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GNSS Augmentation for ERTMS/ETCS

Interface Control Document for
GA-OB / GA-TS (Airgap)

EUG Solution for Enhanced Onboard Localisation Change Request (CR1368) – GNSS Augmentation for ERTMS/ETCS

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Version	Date	Modification / Description	Editor
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0a	21/05/2020	Initial version (incomplete draft) – update	C. Wullems (ESA)
0a	26/05/2020	Update after internal review (C. Lopez de Echazarreta, ESA)	
0a	05/06/2020	Update after internal review (C. Neville, GSA)	
0a	15/06/2020	Update after internal review (E. Lacarra, R. Gonzalez, N. Blanco, ESSP)	
0b	16/06/2020	Major update considering a new TTA mechanism	C. Wullems (ESA)
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0e	29/04/2022	Update after internal review (C. Lopez de Echazarreta, F. Salgueiro, ESA)	
0f	31/05/2022	Draft release for EURAIL System Pillar	C. Wullems (ESA)
0g	30/04/2023	Update after JWG workshop 29/09/2022: • updating of messages and packets addressing action items related to protocol changes (e.g., removal of versioning); and • updated reference architecture in figure 1 (aligned with SRS) addressing action items related to simplification of trackside functions.	C. Wullems (ESA)
0g	15/06/2023	Document update: • addition of SysML BDDs for messages and packets; • GNSS navigation packets with encapsulation of GNSS navigation data to simplify navigation data processing requirements of ED-259A • improvement of GNSS navigation data selection parameters; and • moving section addressing message format before section addressing packet format and re-order of items alphabetically.	C. Wullems (ESA)
0g	06/10/2023	Minor updates after JWG workshop 02/10/2023. Draft release for input to ERJU work packages on GNSS Augmentation for Rail based on EGNOS.	C. Wullems (ESA)

Table of Contents

1 Introduction

1.1 Scope and Purpose

1.1.1.1 This document is the Interface Control Document (ICD) for the interface between GNSS Augmentation On-board (GA-OB) and GNSS Augmentation Trackside (GA-TS). The scope of the document is to define interoperability-relevant messages, packets and variables exchanged over the airgap for GNSS augmentation, enabling the use of GNSS within enhanced onboard localisation equipment in ETCS/ERTMS.

1.1.1.2 Figure 1 illustrates the high-level reference functional architecture of GNSS Augmentation for ERTMS/ETCS and applicability of this document.
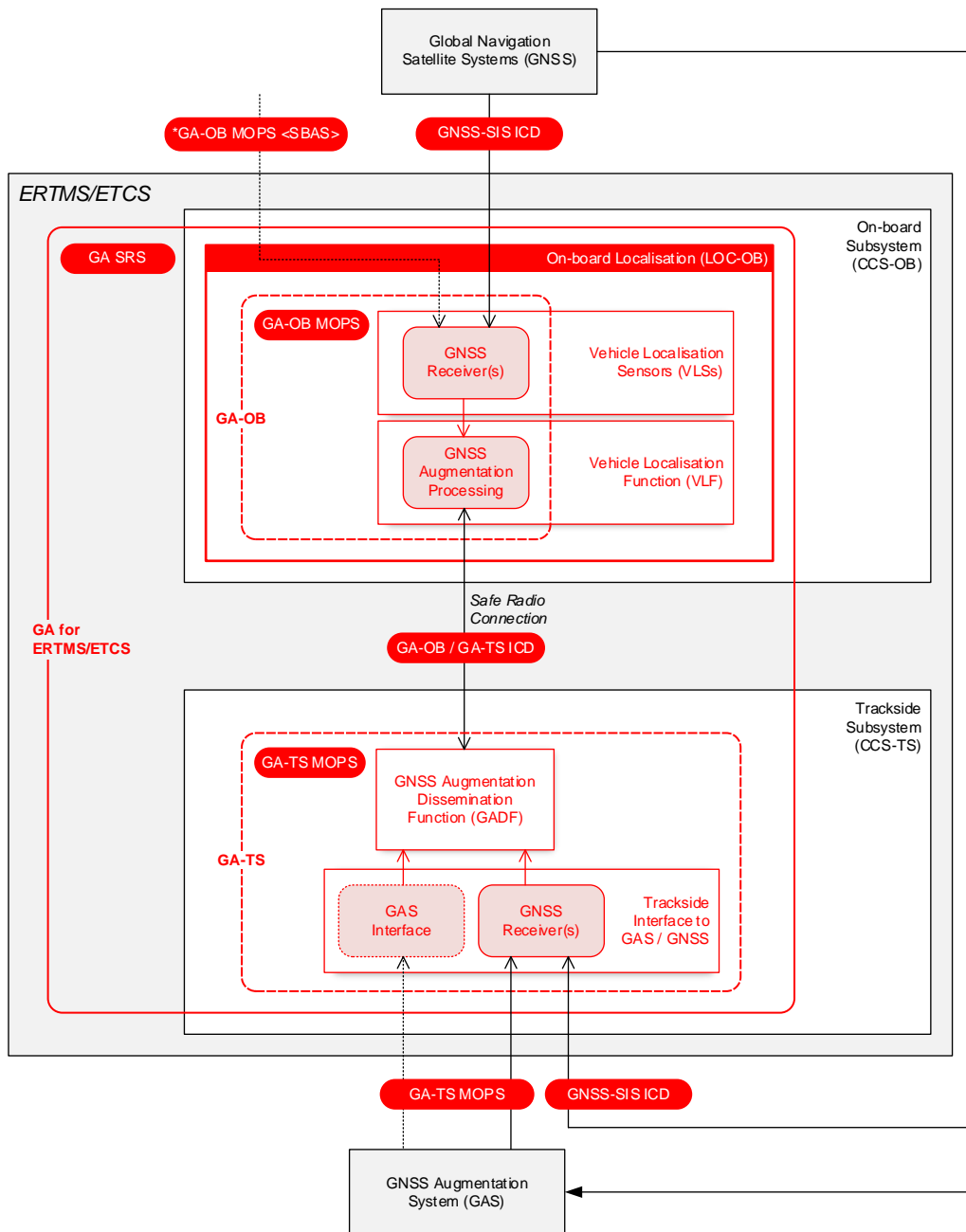

Figure 1. GNSS Augmentation Reference Functional Architecture for ERTMS/ETCS

1.1.1.3   It should be noted that the safe radio connection between the GA-OB and GA-TS is intentionally left undefined; for example, the safe radio connection could potentially be the EURORADIO channel between the on-board and trackside, or a dedicated GNSS augmentation radio channel between the GA-OB and GA-TS.

1.1.1.4   Refer to [EUG-20E085] for details on the protocol exchange of GNSS augmentation-related information over the airgap, timeouts, acknowledgements, and retransmission mechanism.

1.2   References

1.2.1.1   The following documents are references in this document:

PERSPECTIVE	Report on ERTMS Longer Term Perspective, 18/12/2015
[SS026-3]	UNISIG, "ERTMS/ETCS – System Requirements Specification Chapter 7 – Principles – SUBSET-026-3 Issue 3.6.0." 2016
[SS026-7]	UNISIG, "ERTMS/ETCS – System Requirements Specification Chapter 7 – ERTMS/ETCS language – SUBSET-026-7 Issue 3.6.0." 2016
[SS026-8]	UNISIG, "ERTMS/ETCS – System Requirements Specification Chapter 8 – Messages – SUBSET-026-8 Issue 3.6.0." 2016
[SS040]	UNISIG, "ERTMS/ETCS – Dimensioning and Engineering Rules – SUBSET-040 Issue 3.4.0." 2015
[SS054]	ERA, "ERTMS/ETCS – Responsibilities and Rules for the Assignment of Values to ETCS Variables Issue 3.0.0." 2011
[EUG-20E086]	EUG, "GNSS Augmentation for ERTMS/ETCS – System Functional Hazard Analysis. Version 0g." 2023.
[EUG-20E085]	EUG, "GNSS Augmentation for ERTMS/ETCS – System Requirement Specification. Version 0g." 2023.
[ESSP-TN-25931]	ESSP, "SBAS L1 Receiver Guidelines for Railway – On-board Unit. Issue 01-00." 2020.
[ESSP-TN-26038]	ESSP, "SBAS L1 Receiver Guidelines for Railway – Trackside Unit. Issue 01-00." 2020.
[ESSP-TN-26136]	ESSP, "SBAS DFMC Receiver Guidelines for Railway – On-board Unit. Issue 01-00." 2020.
[ESSP-TN-26137]	ESSP, "SBAS DFMC Receiver Guidelines for Railway – Trackside Unit. Issue 01-00." 2020.

[DO229]	RTCA, "DO-229F – Minimum Operational Performance Standards for Global Positioning System/Satellite Based Augmentation System Airborne Equipment." RTCA Inc., Washington D.C., USA, 2020.
[ED259]	EUROCAE, "ED-259A (v0.17) – Minimum Operational Performance Standard for Galileo / Global Positioning System / Satellite-based Augmentation System Airborne Equipment." Saint-Denis, France, 2022.
[IS-GPS-200]	GPS Directorate, "Interface Specification – NAVSTAR GPS Space Segment / Navigation User Segment User Interfaces – IS-GPS-200. Rev. N." 2022.
[IS-GPS-705]	GPS Directorate, "Interface Specification – NAVSTAR GPS Space Segment / User Segment L5 Interfaces – IS-GPS-705. Rev. J." 2022.
[GAL-OS-SIS-ICD]	European Commission, "European GNSS (Galileo) Open Service – Signal-in-Space Interface Control Document. Issue 2.0." 2021.

