

Work Package 3: "Modeling"

openETCS Architecture and Design Specification

Software Component Design and Internal Interface Specification

Peter Mahlmann, Bernd Hekele, Baseliyos Jacob, Peyman Farhang, Uwe Steinke, Christian Stahl, Jakob Gärtner, Mairamou Haman Adji, Stefan Karg, Jos Holtzer, Jan Welvaarts, Vincent Nuhaan, Thorsten Schulz, Benjamin Beichler, Marielle Petit-Doche, Matthias Güdemann, Veronique Gontier, Christian Giraud, Fausto Cochetti, Alexander Stante and David Mentre

September 2015



Funded by:


 Federal Ministry
 of Education
 and Research

 Région de
 Bruxelles-
 Capitale

 GOBIERNO
 DE ESPAÑA

 MINISTERIO
 DE INDUSTRIA, ENERGÍA
 Y TURISMO

This page is intentionally left blank

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

openETCS Architecture and Design Specification

Software Component Design and Internal Interface Specification

Document approbation

Lead author:	Technical assessor:	Quality assessor:	Project lead:
location / date	location / date	location / date	location / date
signature	signature	signature	signature
Peter Mahlmann (DB Netz AG)	Jan Welte (Technische Universität Braunschweig)	Izaskun de la Torre (SQS)	Klaus-Rüdiger Hase (DB Netz AG)

Peter Mahlmann, Bernd Hekele, Baseliyos Jacob, Peyman Farhang

DB Netz AG

Uwe Steinke

Siemens AG

Christian Stahl

TWT GmbH

Jakob Gärtner, Mairamou Haman Adji, Stefan Karg

LEA Railergy

Jos Holtzer, Jan Welvaarts, Vincent Nuhaan

Nederlandss Spoorwegen

Thorsten Schulz, Benjamin Beichler

University of Rostock

Marielle Petit-Doche, Matthias Güdemann

Systerel

Veronique Gontier

All4Tec

Christian Giraud, Fausto Cochetti

Alstom

Alexander Stante

Fraunhofer ESK

David Mentre

MERCE

Architecture and Design Specification

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

Disclaimer: This work is licensed under the "openETCS Open License Terms" (oOLT) dual Licensing: European Union Public Licence (EUPL v.1.1+) AND Creative Commons Attribution-ShareAlike 3.0 – (cc by-sa 3.0)

THE WORK IS PROVIDED UNDER openETCS OPEN LICENSE TERMS (oOLT) WHICH IS A DUAL LICENSE AGREEMENT INCLUDING THE TERMS OF THE EUROPEAN UNION PUBLIC LICENSE (VERSION 1.1 OR ANY LATER VERSION) AND THE TERMS OF THE CREATIVE COMMONS PUBLIC LICENSE ("CCPL"). THE WORK IS PROTECTED BY COPYRIGHT AND/OR OTHER APPLICABLE LAW. ANY USE OF THE WORK OTHER THAN AS AUTHORIZED UNDER THIS OLT LICENSE OR COPYRIGHT LAW IS PROHIBITED.

BY EXERCISING ANY RIGHTS TO THE WORK PROVIDED HERE, YOU ACCEPT AND AGREE TO BE BOUND BY THE TERMS OF THIS LICENSE. TO THE EXTENT THIS LICENSE MAY BE CONSIDERED TO BE A CONTRACT, THE LICENSOR GRANTS YOU THE RIGHTS CONTAINED HERE IN CONSIDERATION OF YOUR ACCEPTANCE OF SUCH TERMS AND CONDITIONS.

<http://creativecommons.org/licenses/by-sa/3.0/>
<http://joinup.ec.europa.eu/software/page/eupl/licence-eupl>

Modification History

Version	Sections	Modification / Description	Author	Date
0.1	all	Initial document providing structure	Peter Mahlmann	27.05.2015
0.2	2	New template for design descriptions	Peter Mahlmann	10.06.2015
0.3	all	Transferred existing documentation to new template	Peter Mahlmann	22.06.2015
0.4	5	Updated component hierarchy to match current SCADE model	Peter Mahlmann	15.09.2015

Table of Contents

Modification History	iv
List of Figures	ix
Todo list	x
1 Introduction	1
1.1 Input Documents	1
1.2 Software and Tools used for Development	1
1.3 General Remarks on the openETCS OBU Model	2
I System Architecture and Functional Breakdown	3
2 System Architecture	4
2.1 Top Level Architecture and External Interfaces	4
2.2 Functional breakdown of the ETCS OBU	4
II Design Description	8
3 General Design Decisions	9
4 F1: Receive Information from Trackside	10
4.1 ETCS Messaging: TrackMessages	10
4.1.1 Component Requirements	10
4.1.2 Interface	11
4.1.2.1 Inputs	11
4.1.2.2 Outputs	12
4.1.3 Subcomponents	14
4.1.3.1 Read_Packets	14
4.1.3.2 Extract Packet 5	15
5 F2: ETCS Kernel	17
5.1 ETCS Kernel Overview	17
5.1.1 External Interfaces	18
5.1.1.1 External Inputs	18
5.1.1.2 External Outputs	19
5.2 F2.1: Manage_TrackSideInformation_Integration	20
5.2.1 Component Requirements	20
5.2.2 Interface	21
5.2.2.1 Inputs	21
5.2.2.2 Outputs	30
5.2.3 Subcomponents	38
5.2.3.1 Receive_TrackSide_Msg	38
5.2.3.2 CheckBGConsistency	39
5.2.3.3 CheckEuroradioMessage	41
5.2.3.4 ValidateDataDirection	41
5.2.3.5 InformationFilter	42

5.3	F2.2: Manage_ETCS_Procedures	43
5.3.1	Component Requirements	43
5.3.2	Interface	45
5.3.2.1	Inputs	45
5.3.2.2	Outputs	50
5.3.3	Subcomponents	54
5.3.3.1	Awakness_of_Train	54
5.3.3.2	NP	54
5.3.3.3	SoM_L2_3_FS_SR_OS_LS_SH	55
5.3.3.4	SoM_NTC_SN	55
5.4	F2.3: trainData	56
5.4.1	Component Requirements	56
5.4.2	Interface	57
5.4.2.1	Inputs	57
5.4.2.2	Outputs	61
5.4.3	Subcomponents	62
5.5	F2.4: TrackAtlas	62
5.5.1	Component Requirements	62
5.5.2	Interface	63
5.5.2.1	Inputs	63
5.5.2.2	Outputs	64
5.5.3	Subcomponents	64
5.5.3.1	StoreRaw_NV	65
5.5.3.2	Build_GradientProfile	65
5.5.3.3	Build_MA	66
5.5.3.4	Build_MRSP	66
5.5.3.5	Manage_EmergencyStop	67
5.5.3.6	C_P003V1_OBU_P003_OBU	67
5.5.3.7	GradientProfile_to_DMI	68
5.5.3.8	Manage_MA_Request	68
5.5.3.9	TA_to_ML	69
5.5.3.10	SSP_to_MRSP	69
5.5.3.11	MRSP_to_MRSP_to_DMI	70
5.6	F2.5: Mode_and_Level	70
5.6.1	Component Requirements	70
5.6.2	Interface	70
5.6.2.1	Inputs	71
5.6.2.2	Outputs	75
5.6.3	Subcomponents	76
5.6.3.1	Level_Management	76
5.6.3.2	Mode_Management	77
5.6.3.3	Check_and_Provide_Mode_and_Level	78
5.7	F2.6: calculateTrainPosition	79
5.7.1	Component Requirements	79
5.7.2	Interface	80
5.7.2.1	Inputs	81
5.7.2.2	Outputs	85
5.7.3	Subcomponents	90
5.7.3.1	msg_2_passedBG	90
5.7.3.2	calculateBGLocations	90
5.7.3.3	delDispensableBGs	91
5.7.3.4	addAnnouncedBGs	92

5.7.3.5	calculateTrainpositionInfo	92
5.7.3.6	calculateTrainPositionAttributes	93
5.7.3.7	linkedBG_missed	93
5.7.3.8	twoconsecutiveLinkedBGs_missed	94
5.8	F2.7: SpeedSupervision_Integration	95
5.8.1	Component Requirements	95
5.8.2	Interface	95
5.8.2.1	Inputs	95
5.8.2.2	Outputs	100
5.8.3	Subcomponents	104
5.8.3.1	SDM_InputWrapper	104
5.8.3.2	TargetManagement	105
5.8.3.3	AGradient	106
5.8.3.4	ABrakeFactory	107
5.8.3.5	addGradient	108
5.8.3.6	CalcBrakingCurves_Integration	108
5.8.3.7	SDMLimitLocations	109
5.8.3.8	SDM_Commands	110
5.9	F2.8: Provide_Position_Report.....	111
5.9.1	Component Requirements	111
5.9.2	Interface	112
5.9.2.1	Inputs	112
5.9.2.2	Outputs	121
5.9.3	Subcomponents	123
5.9.3.1	ReceiveReportParameters	123
5.9.3.2	PosReport_Supervision	123
5.9.3.3	ErrorManager	124
5.9.3.4	Build_Packets0_1	124
5.9.3.5	Build_PosReport	125
5.9.3.6	AddBGToFIFO	126
5.10	F2.9: Manage_Radio_Communication and RBC_Handover.....	126
5.10.1	Component Requirements	126
5.10.2	Interface	127
5.10.2.1	Inputs	128
5.10.2.2	Outputs	136
5.10.3	Subcomponents	144
5.10.3.1	RBC_Handover	144
5.10.3.2	Management_of_Radio_Communication	145
5.10.3.3	mobileDataRouter	146
5.11	F2.10: ManageDMIInput	147
5.11.1	Component Requirements	147
5.11.2	Interface	147
5.11.2.1	Inputs	147
5.11.2.2	Outputs	148
5.11.3	Subcomponents	149
5.12	F2.11: ManageDMIOutput	149
5.12.1	Component Requirements	149
5.12.2	Interface	150
5.12.2.1	Inputs	150
5.12.2.2	Outputs	151
5.12.3	Subcomponents	151
5.12.3.1	cyclicReportToDMI	152

5.12.3.2	ManageTextMessages	152
5.12.3.3	copyTrackDescription	153
5.12.3.4	toEntryRequest	153
5.12.3.5	sendBrakesToDMI	154
5.12.3.6	manageDMI_Output	154
5.12.3.7	sendTrainData	155
5.12.3.8	sendVersion	155
5.12.3.9	sendLevelListPkg	156
5.13	F2.12: ManageTIUInput	156
5.13.1	Component Requirements	156
5.13.2	Interface	156
5.13.2.1	Inputs	157
5.13.2.2	Outputs	157
5.13.3	Subcomponents	158
5.13.3.1	mergeTIU_Info	158
5.13.3.2	getTIUStatusFromData	159
5.14	F2.13: ManageTIUOutput	159
5.14.1	Component Requirements	159
5.14.2	Interface	160
5.14.2.1	Inputs	160
5.14.2.2	Outputs	161
5.14.3	Subcomponents	162
5.14.3.1	handleTraction	162
5.14.3.2	manageTIU_output	162
6	F3: Measure Train Movement	164
7	F4: Manage Radio Communication	165
8	F5: Manage JRU	166
9	F6: DMI Controller	167
9.1	DMI	167
9.1.1	Component Requirements	167
9.1.2	Interface	167
9.1.2.1	Inputs	167
9.1.2.2	Outputs	172
	References	176

List of Figures

Figure 1. Scope of openETCS OBU model system according to ERA TSI Chapter 2.5.....	5
Figure 2. Top level architecture with external interfaces.....	6
Figure 3. DMI Interfaces.....	6
Figure 4. 2nd level system architecture view.....	7
Figure 5. TrackMessages SysML diagram.....	11
Figure 6. F2: ETCS Kernel SysML diagram.....	17
Figure 7. Manage_TrackSideInformation_Integration component SysML diagram.....	25
Figure 8. High level overview of the InformationFilter components.....	44
Figure 9. Manage_ETCS_Procedures component SysML diagram.....	45
Figure 10. trainData component SysML diagram.....	57
Figure 11. TrackAtlas component SysML diagram.....	63
Figure 12. Mode_and_Level component SysML diagram.....	71
Figure 13. calculateTrainPosition SysML diagram.....	81
Figure 14. Structure of component SpeedSupervision_Integration.....	96
Figure 15. Provide_Position_Report component SysML diagram.....	112
Figure 16. Manage_Radio_Communication component SysML diagram.....	128
Figure 17. ManageDMIInput SysML diagram.....	152
Figure 18. ManageDMIOutput SysML diagram.....	152
Figure 19. ManageTIUInput SysML diagram.....	157
Figure 20. ManageTIUOutput SysML diagram.....	160
Figure 21. DMI component SysML diagram.....	170

Todo list

list has to be completed.....	1
list and descriptions have to be checked for completeness.....	1
Hashtag has to be updated once the model and document are ready for release.....	2
has to be completed	4
paragapoh has to be checked and extended to be more clear.....	4
check if figure is correct. Do we need this figure anyway? If so, make it more appealing.....	4
Figure is incomplete and erroneous... F2 is not connected, F2 exists twice	4
Should this block be described using the new component description template? Section needs to be completed	4
to be completed.....	9
Chapter needs to be completed. Will there be more components?.....	10
section needs to be completed	10
Figure: [Put SysML diagram of component here]	11
components should be listed here	12
to be checked.....	12
to be checked.....	17
descriptions needs to be improved	17
descriptions needs to be improved	17
to be completed.....	17
descriptions needs to be improved	17
Figure: [Put SysML diagram of component here]	17
to be checked.....	18
to be checked.....	18

[illegible]

To be completed.....	34
To be completed.....	34
To be completed.....	34
To be completed.....	34
To be completed.....	34
To be completed.....	34
To be completed.....	34
To be completed.....	34
To be completed.....	35
To be completed.....	35
To be completed.....	35
To be completed.....	35
To be completed.....	35
To be completed.....	35
To be completed.....	35
To be completed.....	35
To be completed.....	36
To be completed.....	36
To be completed.....	36
To be completed.....	36
To be completed.....	36
To be completed.....	36
To be completed.....	36
To be completed.....	37
To be completed.....	37
To be completed.....	37
To be completed.....	37
To be completed.....	37

To be completed.....	37
To be completed.....	37
To be completed.....	37
Information filter component description needs to be checked, i.e. is the description still up to date? Should more documentation provided for this component in the ADD (please check with Bernd Hekele)?	42
Figure: [Put SysML diagram of component here]	45
To be completed.....	45
To be completed.....	47
To be completed.....	47
To be completed.....	47
To be completed.....	47
To be completed.....	47
To be completed.....	47
To be completed.....	48
To be completed.....	48
exact name of component in the SCADE model has be used	48
To be completed.....	48
To be completed.....	48
To be completed.....	48
To be completed.....	48
To be completed.....	49
To be completed.....	49
To be completed.....	49
To be completed.....	49
exact name of component in the SCADE model has be used	49
To be completed.....	50

