>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 ?? 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] |

4.2.3.1.2 Interface

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

4.2.3.2 TargetManagement

225 4.2.3.2.1 Component Requirements

| | |
|------------------------|--|
| Component name | TargetManagement |
| Link to SCADE model | ??? |
| SCADE designer | Christian Stahl, TWT |
| Description | <p>This operator calculates/updates the list of targets to be supervised by the block “Train Supervision”. 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 single End of Authority target, a list of all MRSP-Targets and a list of all LoA-Targets.</p> <p>Derivation of Targets from Movement Authority Sections The sections of the <i>Movement Authority</i> could cause two types of targets:</p> <p>End Of Authority(EoA) only one could exist and this is only in the <i>end section</i> of the <i>MA</i></p> <p>Limit of Authority (LoA) is possibly in every section of the <i>MA</i> except the end section</p> <p>In every cycle in which the <i>MA</i> is updated, the operator iterates through the entire <i>MA</i> and puts all speed limitations by <i>LoAs</i> into a list of targets. The end section is used to derived the <i>EoA</i> target. All <i>LoA</i> targets are sorted by location.</p> <p>Derivation of Targets from MRSP According to [1, Chapt. 3.13.8.2], every speed decrease of the <i>MRSP</i> is used to derive a target. Therefore in every cycle in which the <i>MRSP</i> is updated, the operator iterates through the entire <i>MRSP</i> searching for all <i>MRSP</i> targets. For this purpose, every element of the <i>MRSP</i> is compared with its successor.</p> <p>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 max safe front end position with the target position.</p> |
| Input documents | Subset-026, Chapter 3.13.8.2: Determination of the supervised targets |
| 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] |

4.2.3.2.2 Interface

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

4.2.3.3 CalcBrakingCurves_Integration

230 4.2.3.3.1 Component Requirements

| | |
|------------------------|---|
| Component name | CalcBrakingCurves_Integration |
| Link to SCADE model | ??? |
| SCADE designer | Christian Stahl, TWT |
| 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 after the estimated front end position of the train has been passed. |
| 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 | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

4.2.3.3.2 Interface

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

4.2.3.4 SDMLimitLocations

235 4.2.3.4.1 Component Requirements

| | |
|---------------------|-------------------|
| Component name | SDMLimitLocations |
| Link to SCADE model | ??? |
| SCADE designer | ??? |

| | |
|------------------------|--|
| Description | <p>This operator calculates the various locations 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 | [If applicable description of time constraints, otherwise n/a] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

4.2.3.4.2 Interface

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

4.2.3.5 CalcSpeeds

240 4.2.3.5.1 Component Requirements

| | |
|------------------------|--|
| Component name | CalcSpeeds |
| Link to SCADE model | ??? |
| SCADE designer | ??? |
| Description | This operator calculates the various speeds needed to determine the speed and distance monitoring commands. This operator will be integrated into other operators in the next iteration. |
| Input documents | Subset-026, Chapter 3.8: Movement authority |
| 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] |

4.2.3.5.2 Interface

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

4.2.3.6 ReleaseSpeed_Selection

245 4.2.3.6.1 Component Requirements

| | |
|------------------------|--|
| Component name | ReleaseSpeed_Selection |
| Link to SCADE model | ??? |
| SCADE designer | ??? |
| Description | This operator outputs the release speed which can be given either by the national values or the movement authority. This operator will be integrated into other operators in the next iteration. |
| Input documents | Subset-026, Chapter 3.8: Movement authority |
| 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] |

4.2.3.6.2 Interface

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

4.2.3.7 SDM_Commands

250 4.2.3.7.1 Component Requirements

| | |
|---------------------|---------------------|
| Component name | SDM_Commands |
| Link to SCADE model | ??? |
| SCADE designer | ??? |

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

4.2.3.7.2 Interface

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

4.2.3.8 SDM_OutputWrapper

255 4.2.3.8.1 Component Requirements

| | |
|------------------------|---|
| Component name | SDM_OutputWrapper |
| Link to SCADE model | ??? |
| SCADE designer | ??? |
| Description | <p>This operator is the counterpart to operator SDM_OutputWrapper—that is, it converts all internal outputs of block “Speed Supervision” that contain information about length, speed, distance, and acceleration defined as real into int, such that all other blocks can stick to their types and also performs the calculation into units used by the environment.</p> <p>This operator forwards input messages and transforms inputs messages into an internal type thereby converting real to int.</p> |
| Input documents | Subset-026, Chapter 3.13: Speed and distance monitoring |
| Safety integrity level | 4 |
| Time constraints | [If applicable description of time constraints, otherwise n/a] |

[Put SysML diagram of component here]
Figure 5. Manage_ETCS_Procedures component SysML diagram

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

4.2.3.8.2 Interface

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

4.3 Manage_ETCS_Procedures

260 4.3.1 Component Requirements

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

4.3.2 Interface

An overview of the interface of component Manage_ETCS_Procedures is shown in Figure 5. The inputs and outputs are described in detail in Section 4.3.2.1 respectively 4.3.2.2. Sub components are described in Section 4.3.3.