1.3 Terms and Abbreviations

1.3.1.1 The following terms and abbreviations are used in this document:

BDD	Block Definition Diagram (SysML)
CCS	Control-Command and Signalling
CRC	Cyclic Redundancy Check
DFMC	Dual Frequency Multiple Constellation
DNU	Do Not Use
EEIG	European Economic Interest Group
EGNOS	European Geostationary Navigation Overlay Service (SBAS developed by the European Union)
ERA	European Union Agency for Railways (formerly European Railway Agency)
ERJU	Europe's Rail Joint Undertaking
ERTMS	European Rail Traffic Management System
ESA	European Space Agency
ESSP	European Satellite Services Provider
ETCS	European Train Control System
EUG	EEIG ERTMS Users Group

EUSPA	European Union Agency for the Space Programme (formerly the European GNSS Agency)
FRMCS	Future Railway Mobile Communication System
GA-OB	GNSS Augmentation On-board
GA-TS	GNSS Augmentation Trackside
GEO	Geostationary Earth Orbit
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM-R	Global System for Mobile Communications – Railway
ICD	Interface Control Document
IOD	Issue of Data
LSBs	Least Significant Bits
MOPS	Minimum Operation Performance Standard
MT	Message Type
OBU	On-Board Unit
OS	Open Service
PRN	Pseudo-Random Noise
RBC	Radio Block Centre
RIMS	Range and Integrity Monitoring Stations
RTCA	Radio Technical Commission for Aeronautics
SARPs	Standards and Recommended Practices
SBAS	Satellite Based Augmentation System
SFSC	Single Frequency Single Constellation
SIS	Signal in Space
SoL	Safety of Life
SPS	Standard Positioning Service
SV	Satellite Vehicle
SysML	Systems Modelling Language (a profile of the Unified Modelling Language v.2 (UML 2) for systems engineering applications)
TBC	To Be Confirmed
TTA	Time To Alert

UTC	Universal Time Coordinate

2 List of Fixed Value Data

Fixed Value Data	Value	Name
GNSS augmentation maximum on-board equipment TTA budget	800 ms [TBC]	T_GAMAXOBTTA
Timeout for retransmission of an unacknowledged *GNSS Augmentation Message*	2000 ms [TBC]	T_GAMRTIMEOUT
Timeout for retransmission of an unacknowledged *GNSS Augmentation Active Data Set* message	5000 ms [TBC]	T_GAADSRTIMEOUT
Timeout for retransmission of an unacknowledged *GNSS Navigation Data Set* message	5000 ms [TBC]	T_GNSSNDSRTIMEOUT
Maximum number of retries for retransmission of an unacknowledged *GNSS Augmentation Active Data Set* message	2 [TBC]	N_GAADSMAXRETRIES
Maximum number of retries for retransmission of an unacknowledged *GNSS Navigation Data Set* message	5 [TBC]	N_GNSSNDSMAXRETRIES

3 List of National / Default Data

3.1.1.1 Note: the following National Values are specific to the GNSS augmentation service.

3.2 EGNOS L1 and DFMC Railway SoL Services

National / Default Data	Default Value	Name
GA Maximum System TTA	5200 ms	T_NVGAMAXSYSTTA
GA Maximum TTA	8000 ms [TBC]	T_NVGAMAXTTA
GA Broadcast Update Rate	1000 ms	T_NVGAMBUR

4 Messages

4.1 Format of Radio Messages

4.1.1.1 The format of messages in this ICD is consistent with radio messages defined in the ERTMS/ETCS SRS [SS026-8]; however, fields that are not required for messages exchanged between GA-OB and GA-TS (e.g., NID_LRBG for track to train messages, and Packet 0 or 1 for train to track messages) have been removed.

4.1.1.2 Messages are composed of predefined variables and packets.

4.1.1.3 All message identifiers not listed in 4.2 shall be considered as invalid values when received by the GA-OB.

4.1.2 Track to Train Messages

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from trackside (GA-TS), consistent with requirements defined in the ERTMS/ETCS SRS sections 3.16.3.2 and 3.16.3.3 [SS-026-3].
4	M_ACK	Indicates whether the message must be acknowledged (or not) by the GA-OB
…	Variables as required by NID_MESSAGE	If needed for this message. Used when sending variables that are not included in a packet.
…	Packets as required by NID_MESSAGE	If needed for this message.
	Optional packets	
	Padding	If required.

4.1.3 Train to Track Messages

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from train (GA-OB), consistent with requirements defined in the ERTMS/ETCS SRS sections 3.16.3 [SS-026-3].
4	NID_ENGINE	Identity of the train
	Variables as required by NID_MESSAGE	If needed for this message. Used when sending variables that are not included in a packet.
…	Packets as required by NID_MESSAGE	If needed for this message.
	Optional packets	
	Padding	If required.

4.2 List of Radio Messages

4.2.1.1 This section identifies radio messages with the corresponding Message Identifier and Message Name.

4.2.2 Train to Track Radio Messages

4.2.2.1 The following messages are transmitted by the GA-OB to the GA-TS:

Mes. Id.	Message Name	Page N°
TBC	Acknowledgement	13
TBC	Allocate GA Message Stream	14
TBC	Initiate GA Session	15
TBC	GA Active Data Request	16
TBC	GNSS Navigation Data Request	17
TBC	Resume GA Message Stream	18
TBC	Suspend GA Message Stream	19
TBC	Terminate GA Session	20

4.2.3 Track to Train Radio Messages

4.2.3.1 The following messages are transmitted by the GA-TS to the GA-OB:

Mes. Id.	Message Name	Page N°
TBC	GA Active Data Set	21
TBC	GA Message	22
TBC	GA Message Stream Allocated / Resumed	23
TBC	GA Message Stream Suspended	24
TBC	GA Session Error	25
TBC	GA Session Established	26
TBC	GA Session Terminated	27
TBC	GNSS Navigation Data Set	28

4.3 Definition of Radio Messages from Train to Track

4.3.1 Acknowledgement

4.3.1.1 Acknowledgement message composition:
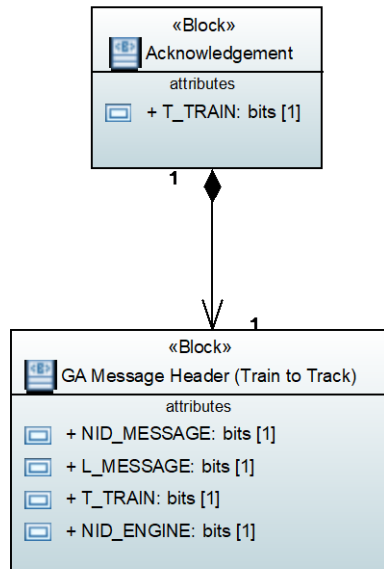
Figure 2. Acknowledgement BDD

4.3.1.2 This message is consistent with Message 146 defined in the ERTMS/ETCS SRS [SS026-8].

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from train (GA-OB)
4	NID_ENGINE	Identify of the train
5	T_TRAIN	Timestamp contained in the message that is acknowledged

4.3.2   Allocate GA Message Stream

4.3.2.1   Allocate GA Message Stream message composition:
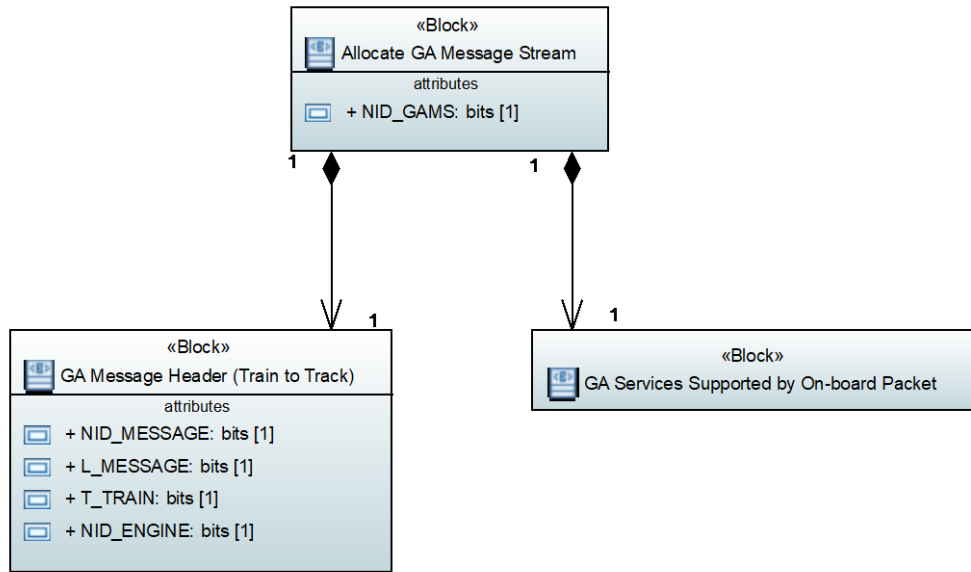
Figure 3. Allocate GA Message Stream BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from train (GA-OB)
4	NID_ENGINE	Identify of the train
5	NID_GAMS	GA message stream identifier
7	Packet of type TBC	GA Services Supported by On-board packet

4.3.3 Initiate GA Session

4.3.3.1 Initiate GA Session message composition:
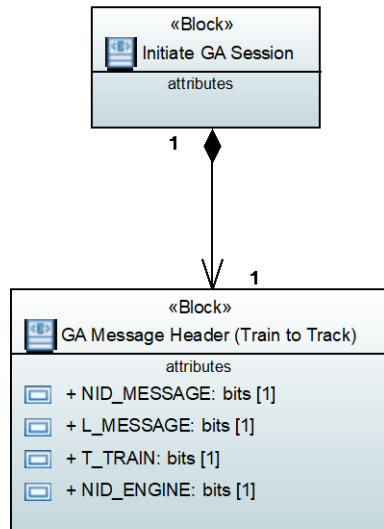
Figure 4. Initiate GA Session BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from train (GA-OB)
4	NID_ENGINE	Identify of the train

4.3.4 GA Active Data Request

4.3.4.1 GA Active Data Request message composition:
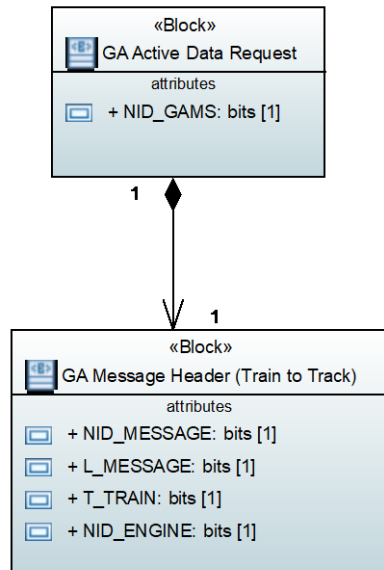
Figure 5. GA Active Data Request BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from train (GA-OB)
4	NID_ENGINE	Identify of the train
5	NID_GAMS	GA message stream identifier

4.3.5 GNSS Navigation Data Request

4.3.5.1 GNSS Navigation Data Request message composition:
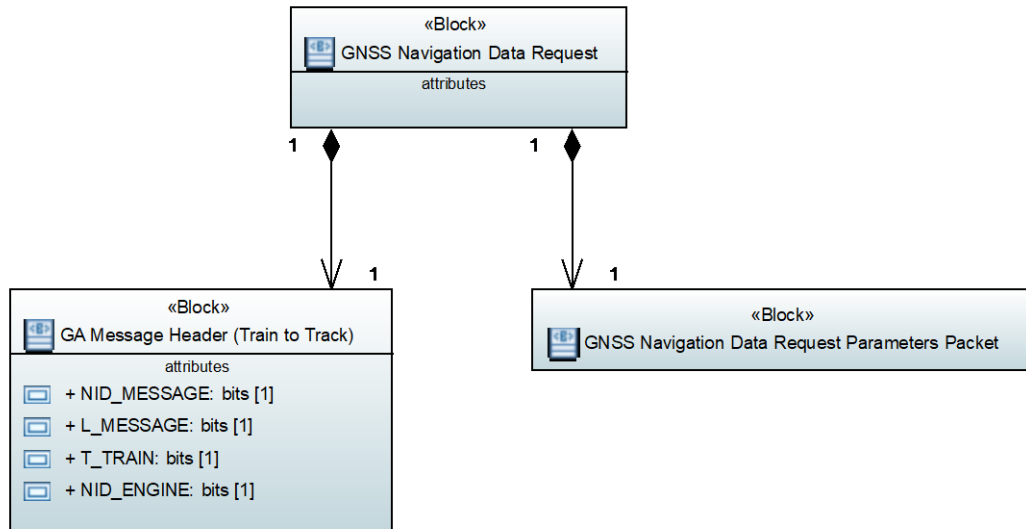
Figure 6. GNSS Navigation Data Request BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from train (GA-OB)
4	NID_ENGINE	Identify of the train
5	Packet of type TBC	GNSS Navigation Data Request Parameters packet