To be completed.....	50
To be completed.....	50
To be completed.....	50
exact name of component in the SCADE model has be used	50
To be completed.....	51
To be completed.....	51
To be completed.....	51
To be completed.....	51
exact name of component in the SCADE model has be used	51
To be completed.....	51
To be completed.....	51
To be completed.....	52
To be completed.....	52
exact name of component in the SCADE model has be used	52
exact name of component in the SCADE model has be used	52
exact name of component in the SCADE model has be used	53
Figure: [Put SysML diagram of component here]	57
descriptions needs to be improved to be more comprehensive.....	57
Looking at this input this seems to be a complex structure. Consider describing the structure instead of refering to the valid flag only.	58
Looking at this input this seems to be a complex structure. Consider describing the structure instead of refering to the valid flag only.	59
Looking at this input this seems to be a complex structure. Consider describing the structure instead of refering to the valid flag only.	59
Looking at this input this seems to be a complex structure. Consider describing the structure instead of refering to the valid flag only.	60
section needs to be completed	61
section needs to be completed	62

Section needs to be completed.....	62
Figure: [Put SysML diagram of component here]	63
table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a paritcular input ot output.	71
more detail should be given here.....	71
to be completed.....	71
to be completed.....	71
to be completed.....	72
table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a paritcular input ot output.	72
to be completed.....	72
to be completed.....	72
to be completed.....	72
to be completed.....	72
table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a paritcular input ot output.	72
to be completed.....	73
to be completed.....	73
to be completed.....	73
table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a paritcular input ot output.	73
to be completed.....	73
to be completed.....	74
to be completed.....	74
table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a paritcular input ot output.	74
to be completed.....	74
to be completed.....	74

to be completed.....	74
to be completed.....	74
table has been truncated. Please do not remove rows from the table template. Just use "n/a" if a row is not relevant for a particular input or output.	74
Please use exact component name from SCADE model.	75
to be completed.....	75
to be completed.....	75
to be completed.....	75
Description of outputs needs to be completed	75
to be completed.....	77
to be completed.....	77
to be completed.....	78
to be completed.....	78
to be completed.....	79
to be completed.....	79
To be completed.....	97
Figure: [Put SysML diagram of component here]	128
section and corresponding subsections have to be completed.....	147
section and corresponding subsections have to be completed.....	149
Figure: [Put SysML diagram of component here]	152
Figure: [Put SysML diagram of component here]	152
section and corresponding subsections have to be completed.....	156
Figure: [Put SysML diagram of component here]	157
section and corresponding subsections have to be completed.....	159
Figure: [Put SysML diagram of component here]	160
This chapter needs to be completed and a responsible developer has to be identified.....	167

1 Introduction

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

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

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

1.1 Input Documents

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

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

list has to be completed

1.2 Software and Tools used for Development

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

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

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

list and descriptions have to be checked for completeness

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

1.3 36 General Remarks on the openETCS OBU Model

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

41 1c06cc2d4a0d8f27569e065e2a9edf924b453ff1

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

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

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

48

Part I

49

System Architecture and Functional Breakdown

50

2 System Architecture

has to be completed

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

2.1 Top Level Architecture and External Interfaces

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

paragaphoh has to be checked and extended to be more clear

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

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

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

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

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

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

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

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

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

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

2.2 Functional breakdown of the ETCS OBU

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

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

Should this block be described using the new compo-



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



Figure 2. Top level architecture with external interfaces.



Figure 3. DMI Interfaces.



Figure 4. 2nd level system architecture view.

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

Part II

Design Description

3⁹⁹ General Design Decisions

100

to be completed

4 F1: Receive Information from Trackside

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

4.1 ETCS Messaging: TrackMessages

section needs to be completed

4.1.1 Component Requirements

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

Input documents	Subset-026, Chapter 6 Subset-026, Chapter 7 Subset-026, Chapter 8 The objective of this component (the full TrackMessages library) is to provide a full formalisation of above chapters in Subset-026
Safety integrity level	4
Time constraints	n/a (for the provided example function)
API requirements	In the demonstrator context, the API is fully defined on SCADE model level. For integration with external systems (BTM, Radio, Subset-076 or Subset-94), additional conversion to/ from bit-level representation will be required

106 **4.1.2 Interface**

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

109 **4.1.2.1 Inputs**

110 **4.1.2.1.1 Message_In**

Input name	Message_In
Description	Message_In takes the compressed track-to-train messages that have either been compressed by the trackside simulation components of the TrackMessages library, or have been filled by the API. All packets that are part of the same message are transmitted within one cycle of the model's execution. Message_IN is taking the compressed packet information from the track to train dataflow.
Source	Manage_TrackSideInformation_Integration
Type	Common_Types_Pkg::CompressedPackets_T

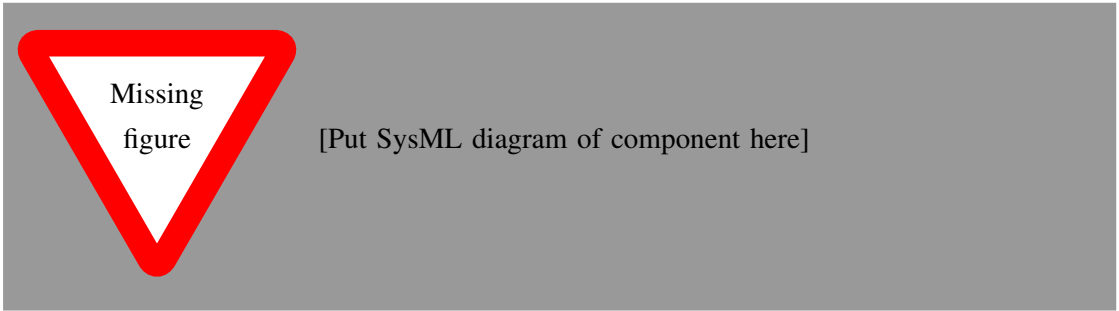


Figure 5. TrackMessages SysML diagram

Valid range of values	The consistency of the metadata is checked at the input side. The ranges of the transported variables are checked at the conversion step (from integer format to SRS-conform format).
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	The content of this input is not checked, as any issues will be found at conversion level. If the metadata are not matching the search criteria the packet will be considered as non existent and will therefore be ignored.

111 4.1.2.2 Outputs

112 4.1.2.2.1 received

Output name	received
Description	Flag to indicate reception of a packet 5 from trackside in the current cycle.
Destination	Any calling component. components should be listed here
Type	bool
Valid range of values	to be checked true Packet 5 has been received in the current cycle. false Packet 5 has not been received in the current cycle.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

113 4.1.2.2.2 P005_OBU_out

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

Type	TM::P005_OBU_T
Valid range of values	<p>TM::P005_OBU_T is a complex data type. Values are given for each element. Format is: Type Name: range/list of values</p> <ul style="list-style-type: none"> • bool valid: [true false] • q_dir Q_DIR: [Q_DIR_Both_directions Q_DIR_Nominal Q_DIR_Reverse] • l_packet L_PACKET: (0-8191) • q_scale Q_SCALE: [ENUM_Q_SCALE_10cm ENUM_Q_SCALE_1m ENUM_Q_SCALE_10m] • n_iter N_ITER: (0-33) (<i>Remark: start section from the original packet is integrated into the list of sections</i>) <p>The structured element sections is an array of type P005_section_enum_T. For each element, the valid range of values is as follows:</p> <ul style="list-style-type: none"> • bool valid: [true false] (<i>Remark: Check for consistency with the value of n_iter</i>) • d_link D_LINK: (0-32767) • q_newcountry Q_NEWCOUNTRY: [TM_conversions::ENUM_Q_NEWCOUNTRY_same TM_conversions::ENUM_Q_NEWCOUNTRY_not_same] • nid_c NID_C: (0-1023) • nid_bg NID_BG: (0-16383) • q_linkorientation Q_LINKORIENTATION: [TM_conversions::ENUM_Q_LINKORIENTATION_reverse TM_conversions::ENUM_Q_LINKORIENTATION_nominal] • q_linkreaction Q_LINKREACTION: [TM_conversions::ENUM_Q_LINKREACTION_Train_trip TM_conversions::ENUM_Q_LINKREACTION_Apply_service_brake TM_conversions::ENUM_Q_LINKREACTION_No_Reaction] • q_locacc Q_LOCACC: (0-63) <p><i>Only an output structure with the structured element "valid" set to "true" is to be considered as received. If this field is set to true, the Output 1 (received) must equally be set to "true".</i></p>

Behaviour when value is at boundary n/a

Behaviour for values out of valid range

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

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

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

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

114 4.1.3 Subcomponents

115 4.1.3.1 Read_Packets

116 4.1.3.1.1 Component Requirements

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

Description	<p>RECV_ReadPackets extracts packet data information and raw compressed packet data from the compressed packets data flow, using filter criteria provided through parameter inputs:</p> <ul style="list-style-type: none"> • NID_PACKET: search for a specific packet. • Version Number: search for a specific version number. • Q_DIR: search for packets that are only valid for a specific direction. • Serial number: search for a specific packet instance, if several instances of a given packet type exist. • F_Version: Flag to decide whether to evaluate or ignore packet version information. • F_id: Flag whether to evaluate or ignore packet serial number information. <p>The operator TM_lib_internal::RECV_ReadPackets takes a set of parameter data to:</p> <ol style="list-style-type: none"> 1. Search the metadata of the compressed packets data flow using the provided parameters to determine if a matching packet is contained in any given cycle. 2. Output the flag "received" exactly in any cycle a matching packet is found 3. Output an array of compressed packet data that is filled with the data from the identified packet.
-------------	--

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

117 4.1.3.1.2 Interface

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

120 4.1.3.2 Extract Packet 5

121 4.1.3.2.1 Component Requirements

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

122 4.1.3.2.2 Interface

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

5 F2: ETCS Kernel

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

5.1 ETCS Kernel Overview

The ETCS Kernel module consists of the 13 functional components, i.e. F1.1 to F1.13 as depicted in Figure 6. In the following we briefly describe the functionality of these subcomponents.

F2.1: Manage_TrackSideInformation_Integration This component is responsible for receiving Eurobalise telegrams and Euroradio messages from the API and performs several consistency checks on the inputs. For details see Section 5.2.

to be checked

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

descriptions needs to be improved

F2.3: trainData Implementation of the train data with the corresponding interfaces to track, driver and RBC. For details see Section ??.

descriptions needs to be improved

F2.4: TrackAtlas t.b.d. For details see Section ??.

to be completed

F2.5: Mode_and_Level Defines the status of the ETCS regarding on-board functional status and track infrastructure. For details see Section ??.

descriptions needs to be improved

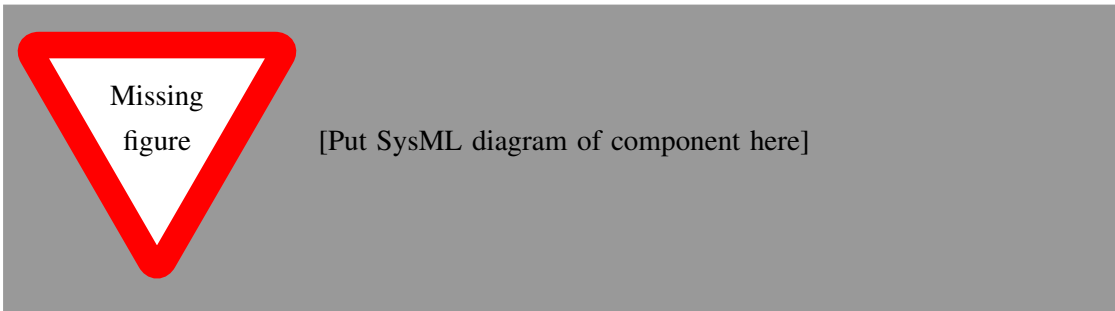


Figure 6. F2: ETCS Kernel SysML diagram

149 **F2.6: calculateTrainPosition** The purpose of this component is to calculate the locations of
 150 linked and unlinked balise groups and the current train position while the train is running
 151 along the track. For details see Section ??.

152 **F2.7: SpeedSupervision_Integration** This component monitors the current speed of the train
 153 and its location to ensure that the speed remains within the given speed and distance limits.
 154 For details see Section ??.

155 to be checked

156 **F2.8: Provide_Position_Report** The component builds a position report for the RBC, i.e.,
 157 message 132, and provides it as an output. For details see Section ??.

158 to be checked

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

164 **F2.10: ManageDMIInput** This component handles messages respectively data coming from
 165 the Driver Machine Interface (DMI) to the ETCS OBU. For details see Section ??.

166 to be checked

167 **F2.11: ManageDMIOutput** This component handles messages respectively data being send
 168 from the ETCS OBU to the DMI. For details see Section ??.

169 to be checked

170 **F2.12: ManageTIUInput** This component handles messages respectively data coming from
 171 the Train Interface Unit (TIU) to the ETCS OBU. For details see Section ??.

172 to be checked

173 **F2.13: ManageTIUOutput** This component handles messages respectively data being send
 174 from the ETCS OBU to the TIU. For details see Section 5.14.

175 to be checked

176 5.1.1 External Interfaces

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

179 5.1.1.1 External Inputs

180 5.1.1.1.1 [Input 1 name]

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

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

181 5.1.1.1.2 [Input 2 name]

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

182 5.1.1.2 External Outputs

183 5.1.1.2.1 [Output 1 name]

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

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

184 5.1.1.2.2 [Output 2 name]

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

5.2₁₈₅ F2.1: Manage_TrackSideInformation_Integration

186 5.2.1 Component Requirements

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

Description	<p>The 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. Finally, the received message is handled in the information filter. The information filter may, depending on level, mode and announced level transitions and radio handover scenarios, let information pass immediately, store information for a later transfer or reject information.</p> <p>Information in this sense is packets in the context of messages.</p>
-------------	---

Input documents	See subcomponents.
Safety integrity level	4
Time constraints	The component has to be able to receive balise telegrams and radio messages according to the ETCS [?] performance requirements). In highspeed traffic, a group of 8 balises must be read in about 250 msec. In addition, 1 message per sec. on the radio interface is to be expected.
API requirements	Interfaces to this unit are defined in the API sections [BTM], [EURORADIO], [ODO]. In these sections, also a detailed definition of the concepts implemented on those interfaces is documented.

187 5.2.2 Interface

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

191 5.2.2.1 Inputs

192 5.2.2.1.1 fullChecks

Input name	fullChecks
Description	Indicates, if all checks on the message should be performed. This parameter is for testing purposes only and has to be replaced by a constant in real operation.
Source	This item is only relevant in verification phases. In a real system checks are always activated.

Type	bool
Valid range of values	<p>true All checks are performed.</p> <p>false Component InformationFilter is deactivated.</p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

193 **5.2.2.1.2 API_trackSide_Message**

Input name	API_trackSide_Message
------------	-----------------------

Description

Track side message received from the API. The API performs pre-processing of RTM and BTM messages and delivers a maximum of a single message per cycle. The structure of this message is defined in the API [BTM] and [EURORADIO] sections. The input consists of the following main components:

valid (bool): indicates the information has been refreshed in the cycle.

true : information is updated in this cycle

false : information is unchanged.

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

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

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

msrc_Euroradio : indicates the information is a euroradio message.

msrc_Eurobalise : indicates the information is a balise telegram.