265 4.3.2.1 Inputs

4.3.2.1.1 [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] |
|---|--|

4.3.2.1.2 [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] |

4.3.2.2 Outputs

4.3.2.2.1 [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] |

270 4.3.2.2.2 [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] |

4.3.3 Sub Components

4.3.3.1 Awakening_of_train

4.3.3.1.1 Component Requirements

| | |
|------------------------|--|
| Component name | Manage_ETCS_Procedures |
| Link to SCADE model | https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/Procedures/ManageProcedure_Pkg.xscade |
| SCADE designer | ??? |
| Description | <p>This component describes the Start of Mission procedure of the train until the status of the awakness. From this point of the awakness the train will be able to start different modes, levels and further procedure. See scope of the Start of Mission - Awakness of train in the figure below.</p> <p>For the third iteration just a part of the Scope has been design. To complete the scenario in the third iteration the ideal path to the awakness of train until the state "waiting for Driver selection of "Start"" have been realized. Furthermore the initial data from the persistend database such as Level, Driver ID, Train Number, Train Data, Radio Number, RBC ID hase been consider as constants.</p> |
| Input documents | Subset-026, Chapter 5, § 5.4 |
| 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] |

4.3.3.1.2 Interface

²⁷⁵ For an overview of the interface of this internal component we refer to the SCADE model (c.f. link above) respectively the SCADE generated documentation.

4.3.3.2 SOM_Level_2_3

4.3.3.2.1 Component Requirements

| | |
|----------------|---------------|
| Component name | SOM_Level_2_3 |
|----------------|---------------|

| | |
|------------------------|--|
| Link to SCADE model | https://github.com/openETCS/modeling/blob/master/model/Scade/System/ObuFunctions/Procedures/SoM_SR_FS_OS_LS_SH_SN_UN.xscade |
| SCADE designer | ??? |
| Description | This functionality describes the Start of Mission procedure of the train in Level 2 or 3 and the Modes SR FS OS LS SH where the train under the defined Mode Level supervision starts running. For the this iteration just a part of the Scope has been design. To complete the scenario in the third iteration the path "Full Supervision Movement Authority received from RBC" has been realized. The state will end after the train receives the Change Authority to FS and will be ready to run. |
| Input documents | Subset-026, Chapter 5, § 5.4 |
| 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] |

4.3.3.2.2 Interface

²⁸⁰ For an overview of the interface of this internal component we refer to the SCADE model (c.f. link above) respectively the SCADE generated documentation.

4.4 Manage_Track_Data

4.4.1 Component Requirements

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

4.4.2 Interface

[Put SysML diagram of component here]
Figure 6. Manage_Track_Data component SysML diagram

285 An overview of the interface of component Manage_Track_Data is shown in Figure 6. The inputs and outputs are described in detail in Section 4.4.2.1 respectively 4.4.2.2. Sub components are described in Section 4.4.3.

4.4.2.1 Inputs

4.4.2.1.1 [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] |

290 **4.4.2.1.2 [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] |

4.4.2.2 Outputs

4.4.2.2.1 [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] |

4.4.2.2.2 [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] |

4.4.3 Sub Components

295 4.4.3.1 Calculate_Train_Position

4.4.3.1.1 Component Requirements

| | |
|---------------------|--------------------------|
| Component name | Calculate_Train_Position |
| Link to SCADE model | ??? |
| SCADE designer | ??? |

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

4.4.3.1.2 Interface

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

300 4.4.3.2 Provide_Position_Report

4.4.3.2.1 Component Requirements

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

| | |
|------------------------|--|
| Link to SCADE model | ??? |
| SCADE designer | ??? |
| Description | <p>This function takes the current train position and generates a position report which is sent to the RBC. The point in time when such a report is sent is determined by events, on the one hand, and position report parameters—which are basically triggers—provided by the RBC or a balise group passed, on the other hand. The functionality is modeled using four operators, which are explained below.</p> <p>CalculateSafeTrainLength Calculates the the <code>safeTrainLength</code> and the <code>MinSafeRearEnd</code> according to [1, Chapter 3.6.5.2.4/5]. <code>safeTrainLength = absolute(EstimatedFrontEndPosition - MinSafeRearEnd)</code> where <code>MinSafeRearEnd = minSafeFrontEndPosition - L_TRAIN</code>.</p> <p>EvaluateTriggerAndEvents Returns a Boolean modelling whether the sending of the next position report is triggered or not. This value is the conjunction of the evaluation of all triggers (<code>PositionReportParameters</code>, i.e., Packet 58) and events (see [1, Chapter 3.6.5.1.4]).</p> <p>ErrorManager Takes a boolean flag for each possible error that has been occurred and outputs the respective error using type <code>M_ERROR</code>.</p> <p>CollectData This operation aggregates data of Packet 0, ..., Packet 5 and the header to a position report.</p> |
| Input documents | Subset-026, Chapter 3.6.5 |
| 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] |