4.3.6   Resume GA Message Stream

4.3.6.1   Resume GA Message Stream message composition:
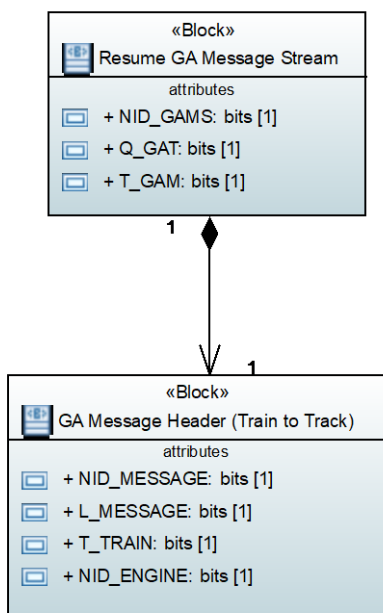
Figure 7. Resume GA Message Stream BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from train (GA-OB)
4	NID_ENGINE	Identify of the train
5	NID_GAMS	GA message stream identifier
6	Q_GAT	GA reference time for T_GAM
7	T_GAM	Timestamp of last GA message reception for message stream to be resumed

4.3.7 Suspend GA Message Stream

4.3.7.1 Suspend GA Message Stream message composition:
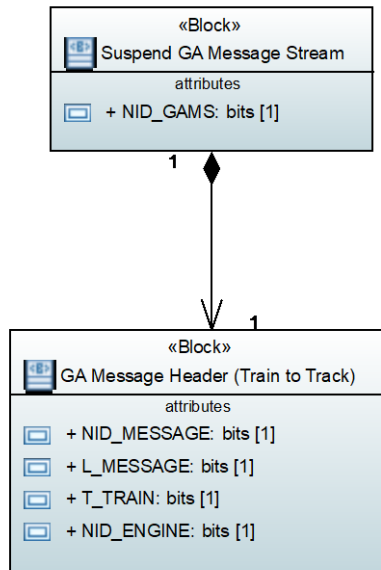
Figure 8. Suspend GA Message Stream BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from train (GA-OB)
4	NID_ENGINE	Identify of the train
5	NID_GAMS	GA message stream identifier

4.3.8   Terminate GA Session

4.3.8.1   Terminate GA Session message composition:
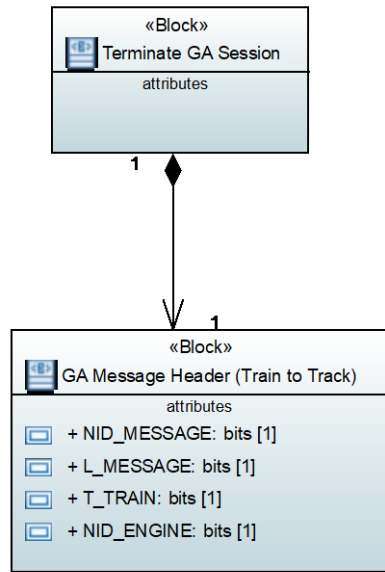
Figure 9. Terminate GA Session BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from train (GA-OB)
4	NID_ENGINE	Identify of the train

4.4 Definition of Radio Messages from Track to Train

4.4.1 GA Active Data Set

4.4.1.1 GA Active Data Set message composition:
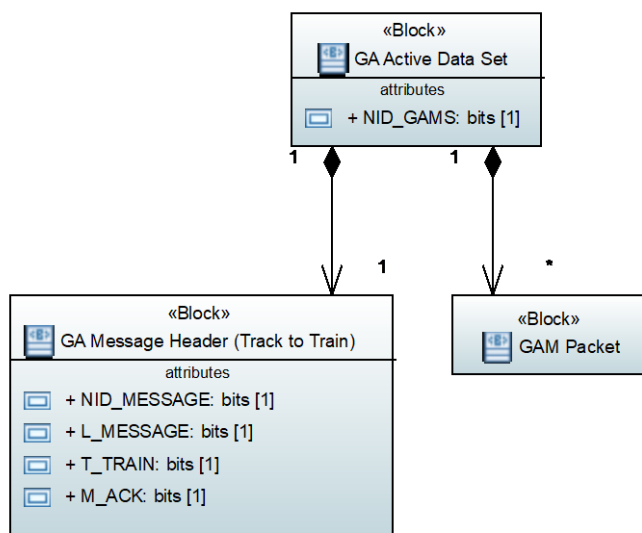
Figure 10. GA Active Data Set BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from trackside (GA-TS)
4	M_ACK	Indicates whether message must be acknowledged by the GA-OB
5	NID_GAMS	GA message stream identifier
6	Packet(s) of type TBC	GA active data as a set of GAM packets.

4.4.2   GA Message

4.4.2.1   GA Message composition:
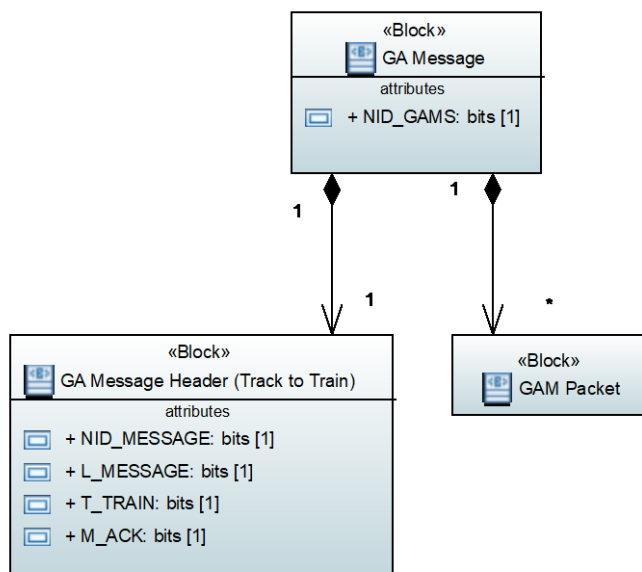
Figure 11. GA Message BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from trackside (GA-TS)
4	M_ACK	Indicates whether message must be acknowledged by the GA-OB
5	NID_GAMS	GA message stream identifier
6	Packet(s) of type TBC	GAM packet(s)

4.4.3 GA Message Stream Allocated / Resumed

4.4.3.1 GA Message Stream Allocated / Resumed message composition:
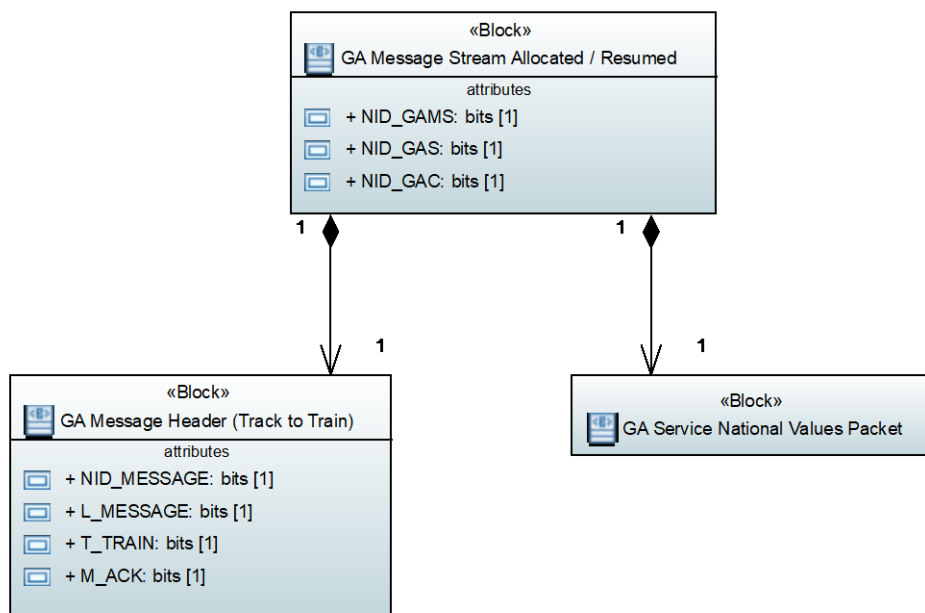
Figure 12. GA Message Stream Allocated / Resumed BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from trackside (GA-TS)
4	M_ACK	Indicates whether message must be acknowledged by the GA-OB
5	NID_GAMS	GA message stream identifier
6	NID_GAS	GA service identifier
7	NID_GAC	GA channel identifier
8	Packet of type TBC	GA Service National Values packet

4.4.4 GA Message Stream Suspended

4.4.4.1 GA Message Stream Suspended message composition:
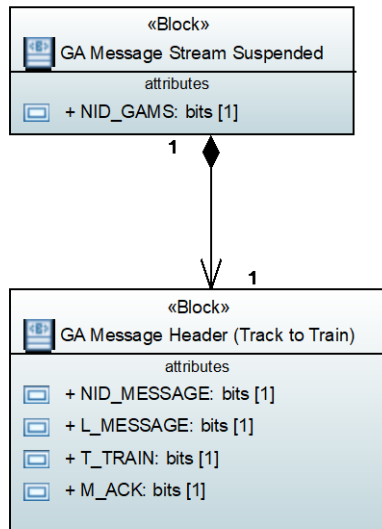
Figure 13. GA Message Stream Suspended BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from trackside (GA-TS)
4	M_ACK	Indicates whether message must be acknowledged by the GA-OB
5	NID_GAMS	GA message stream identifier

4.4.5 GA Session Error

4.4.5.1 GA Session Error message composition:
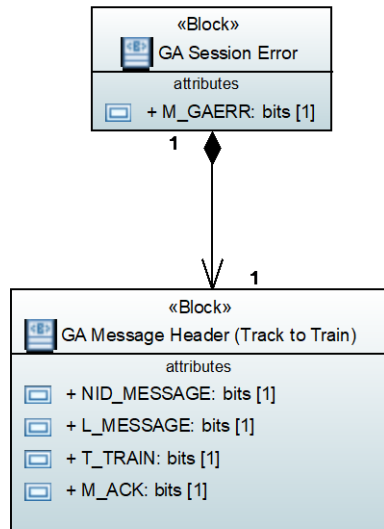
Figure 14. GA Session Error BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from trackside (GA-TS)
4	M_ACK	Indicates whether message must be acknowledged by the GA-OB
5	M_GAERR	GA session error type identifier