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

btm_msg (API_Msg_Pkg::API_TelegramHeader_T): telegram header with some additional information provided by the btm-module. The header looks like:

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

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

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

api_header (API_Msg_Pkg::API_TelegramHeader_T) header of the telegram similar to subset 26 section 8.4.2.1. The information in the telegram is not packed on bit-boundaries.

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

rtm_msg (API_Msg_Pkg::API_RadioMsgHeader_T): radio message header with some additional information added by the rtm module. The information looks like:

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

Source	API
Type	API_Msg_Pkg::API_TrackSideInput_T
Valid range of values	Access to the information has to be guarded by the valid flag and similar flags deeper in the structure of thi interface. Checks on individual vlaues of components of messages, telegrams and packets is part of the decoding function. We assume information is valid in this part of the system.
Behaviour when value is at boundary	n/a (structure)
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

194 5.2.2.1.3 ActualOdometry

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

195 5.2.2.1.4 reset

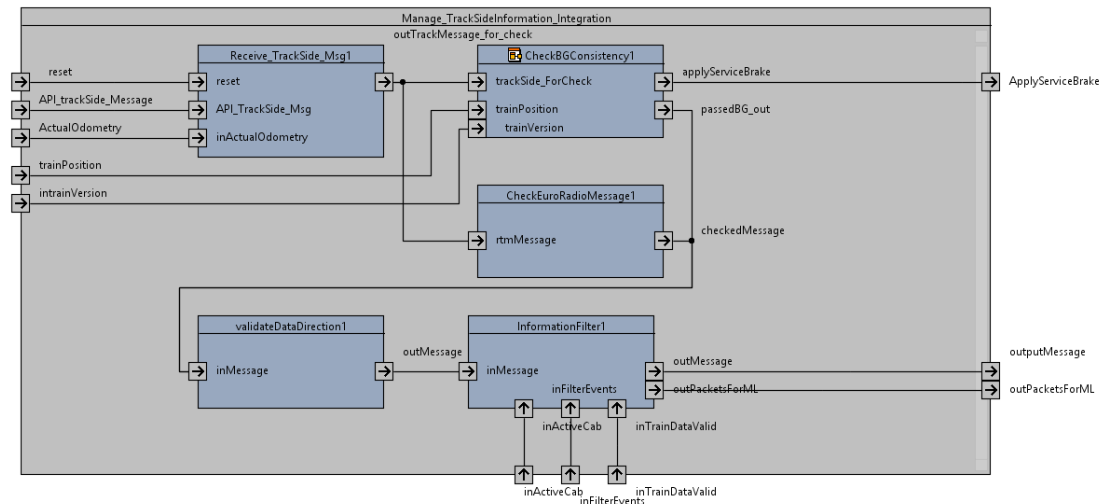


Figure 7. Manage_TrackSideInformation_Integration component SysML diagram.

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. The reset option is to be used when the evc is started or in system error scenarios.
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	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

196 **5.2.2.1.5 trainPosition**

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

197 **5.2.2.1.6 modeAndLevel**

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

198 **5.2.2.1.7 tNvContact**

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

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

199 **5.2.2.1.8 intrainVersion**

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

200 **5.2.2.1.9 lastRelevantEventTimestamp**

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

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

201 5.2.2.1.10 connectionStatus

Input name	connectionStatus
Description	Status information about the radio connection. The information is needed to perform the timing check, which depends on the connection state in the radioCheck model.
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	n/a

Behaviour for values out of valid range n/a

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

202 5.2.2.1.11 inSupervisingRbcId

Input name	inSupervisingRbcId
Description	For the subcomponent InformationFilter, the information which radio messages are sent by the supervising RBC is needed. To recognize these messages, the identifier of the supervising RBC is needed. The input is used in the InformationFilter
Source	ManageRadioCommunication
Type	int
Valid range of values	0, 1, 2
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	is interpreted as no valid radio connection.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	is interpreted as no valid radio connection.

203 5.2.2.1.12 inAnnouncedBGs

Input name	inAnnouncedBGs
Description	Provides information about balise groups as known in the evc. This information is generated by Calculate Train Position based on the linking information received from trackside and on the balise groups passed by the train.
Source	CalculateTrainPosition
Type	TrainPosition_Types_Pck::positionedBGs_T
Valid range of values	each balise group netry is identified by an valid flag.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a

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

204 5.2.2.1.13 q_nvlocacc

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

205 5.2.2.1.14 inActiveCab

Input name	inActiveCab
Description	Indicates the cab is active. Used by InformationFilter
Source	trackAtlas
Type	Q_NVLOCACC
Valid range of values	0 .. 63
Behaviour when value is at boundary	no impact
Behaviour for values out of valid range	will result in wrong calculation of inaccuracy of the train.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	see above

206 5.2.2.2 Outputs

207 **5.2.2.2.1 outputMessage**

Output name	outputMessage
Description	Combines both balise and radio messages to one common datatype. This datatype contains all variables and packets, which are possible for the given scenario.
Destination	[Name of the destination component(s)] To be completed
Type	Common_Types_Pkg::ReceivedMessage_T
Valid range of values	[Complete list of valid values] To be completed
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary] To be completed
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range] To be completed
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] To be completed

208 **5.2.2.2.2 ApplyServiceBrake**

Output name	ApplyServiceBrake
Description	Indicates if the balise group the train just passed could not be processed correctly. The check results in the request for a service break.
Destination	[Name of the destination component(s)] To be completed
Type	bool
Valid range of values	[Complete list of valid values] To be completed

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

209 5.2.2.2.3 BadBaliseMessageToDMI

Output name	BadBaliseMessageToDMI
Description	Information to be passed to the DMI to indicate the reception of a “bad balise” to the driver.
Destination	DMI
Type	bool
Valid range of values	<p>true ???</p> <p>false ???</p> <p>To be completed</p>
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary] To be completed
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range] To be completed
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] To be completed

210 5.2.2.2.4 errorLinkedBG

Output name	errorLinkedBG
Description	[Brief description of the output] To be completed
Destination	[Name of the destination component(s)] To be completed
Type	[Type of the output] To be completed
Valid range of values	<p>true An error in a linked balise group was detected.</p> <p>false No error in a linked balise group was detected.</p>
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary] To be completed
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range] To be completed
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] To be completed

211 5.2.2.2.5 errorUnlinkedBG

Output name	errorUnlinkedBG
Description	[Brief description of the output] To be completed
Destination	[Name of the destination component(s)] To be completed

Type	bool
Valid range of values	<p>true An error in a unlinked balise group was detected.</p> <p>false No error in a unlinked balise group was detected.</p>
Behaviour when value is at boundary	<p>[Description of components behaviour when output value is at boundary]</p> <p>To be completed</p>
Behaviour for values out of valid range	<p>[Description of components behaviour when output value is out of valid range]</p> <p>To be completed</p>
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	<p>[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]</p> <p>To be completed</p>

212 5.2.2.2.6 passedBG

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

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

213 5.2.2.2.7 outPositionParams

Output name	outPositionParams
Description	Provides the parameters for the position report in a special format needed by the component ProvidePositionReport.
Destination	[Name of the destination component(s)] To be completed
Type	Common_Types_Pkg::PositionReportParameter_T To be completed
Valid range of values	[Complete list of valid values] To be completed
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary] To be completed
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range] To be completed
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] To be completed

214 5.2.2.2.8 outRadioManagement

Output name	outRadioManagement
Description	Provides the messages for radio session management in a special format needed by the component ManagementOfRadioCommunication.

Destination	[Name of the destination component(s)] To be completed
Type	Common_Types_Pkg::radioManagementMessage_T
Valid range of values	[Complete list of valid values] To be completed
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary] To be completed
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range] To be completed
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] To be completed

215 5.2.2.2.9 radioSequenceError

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

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

216 5.2.2.2.10 radioMessageConsistencyError

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

217 5.2.3 Subcomponents

218 5.2.3.1 Receive_TrackSide_Msg

219 5.2.3.1.1 Component Requirements

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

Input documents	Subset-026, Chapter 7 and 8: Definition of the Balise Telegram Subset-026, Chapter 4.2.2, 4.2.4, 4.2.9: Interface to the BTM Subset-026, Chapter 3.4.1 - 3.4.3, 3.16.2: Handling of Balise Telegrams Subset-026, Chapter 3.16.2: Check of the balise group Subset-026, Chapter 3.4.2: Determining the orientation Subset-026, Chapter 4.5.2 Active Functions Table Subset-026, Chapter 8.4.4: Rules for Euroradio messages
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

220 5.2.3.1.2 Interface

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

223 5.2.3.2 CheckBGConsistency

224 5.2.3.2.1 Component Requirements

Component name	CheckBGConsistency
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/CheckBGConsistency
SCADE designer	Peyman Farhangi, DB Netz AG

Description	<p>The function "Receive_TrackSide_Msg" collects the telegrams in an array. If one or more telegrams are received multiple times, either whole the array or single telegram should be deleted.(e.g.if the train moves back.) The balises in a group are to be expected in a certain distance from each other. The function "Receive_TrackSide_Msg" checks if the telegrams has been received in due time and at the right expected location.</p> <p>The function "CheckBGConsistency" verifies the completeness and correctness of the received telegrams from balise groups and composes the balise message from the received telegram array (input from "Receive_TrackSide_Msg"). A balise message is built from at least one telegram and a maximum of 8 telegrams. When linking information is used on-board, only balise groups marked as linked and included in the linking information and balise groups marked as unlinked shall be taken into account.</p> <ul style="list-style-type: none"> • A message is still complete and correct, if a telegram is missing (or not decoded or incompletely decoded), and this telegram is duplicated within the balise group and the duplicating one is correctly read. • In case of multiple balises, the order of the balises must be either ascending (nominal) or descending (reverse). • A message is not correct, if a message counters (M_MCOUNT) equals 254 (that means: The telegram never fits any message of the group). A message counter can equal 255 (that means: The telegram fits with all telegrams of the same balise group) and all other values must be the same. <p>The orientation of the BG and the running direction of the train are calculated in this block. When linking information is used on-board, the check, if the message of linked balise group has been received in due time and at the expected location, will be performed in "Calculate Train Position". The checks on the validity of the data in the packets and the validity with respect to the direction of motion will be performed in other modules, e.g. "Validate Data Direction".</p>
Input documents	<p>Subset-026, Chapter 7 and 8: Definition of the Balise Telegram</p> <p>Subset-026, Chapter 3.4.1-3, 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 4.5.2: Active Functions Table</p>
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

225 5.2.3.2.2 Interface

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

5.2.3.3 CheckEuroradioMessage

5.2.3.3.1 Component Requirements

Component name	CheckEuroradioMessage
Link to SCADE model	https://github.com/openETCS/modeling/tree/b9c31ce6fdf702b412bbeab3032a8a4dc7c92e5c/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/CheckEuroRadioMessage
SCADE designer	Stefan Karg, LEA Railergy
Description	<p>The component “CheckEuroradioMessage” performs consistency and timing checks on the received radio message. These checks are:</p> <ul style="list-style-type: none"> • checking the message sequence • check if the message violates timing constraints (T_NVCONTACT) • check if all mandatory elements are included • check if no elements are included, which are forbidden for the given message id <p>Messages, which violate one or more of these criteria are marked as invalid in the message header and the component signals the reason for the invalidation via different flags as described in the SCADE model.</p>
Input documents	Subset-026, Chapter 3.16 Subset-026, Chapter 8.4.4
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.2.3.3.2 Interface

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

5.2.3.4 ValidateDataDirection

5.2.3.4.1 Component Requirements

Component name	ValidateDataDirection
----------------	-----------------------

Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/BaliseGroup/ValidateDataDirection
SCADE designer	Stefan Karg, LEA Railergy
Description	<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

235 5.2.3.4.2 Interface

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

238 5.2.3.5 InformationFilter

239 5.2.3.5.1 Component Requirements

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

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

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

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

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

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

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

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

241 5.2.3.5.2 Interface

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

5.3₂₄₄ F2.2: Manage_ETCS_Procedures

245 5.3.1 Component Requirements

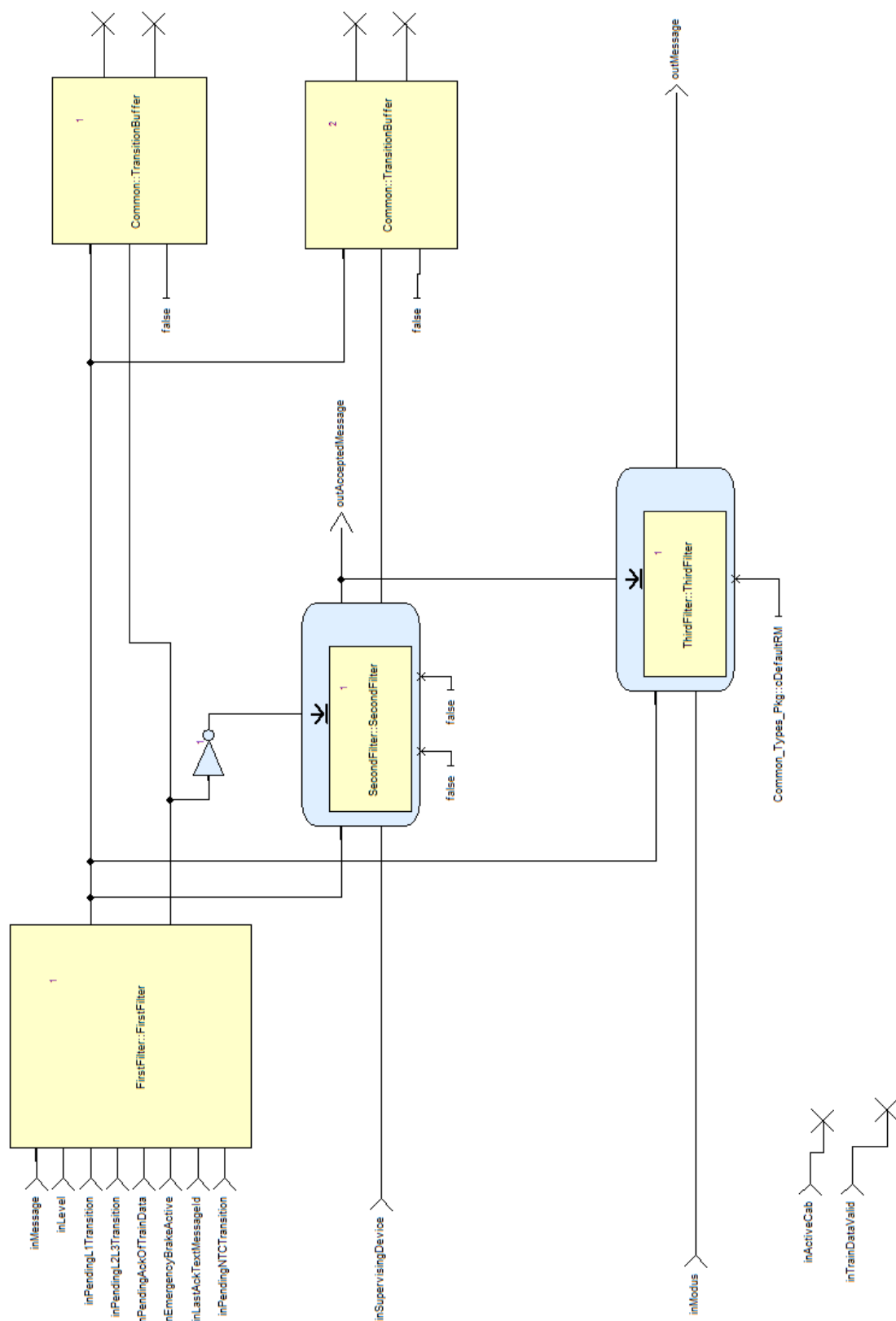


Figure 8. High level overview of the InformationFilter components.