4.4.3.2.2 Interface

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

4.5₃₀₅ Mode_and_Level

4.5.1 Component Requirements

| | |
|---------------------|----------------|
| Component name | Mode_and_Level |
| Link to SCADE model | ??? |
| SCADE designer | ??? |
| Description | ??? |

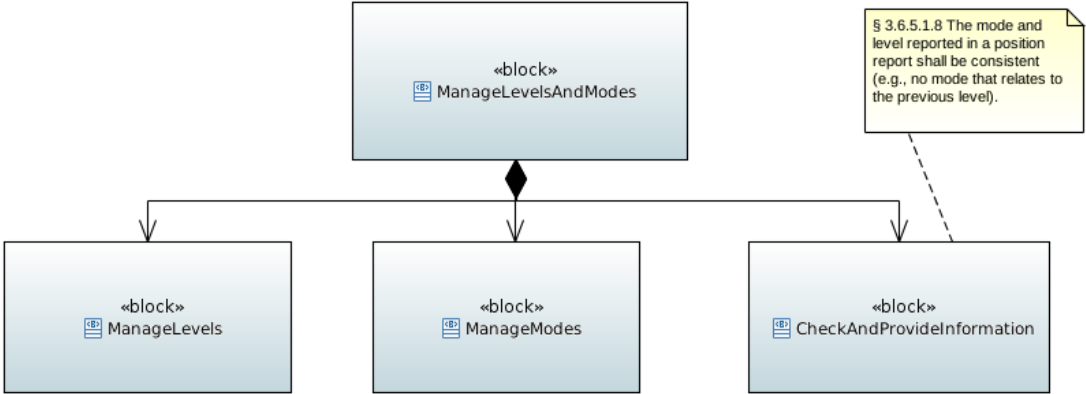


Figure 7. Mode_and_Level component SysML diagram

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

4.5.2 Interface

An overview of the interface of component Mode_and_Level is shown in Figure 7. The inputs and outputs are described in detail in Section 4.5.2.1 respectively 4.5.2.2. Sub components are described in Section 4.5.3.

4.5.2.1 Inputs

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

4.5.2.1.2 [Input 2 name]

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

310

4.5.2.2 Outputs

315 4.5.2.2.1 [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] |

4.5.2.2.2 [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] |

4.5.3 Sub Components

4.5.3.1 Level_Management

4.5.3.1.1 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, Systere1 |
| 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 acknowledge 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] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

320 4.5.3.1.2 Interface

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

4.5.3.2 Mode_Management

4.5.3.2.1 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, Systere1 |

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

325 4.5.3.2.2 Interface

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

4.5.3.3 Check_and_Provide_Mode_and_Level

4.5.3.3.1 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] |
| API requirements | [If applicable description of API requirements, otherwise n/a] |

Management of radio communication SysML diagramm
Figure 8. Manage_Radio_Communication component SysML diagram

330 4.5.3.3.2 Interface

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

4.6 Manage_Radio_Communication

4.6.1 Component Requirements

| | |
|------------------------|--|
| Component name | Mode_and_Level |
| Link to SCADE model | ??? |
| SCADE designer | Uwe Steinke, Siemens AG |
| Description | ??? |
| 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] |

335 4.6.2 Interface

An overview of the interface of component Manage_Radio_Communication is shown in Figure 8. The inputs and outputs are described in detail in Section 4.6.2.1 respectively 4.6.2.2. Sub components are described in Section 4.6.3.