4.4.6 GA Session Established

4.4.6.1 GA Session Established message composition:
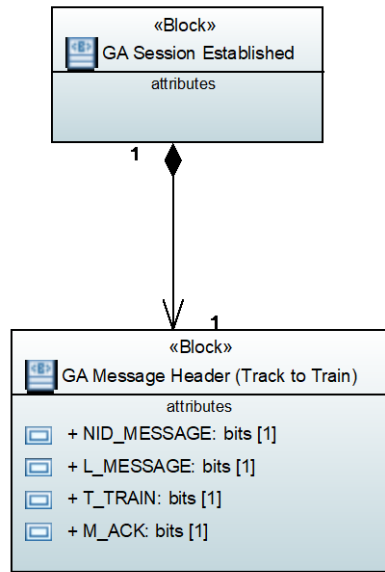
Figure 15. GA Session Established BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from trackside (GA-TS)
4	M_ACK	Indicates whether message must be acknowledged by the GA-OB

4.4.7 GA Session Terminated

4.4.7.1 GA Session Terminated message composition:
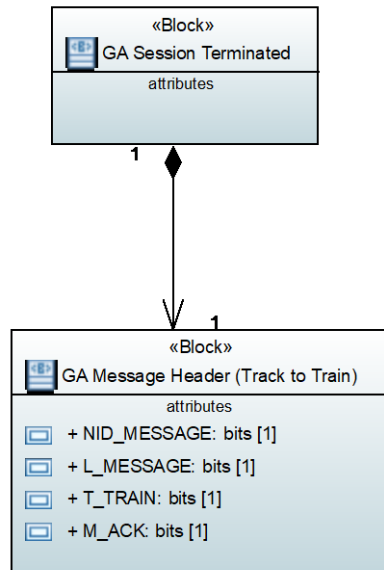
Figure 16. GA Session Terminated BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from trackside (GA-TS)
4	M_ACK	Indicates whether message must be acknowledged by the GA-OB

4.4.8   GNSS Navigation Data Set

4.4.8.1   GNSS Navigation Data Set message composition:
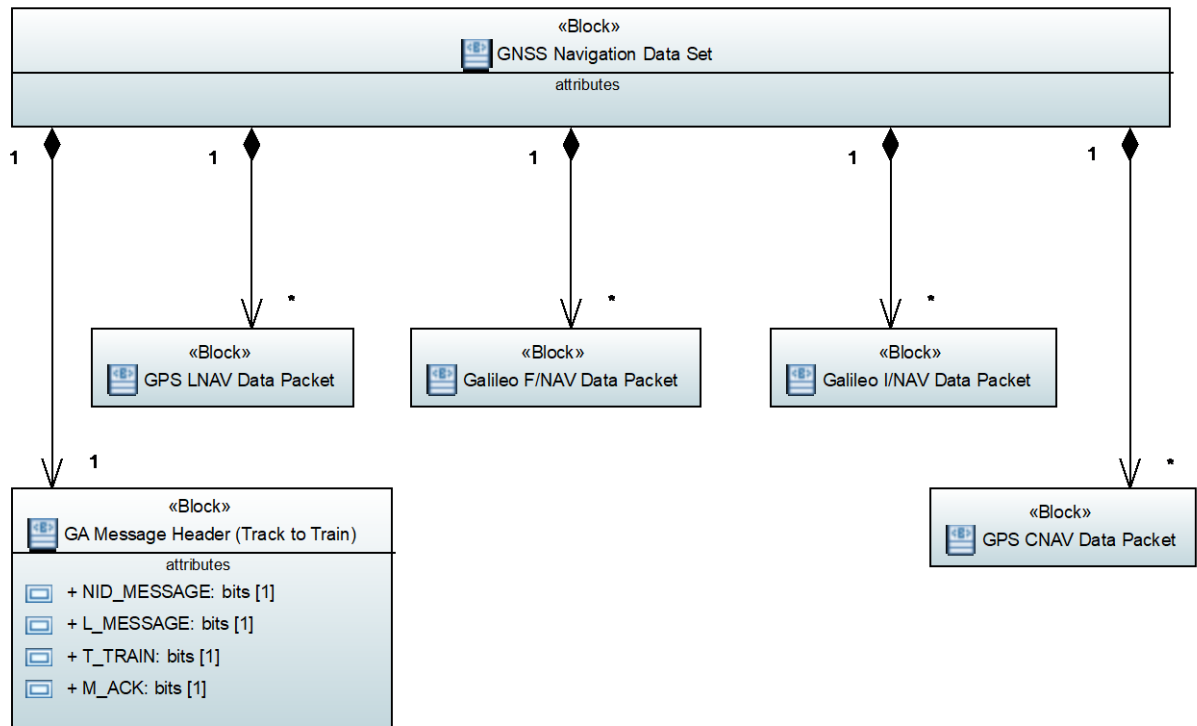
Figure 17. GNSS Navigation Data Set BDD

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	Message identification number
2	L_MESSAGE	Message length including everything from field 1 to padding (inclusive)
3	T_TRAIN	Timestamp from trackside (GA-TS)
4	M_ACK	Indicates whether message must be acknowledged by the GA-OB
5	Packet(s) of type TBC, TBC, …	E.g., GPS LNAV Data, Galileo F/NAV Data, Galileo I/NAV Data, and GPS CNAV Data packets.

5 Packets

5.1 Format of Packets

5.1.1.1 Packets are multiple variables grouped into a single unit, with a defined internal structure.

5.1.1.2 The packet definition does not change when transmitted over different transmission media.

5.1.1.3 All packet identifiers not listed in 5.2 shall be considered as invalid values when received by the GA-OB.

5.1.1.4 N_ITER specifies the number of iterations of a variable or group of variables which follow.

5.1.1.5 If N_ITER is 0 then no variables follow.

5.1.1.6 Two or more nested levels of iterations can exist.

5.1.1.7 If, depending on the value of a previous qualifier variable in the packet, a variable is optional, it is written indented in the packet definition.

5.1.2 Track to Train

5.1.2.1 The packet structure is as follows:

Number	NID_PACKET	Packet identifier
Direction	Q_DIR	Specifies the validity direction of transmitted data
Length	L_PACKET	Number of bits in the packet
Scale	Q_SCALE	Specifies which scale is used for distance/length information within the packet. There is no Q_SCALE variable in packets which do not contain distance information.
Information	…	Well-defined set(s) of variables

5.1.3 Train to Track

5.1.3.1 The packet structure is as follows:

Number	NID_PACKET	Packet identifier
Length	L_PACKET	Number of bits in the packet
Scale	Q_SCALE	Specifies which scale is used for distance/length information within the packet. There is no Q_SCALE variable in packets which do not contain distance information.
Information	…	Well-defined set(s) of variables

5.2 List of Packets

5.2.1.1   This section identifies packets with the corresponding Packet Number and Packet Name.

5.2.2 Track to Train

5.2.2.1   The following packets are included in messages transmitted by the GA-TS to the GA-OB:

Packet Number	Packet Name	Page N°
TBC	GAM	31
TBC	GA Service National Values	32
TBC	GPS LNAV Data	33
TBC	Galileo F/NAV Data	34
TBC	Galileo I/NAV Data	35
TBC	GPS CNAV Data	36
TBC	Reserved for other navigation data / from other GNSS	N/A

5.2.3 Train to Track

5.2.3.1   The following packets are included in messages transmitted by the GA-OB to the GA-TS:

Packet Number	Packet Name	Page N°
TBC	GA Services Supported by On-board	37
TBC	GNSS Navigation Data Request Parameters	38

5.3 Packets: Track to Train

5.3.1 GAM (GNSS Augmentation Message)

5.3.1.1 GAM packet composition:

Figure 18. GAM BDD

Description	This packet encapsulates a GNSS augmentation message (e.g., SBAS L1 and DFMC messages in the case of EGNOS) and is used to disseminate GNSS augmentation message streams to the on-board.		
Content	**Variable**	**Length**	**Comment**
	NID_PACKET	8	Packet identifier
	Q_DIR	2	Validity direction of transmitted data
	L_PACKET	13	Packet length
	Q_GAMT	4	GA message type
	Q_GAT	4	GA reference time qualifier
	T_GAM	32	Timestamp of GA message reception (i.e., timestamp of the end of the reception of the augmentation message by trackside)
	M_GAM	$n \leq 3840$	GA message

*Note: maximum ETCS message length of 500 bytes cannot be exceeded (maximum length per message to allow for the dimensioning of radio input buffers) [SS040, 4.2.2.1].

5.3.2   GA Service National Values

5.3.2.1   GA Service National Values packet composition:
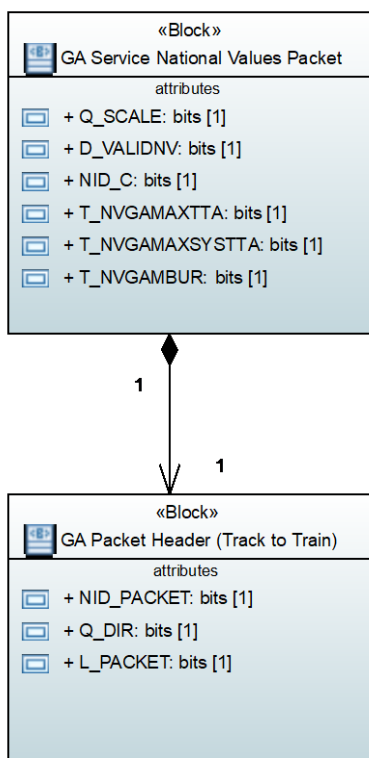
Figure 19. GA Service National Values BDD

Description	This packet provides a set of National Values related to a specific GNSS augmentation service		
Content	**Variable**	**Length**	**Comment**
	NID_PACKET	8	Packet identifier
	Q_DIR	2	Validity direction of transmitted data
	L_PACKET	13	Packet length
	Q_SCALE	2	Qualifier to indicate the same scale used for describing all distances/lengths inside the packet that contains Q_SCALE
	D_VALIDNV	15	Distance to start of validity of national values
	NIC_C	10	Code used to identify the country or region in which the GA-TS is situated. These need not necessarily follow administrative or political boundaries.
	T_NVGAMAXTTA	16	GA maximum TTA
	T_NVGAMAXSYSTTA	16	GA maximum system TTA budget
	T_NVGAMBUR	16	GAM broadcast update rate