Figure 9. Manage_ETCS_Procedures component SysML diagram

Component name	Manage_ETCS_Procedures
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/Procedures
SCADE designer	Baseliyos Jacob, DB Netz AG
Description	This function describes the Start of Mission procedure of the train until the current status will change to another mode, level or other procedure.
Input documents	Subset-026, Chapter 5.4
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

5.3.2 Interface

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

5.3.2.1 Inputs

5.3.2.1.1 statusDMI_from_DMI

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

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

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

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

252 5.3.2.1.2 Status_MA_FS_SR_OS_LS_SH_from_MA_L2_Management

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

Valid range of values

true Movement Authority for Level 2 FS is valid

false Movement Authority for Level 2 FS is not valid

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

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

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

253 5.3.2.1.3 systemtime

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

Behaviour for values out of valid range System time is assumed to be valid.

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

254 5.3.2.1.4 StatusModeandLevel_from_Level_and_Mode_Management

Input name	StatusModeandLevel_from_Level_and_Mode_Management
Description	Status of Mode and Level.
Source	ManageLevelsAndModes
Type	Level_And_Mode_Types_Pkg::T_Mode_Level
Valid range of values	To be completed
Behaviour when value is at boundary	To be completed
Behaviour for values out of valid range	To be completed
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	To be completed

255 5.3.2.1.5 mobileSwStatus_p_from_MoRC

Input name	mobileSwStatus_p_from_MoRC
Description	Information about SW status from Management of Radio Communication function.
Source	MoRC
Type	MoRC_Pck::mobileSWStatus_Type
Valid range of values	To be completed
Behaviour when value is at boundary	To be completed

Behaviour for values out of valid range

To be completed

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

To be completed

256 5.3.2.1.6 statusRBCSessionEstablished_status_from_MoRC

Input name	statusRBCSessionEstablished_status_from_MoRC
------------	--

Description	Information about RBC Session status from the Management of Radio Communication function.
-------------	---

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

Type	Radio_Types_Pkg::sessionStatus_Type
------	-------------------------------------

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

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

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

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

257 5.3.2.1.7 cabStatus_from_TIU

Input name	cabStatus_from_TIU
------------	--------------------

Description	Information about cab desk status from Train Interface Unit function.
-------------	---

Source	manageTIUInput
--------	----------------

Type	TIU_Types_Pkg::TIU_trainStatus_T
------	----------------------------------

Valid range of values

To be completed

Behaviour when value is at boundary

To be completed

Behaviour for values out of valid range

To be completed

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

To be completed

258

5.3.2.1.8 statusValid_Position_from_Position_Calculation

Input name	statusValid_Position_from_Position_Calculation
Description	Information about validity status of the train position calculation.
Source	TrainPosition exact name of component in the SCADE model has be used
Type	bool
Valid range of values	<p>true Calculated train position is valid</p> <p>false Calculated train position is not valid</p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

259

5.3.2.1.9 status_DMILEvel_from_DMI

Input name	status_DMILEvel_from_DMI
Description	Information about the status of DMI menu and level request from DMIController function.

Source	ManageDMIInput
Type	DMI_Messages_DMI_to_EVC_Pkg::DMI_Driver_Request_T
Valid range of values	To be completed
Behaviour when value is at boundary	To be completed
Behaviour for values out of valid range	To be completed
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	To be completed

260 5.3.2.1.10 LevelValid_from_Level_and_Mode_Management

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

261 5.3.2.2 Outputs

262 5.3.2.2.1 DMI_Entry_Request_to_DMI

Output name	DMI_Entry_Request_to_DMI
Description	Information about input request to the driver.
Destination	ManageDMIOutput
Type	DMI_Messages_EVC_to_DMI_Pkg::DMI_Entry_Request_T
Valid range of values	To be completed
Behaviour when value is at boundary	To be completed
Behaviour for values out of valid range	To be completed
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	To be completed

263 5.3.2.2.2 request_Start_Mobile_Terminal_and_RBC_Registration_to_MoRC

Output name	request_Start_Mobile_Terminal_and_RBC_Registration_to_MoRC
Description	This output is a trigger to start the mobile terminal and RBC session registration within the Management of Radio Communication function.
Destination	MoRC exact name of component in the SCADE model has be used
Type	Common_Types_Pkg::radioManagementMessage_T
Valid range of values	To be completed
Behaviour when value is at boundary	To be completed

Behaviour for values out of valid range

To be completed

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

To be completed

264 5.3.2.2.3 powerUp_to_MoRC

Output name	powerUp_to_MoRC
Description	This output is the trigger to activate the Management of Radio Communication function.
Destination	MoRC exact name of component in the SCADE model has be used
Type	bool
Valid range of values	true MoRC will be activated false no action
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

265 5.3.2.2.4 statusstartofmissionongoing_to_MoRC

Output name	statusstartofmissionongoing_to_MoRC
Description	This output gives the information about the start of mission status procedure to the Management of Radio Communication function.
Destination	MoRC exact name of component in the SCADE model has be used
Type	bool

Valid range of values

true Start of mission procedure is currently ongoing

false Start of mission procedure is currently not ongoing

Behaviour when value is at boundary n/a

Behaviour for values out of valid range n/a

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

266 5.3.2.2.5 powerOff_to_MoRC

Output name powerOff_to_MoRC

Description This output is the trigger to de-activate the Management of Radio Communication function.

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

Type bool

Valid range of values

true MoRC will be deactivated

false no action

Behaviour when value is at boundary n/a

Behaviour for values out of valid range n/a

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

267 5.3.2.2.6 start_ack_to_TIU

Output name start_ack_to_TIU

Description This output indicates that the start of mission procedure is completed.

Destination	ManageTIUOutput
Type	bool
Valid range of values	true Start of mission procedure is completed
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

268 5.3.3 Subcomponents

269 5.3.3.1 Awakness_of_Train

270 5.3.3.1.1 Component Requirements

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

271 5.3.3.1.2 Interface

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

274 5.3.3.2 NP

275 5.3.3.2.1 Component Requirements

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

276 5.3.3.2.2 Interface

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

279 5.3.3.3 SoM_L2_3_FS_SR_OS_LS_SH

280 5.3.3.3.1 Component Requirements

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

281 5.3.3.3.2 Interface

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

284 5.3.3.4 SoM_NTC_SN

285 5.3.3.4.1 Component Requirements

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

286 5.3.3.4.2 Interface

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

5.4₂₈₉ F2.3: trainData

290 5.4.1 Component Requirements

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



Figure 10. trainData component SysML diagram

Description	<p>Implementation of the train data with the corresponding interfaces to track, driver and RBC.</p> <div>descriptions needs to be improved to be more comprehensive</div> <p>Data first is received from the train (TIU). Second step: train data is sent to the driver (DMI). The part relevant for driver interface is confirmed by the driver and sent back to the EVC. Data received via this interface is merged with the data received via TIU. Message Flow:</p> <ul style="list-style-type: none">• sending Message 129 (Validated Train Data)• receiving Message 8 (Acknowledgment of Train Data) is processed as apart of the validation procedure with the RBC.• sending Message 146 (Acknolwedement) in the context of this message flow. T_TRAIN parameter of the messages is used to confirm the association of the messages. <p>The trainData component uses a dedicated state for controlling the reception of the acknowledgement.</p>
Input documents	Subset-026, Chapter 3.18.3
Safety integrity level	4
Time constraints	n/a
API requirements	Train Data needs systemtime for stamping messages, access to input from the track messages and access to the output of RBC messages.

291 **5.4.2 Interface**

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

295 **5.4.2.1 Inputs**

296 **5.4.2.1.1 reset**

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

297 5.4.2.1.2 trainDatafromTIU

Input name	trainDatafromTIU
Description	Train data received via TIU. The availability of data is indicated with the valid flag. This data is expected to be received in the first place. In the current implementation it is not supported to change data after a mission has been started.
Source	Train Interface Unit (TIU)
Type	TIU_Types_Pkg::trainData_T
Valid range of values	<p>Input with valid information is indicated with the valid flag.</p> <p>Looking at this input this seems to be a complex structure. Consider describing the structure instead of referring to the valid flag only.</p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	When valid flag indicates false the data to be used is assumed to be default values. The component is not used when valid flag is false.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Information is only expected at Start of Mission Procedure. Once the information is successfully received it is not considered any more. Change of train data by train during mission is not supported by this version of the openETCS OBU model.

298 **5.4.2.1.3 trainDatafromDriver**

Input name	trainDatafromDriver
Description	Train data received via DMI from the driver. The availability of data is indicated with the valid flag. This data is expected to be received in the first place. In the current implementation it is not supported to change data after a mission has been started.
Source	Driver Machine Interface (DMI)
Type	DMI_Messages_Bothways_Pkg::DMI_Train_Data_T
Valid range of values	Input with valid information is indicated with the valid flag. Looking at this input this seems to be a complex structure. Consider describing the structure instead of referring to the valid flag only.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	When valid flag indicates false the data to be used is assumed to be default values. The component is not used when valid flag is false.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	No checks on individual values is done in this part of the openETCS EVC. We assume - if necessary - appropriate checks are part of the interface layer (e.g., CRC checks) This type of checks is not in the scope of the openETCS project.

299 **5.4.2.1.4 trainDataAckfromDriver**

Input name	trainDataAckfromDriver
Description	During start of mission the driver has to validate the train data. The confirmation is visible based on this input. Presence of the input is indicated with the valid flag. Looking at this input this seems to be a complex structure. Consider describing the structure instead of referring to the valid flag only.
Source	Driver Machine Interface (DMI)
Type	DMI_Messages_DMI_to_EVC_Pkg::DMI_Train_Data_Ack_T
Valid range of values	Input with valid information is indicated with the valid flag. In addition, the ack parameter has to be evaluated in order to recognise the decision of the driver.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	when valid flag indicates false the data to be used is assumed to be default values. The component is not used when valid flag is false.

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

300 5.4.2.1.5 trackMessages

Input name	trackMessages
Description	Information carries the message received from RBC. Information is only used when the valid flag is true and the message source is Radio. Other information is not relevant. Information is evaluated as long as the validation procedure is not completed and a validation request with the RBC is pending.
Source	Radio Transmission Module (RTM)
Type	Common_Types_Pkg::ReceivedMessage_T
Valid range of values	Input with valid information is indicated with the valid flag. Looking at this input this seems to be a complex structure. Consider describing the structure instead of referring to the valid flag only.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	When valid flag indicates false the data to be used is assumed to be default values. The component is not used when valid flag is false.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	No checking on individual values is done in this part of the openETCS EVC. We assume - if necessary - appropriate checks are part of the interface layer (e.g., CRC checks) This type of checks is not in the scope of the openETCS project.

301 5.4.2.1.6 timeStamp

Input name	timeStamp
Description	Timestamp for messaging to the RBC.
Source	Derived from train time.
Type	T_TRAIN
Valid range of values	Positive non-zero real
Behaviour when value is at boundary	Parameter is not used for computation or addressing. No impact in this model.
Behaviour for values out of valid range	No impact in the EVC. Communication to the RBC will be broken.

Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Communication to the RBC will be broken. No safety issue in the EVC since RBC connection errors are covered by the EVC function.
---	--

302 5.4.2.1.7 eventsForTrainData

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

303 5.4.2.2 Outputs

304 section needs to be completed

305 5.4.2.2.1 [Output 1 name]

Output name	[Name of the output]
Description	[Brief description of the output]
Destination	[Name of the destination component(s)]
Type	[Type of the output]
Valid range of values	[Complete list of valid values]

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

306 5.4.2.2.2 [Output 2 name]

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

307 5.4.3 Subcomponents

308 section needs to be completed

5.5₃₀₉ F2.4: TrackAtlas

310 Section needs to be completed

311 5.5.1 Component Requirements

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



Figure 11. TrackAtlas component SysML diagram

Safety integrity level	4
Time constraints	[If applicable description of time constraints, otherwise n/a]
API requirements	[If applicable description of API requirements, otherwise n/a]

5.5.2 Interface

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

5.5.2.1 Inputs

5.5.2.1.1 [Input 1 name]

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

5.5.2.1.2 [Input 2 name]

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

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

319 5.5.2.2 Outputs

320 5.5.2.2.1 [Output 1 name]

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

321 5.5.2.2.2 [Output 2 name]

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

322 5.5.3 Subcomponents

323 5.5.3.1 StoreRaw_NV

324 5.5.3.1.1 Component Requirements

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

325 5.5.3.1.2 Interface

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

328 5.5.3.2 Build_GradientProfile

329 5.5.3.2.1 Component Requirements

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

330 5.5.3.2.2 Interface

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

333 5.5.3.3 Build_MA

334 5.5.3.3.1 Component Requirements

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

335 5.5.3.3.2 Interface

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

338 5.5.3.4 Build_MRSP

339 5.5.3.4.1 Component Requirements

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

340 5.5.3.4.2 Interface

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

343 5.5.3.5 Manage_EmergencyStop

344 5.5.3.5.1 Component Requirements

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

345 5.5.3.5.2 Interface

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

348 5.5.3.6 C_P003V1_OBU_P003_OBU

349 5.5.3.6.1 Component Requirements

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

350 5.5.3.6.2 Interface

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

353 5.5.3.7 GradientProfile_to_DMI

354 5.5.3.7.1 Component Requirements

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

355 5.5.3.7.2 Interface

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

358 5.5.3.8 Manage_MA_Request

359 5.5.3.8.1 Component Requirements

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

360 5.5.3.8.2 Interface

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

363 5.5.3.9 TA_to_ML

364 5.5.3.9.1 Component Requirements

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

365 5.5.3.9.2 Interface

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

368 5.5.3.10 SSP_to_MRSP

369 5.5.3.10.1 Component Requirements

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

370 5.5.3.10.2 Interface

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

373 5.5.3.11 MRSP_to_MRSP_to_DMI

374 5.5.3.11.1 Component Requirements

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

375 5.5.3.11.2 Interface

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

5.6₃₇₈ F2.5: Mode_and_Level

379 5.6.1 Component Requirements

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

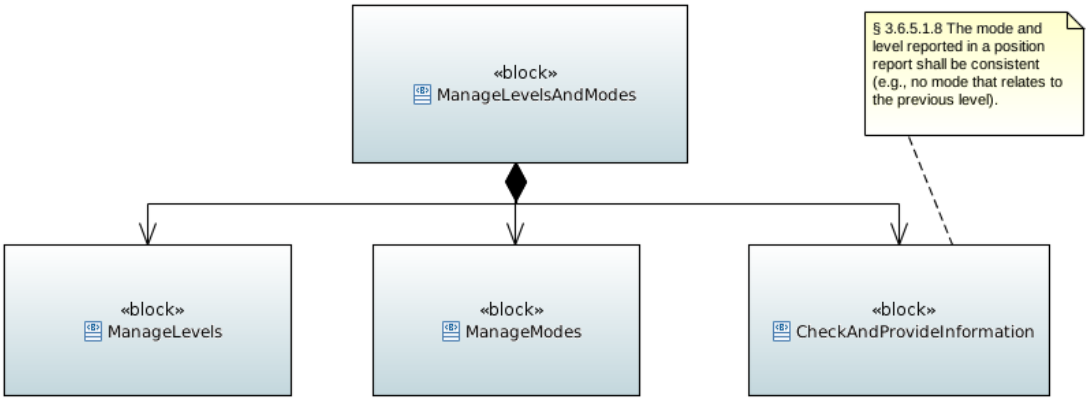


Figure 12. Mode_and_Level component SysML diagram

5.6.2 Interface

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

5.6.2.1 Inputs

5.6.2.1.1 Data_From_TIU

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

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

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

387 5.6.2.1.2 Cab_In

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

Input name	Cab_In
Description	Identification of the cabine where the EVC is implemented
Source	??? to be completed
Type	TIU_Types_Pkg::cab_ID_T
Valid range of values	[CabUndefined, CabA, CabB]
Behaviour when value is at boundary	[Description of components behaviour when input value is at boundary] to be completed
Behaviour for values out of valid range	[Description of components behaviour when input value is out of valid range] to be completed
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)] to be completed