4.6.2.1 Inputs

340 4.6.2.1.1 [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] |

4.6.2.1.2 [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] |

4.6.2.2 Outputs**4.6.2.2.1 [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] |

4.6.2.2.2 [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] |

345 4.6.3 Sub Components

4.6.3.1 Management_of_Radio_Communication

4.6.3.1.1 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 | Marielle Petit-Doche, Systerel |

| | |
|------------------------|---|
| Description | <p>The management of radio communication <i>MoRC</i> implements the onboard management part of a single communication session with the track, i.e. a single RBC. It controls the establishing, maintaining and termination process of a radio communication session and steers the underlying communication safety layer and the mobile device. Those and the data transfer itself are not part of the function.</p> <p>The kernel function of the <i>MoRC</i> component is <i>managementOfRadioCommunication</i> (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, <i>managementOfRadioCommunication</i> does neither.</p> <p>To be capable of being integrated with other OBU software components, <i>MoRC</i> 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 <i>MoRC</i>, <i>MoRC_Main</i>.</p> <p>The function <i>managementOfRadioCommunication</i> 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 <i>NoSession</i>) currently, the state machine waits for events that initiate a session (subfunction <i>initiate_a_Session</i>). When the appropriate conditions are fulfilled, the state machine moves to the <i>Establishing</i> state. Here in, it runs through the sequence required for establishing a session (subfunction <i>establish_a_Session</i>). Dependent on the results, the state machine changes over to the <i>Maintaining</i> or <i>Terminating</i> state. While in <i>Maintaining</i>, the communication connection is monitored. When an event triggering the session termination occurs, the state machine switches to the state <i>Terminating</i> with the subfunction <i>terminating_a_CommunicationSession</i> and performs the session termination sequence.</p> <p>In parallel to the main state machine, <i>managementOfRadioCommunication</i> monitors all the time whether the session has to be terminated (subfunction <i>initiateTerminatingASession</i>) or if the session has to be terminated and subsequently established (subfunction <i>terminateAndEstablishSession</i>). <i>registeringToTheRadioNetwork</i> is responsible for connection to the radio network. <i>safeRadioConnectionIndication</i> controls the radio connection indication for the driver.</p> |
| 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] |

4.6.3.1.2 Interface

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

5 F3: Measure Train Movement

6 F4: Manage Radio Communication

7 F5: Manage JRU

8 F6: DMI Controller

8.1³⁵⁵ DMI

8.1.1 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] |

8.1.2 Interface

An overview of the interface of component DMI is shown in Figure 9. The inputs and outputs are described in detail in Section 8.1.2.1 respectively 8.1.2.2.

³⁶⁰ 8.1.2.1 Inputs

8.1.2.1.1 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] |

8.1.2.1.2 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] |

8.1.2.1.3 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] |

8.1.2.1.4 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] |

365 8.1.2.1.5 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] |

8.1.2.1.6 DMI_icons

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

8.1.2.1.7 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 boundary] |
| Behaviour for values out of valid range | [Description of components behaviour when input value is out of valid range] |

8.1.2.1.8 DMI_train_running_number

| | |
|---|--|
| Input name | DMI_train_running_number |
| Description | Contains the default or entered train running number |
| 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] |

8.1.2.1.9 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] |

370 8.1.2.1.10 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] |

8.1.2.2 Outputs

8.1.2.2.1 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] |

8.1.2.2.2 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] |

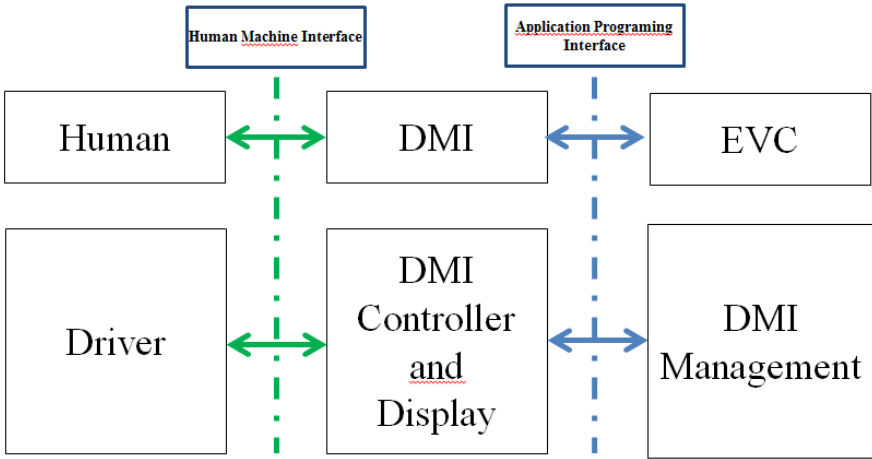


Figure 9. DMI component SysML diagram

8.1.2.2.3 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] |

8.1.2.2.4 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] |

8.1.2.2.5 DMI_text_message_ack

| | |
|-------------|------------------------------|
| Output name | DMI_text_message_ack |
| Description | Text message acknowledgement |

8.1.2.2.6 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] |

8.1.2.2.7 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] |

8.1.2.2.8 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] |

380 **8.1.2.2.9 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] |

References

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