5.3.3   GPS LNAV Data

5.3.3.1   GPS LNAV Data packet composition:
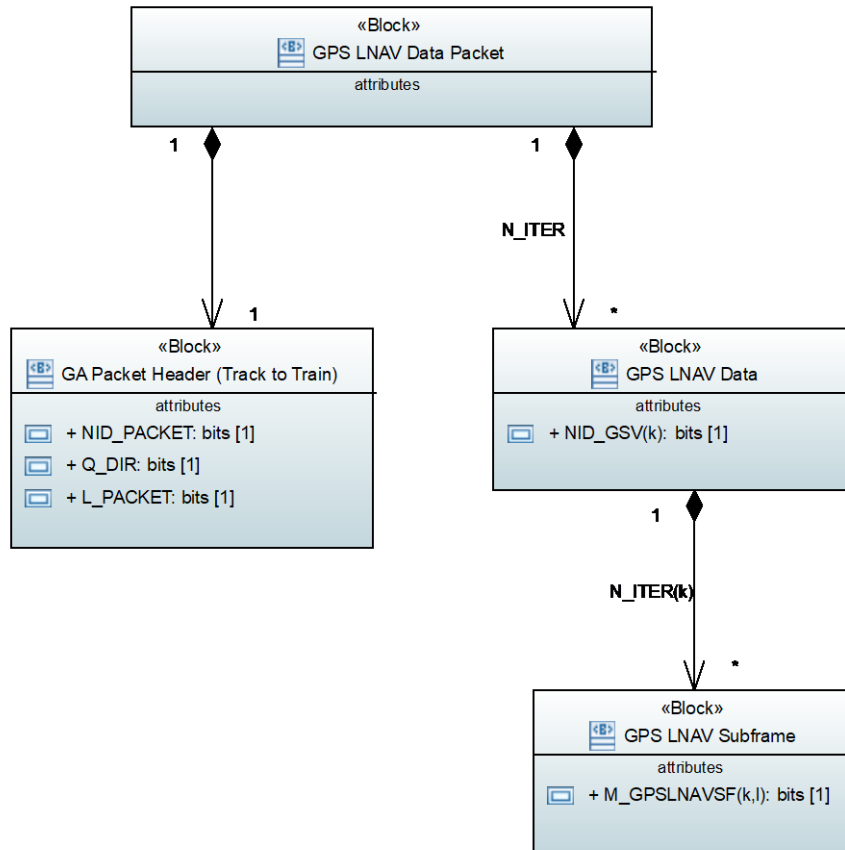
Figure 20. GPS LNAV Data BDD

Description	This packet is used to disseminate selected GPS LNAV subframes to the on-board.		
Content	Variable	Length	Comment
	NID_PACKET	8	Packet identifier
	Q_DIR	2	Validity direction of transmitted data
	L_PACKET	13	Packet length
	N_ITER	5	Number of iterations of data set following this variable. If N_ITER is 0 then no data set is following.
	NID_GSV(k)	8	Identify number of the GNSS satellite vehicle (SV)
	N_ITER(k)	5	Number of iterations of data set following this variable. If N_ITER is 0 then no data set is following.
	M_GPSLNAVSF(k,l)	300	GPS LNAV Subframe

5.3.4   Galileo F/NAV Data

5.3.4.1   Galileo F/NAV Data packet composition:
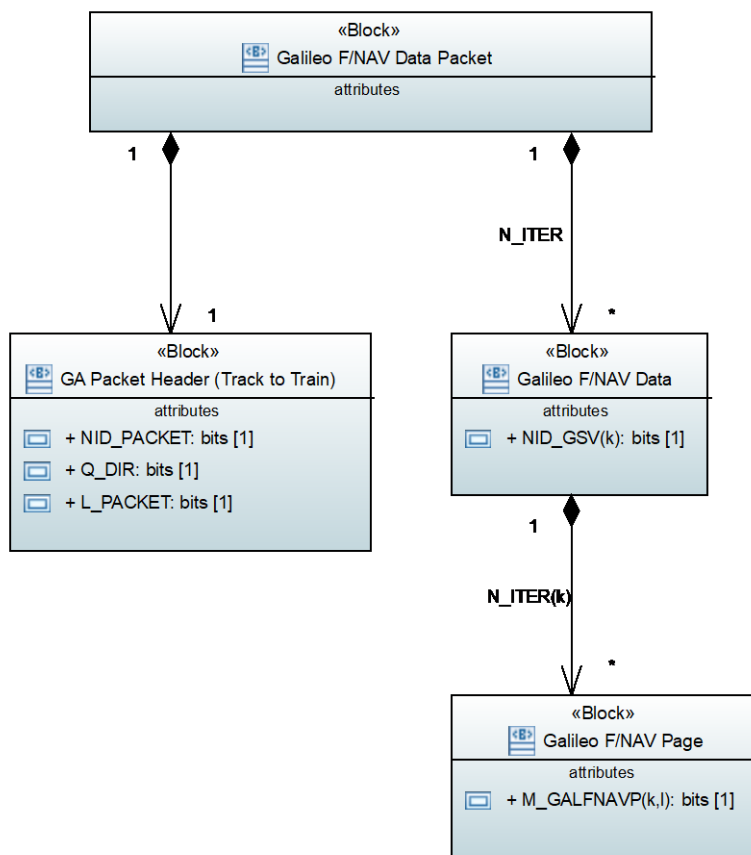
Figure 21. Galileo F/NAV Data BDD

Description	This packet is used to disseminate Galileo F/NAV pages to the on-board.		
Content	**Variable**	**Length**	**Comment**
	NID_PACKET	8	Packet identifier
	Q_DIR	2	Validity direction of transmitted data
	L_PACKET	13	Packet length
	N_ITER	5	Number of iterations of data set following this variable. If N_ITER is 0 then no data set is following.
	NID_GSV(k)	8	Identify number of the GNSS satellite vehicle (SV)
	N_ITER(k)	5	Number of iterations of data set following this variable. If N_ITER is 0 then no data set is following.
	M_GALFNAVP(k,l)	238	Galileo F/NAV Page

5.3.5 Galileo I/NAV Data

5.3.5.1 Galileo I/NAV Data packet composition:
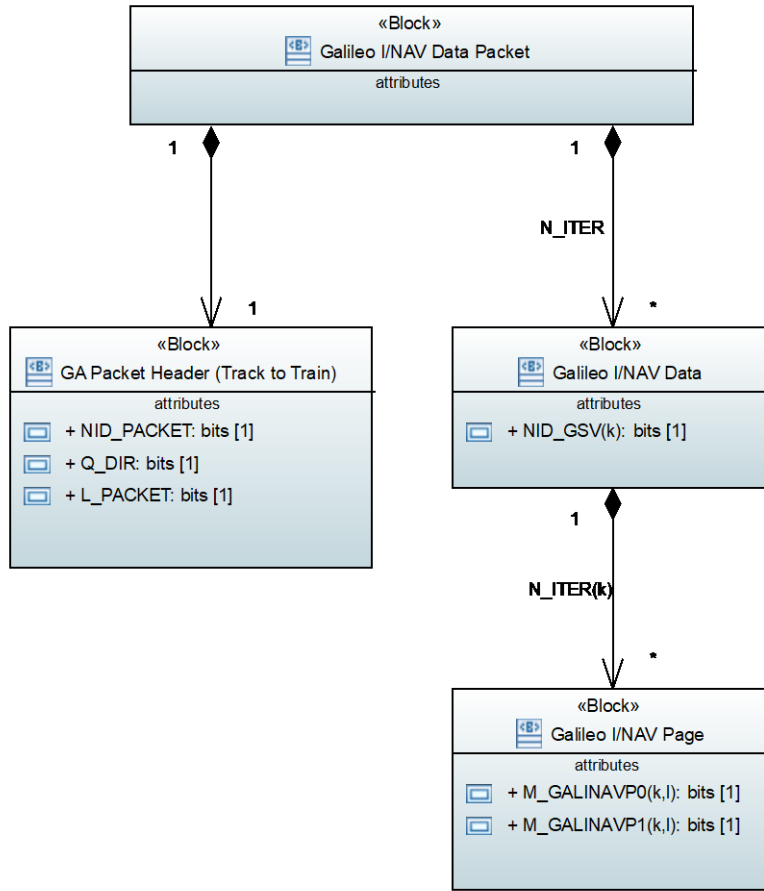
Figure 22. Galileo I/NAV BDD

Description	This packet is used to disseminate Galileo I/NAV pages to the on-board.		
	In the case of the EGNOS DFMC Railway SoL Service, Galileo I/NAV data is not required as Galileo F/NAV data is used; however, I/NAV data is made available to support degraded operating modes (i.e., not using EGNOS) if required.		
Content	**Variable**	**Length**	**Comment**
	NID_PACKET	8	Packet identifier
	Q_DIR	2	Validity direction of transmitted data
	L_PACKET	13	Packet length
	N_ITER	5	Number of iterations of data set following this variable. If N_ITER is 0 then no data set is following.
	NID_GSV(k)	8	Identify number of the GNSS satellite vehicle (SV)
	N_ITER (k)	5	Number of iterations of data set following this variable. If N_ITER is 0 then no data set is following.
	M_GALINAVP0(k,l)	114	Galileo I/NAV Even Page Part
	M_GALINAVP1(k,l)	114	Galileo I/NAV Odd Page Part

5.3.6 GPS CNAV Data

5.3.6.1 GPS CNAV Data packet composition:
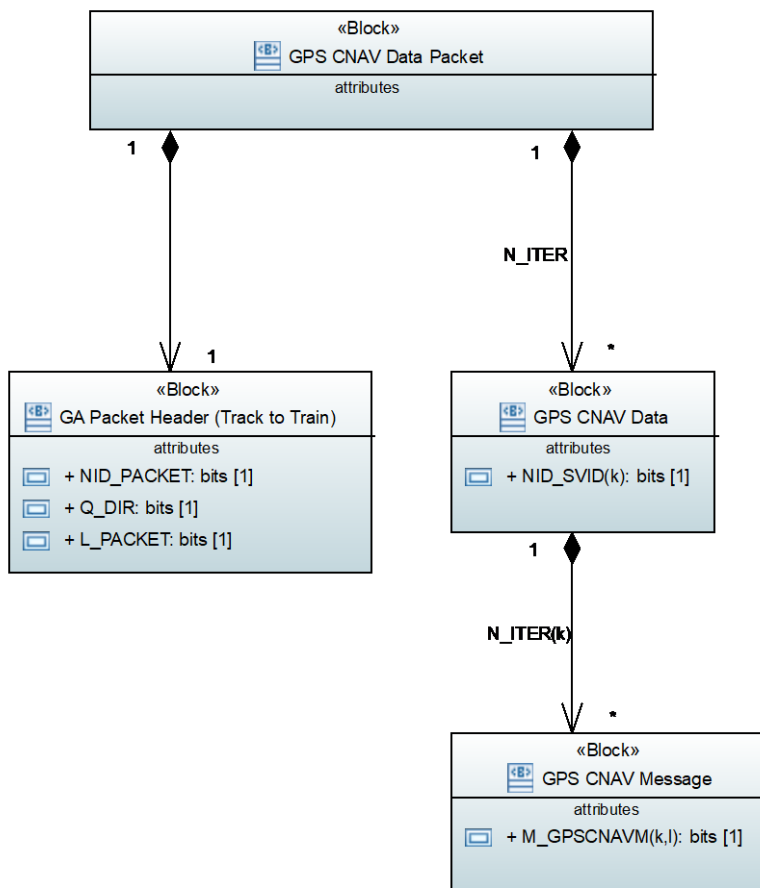
Figure 23. GPS CNAV Data BDD

Description	This packet is used to disseminate GPS CNAV messages to the on-board.		
	In the case of EGNOS DFMC Railway SoL Service, GPS CNAV data is not required as GPS LNAV data is used; however, CNAV data is made available to support degraded operating modes (i.e., not using EGNOS) if required.		
Content	**Variable**	**Length**	**Comment**
	NID_PACKET	8	Packet identifier
	Q_DIR	2	Validity direction of transmitted data
	L_PACKET	13	Packet length
	N_ITER	5	Number of iterations of data set following this variable. If N_ITER is 0 then no data set is following.
	NID_SVID(k)	8	Identify number of the GNSS satellite vehicle (SV)
	N_ITER (k)	5	Number of iterations of data set following this variable. If N_ITER is 0 then no data set is following.
	M_GPSCNAVM(k,l)	300	GPS CNAV message