389 5.6.2.1.3 Data_From_DMI

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

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

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

391 5.6.2.1.4 driver_level_transition_in

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

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

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

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

393 5.6.2.1.5 Data_From_Track_Packets

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

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

395 5.6.2.1.6 Data_From_speed_and_Supervision

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

Input name	Data_From_speed_and_Supervision
Description	Data provided by the speed and supervision function
Source	Speed and Supervision function Please use exact component name from SCADE model.
Type	Level_And_Mode_Types_Pkg::T_Data_From_Speed_Supervision
Valid range of values	<p>Input type a complex type</p> <ul style="list-style-type: none"> • <i>Estim_front_End_overpass_SR_Dist : bool</i>: the train overpass the SR distance with its estimated front end (from SR to trip mode condition 42) • <i>Estim_Front_End_Rear_SSP : bool</i>: estimated front end is rear of the start location of either SSP or gradient profile stored on-board (from FS, LS, OS to trip mode condition 69) • <i>Override_Function_Active</i>: boolean to indicate the state of the activation function • <i>EOA_Antenna_Overpass : bool</i>: the train overpasses the EOA with min safe antenna position Level 1 (from FS, LS, OS to trip mode condition 12) • <i>EOA_Front_End : bool</i> the train overpasses the EOA with min safe front end, Level 2 or 3 (from FS, LS, OS to trip mode condition 16) • <i>Train_Speed_Under_Override_Limit : bool</i> supervision when override function is active (to SR mode condition 37)
Behaviour when value is at boundary	<p>[Description of components behaviour when input value is at boundary]</p> <p>to be completed</p>
Behaviour for values out of valid range	<p>[Description of components behaviour when input value is out of valid range]</p> <p>to be completed</p>
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	<p>[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]</p> <p>to be completed</p>

Description of outputs needs to be completed

398

399 5.6.2.2.1 [Output 1 name]

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

400 5.6.2.2.2 [Output 2 name]

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

401 5.6.3 Subcomponents

402 5.6.3.1 Level_Management

403 5.6.3.1.1 Component Requirements

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

404 5.6.3.1.2 Interface

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

407 5.6.3.2 Mode_Management

408 5.6.3.2.1 Component Requirements

Component name	Mode_Management
----------------	-----------------

Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes/Modes
SCADE designer	Marielle Petit-Doche, Systerel
Description	<p>This function is in charge of the computation of new mode to apply according to conditions from inputs (track information, driver interactions, train data,...) and other functions.</p> <p>Three subfunctions are defined:</p> <p>Inputs proceeds to inputs check and preparation.</p> <p>ComputeModesCondition performs all specific procedure linked to mode management and defined in [1] sections 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.11, 5.12, 5.13, 5.19 and specifies the conditions to define a mode transition according condition table of section 4.6.3 of [1]</p> <p>SwitchModes performs the mode selection according the conditions and priorities defined in transition table section 4.6.2 of [1]</p> <p>Outputs prepares packet of outputs.</p>
Input documents	Subset-026, Chapter 4.4, 4.6, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.11, 5.12, 5.13, 5.19
Safety integrity level	4
Time constraints	[If applicable description of time constraints, otherwise n/a] to be completed
API requirements	[If applicable description of API requirements, otherwise n/a] to be completed

409 5.6.3.2.2 Interface

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

412 5.6.3.3 Check_and_Provide_Mode_and_Level

413 5.6.3.3.1 Component Requirements

Component name	Check_and_Provide_Mode_and_Level
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLevelsAndModes/Modes

SCADE designer	Marielle Petit-Doche, Systerel
Description	Checks compatibility between mode and level and provides outputs.
Input documents	Subset-026, Chapter 3.6.5
Safety integrity level	4
Time constraints	[If applicable description of time constraints, otherwise n/a] to be completed
API requirements	[If applicable description of API requirements, otherwise n/a] to be completed

414 5.6.3.3.2 Interface

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

5.7₄₁₇ F2.6: calculateTrainPosition

418 5.7.1 Component Requirements

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

Description	<p>The main purpose of the function is to calculate the locations of linked and unlinked balise groups (BGs) and the current train position while the train is running along the track. In detail, the calculateTrainPosition function provides a couple of essential subfunctions for the onboard unit. These are mainly:</p> <ul style="list-style-type: none"> • Creating and maintaining an obu internal coordinate system for all types of location based data. • Storing all linked and unlinked balise groups resulting from over passing or from announcements (linking information) from the track. • Calculating and maintaining the locations of all stored balise groups during the train trip, based on odometry and linking information. • Permanently calculating the current train position based on odometry and passed balise group information. • Providing the last recently passed linked balise group as the LRBG. • Providing additional position attribute information. • Deleting stored balise groups, when appropriate. • Detecting linking consistency errors. • Determining, if linking is used on board. <p>The calculation algorithms for locations and positions are implemented as specified in https://github.com/openETCS/SRS-Analysis/blob/master/System%20Analysis/WorkingRepository/Group4/SUBSET_26_3-6/DetermineTrainLocationProcedures.pdf</p>
Input documents	Subset-026, Chapter 3.6
Safety integrity level	4
Time constraints	All events at the calculateTrainPosion inputs must be applied strictly in the correct chronological order.
API requirements	The currentOdometry input as well as the odometry stamps within msgFromTrack must be fed with odometry values strictly adhering to https://github.com/openETCS/SRS-Analysis/blob/master/System%20Analysis/WorkingRepository/Group4/SUBSET_26_3-6/DetermineTrainLocationProcedures.pdf , chapt. 3.

419 5.7.2 Interface

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

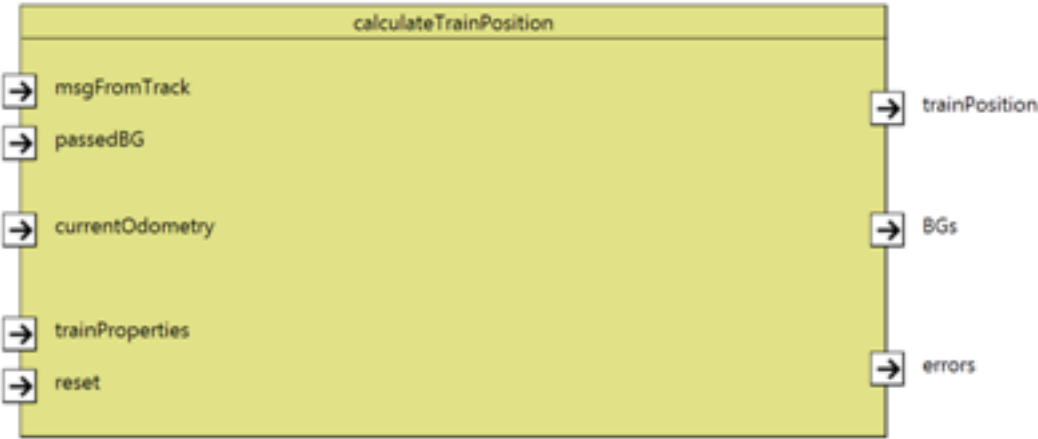


Figure 13. calculateTrainPosition SysML diagram

423 **5.7.2.1 Inputs**

424 **5.7.2.1.1 currentOdometry**

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

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

425 5.7.2.1.2 msgFromTrack

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

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

Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Enumerated values out of range prohibit code generation. In all other cases, calculateTrainPosition does not have the knowledge for out-of-range checks.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Causes misbehaviour.

426 5.7.2.1.3 trainProperties

Input name	trainProperties
Description	Supplies calculateTrainPosition with train specific properties required for position calculation.
Source	EVC_Support_Pkg::maintainTrainProperties
Type	TrainPosition_Types_Pck::trainProperties_T
Valid range of values	<p>TrainPosition_Types_Pck::trainProperties_T is a complex data type. Values are given for each element. Format is: Type Name: range / list of values.</p> <ul style="list-style-type: none"> • nid_engine:: NID_ENGINE as defined by subset 026-7. • nid_operational: NID_OPERATIONAL as defined by subset 026-7. • l_train: L_TRAIN as defined by subset 026-7. • d_baliseAntenna_2_frontend: Obu_BasicTypes_Pkg::LocWithInAcc_T: Distance from the trains balise antenna to the trains front end, in cm with uncertainties. • d_frontend_2_rearend: Obu_BasicTypes_Pkg::LocWithInAcc_T: Distance from the trains Distance from the trains front end to rear end, in cm with uncertainties. • locationAccuracy_DefaultValue: Obu_BasicTypes_Pkg::LocWithInAcc_T: Default location accuracy of balise groups (subset 026, 3.6.4.3.2), in cm with uncertainties. • centerDetectionAcc_DefaultValue: Obu_BasicTypes_Pkg::LocWithInAcc_T: Default accuracy of balise groups detection of the BTM, in cm with uncertainties. Will be applied, if centerDetectionInaccuracy from BTM is not available, especially for announced and not yet passed BGs.

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

Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Enumerated values out of range prohibit code generation. In all other cases, calculateTrainPosition does not have the knowledge for out-of-range checks.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Causes misbehaviour.

427 5.7.2.1.4 passedBG

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

428 5.7.2.1.5 reset

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

429 5.7.2.2 Outputs

430 5.7.2.2.1 trainPosition

Output name	trainPosition
-------------	---------------

Description	Provides the current train position and LRBG with its attributes. All distance and location computations of the OBU must be based on this information.
Destination	Any drain component which needs the current train position or LRBG.
Type	TrainPosition_Types_Pck::trainPosition_T

Valid range of values	<p>TrainPosition_Types_Pck::trainPosition_T is a complex data type. Values are given for each element. Format is: Type Name: range / list of values.</p> <ul style="list-style-type: none"> • valid: bool: [true false]. Always true, except for exceptional circumstances. • timestamp: Obu_BasicTypes_Pkg::T_internal_Type: latest time in ms. • trainPositionIsUnknown: bool: true, if the train position is evaluated as "unknown" (refer to subset-026, 3.6.3.1.3.1). • noCoordinateSystemHasBeenAssigned: bool: refer to subset 026, 3.4.2, 3.6.3.1.4. • trainPosition: Obu_BasicTypes_Pkg::LocWithInAcc_T: The calculated train position with uncertainties • estimatedFrontEndPosition: Obu_BasicTypes_Pkg::Location_T: Train front end position in cm. • minSafeFrontEndPosition: Obu_BasicTypes_Pkg::Location_T: Train front end position in cm. • maxSafeFrontEndPosition: Obu_BasicTypes_Pkg::Location_T: Train front end position in cm. • LRBG: TrainPosition_Types_Pck::positionedBG_T: the current LRBG. • prvLRBG: TrainPosition_Types_Pck::positionedBG_T: the balise group passed previously to LRBG. For type definition, see below. • nominalOrReverseToLRBG: Q_DLRBG: Orientation of the train in relation to the direction of the LRBG, see subset 026-7. • trainOrientationToLRBG: Q_DIRLRBG: Orientation of the train in relation to the direction of the LRBG, see subset 026-7. • trainRunningDirectionToLRBG: Q_DIRTRAIN: Direction of train movement in relation to the LRBG orientation, see subset 026-7. • linkingIsUsedOnboard: bool: Designates, if at least one announced linked BG is ahead. <p><i>calculateTrainPosition provides the train position to whom it concerns and recalculates it in every clock cycle.</i></p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a

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

431 5.7.2.2.2 BGs

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

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

432 5.7.2.2.3 errors

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

Behaviour when value is at boundary n/a

Behaviour for values out of valid range n/a

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

433 5.7.3 Subcomponents

434 5.7.3.1 msg_2_passedBG

435 5.7.3.1.1 Component Requirements

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

436 5.7.3.1.2 Interface

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

439 5.7.3.2 calculateBGLocations

440 5.7.3.2.1 Component Requirements

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

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

441 5.7.3.2.2 Interface

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

444 5.7.3.3 delDispensableBGs

445 5.7.3.3.1 Component Requirements

Component name	delDispensableBGs
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/ManageLocationRelatedInformation/TrainPosition/CalculateTrainPosition
SCADE designer	Uwe Steinke, Siemens AG
Description	Deletes balise groups not needed any more from the list of known balise groups
Input documents	Subset-026, Chapter 3.6.2.2.2 c)
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

446 5.7.3.3.2 Interface

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

449 **5.7.3.4 addAnnouncedBGs**

450 **5.7.3.4.1 Component Requirements**

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

451 **5.7.3.4.2 Interface**

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

454 **5.7.3.5 calculateTrainpositionInfo**

455 **5.7.3.5.1 Component Requirements**

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

Time constraints	n/a
API requirements	n/a

456 5.7.3.5.2 Interface

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

459 5.7.3.6 calculateTrainPositionAttributes

460 5.7.3.6.1 Component Requirements

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

461 5.7.3.6.2 Interface

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

464 5.7.3.7 linkedBG_missed

465 5.7.3.7.1 Component Requirements

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

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

466 5.7.3.7.2 Interface

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

469 5.7.3.8 twoconsecutiveLinkedBGs_missed

470 5.7.3.8.1 Component Requirements

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

471 5.7.3.8.2 Interface

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

5.8⁴⁷⁴ F2.7: SpeedSupervision_Integration

475 5.8.1 Component Requirements

Component name	SpeedSupervision_Integration
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervision
SCADE designer	Benjamin Beichler, University of Rostock Christian Stahl, TWT Thorsten Schulz, University of Rostock
Description	<p>The task of SDM is to monitor the speed of the train and the train location and as such to ensure that the speed remains within the given speed and distance limits. This block is based on [1, Chapt. 3.13]. The integration node “SpeedSupervision_Integration” takes as input (1) movement related information such as train speed, train position and acceleration, (2) train related information such as brake information and train length, and (3) track related information such as speed and distance limits and national values.</p> <p>Based on this information a speed profile is calculated. Speed restrictions create target speeds (targets) that have to be followed. For each such target braking curves are generated to supervise at which location of the track the train must apply the brake. In case of no target restrictions the train may accelerate to the supervised maximum speed of the speed profile. These calculations lead to commands being sent to the driver and the brake system.</p> <p>The functionality is modeled using eight subcomponents, as shown in Figure 14, which are explained in Section 5.8.3.</p> <p>The current status of the analysis of “SDM” and a functional breakdown can be found in a separate document, SpeedSupervision_analysis.pdf.</p>
Input documents	Subset-026, Chapter 3.13: Speed and distance monitoring
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

476 5.8.2 Interface

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

480 5.8.2.1 Inputs

481 5.8.2.1.1 National Values

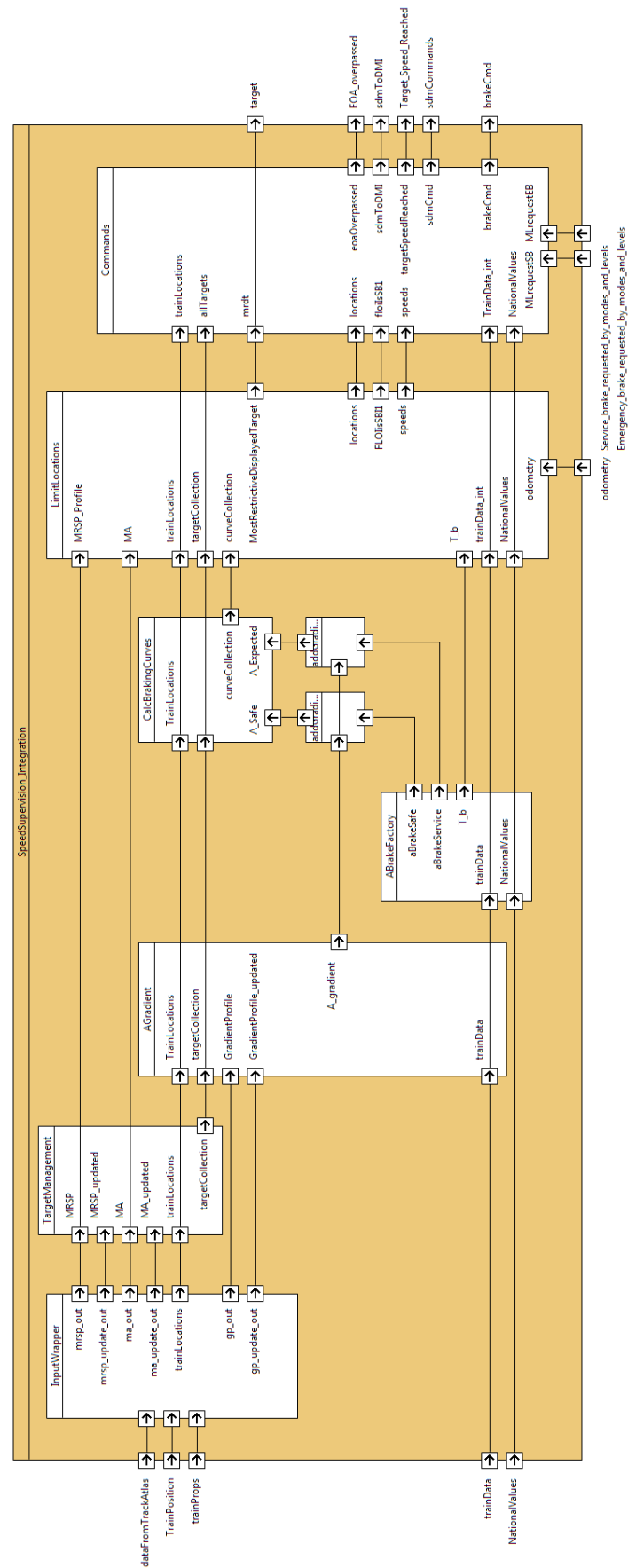


Figure 14. Structure of component SpeedSupervision_Integration.

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

482 5.8.2.1.2 Train Position

Input name	TrainPosition
Description	This input is the current train position.
Source	calculateTrainPosition
Type	trainPosition_T
Valid range of values	<p>trainPosition_T is a complex data type. Value valid must not be false for proper function and it may not be properly checked in current release. Furthermore, reversing (decreasing positions, reverse flag set) is currently NOT supported and leads to undefined behaviour. No brake will be thrown in this occasion.</p> <div style="background-color: #90EE90; border: 1px solid black; border-radius: 5px; padding: 2px; display: inline-block;">To be completed</div>
Behaviour when value is at boundary	Not checked, may overflow.
Behaviour for values out of valid range	Currently not checked.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Not checked; node must not be called without reasonable position data. Valid flag is not checked (bug), as SDM has not yet implemented exception handling on unacceptable input data.

483 **5.8.2.1.3 Odometry**

Input name	odometry
Description	This input is the odometry data.
Source	API_Odometry
Type	odometry_T
Valid range of values	complex data type used fields are: - acceleration: Obu_BasicTypes_Pkg::A_internal_Type. No valid range defined, neither checked. - motionState: [noMotion Motion] (enum type) - motionDirection: is NOT evaluated currently which leads to erroneous behaviour when driving anti-nominal direction.
Behaviour when value is at boundary	Possible overflow not evaluated.
Behaviour for values out of valid range	Not checked.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Not handled, valid data is expected for valid function. Valid flag is not checked (bug), as SDM has not yet implemented exception handling on unacceptable input data.

484 **5.8.2.1.4 Train Properties**

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

485 **5.8.2.1.5 Train Data**

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

486 **5.8.2.1.6 Track Data**

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

Behaviour for values out of valid range	If the MA is not valid the brake should be commanded.
---	---

Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Absence of minimal MRSP is not detected but trusted. Validity of MA is not checked up front.
---	--

487 5.8.2.2 Outputs

488 5.8.2.2.1 sdmToDMI

Output name	sdmToDMI
Description	This output contains information about different speeds and positions and the current supervision status. This information shall be displayed to the driver.
Destination	<ul style="list-style-type: none"> TrackAtlas (5.5.2.1) manageDMI_output (18) ROOT_integration
Type	speedSupervisionForDMI_T (complex)
Valid range of values	<p>speedSupervisionForDMI_T is a complex data type. Values are given for each element. Format is: Type Name: range/list of value.</p> <ul style="list-style-type: none"> bool valid: [true, false] true, if internal state of speed monitoring is defined [CSM, TSM, RSM]; false, if it is undefined V_internal_Type targetSpeed, permittedSpeed, releaseSpeed, interventionSpeed: 0 or above, not internally limited; set to cDMIUnknownSpeed (-1) if not defined L_internal_Type location_brake_curve_starting_point, location-BrakeTarget, distanceIndicationPoint: calculated locations M_SupervisionDisplay_T supervisionDisplay: [supDis_normal, supDis_indication, supDis_overspeed, supDis_warning, supDis_intervention] M_SUPERVISION_STATUS sup_status: [CSM, TSM, RSM, unknown], PIM is not referenced
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Location values may not be meaningful in some situations. This is not directly linked to the specific items but maybe accessible from further context such as supervisionDisplay and sup_status.

Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Valid can be false in case of initialization. All values must be disregarded then.
---	--

489 5.8.2.2.2 target

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

490 5.8.2.2.3 sdmCommands

Output name	sdmCommands
Description	This output gives some intermediate results of operator SDM_Commands. It is currently used for test purposes only.
Destination	n/a, null-sink

Type	SDM_Commands_T (complex)
Valid range of values	Containing values are either boolean command-trigger flags, the internal state of the SDM_commands state-machine or speed/distance types with guarding bool valid flag. For in-depth description see generated documentation.
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	<ul style="list-style-type: none"> • Bool are always in range. • The internal state SupervisionStatus_T is Undefined_Supervision at initialization and renders the output sdmToDMI's valid flag to false. • Speeds estimatedSpeed, permittedSpeed, releaseSpeed, mrdt-Speed, sbiSpeed and distance targetDistance must be ignored and contain invalid values if the corresponding valid-flag is false. Valid-marked outputs are not artificially limited to a sane range and rely on correctly specified algorithms.
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Overall .valid is always set, individual speeds have their corresponding valid flag. Values may not have a valid output depending on the situation.

491 5.8.2.2.4 brakeCmd

Output name	brakeCmd
Description	This output is the brake command, indicating whether performing the service brake and/or the emergency brake have been commanded.
Destination	<ul style="list-style-type: none"> • TIU_OutputIntegration (20) • manageDMI_output (18) • ROOT_integration
Type	Brake_command_T (complex)

Valid range of values	<p>Brake_command_T is a complex data type. Values are given foreach element. Format is: Type Name: range/list of value</p> <ul style="list-style-type: none"> • bool valid: true (constant) • M_brake_signal_command_T m_servicebrake_cm: <ul style="list-style-type: none"> brake_signal_command_not_defined No change of brake state requested, keep last. apply_brake service brakes must be applied release_brake service brakes must be released • M_brake_signal_command_T m_emergencybrake_cm: <ul style="list-style-type: none"> brake_signal_command_not_defined No change of brake state requested, keep last. apply_brake emergency brakes must be applied release_brake emergency brakes must be released <p>Brake commands are edge triggered and may only be defined in a single cycle.</p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	brakeCmd is constantly valid, but may not contain a command change.

492 5.8.2.2.5 EOA_overpassed

Output name	EOA_overpassed
Description	This output is true if the end of authority has been overpassed and false otherwise. In Level 1 this is compensated by the antenna offset.
Destination	n/a, null-sink in current release
Type	bool
Valid range of values	<p>true The train's front end has passed the end of authority</p> <p>false The end of authority is ahead of the train.</p>
Behaviour when value is at boundary	n/a

Behaviour for values out of valid range n/a

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

493 5.8.2.2.6 Target_Speed_Reached

Output name	Target_Speed_Reached
Description	This output is true if the current speed is greater than or equal the target speed and false otherwise.
Destination	n/a, null-sink in current release
Type	bool
Valid range of values	<p>true The current speed is greater than or equal to the target speed or target is invalid</p> <p>false The current speed is less than the target speed</p> <p>Value must be ignored, if output target (5.8.2.2.2) is invalid.</p>
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

494 5.8.3 Subcomponents

495 5.8.3.1 SDM_InputWrapper

496 5.8.3.1.1 Component Requirements

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

Description	<p>The motivation for this operator is to convert all inputs of SDM that contain information about length, speed, distance, and acceleration defined as integer into <code>real</code> to allow automatically the highest precision in the calculations by the meaning of floating point operations. In addition, to ease the modeling, inside block “Speed Supervision” only units meters ($[m]$), seconds ($[s]$), meters per second ($[\frac{m}{s}]$), and meters per square second ($[\frac{m}{s^2}]$) are used. This operator forwards input messages, takes data from complex data types or transforms inputs messages into an internal type thereby converting int to real.</p>
Input documents	Subset-026, Chapter 3.13, (not specific, helper function)
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

497 5.8.3.1.2 Interface

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

500 5.8.3.2 TargetManagement

501 5.8.3.2.1 Component Requirements

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

Description This operator calculates/updates the list of targets to be supervised by SDM. Taking the current movement authority, the most restrictive speed profile and the current maximum safe front end position as an input, the operator outputs a list of MRSP-Targets and a Limit-of-Authority-Target (LoA) or, if an End of Authority is known, the End-of-Authority-Target (EoA) and the Supervised Location (SvL). Since LoA and SvL are mutually exclusive but both result in a trip-target, they use the same flow.

Derivation of Targets from Movement Authority

The *Movement Authority* creates three types of targets:

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

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

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

Derivation of Targets from MRSP

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

Update of Targets

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

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

502 **5.8.3.2.2 Interface**

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

505 **5.8.3.3 AGradient**

506 **5.8.3.3.1 Component Requirements**

Component name	AGradient
----------------	-----------

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

507 **5.8.3.3.2 Interface**

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

510 **5.8.3.4 ABrakeFactory**

511 **5.8.3.4.1 Component Requirements**

Component name	ABrakeFactory
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervision/SDM_Models
SCADE designer	Thorsten Schulz, University of Rostock
Description	This operator implements the braking models. At this stage only the lamda trains (conversion) model is implemented. The output of the conversion model are a location independent, but highly National Values dependent, braking curves. One for the service brake and one for the emergency brake. As a side product, the model related brake build-up times are also generated.
Input documents	Subset-026, Chapter 3.13.2.2.3 Braking Models, Chapter 3.13.2.2.4,5 Brake Position, Percentage, Chapter 3.13.2.3.7 National Values for SDM, Chapter 3.13.3 Conversion Models, 3.13.6 Calculation of the deceleration and brake build-up times
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

512 5.8.3.4.2 Interface

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

515 5.8.3.5 addGradient

516 5.8.3.5.1 Component Requirements

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

517 5.8.3.5.2 Interface

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

520 5.8.3.6 CalcBrakingCurves_Integration

521 5.8.3.6.1 Component Requirements

Component name	CalcBrakingCurves_Integration
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/SpeedSupervision/CalcBrakingCurves
SCADE designer	Benjamin Beichler, University of Rostock

Description	For each type of target a certain braking curve has to be calculated. This curve enables proactive monitoring of the train's speed. A reverse lookup on this braking curve indicates, where the train has to start braking given the current speed. The braking curve does not depend on the actual train status. As a consequence the braking curve stays constant over time. As a legitimate simplification the calculation of the braking curve is not extended past the estimated front end position of the train.
Input documents	Subset-026, Chapter 3.13.8.3: Emergency Brake Deceleration curves (EBD) Subset-026, Chapter 3.13.8.4: Service Brake Deceleration curves (SBD) Subset-026, Chapter 3.13.8.5: Guidance curves (GUI)
Safety integrity level	4
Time constraints	n/a
API requirements	n/a