5.4 Packets: Train to Track

5.4.1 GA Services Supported by On-board

5.4.1.1 GA Services Supported by On-board packet composition:
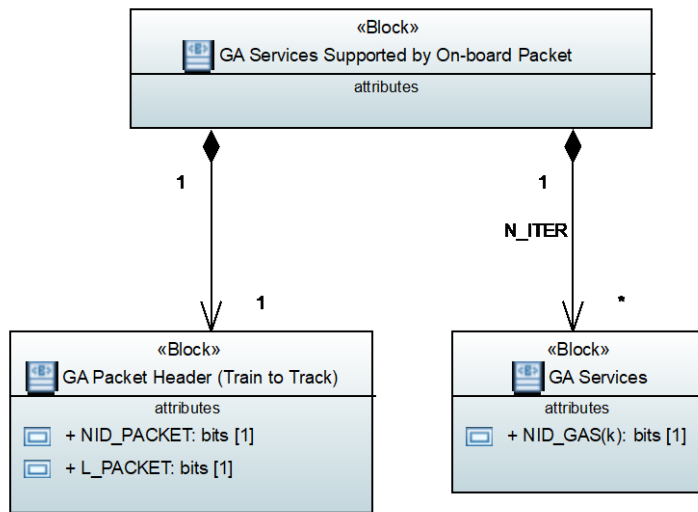
Figure 24. GA Services Supported by On-board BDD

Description	This packet provides trackside with the GNSS Augmentation (GA) services supported by the on-board		
Content	**Variable**	**Length**	**Comment**
	NID_PACKET	8	Packet identifier
	L_PACKET	13	Packet length
	N_ITER	5	Number of iterations of data set following this variable. If N_ITER is 0 then no data set is following.
	NID_GAS(k)	5	GA service identifier

5.4.2 GNSS Navigation Data Request Parameters

5.4.2.1 GNSS Navigation Data Request Parameters packet composition:
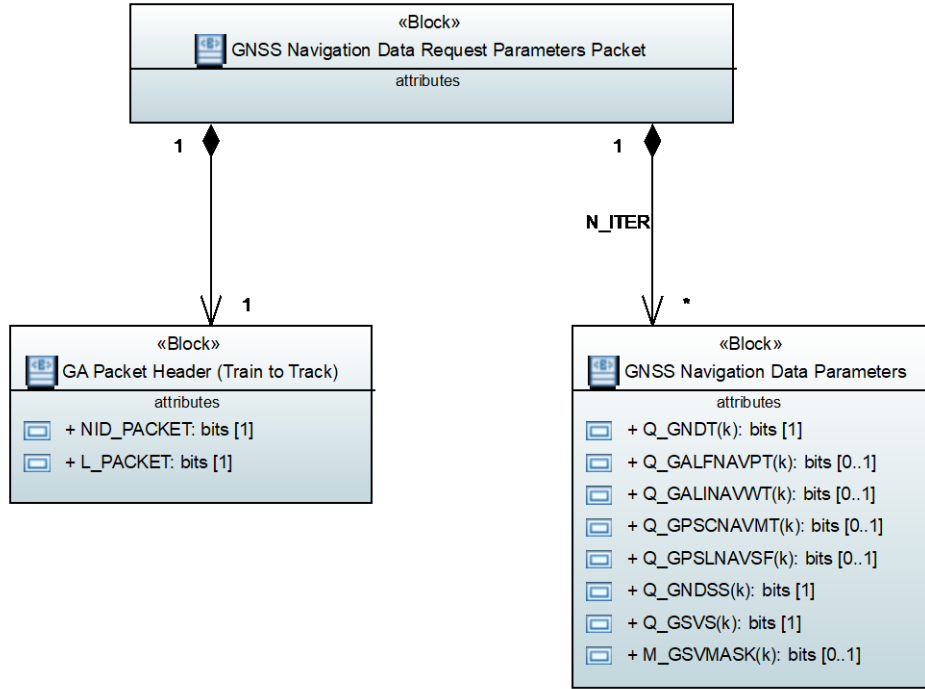
Figure 25. GNSS Navigation Data Request Parameters BDD

Description	This packet provides the GA-TS with the GNSS navigation data request parameters		
Content	**Variable**	**Length**	**Comment**
	NID_PACKET	8	Packet identifier
	L_PACKET	13	Packet length
	N_ITER	5	Number of iterations of data set following this variable. If N_ITER is 0 then no data set is following.
	Q_GNDT(k)	8	Qualifier to indicate the GNSS navigation data set type to be requested
	Q_GPSLNAVSF(k)	8	Only if Q_GNDT = 0 GPS LNAV subframes to be requested
	Q_GALFNAVPT(k)	8	Only if Q_GNDT = 1 Galileo F/NAV pages to be requested
	Q_GALINAVWT(k)	16	Only if Q_GNDT = 2 Galileo I/NAV words to be requested
	Q_GPSCNAVMT(k)	16	Only if Q_GNDT = 3 GPS CNAV messages to be requested
	Q_GNDSS(k)	3	Qualifier for GNSS navigation data set selection (IODs)
	Q_GSVS(k)	2	Qualifier for GNSS satellite vehicle (SV) selection

		M_GSVMASK(k)	214	Only if Q_GSVS = 1 GNSS satellite vehicle mask to select satellites

5.5 Definitions of Variables

5.5.1.1 Variables are used to encode single data values. Variables cannot be split in minor units. The whole variable has one type (meaning).

5.5.1.2 Variables may have special values which are related to the basic meaning of the variable.

5.5.1.3 Special values have always the highest values in a variable (e.g., 32767 = "unknown").

5.5.1.4 Spare values are located between the normal and special values in the variable range.

5.5.1.5 Names of variables are unique. A variable is used in context with the meaning as described in the variable definition. Variables with different meanings have different names.

5.5.1.6 All variable definitions are independent of the transport media over which they are used, if used in more than one media.

5.5.1.7 Signed values shall be encoded as 2's complement.

5.5.1.8 One-bit variables (Boolean) always use 0 for false and 1 for true.

5.5.1.9 Offsets for numerical values are avoided (0 is used for 0, 1 for 1, etc.) except where justified.

5.5.1.10 When transmitting over the different transmission media, the most significant bit shall be transmitted first.

5.5.1.11 All Variables have one of the following prefixes:

A_	Acceleration
D_	Distance
G_	Gradient
L_	Length
M_	Miscellaneous
N_	Number
NC_	Class Number
NID_	Identity Number
Q_	Qualifier
T_	Time/date
V_	Speed
X_	Text

5.5.2 Variables Related to GA Message Header Format

5.5.2.1 The following variables related to the format of the GA message header are consistent with the variables defined in the ERTMS/ETCS SRS [SS026-7].

5.5.2.2 L_MESSAGE

Name	Message length		
Description	L_MESSAGE indicates the length of the message in bytes, including all packets and all variables defined in the message header (NID_MESSAGE and L_MESSAGE also).		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
10 bits	0	1023	1 byte

5.5.2.3 M_ACK

Name	Qualifier for acknowledgement request		
Description	Indicates whether the message must be acknowledged or not		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
1 bit			
Special/Reserved Values	0	No acknowledgement required	
	1	Acknowledgement required	

5.5.2.4 NID_ENGINE

Name	Onboard ETCS identity		
Description	ETCS identity number is uniquely defined for ERTMS/ETCS purposes		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
24 bits			

5.5.2.5 NID_MESSAGE

Name	Message identifier		
Description	Message identifier		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
8 bits	0	255	Numbers

5.5.2.6 T_TRAIN

Name	Trainborne clock		
Description	Time, according to trainborne clock, at which message is sent		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
32 bits	0 s	42949672.94 s	10 ms
Special/Reserved Values	4294967295	Unknown	

5.5.3 Variables Related to GA Packet Header Format

5.5.3.1 The following variables related to the format of the GA packet header are consistent with the variables defined in the ERTMS/ETCS SRS [SS026-7].

5.5.3.2 D_VALIDNV

Name	Distance to start of validity of national values		
Description			
Length of variable	Minimum Value	Maximum Value	Resolution/formula
15 bits	0 cm	327.660 km	10 cm, 1m or 10 m depends on Q_SCALE
Special/Reserved Values	32767	Now (National Values are immediately applicable)	

5.5.3.3 L_PACKET

Name	Packet length		
Description	L_PACKET indicates the length of the packet in bits, including all bits of the packet header		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
13 bits	0	8191	1 bit

5.5.3.4 NID_C

Values are assigned by ERA to a Member State. Refer to [SS054].

Name	Identity number of the country or region		
Description	Code used to identify the country or region in which the GA-TS is situated. These need not necessarily follow administrative or political boundaries.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
10 bits	0	1024	Numbers

5.5.3.5   NID_PACKET

Name	Packet identifier		
Description	This is used in the header for each packet, allowing the receiving equipment to identify the data which follows		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
8 bits	0	255	Numbers

5.5.3.6   Q_DIR

Name	Validity direction of transmitted data		
Description	Qualifier to indicate the relevant validity direction of transmitted data, with reference to directionality of the LRBG, in case of information sent via radio.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
2 bits			
Special/Reserved Values	00	Reverse	
	01	Nominal	
	10	Both directions	
	11	Spare	

5.5.3.7   Q_SCALE

Name	Qualifier for the distance/length scale		
Description	Qualifier to indicate the same scale used for describing all distances/lengths inside the packet that contains Q_SCALE		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
2 bits			
Special/Reserved Values	0	10 cm scale	
	1	1 m scale	
	2	10 m scale	
	3	Spare	

5.5.4 Variables Related to GNSS Augmentation

5.5.4.1 M_GAERR

Name	GA Session Error Type		
Description	GNSS augmentation session error type		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
8 bits	0	255	
	0	Unable to establish GA session	
	1	Unable to resume primary GA message stream	
	2	Unable to resume secondary GA message stream	
	3 – 254	Spare	
	255	Unknown service error	

5.5.4.2 M_GAM

Name	GA Message		
Description	Encapsulates GNSS augmentation messages. SBAS L1 (SFSC) and L5 (DFMC) messages are 250 bits. For L1 SBAS messages: 8-bit preamble (24 bits over 3 blocks), 6-bit message type identifier, 212-bit data field and 24-bit CRC; for L5 SBAS messages: 4-bit preamble (24 bits over 6 blocks), 6-bit message type identifier, 216-bit data field and 24-bit CRC.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
n bits	0	3840 bits*	(480 bytes)

*Note: maximum ETCS message length of 500 bytes cannot be exceeded (maximum length per message to allow for the dimensioning of radio input buffers) 4.2.2.1 [SS040].