522 5.8.3.6.2 Interface

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

525 5.8.3.7 SDMLimitLocations

526 5.8.3.7.1 Component Requirements

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

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

527 5.8.3.7.2 Interface

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

530 5.8.3.8 SDM_Commands

531 5.8.3.8.1 Component Requirements

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

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

532 5.8.3.8.2 Interface

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

5.9₅₃₅ F2.8: Provide_Position_Report

536 5.9.1 Component Requirements

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

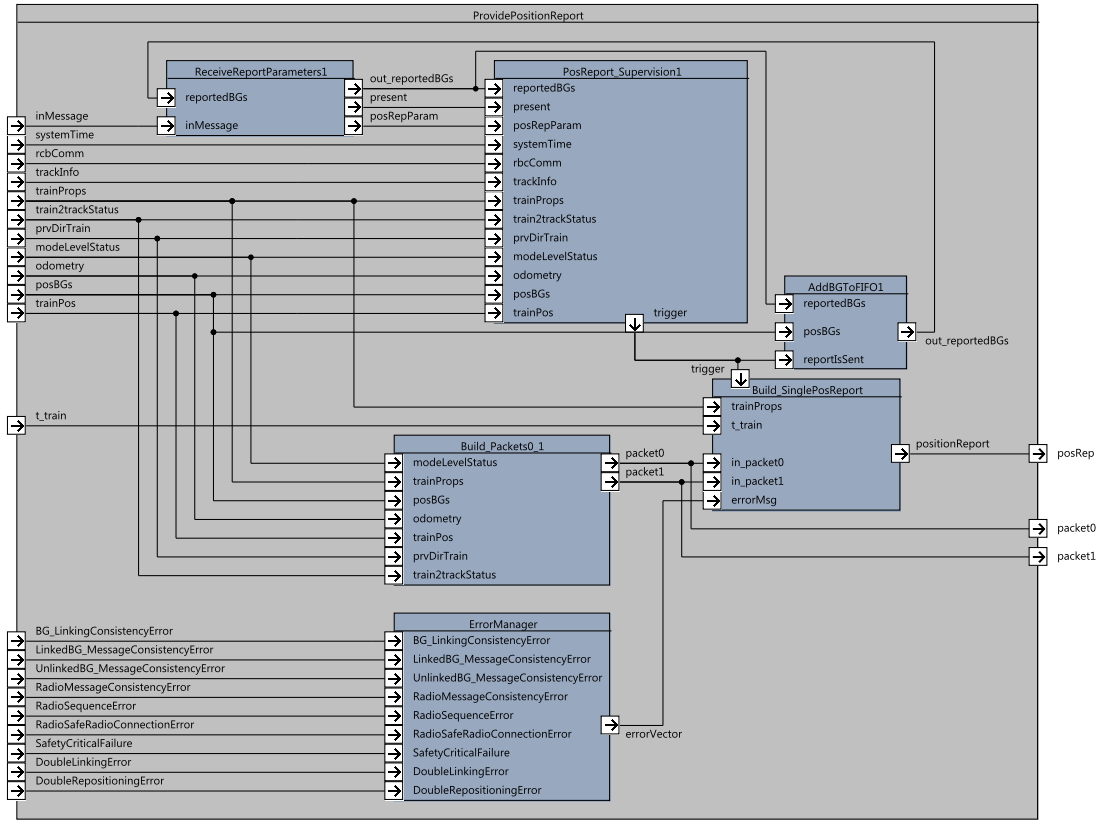


Figure 15. Provide_Position_Report component SysML diagram

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

5.9.2 Interface

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

5.9.2.1 Inputs

5.9.2.1.1 inMessage

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

Type	Common_Types_Pkg::ReceivedMessage_T
Valid range of values	as defined in SCADE
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	If valid is false, then input is ignored.

543 5.9.2.1.2 systemTime

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

544 5.9.2.1.3 rbcComm

Input name	rbcComm
Description	Variables modeling stati regarding the RBC communication.
Source	MoRC_Pck::MoRC_Main
Type	RBC_Communication_T
Valid range of values	as defined in SCADE
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a

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

545 **5.9.2.1.4 trackInfo**

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

546 **5.9.2.1.5 trainProps**

Input name	trainProps
Description	The train properties.
Source	EVC_Support_Pkg::maintainTrainProperties
Type	TrainPosition_Types_Pck::trainProperties_T
Valid range of values	as defined in SCADE
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

547 **5.9.2.1.6 train2trackStatus**

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

548 5.9.2.1.7 prvDirTrain

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

549 5.9.2.1.8 modeLevelStatus

Input name	modeLevelStatus
Description	Information referring to mode and level status.
Source	ManageLevelAndMode
Type	ModeLevel2PositionReport_T
Valid range of values	as defined in SCADE

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

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

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

550 5.9.2.1.9 odometry

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

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

Source	API
--------	-----

Type	Obu_BasicTypes_Pkg::odometry_T
------	--------------------------------

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

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

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

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

551 5.9.2.1.10 posBGs

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

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

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

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

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

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

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

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

552 5.9.2.1.11 trainPos

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

553 5.9.2.1.12 t_train

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

554 5.9.2.1.13 BG_LinkingConsistencyError

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

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

555 5.9.2.1.14 LinkedBG_MessageConsistencyError

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

556 5.9.2.1.15 UnlinkedBG_MessageConsistencyError

Input name	UnlinkedBG_MessageConsistencyError
Description	True if respective error has occurred; otherwise false.
Source	Manage_TrackSideInformation_Integration_Pkg:: Manage_TrackSideInformation_Integration
Type	bool
Valid range of values	as defined in SCADE

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

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

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

557 5.9.2.1.16 RadioMessageConsistencyError

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

558 5.9.2.1.17 RadioSequenceError

Input name	RadioSequenceError
Description	True if respective error has occurred; otherwise false.
Source	Manage_TrackSideInformation_Integration_Pkg:: Manage_TrackSideInformation_Integration
Type	bool
Valid range of values	as defined in SCADE
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a

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

559 5.9.2.1.18 RadioSafeRadioConnectionError

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

560 5.9.2.1.19 SafetyCriticalFailure

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

561 5.9.2.1.20 DoubleLinkingError

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

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

562 5.9.2.1.21 DoubleRepositioningError

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

563 5.9.2.2 Outputs

564 5.9.2.2.1 packet0

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

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

565 5.9.2.2.2 packet1

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

566 5.9.2.2.3 posRep

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

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

567 5.9.3 Subcomponents

568 5.9.3.1 ReceiveReportParameters

569 5.9.3.1.1 Component Requirements

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

570 5.9.3.1.2 Interface

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

573 5.9.3.2 PosReport_Supervision

574 5.9.3.2.1 Component Requirements

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

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

575 5.9.3.2.2 Interface

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

578 5.9.3.3 ErrorManager

579 5.9.3.3.1 Component Requirements

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

580 5.9.3.3.2 Interface

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

583 5.9.3.4 Build_Packets0_1

584 5.9.3.4.1 Component Requirements

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

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

585 5.9.3.4.2 Interface

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

588 5.9.3.5 Build_PosReport

589 5.9.3.5.1 Component Requirements

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

590 5.9.3.5.2 Interface

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

593 5.9.3.6 AddBGToFIFO

594 5.9.3.6.1 Component Requirements

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

595 5.9.3.6.2 Interface

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

5.10₈ F2.9: Manage_Radio_Communication and RBC_Handover

599 5.10.1 Component Requirements

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

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

Input documents	Subset-026, Chapter 3.5 Subset-026, Chapter 3.15 Subset-026, Chapter 5.15
Safety integrity level	4
Time constraints	Function activation has to facilitate the internally implemented time delays
API requirements	Interfaces with the OBUs mobile modems via API

600 5.10.2 Interface



Figure 16. Manage_Radio_Communication component SysML diagram

601 An overview of the interface of component MoRC_HO is shown in Figure 16. The inputs and
602 outputs are described in detail in Section 5.10.2.1 respectively 5.10.2.2. Sub components are
603 described in Section 5.10.3.

604 **5.10.2.1 Inputs**

605 **5.10.2.1.1 [mode]**

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

606 **5.10.2.1.2 [level]**

Input name	level
Description	Current Operating Level
Source	???
Type	M_LEVEL
Valid range of values	Defined by M_LEVEL enumerations
Behaviour when value is at boundary	n/a

Behaviour for values out of valid range	Code generation fails
Behaviour when value is	Misbehaviour

Description	Collection of input events and OBU operating phases
Source	Collection of source components responsible for the information
Type	RCM_Session_Types_Pkg::obuEventsAndPhases_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

608 5.10.2.1.4 [atPowerUpRadioNetworkID]

Input name	atPowerUpRadioNetworkID
Description	Radio network ID to be used at power up
Source	???
Type	Packet_Types_Pkg::P45_RadioNetworkRegistration_T
Valid range of values	Ref. to NID_MN (Identity of Radio Network)
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	OBU registers to unwanted radio network
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	OBU registers to unwanted radio network

609 5.10.2.1.5 [newRadioNetworkIDFromDriver]

Input name	newRadioNetworkIDFromDriver
Description	Radio network ID entered by the driver
Source	???
Type	Packet_Types_Pkg::P45_RadioNetworkRegistration_T
Valid range of values	Ref. to NID_MN (Identity of Radio Network)

Behaviour when value is
at boundary

n/a

Behaviour for values out
of valid range

OBU registers to unwanted radio network

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

OBU registers to unwanted radio network

610 5.10.2.1.6 [mobileRegistrationContext_1]

Input name	mobileRegistrationContext_1
Description	Current registration status information from mobile modem 1
Source	API
Type	RCM_Types_Pkg::mobileRegistrationContext_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Misbehaviour
Behaviour when value is erroneous, absent or un- wanted (i.e. spurious)	Misbehaviour

611 5.10.2.1.7 [mobileRegistrationContext_2]

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

612 **5.10.2.1.8 [mobileConnectionContext_1]**

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

613 **5.10.2.1.9 [mobileConnectionContext_2]**

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

614 **5.10.2.1.10 [dataFromTrack_in]**

Input name	[dataFromTrack_in]
Description	Messages received from track
Source	Manage_TrackSideInformation_Integration
Type	RCM_MsgTypes_Pkg::msgFromTrack_T

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

615 5.10.2.1.11 [dataToRBC_in]

Input name	dataToRBC_in
Description	Messages to be routed to the supervising RBC
Source	All components transmitting messages to the RBC
Type	RCM_MsgTypes_Pkg::msgToTrack_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Confused RBC communication
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Confused RBC communication

616 5.10.2.1.12 [positionReport_in]

Input name	positionReport_in
Description	Current position report to be transmitted to the handing over and/or accepting RBC under control of <i>MoRC_HO</i>
Source	providePositionReport
Type	RCM_MsgTypes_Pkg::msgToTrack_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	RBC receives faulty position report

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

617 5.10.2.1.13 [trainData_in]

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

618 5.10.2.1.14 [trainPosition]

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

619 5.10.2.1.15 [BGs]

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

620 **5.10.2.1.16 [t_train]**

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

621 **5.10.2.1.17 [reset]**

Input name	reset
Description	Initializes the component and deletes the internal storage
Source	The OBUs system start controller
Type	bool
Valid range of values	true false

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

622 **5.10.2.1.18 [sessionManagementAbility]**

Input name	sessionManagementAbility
Description	Configurable ability to manage one or two sessions and mobile modems onboard
Source	The OBUs configuration manager
Type	Handover_Pkg::abilityToHandleCommunicationSessions
Valid range of values	isAbleToManageOneSession isAbleToManageTwoSessions
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

623 **5.10.2.1.19 [trainProperties]**

Input name	trainProperties
Description	Train parameters used to calculate the handover location and to generate messages to the RBC
Source	The OBUs configuration manager
Type	TrainPosition_Types_Pck::trainProperties_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Faulty parametrization

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

624 5.10.2.1.20 [configData]

Input name	configData
Description	Session management configuration parameters
Source	The OBUs configuration manager
Type	RCM_Session_Types_Pkg::morc_configData_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Misbehaviour
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

625 5.10.2.2 Outputs

626 5.10.2.2.1 [radioStatus_1]

Output name	radioStatus_1
Description	Radio registration, connection and session status for radio link 1
Destination	All components which need to know the radio status
Type	RCM_Session_Types_Pkg::morcStatus_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

627 5.10.2.2.2 [radioStatus_2]

Output name	radioStatus_2
Description	Radio registration, connection and session status for radio link 2
Destination	All components which need to know the radio status
Type	RCM_Session_Types_Pkg::morcStatus_T
Valid range of values	n/a
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

628 5.10.2.2.3 [mobileConnectionCmd_1]

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

629 5.10.2.2.4 [mobileConnectionCmd_2]

Output name	mobileConnectionCmd_2
Description	Commands to mobile 2 for radio connection control
Destination	API to radio mobile 2
Type	RCM_Types_Pkg::mobileConnectionCmd_T
Valid range of values	n/a

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

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

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

630 5.10.2.2.5 [mobileRegistrationCmd_1]

Output name	mobileRegistrationCmd_1
-------------	-------------------------

Description	Commands to mobile 1 for radio registration control
-------------	---

Destination	API to radio mobile 1
-------------	-----------------------

Type	RCM_Types_Pkg::mobileRegistrationCmd_T
------	--

Valid range of values	n/a
-----------------------	-----

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

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

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

631 5.10.2.2.6 [mobileRegistrationCmd_2]

Output name	mobileRegistrationCmd_2
-------------	-------------------------

Description	Commands to mobile 2 for radio registration control
-------------	---

Destination	API to radio mobile 2
-------------	-----------------------

Type	RCM_Types_Pkg::mobileRegistrationCmd_T
------	--

Valid range of values	n/a
-----------------------	-----

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

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

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

632 5.10.2.2.7 [safeRadioIndication]

Output name	safeRadioIndication
Description	Safe radio indication for DMI
Destination	DIM via DMI interface
Type	RCM_Session_Types_Pkg::safeRadioConnectionIndication_T
Valid range of values	srci_noConnection srci_connectionLost_setupFailed srci_connectionUp
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	n/a
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

633 5.10.2.2.8 [supervisingRBC]

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

634 5.10.2.2.9 [bufferInformationFromAcceptingRBC]

Output name	bufferInformationFromAcceptingRBC
Description	Informs the InformationFilter to buffer messages received from the accepting RBC
Destination	InformationFilter
Type	bool
Valid range of values	true false
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misbehaviour

635 **5.10.2.2.10 [trainPassesA_RBC_RBC_border_WithItsFrontEnd]**

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

636 **5.10.2.2.11 [msgToRBC_1]**

Output name	msgToRBC_1
Description	Radio message to be transmitted to RBC via mobile modem 1, if session established
Destination	API: interface to mobile modem 1
Type	RCM_MsgTypes_Pkg::msgToTrack_T

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

637 **5.10.2.2.12 [msgToRBC_2]**

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

638 **5.10.2.2.13 [triggerPositionReport]**

Output name	triggerPositionReport
Description	Triggers the providePositionReport function to provide a position report at positionReport_in input
Destination	providePositionReport
Type	bool
Valid range of values	true false
Behaviour when value is at boundary	n/a

Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Causes a mistimed position report

639 **5.10.2.2.14 [triggerTrainData]**

Output name	triggerTrainData
Description	Triggers the provideTrainData function to provide a train data set (packet 11) at trainData_in input
Destination	provideTrainData ???
Type	bool
Valid range of values	true false
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Causes a mistimed train data set transmission to the RBC

640 **5.10.2.2.15 [rejectOrderToContactRBC_or_RIU]**

Output name	rejectOrderToContactRBC_or_RIU
Description	Informs the OBU that the order to contact an RBC has to be rejected
Destination	???
Type	bool
Valid range of values	true false
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	n/a

641 **5.10.2.2.16 [infomDriverNoCompatibleVersionSupported]**

Output name	infomDriverNoCompatibleVersionSupported
Description	Informs the driver that no compatible version is supported
Destination	DMI via DMI interface and API
Type	bool
Valid range of values	true false
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Misinformed train driver

642 **5.10.2.2.17 [memorizeTheLastRadioNetworkID]**

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

643 **5.10.2.2.18 [lastReceivedRadioNetworkID]**

Output name	lastReceivedRadioNetworkID
Description	Provides the last received radio network ID
Destination	External storage via API
Type	Packet_Types_Pkg::P45_RadioNetworkRegistration_T

Valid range of values	Refer to subset 026-7, packet 45
Behaviour when value is at boundary	n/a
Behaviour for values out of valid range	Code generation fails
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	Corrupted stored last radio network ID

644 5.10.2.2.19 [ready]

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

645 5.10.3 Subcomponents

646 5.10.3.1 RBC_Handover

647 5.10.3.1.1 Component Requirements

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

Description	<p>The function <i>processHandingOver</i> implements the process of handing over the OBU from one RBC to a subsequent RBC. This process is based upon orders received from balise and radio.</p> <p><i>processHandingOver</i> terminates the radio session with the current - the handing over - RBC and establishes a session with the new - the accepting - RBC. Dependent on the availability of one or two mobile modems onboard, <i>processHandingOver</i> is able to manage two sessions in parallel or subsequently. For this, it steers two instances of MoRC_Main_v2.</p> <p><i>processHandingOver</i> controls the switchover of the OBUs output data stream to track from the handing over RBC to the accepting RBC and provides the InformationFilter with the supervising RBC information for message buffering and filtering.</p> <p>It in addition, <i>processHandingOver</i> monitors the current train position and executes the handover, when the train front passes the appropriate location.</p>
-------------	---

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

648 5.10.3.1.2 Interface

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

651 5.10.3.2 Management_of_Radio_Communication

652 5.10.3.2.1 Component Requirements

Component name	MoRC_Main_v2 (Management_of_Radio_Communication)
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/ObuFunctions/Radio/MoRC
SCADE designer	Uwe Steinke, Siemens

Description The function *MoRC_Main_v2* implements the session states establishing, maintaining and terminating as described in Subset-026, chap. 3.5. A SCADE state machine reflects this state model accurately. Within each of the states, the activities needed as long as the state is active, are performed.

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

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

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

Input documents	Subset-026, Chapter 3.5
Safety integrity level	4
Time constraints	Implements several time delays, therefore appropriate clocking required
API requirements	Interfaces to the OBUs mobile modem hardware via API

653 5.10.3.2.2 Interface

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

656 5.10.3.3 mobileDataRouter

657 5.10.3.3.1 Component Requirements

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

Safety integrity level	4
Time constraints	n/a
API requirements	n/a

658 5.10.3.3.2 Interface

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

661 5.11 F2.10: ManageDMIInput

662 section and corresponding subsections have to be completed

663 5.11.1 Component Requirements

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

664 5.11.2 Interface

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

668 5.11.2.1 Inputs

669 5.11.2.1.1 [Input 1 name]

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

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

670 5.11.2.1.2 [Input 2 name]

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

671 5.11.2.2 Outputs

672 5.11.2.2.1 [Output 1 name]

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

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

673 5.11.2.2.2 [Output 2 name]

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

674 5.11.3 Subcomponents

675 Currently ManageDMIInput does not have any subcomponents.

5.12₆ F2.11: ManageDMIOutput

677 section and corresponding subsections have to be completed

678 5.12.1 Component Requirements

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

679 5.12.2 Interface

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

683 5.12.2.1 Inputs

684 5.12.2.1.1 [Input 1 name]

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

685 5.12.2.1.2 [Input 2 name]

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

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

686 5.12.2.2 Outputs

687 5.12.2.2.1 [Output 1 name]

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

688 5.12.2.2.2 [Output 2 name]

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

689 5.12.3 Subcomponents



Figure 17. ManageDMIInput SysML diagram

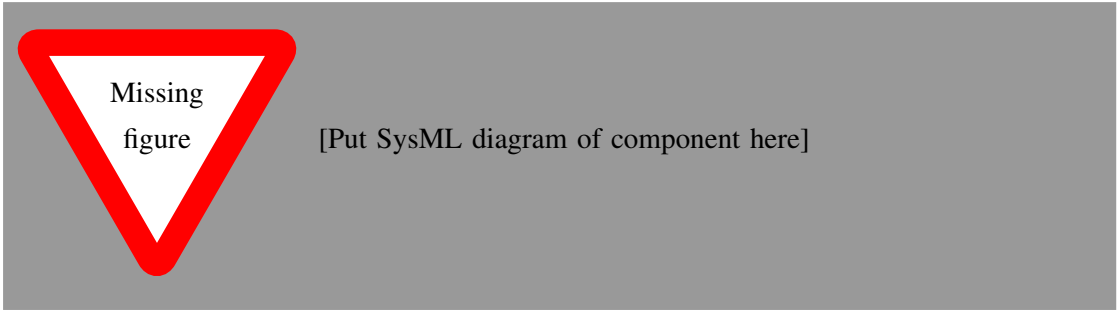


Figure 18. ManageDMIOutput SysML diagram

690 **5.12.3.1 cyclicReportToDMI**

691 **5.12.3.1.1 Component Requirements**

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

692 **5.12.3.1.2 Interface**

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

695 **5.12.3.2 ManageTextMessages**

696 **5.12.3.2.1 Component Requirements**

<i>This work is licensed under the "openETCS Open License Terms" (oOLT).</i>	
Component name	ManageTextMessages
Link to SCADE model	http://???

700 5.12.3.3 copyTrackDescription

701 5.12.3.3.1 Component Requirements

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

702 5.12.3.3.2 Interface

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

705 5.12.3.4 toEntryRequest

706 5.12.3.4.1 Component Requirements

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

707 5.12.3.4.2 Interface

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

710 5.12.3.5 sendBrakesToDMI

711 5.12.3.5.1 Component Requirements

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

712 5.12.3.5.2 Interface

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

715 5.12.3.6 manageDMI_Output

716 5.12.3.6.1 Component Requirements

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

717 5.12.3.6.2 Interface

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

720 **5.12.3.7 sendTrainData**

721 **5.12.3.7.1 Component Requirements**

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

722 **5.12.3.7.2 Interface**

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

725 **5.12.3.8 sendVersion**

726 **5.12.3.8.1 Component Requirements**

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

727 **5.12.3.8.2 Interface**

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

730 5.12.3.9 sendLevelListPkg

731 5.12.3.9.1 Component Requirements

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

732 5.12.3.9.2 Interface

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

5.13₅ F2.12: ManageTIUInput

736 section and corresponding subsections have to be completed

737 5.13.1 Component Requirements

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

738 5.13.2 Interface



Figure 19. ManageTIUInput SysML diagram

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

742 **5.13.2.1 Inputs**

743 **5.13.2.1.1 [Input 1 name]**

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

744 **5.13.2.1.2 [Input 2 name]**

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

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

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

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

747 5.13.2.2.2 [Output 2 name]

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

748 5.13.3 Subcomponents

749 5.13.3.1 mergeTIU_Info

750 5.13.3.1.1 Component Requirements

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

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

751 5.13.3.1.2 Interface

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

754 5.13.3.2 getTIUStatusFromData

755 5.13.3.2.1 Component Requirements

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

756 5.13.3.2.2 Interface

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

5.14 F2.13: ManageTIUOutput

760 section and corresponding subsections have to be completed

761 5.14.1 Component Requirements



Figure 20. ManageTIUOutput SysML diagram

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

5.14.2 Interface

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

5.14.2.1 Inputs

5.14.2.1.1 [Input 1 name]

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

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

768 **5.14.2.1.2 [Input 2 name]**

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

769 **5.14.2.2 Outputs**

770 **5.14.2.2.1 [Output 1 name]**

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

771 **5.14.2.2.2 [Output 2 name]**

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

772 **5.14.3 Subcomponents**773 **5.14.3.1 handleTraction**774 **5.14.3.1.1 Component Requirements**

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

775 **5.14.3.1.2 Interface**

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

778 **5.14.3.2 manageTIU_output**

779 5.14.3.2.1 Component Requirements

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

780 5.14.3.2.2 Interface

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

6⁷⁸³ F3: Measure Train Movement

⁷⁸⁴ This component is not part of the openETCS OBU currently and therefore no detailed description
⁷⁸⁵ is provided here.

7⁷⁸⁶ F4: Manage Radio Communication

⁷⁸⁷ This component is not part of the openETCS OBU currently and therefore no detailed description
⁷⁸⁸ is provided here.

8 ⁷⁸⁹ F5: Manage JRU

⁷⁹⁰ This component is not part of the openETCS OBU currently and therefore no detailed description
⁷⁹¹ is provided here.

9 F6: DMI Controller

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

9.1 DMI

9.1.1 Component Requirements

Component name	DMI
Link to SCADE model	https://github.com/openETCS/modeling/tree/master/model/Scade/System/DMI_Control
SCADE designer	Valerio D'Angelo, DB Netz AG
Description	The DMI controller interacts with the DMI display and is responsible for all procedures between the DMI display and Driver. Furthermore, the DMI controller will interact with the DMI Management to compute the received information (e.g. driver number request, ...) and send, if necessary, data or reports to the DMI Management (acknowledge, text messages...). The DMI Controller is a passive module, this means that all the processing are performed EVC-side, therefore the DMI Controller simply responds to the requests of the EVC or Driver and performs some checks according with the information received from EVC.
Input documents	ERA_ERTMS_015560
Safety integrity level	4
Time constraints	[If applicable description of time constraints, otherwise n/a]
API requirements	[If applicable description of API requirements, otherwise n/a]

9.1.2 Interface

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

9.1.2.1 Inputs

9.1.2.1.1 DMI_entry_request

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

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

801 9.1.2.1.2 DMI_identifier_request

Input name	DMI_identifier_request
Description	Request of the DMI informations
Source	DMI Management
Type	[Type of the input]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when input value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when input value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

802 9.1.2.1.3 DMI_menu_request

Input name	DMI_menu_request
Description	Request to enable or disable buttons
Source	DMI Management
Type	[Type of the input]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when input value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when input value is out of valid range]

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

803 9.1.2.1.4 DMI_dynamic

Input name	DMI_dynamic
Description	Contains informations about current speed, current mode etc.
Source	DMI Management
Type	[Type of the input]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when input value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when input value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

804 9.1.2.1.5 DMI_text_message

Input name	DMI_text_message
Description	Contains predefined or plain text messages
Source	DMI Management
Type	[Type of the input]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when input value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when input value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

805 9.1.2.1.6 DMI_icons

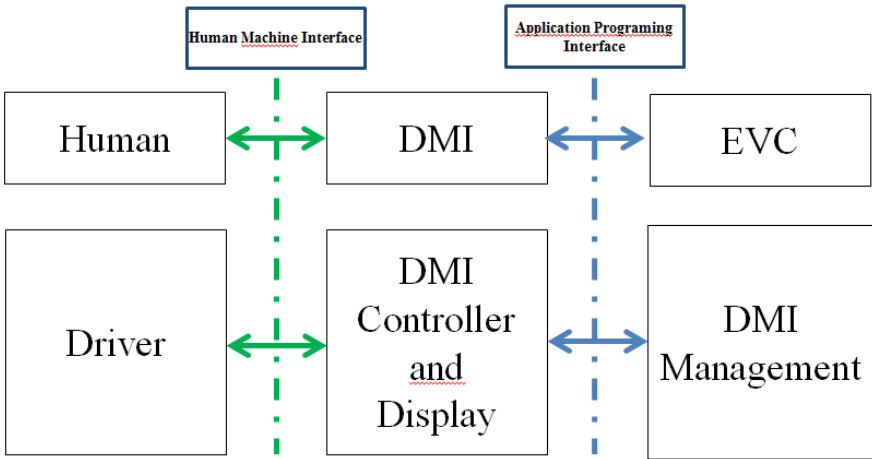


Figure 21. DMI component SysML diagram

Input name	DMI_icons
Description	Request to display one or more icons in any area
Source	DMI Management
Type	[Type of the input]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when input value is at bound-ary]
Behaviour for values out of valid range	[Description of components behaviour when input value is out of valid range]
Behaviour when value is erroneous, absent or un-wanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

806 9.1.2.1.7 DMI_driver_identifier

Input name	DMI_driver_identifier
Description	Contains the default or entered driver identifier
Source	DMI Management
Type	[Type of the input]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when input value is at bound-ary]
Behaviour for values out of valid range	[Description of components behaviour when input value is out of valid range]
Behaviour when value is erroneous, absent or un-wanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

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

808 9.1.2.1.9 DMI_train_data

Input name	DMI_train_data
Description	Contains the default or entered train data
Source	DMI Management
Type	[Type of the input]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when input value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when input value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

809 9.1.2.1.10 TIU_trainStatus

Input name	TIU_trainStatus
Description	Open/close Desk signal
Source	TIU
Type	[Type of the input]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when input value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when input value is out of valid range]

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

810 9.1.2.2 Outputs

811 9.1.2.2.1 DMI_identifier

Output name	DMI_identifier
Description	Information about DMI (e.g. version, cabin identifier etc.)
Destination	DMI Management
Type	[Type of the output]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

812 9.1.2.2.2 DMI_driver_request

Output name	DMI_driver_request
Description	Driver request or acknowledgement
Destination	DMI Management
Type	[Type of the output]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

813 9.1.2.2.3 DMI_train_data_ack

Output name	DMI_train_data_ack
Description	Train data acknowledgement
Destination	DMI Management
Type	[Type of the output]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

814 9.1.2.2.4 DMI_status_report

Output name	DMI_status_report
Description	The actual status of DMI (keep alive)
Destination	DMI Management
Type	[Type of the output]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

815 9.1.2.2.5 DMI_text_message_ack

Output name	DMI_text_message_ack
Description	Text message acknowledgement
Destination	DMI Management
Type	[Type of the output]
Valid range of values	[Complete list of valid values]

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

816 9.1.2.2.6 DMI_icons_ack

Output name	DMI_icons_ack
Description	Icon acknowledgement
Destination	DMI Management
Type	[Type of the output]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

817 9.1.2.2.7 DMI_driver_identifier

Output name	DMI_driver_identifier
Description	Contains the default or entered driver identifier
Destination	DMI Management
Type	[Type of the output]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range]

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

818 9.1.2.2.8 DMI_train_running_number

Output name	DMI_train_running_number
Description	Contains the default or entered train running number
Destination	DMI Management
Type	[Type of the output]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

819 9.1.2.2.9 DMI_train_data

Output name	DMI_train_data
Description	Contains the default or entered train data
Destination	DMI Management
Type	[Type of the output]
Valid range of values	[Complete list of valid values]
Behaviour when value is at boundary	[Description of components behaviour when output value is at boundary]
Behaviour for values out of valid range	[Description of components behaviour when output value is out of valid range]
Behaviour when value is erroneous, absent or unwanted (i.e. spurious)	[Description of components behaviour when value is erroneous, absent or unwanted (i.e. spurious)]

References

- 821 [1] ERA. *System Requirements Specification, SUBSET-026*, v3.3.0 edition, March 2012.