5.5.4.3 M_GALFNAVP

Name	Galileo F/NAV Page		
Description	Encapsulates a Galileo F/NAV page excluding tail bits. Refer to Galileo Open Service SIS Interface Control Document [GAL-OS-SIS-ICD] for page contents.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
238 bits			

5.5.4.4 M_GALINAVP0

Name	Galileo I/NAV Even Page Part		
Description	Encapsulates a Galileo I/NAV even page part excluding tail bits. Refer to Galileo Open Service SIS Interface Control Document [GAL-OS-SIS-ICD] for page contents.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
114 bits			

5.5.4.5   M_GALINAVP1

Name	Galileo I/NAV Odd Page Part		
Description	Encapsulates a Galileo I/NAV odd page part excluding tail bits. Refer to Galileo Open Service SIS Interface Control Document [GAL-OS-SIS-ICD] for page contents.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
114 bits			

5.5.4.6   M_GPSCNAVM

Name	GPS CNAV Message		
Description	Encapsulates a GPS CNAV message. Refer to GPS Interface Specification [IS-GPS-200] for subframe data structure (Appendix III, GPS Navigation Data Structure for CNAV Data DC(T)).		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
300 bits			

5.5.4.7   M_GPSLNAVSF

Name	GPS LNAV Subframe		
Description	Encapsulates a GPS LNAV subframe. Refer to GPS Interface Specification [IS-GPS-200] for subframe data structure (Appendix II, GPS Navigation Data Structure for LNAV Data D(T) for PRN 1-32).		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
300 bits			

5.5.4.8 M_GSVMASK

Name	GNSS satellite vehicle (SV) mask
Description	Satellite slot number (maximum of 37 SVs for each GNSS constellation)
	A value of 1 selects the SV. The Satellite Slot Numbers are assigned in the order of the satellite's identifier of this constellation (for GPS: PRN number; for Galileo: SV identifier).
	Note: Mask follows same format as MT31 from the DFMC aviation MOPS (for DFMC, it is likely that upper GPS PRN range are to be used; however, there are on-going discussions on how this will be handled in PRN mask for DFMC aviation MOPS).

Length of variable	Minimum Value	Maximum Value	Resolution/formula
214 bits			Bitset

Special/Reserved Values	Bits 0 – 31	GPS PRNs 1 to 32
	Bits 32 – 36	GPS reserved
	Bits 37 – 73	Reserved for future use (GLONASS)
	Bits 74 – 109	Galileo SV IDs 1 to 36
	Bit 110	Galileo reserved
	Bits 111 – 118	Spare
	Bits 119 – 157	Reserved for future use
	Bits 158 – 194	Reserved for future use (BeiDou)
	Bits 195 – 206	Reserved
	Bits 207 – 213	Spare

5.5.4.9 N_GAADSMAXRETRIES

Name	Maximum number of retries for retransmission of an unacknowledged *GA Active Data Set* message
Description	Fixed value for the maximum number of retries for retransmission of an unacknowledged *GA Active Data Set* message.

Length of variable	Minimum Value	Maximum Value	Resolution/formula
8 bits	0	255	

5.5.4.10 N_GNSSNDSMAXRETRIES

Name	Maximum number of retries for retransmission of an unacknowledged *GNSS Navigation Data Set* message
Description	Fixed value for the maximum number of retries for retransmission of an unacknowledged *GNSS Navigation Data Set* message.

Length of variable	Minimum Value	Maximum Value	Resolution/formula
8 bits	0	255	

5.5.4.11 NID_GAC

Name	GA Channel Identifier		
Description	GNSS augmentation channel identifier (e.g., for EGNOS, this would be the SBAS PRNs)		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
8 bits	0	255	
Special/Reserved Values	0 – 119	Reserved	
	120 – 158	Range of SBAS PRNs	
	159	EGNOS railway terrestrial dissemination channel (future)	
	160 – 210	Spare	
	211 – 254	Reserved	
	255	Unknown	

5.5.4.12 NID_GAMS

Name	Identifier of the GA message stream		
Description	Identifies GNSS augmentation message stream.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
3 bits	0	7	
Special/Reserved Values	0	Primary GNSS augmentation message stream	
	1	Secondary GNSS augmentation message stream	
	2 – 7	Spare	

5.5.4.13 NID_GAS

Name	GA service identifier		
Description	GNSS augmentation service identifier.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
6 bits			
Special/Reserved Values	0	EGNOS Railway SoL L1 Service	
	1	EGNOS Railway SoL L5 DFMC Service	
	2 – 63	Spare*	

*Note: spare values considered for future use (e.g., other GNSS augmentation services).

5.5.4.14   NID_GSV

Name	Identity number of the GNSS satellite vehicle (SV)		
Description	Satellite slot number (maximum of 37 SVs for each GNSS constellation)		
	The Satellite Slot Numbers are assigned in the order of the satellite's identifier of this constellation (for GPS: PRN number; for Galileo: SV identifier).		
	Note: slot numbering follows same format as MT31 from the DFMC aviation MOPS (for DFMC, it is likely that upper GPS PRN range are to be used; however, there are on-going discussions on how this will be handled in PRN mask for DFMC aviation MOPS).		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
8 bits	0	213	Number
Special/Reserved Values	0 – 31	GPS PRNs 1 to 32	
	32 – 36	GPS reserved	
	37 – 73	Reserved for future use (GLONASS)	
	74 – 109	Galileo SV IDs 1 to 36	
	110	Galileo reserved	
	111 – 118	Spare	
	119 – 157	Reserved for future use	
	158 – 194	Reserved for future use (BeiDou)	
	195 – 206	Reserved	
	207 – 213	Spare	

5.5.4.15   T_GAADSRTIMEOUT

Name	Timeout for retransmission of an unacknowledged *GA Active Data Set* message		
Description	Fixed value for the timeout for retransmission of an unacknowledged *GA Active Data Set* message.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
16 bits	0 ms	65535 ms	1 ms

5.5.4.16   T_GAM

Name	Timestamp of GA message reception		
Description	Timestamp of end of reception of GNSS augmentation message reception by GA-TS. Timestamp reference time is defined by qualifier Q_GAT.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
32 bits	0 ms	604799999 ms	1 ms
Special/Reserved Values	4294967295	Unknown	

5.5.4.17 T_GAMAXOBTTA

Name	GA Maximum On-board Equipment TTA Budget		
Description	Fixed value for the on-board equipment TTA budget allocation for processing latency from end of reception of SBAS message at endpoint in the on-board to raising an alert (negation of fault). Note: Endpoint refers to the Enhanced Vehicle Localisation Function within the on-board CCS subsystem. For example, GNSS augmentation communication channel could include reception of GNSS augmentation messages by the CCS on-board and forwarding on the internal bus (e.g., Profibus) to the Enhanced Vehicle Localisation Function, the endpoint.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
16 bits	0 ms	65535 ms	1 ms

5.5.4.18 T_GAMRTIMEOUT

Name	Timeout for retransmission of an unacknowledged *GA Message*		
Description	Fixed value for the timeout for retransmission of an unacknowledged *GNSS Augmentation Message.* Acknowledgements are required for some types of GNSS augmentation messages (e.g., in the case of SBAS, for GNSS augmentation messages encapsulating an SBAS alert message or Message Type 0 – Do Not Use for Safety Applications).		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
16 bits	0 ms	65535 ms	1 ms

5.5.4.19 T_GATIMEOUT

Name	GNSS Augmentation Message Stream Timeout		
Description	Timeout when no valid GNSS augmentation message has been received for T_GATIMEOUT milliseconds indicating a probable communications link problem or unacknowledged alert sequence. T_GATIMEOUT = T_NVGAMAXTTA – (T_NVGAMAXSYSTTA + T_GAMAXOBTTA)		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
16 bits	0 ms	65535 ms	1 ms

5.5.4.20 T_GNSSNDSRTIMEOUT

Name	Timeout for retransmission of an unacknowledged *GNSS Navigation Data Set* message		
Description	Fixed value for the timeout for retransmission of an unacknowledged *GNSS Navigation Data Set* message.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
16 bits	0 ms	65535 ms	1 ms

5.5.4.21 T_NVGABUR

Name	GA Broadcast Update Rate		
Description	National value for the GA broadcast update rate. Continuity of transmission is guaranteed by transmission of a valid message at the broadcast update rate. (e.g., in the case of SBAS L1 and DFMC services, T_NVGABUR = 1000 ms)		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
16 bits	0 ms	65535 ms	1 ms

5.5.4.22 T_NVGAMAXSYSTTA

Name	GA Maximum System TTA		
Description	National value defining the maximum system TTA for the GA System, which is the maximum duration between the occurrence of an alert condition and reception of the alert at the trackside. The time to detect the alert condition by the GA System is included in this duration. An alert condition occurs when the GA System has erroneously broadcast an integrity data not bounding at the specified confidence level the residuals for any valid combination of active data. (e.g., for EGNOS L1, UDRE and GIVE not bounding ephemeris/clock and ionosphere residuals; and for EGNOS DFMC, DFRE not bounding ephemeris/clock residuals).		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
16 bits	0 ms	65535 ms	1 ms

5.5.4.23   T_NVGAMAXTTA

Name	GA Maximum TTA
Description	National value for the GA maximum TTA (end-to-end).

The dimensioning of this national value shall take into consideration the following:

- GA Maximum System TTA (e.g., 5200 ms in the case of EGNOS L1 and DFMC SoL Services);
- Latency of GA-TS processing (including processing and encapsulation of GA messages; e.g., in the case of EGNOS L1 and DFMC services, this includes allocation for the GA-TS GNSS receiver);
- GA-TS to GA-OB transfer delay over safe radio connection;
- The GA broadcast update rate for supervision of continuity of transmission (e.g., T_NVGAMBUR = 1000 ms in the case of EGNOS L1 and DFMC SoL Services);
- On-board equipment maximum TTA (T_GAMAXOBTTA); and
- Margin to cope with variations in safe radio connection performance.

Note: this value is part of the national values and is configured by the infrastructure manager taking into consideration the performance and dimensioning of the safe radio connection. This variable is used by the GA-OB to determine T_GATIMEOUT for supervision of the GNSS augmentation message stream and to ensure correct assumptions are made within the enhanced vehicle localisation function regarding time to detect and negate faulty measurements caused by GNSS errors or anomalies detected by the GNSS augmentation system.

Tuning of this parameter is a trade-off between impacts on train positioning performance (i.e., degradation from larger values) and impacts on availability from smaller values.

For example, a larger value may result in an increased train confidence interval and reduced accuracy as a result of coasting from last validated train position for longer periods compared to smaller values that may result in more frequent transitions to an unavailability state when threshold is exceeded due to conditions of the safe radio connection.

Length of variable	Minimum Value	Maximum Value	Resolution/formula
16 bits	0 ms	65535 ms	1 ms

5.5.4.24   Q_GALFNAVPT

Name	Qualifier to indicate the Galileo F/NAV Page Type to be requested		
Description	Qualifier to indicate the page type of Galileo E5a F/NAV navigation data that can be included in a request for GNSS navigation data. A value of 1 selects the page type.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
8 bits			Bitset
Special/Reserved Values	Bit 0	Page Type 1: SVID, Clock correction, SISA, Ionospheric correction, BGD, GST, Signal health and Data validity status	
	Bit 1	Page Type 2: Ephemeris (1/3) and GST	
	Bit 2	Page Type 3: Ephemeris (2/3) and GST	
	Bit 3	Page Type 4: Ephemeris (3/3), GST-UTC conversion, GST-GPS* conversion, and TOW	
	Bit 4	Page Type 5: Almanac (SVID1 and SVID2(1/2), week number and almanac reference time	
	Bit 5	Page Type 6: Almanac (SVID2(2/2) and SVID3)	
	Bit 6	Spare	
	Bit 7	Spare	

*Note: GST-GPS time conversion parameters shall not be used by the on-board equipment for safety-related position determination (refer to L1 and DFMC Railway SoL Service MOPS).

5.5.4.25   Q_GALINAVWT

Name	Qualifier to indicate the Galileo I/NAV Page Type to be requested		
Description	Qualifier to indicate the page type of Galileo E1-B I/NAV navigation data that can be included in a request for GNSS navigation data. A value of 1 selects the word type.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
16 bits			Bitset
Special/Reserved Values	Bit 0	Word Type 1: Ephemeris (1/4)	
	Bit 1	Word Type 2: Ephemeris (2/4)	
	Bit 2	Word Type 3: Ephemeris (3/4) and SISA	
	Bit 3	Word Type 4: SVID, Ephemeris (4/4), and Clock correction parameters	
	Bit 4	Word Type 5: Ionospheric correction, BGD, signal health and validity status, and GST	
	Bit 5	Word Type 6: GST-UTC conversion parameters	
	Bit 6	Word Type 7: Almanac for SVID1 (1/2), almanac reference time and almanac reference week number	
	Bit 7	Word Type 8: Almanac for SVID1 (2/2) and SVID2 (1/2)	
	Bit 8	Word Type 9: Almanac for SVID2 (2/2) and SVID3 (1/2)	
	Bit 9	Word Type 10: Almanac for SVID3 (2/2) and GST-GPS conversion parameters*	
	Bit 10	Spare	
	Bit 11	Spare	
	Bit 12	Spare	
	Bit 13	Spare	
	Bit 14	Spare	
	Bit 15	Spare	

*Note: GST-GPS time conversion parameters shall not be used by the on-board equipment for safety-related position determination (refer to L1 and DFMC Railway SoL Service MOPS).

5.5.4.26   Q_GAMT

Name	Qualifier for GA message type		
Description	Qualifier for GA message type.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
4 bits			
Special/Reserved Values	0	Nominal GA message	
	1	GA alert message	
	2	DNU GA message stream (do not use for safety applications)	
	3 – 15	Reserved	

5.5.4.27 Q_GAT

Name	Qualifier to indicate GA reference time		
Description	Qualifier to indicate reference time for GNSS augmentation		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
4 bits			
Special/Reserved Values	0	SNT (SBAS Network Time)	
	1	GPS System Time	
	2	Galileo System Time	
	3 – 14	Reserved	
	15	Unknown	

5.5.4.28 Q_GNDSS

Name	Qualifier for GNSS Navigation Data Set Selection		
Description	Qualifier for GNSS Navigation Data Set Selection		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
3 bits			
Special/Reserved Values	0	Current data set (latest broadcast)	
	1	Matched data set (matched to current augmentation IOD)	
	2	Matched data set and any different* data sets up to the current data set	
	3	Last 2 different* data sets	
	4	Last 3 different* data sets	
	5 – 7	Reserved	

*Note: Different data sets are identified by a bitwise comparison with data of older sets.

5.5.4.29 Q_GNDT

Name	Qualifier to indicate the GNSS Navigation Data Type to be requested		
Description	Qualifier to indicate the type of GNSS navigation data that can be included in a request for GNSS navigation data.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
8 bits			
Special/Reserved Values	0	GPS L1 LNAV	
	1	Galileo F/NAV	
	2	Galileo I/NAV*	
	3	GPS L5 CNAV*	
	4 – 255	Spare	

*Note: these data sets are not required for EGNOS L1 or DFMC Railway SoL Services; however, they are provided to support degraded / alternate modes of operation.

5.5.4.30 Q_GPSCNAVMT

Name	Qualifier to indicate the GPS CNAV Message Type to be requested		
Description	Qualifier to indicate the message type of GPS L5 CNAV navigation data that can be included in a request for GNSS navigation data. A value of 1 selects the message type.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
16 bits			Bitset
Special/Reserved Values	Bit 0	Message Type 10: Ephemeris 1*	
	Bit 1	Message Type 11: Ephemeris 2	
	Bit 2	Message Type 12: Reduced Almanac	
	Bit 3	Message Type 30: Clock, Ionosphere and Group Delay*	
	Bit 4	Message Type 31: Clock and Reduced Almanac	
	Bit 5	Message Type 32: Clock and EOP*	
	Bit 6	Message Type 33: Clock and UTC	
	Bit 7	Message Type 34: Clock and Differential Correction*	
	Bit 8	Message Type 35: Clock and GGTO*	
	Bit 9	Message Type 36: Clock and Text	
	Bit 10	Message Type 37: Clock and Midi Almanac	
	Bit 11	Message Type 40: Integrity Support Message	
	Bit 12	Spare	
	Bit 13	Spare	
	Bit 14	Spare	
	Bit 15	Spare	

*Note: Integrity Status Flag (ISF), L1 Signal Health, L2 Signal Health, Inter-Signal Correction L5-I5 (ISC_{L5I5}), Inter-Signal Correction L2C (ISC_{L2C}), Earth Orientation Parameters (EOP), Differential Corrections and GPS/GNSS Time Offset (GGTO) parameters shall not be used by the on-board equipment for safety-related position determination (refer to L1 and DFMC Railway SoL Service MOPS).

5.5.4.31 Q_GPSLNAVSF

Name	Qualifier to indicate the GPS LNAV Subframe to be requested		
Description	Qualifier to indicate the subframe of GPS L1 LNAV navigation data that can be included in a request for GNSS navigation data. A value of 1 selects the message type.		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
8 bits			Bitset
Special/Reserved Values	Bit 0	Subframe 1: ISF*, TOW, WN, URA, SV Health, Ephemeris (1/3), Differential Group Delay, Clock Correction	
	Bit 1	Subframe 2: ISF*, TOW, Ephemeris (2/3), AODO*	
	Bit 2	Subframe 3: ISF*, TOW, Ephemeris (3/3)	
	Bit 3	Subframe 4 Page 18: ISF*, TOW, Ionospheric and UTC data	
	Bit 4	Almanac Page Type Subframe 4 Pages 2, 3, 4, 5, 7, 8, 9, 10: ISF*, TOW, Almanac data for SV 25 through 32 Subframe 5 Pages 1 through 24: ISF*, TOW, Almanac data for SV 1 through 24	
	Bit 5	Subframe 5 Page 25: ISF*, TOW, SV health data for SV 1 through 24, almanac reference time, almanac reference week number	
	Bit 6	Spare	
	Bit 7	Spare	

*Note: Integrity Status Flag (ISF), and Age of Data Offset (AODO) shall not be used by the on-board equipment for safety-related position determination (refer to L1 and DFMC Railway SoL Service MOPS).

5.5.4.32 Q_GSVS

Name	Qualifier for GNSS Satellite Vehicle Selection		
Description	Qualifier for GNSS Satellite Vehicle Selection		
Length of variable	Minimum Value	Maximum Value	Resolution/formula
2 bits			
Special/Reserved Values	0	SVs in View	
	1	SVs selected by GSV Mask	
	2	Reserved	

Annex A Open Points to be Addressed in Future Iterations of the Specification

A.1.1.1 The following table provides a list of open points related to the ICD to be addressed in future iterations of the specification. Many of these open points are to be addressed in work packages defined by ERJU/ERA/EUSPA/ESA/EUG addressing GNSS Augmentation for Rail based on EGNOS.

Table A-1. Open points list

Ref	Description	Solution / Workstream	Status / Notes
1	Confirm approach for safe radio connection between GA-TS and GA-OB		**Closed.** ICD was initially developed considering use of the safe radio connection between the RBC and ETCS on-board and the message format defined in the ERTMS/ETCS SRS; however, it was decided to make approach more general with the possibility of supporting a specific channel between trackside and on-board for GNSS augmentation (as is done for ATO over ETCS). The standard message format from the ERTMS/ETCS SRS has been utilised in this ICD; however, fields that are not required for messages exchanged between GA-OB and GA-TS (e.g., NID_LRBG for track to train messages, and Packet 0 or 1 for train to track messages) have been removed.
2	Reassess the approach for providing GNSS navigation data considering FRMCS	Preliminary solution provided – to be assessed. [ERJU WBS on GNSS Augmentation for Rail based on EGNOS]	**Open.** Specific packets were initially designed for GNSS navigation data (GPS and Galileo with reserved range of packets for other constellations) to provide GNSS navigation data more efficiently rather than encapsulating the navigation message, which can be inefficient in terms of message size and bandwidth (concerns that were previously voiced by ETCS suppliers in an earlier iteration of the document where navigation message pages / subframes were encapsulated in generic packets). The encapsulation approach was raised again in a subsequent review as it supports definition of packets that are agnostic to navigation data from specific constellations / signals, also considering that in the context of FRMCS, bandwidth constraints may be less of an issue. Further analysis indicated that providing subframes / page / message types requested via a mask can be more bandwidth efficient, whilst simplifying requirements on the trackside and leaving considerably more implementation flexibility up to the supplier (essentially following the approach in the aviation MOPS). For early deployment using bandwidth constrained channels (e.g., GSM-R), supplementary optimised packets could be considered in support of EGNOS L1 service to reduce bandwidth consumption.
3	Determine the need for GNSS navigation data in addition to CEI datasets to be provided to VLF by trackside	To be investigated if item 2 is rejected and specific packets are used.	**Open.** CEI datasets for GPS LNAV and Galileo F/NAV are provided in support of SBAS L1 and DFMC services. GPS C/NAV and Galileo I/NAV CEI datasets are supported for degraded modes of operation where SBAS is not available.

			The need for additional datasets such as UTC parameters, Almanac and Ionospheric model is to be confirmed. Open point #2 should also be taken into consideration.

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