



**EEIG ERTMS Users Group**  
123-133 Rue Froissart, 1040 Brussels, Belgium  
Tel: +32 (0)2 673.99.33 - TVA BE0455.935.830  
Website: [www.ertms.be](http://www.ertms.be) E-mail: [info@ertms.be](mailto:info@ertms.be)

## **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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# 1 Introduction

## 1.1 Scope and Purpose

1.1.1.1 This document provides the 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.

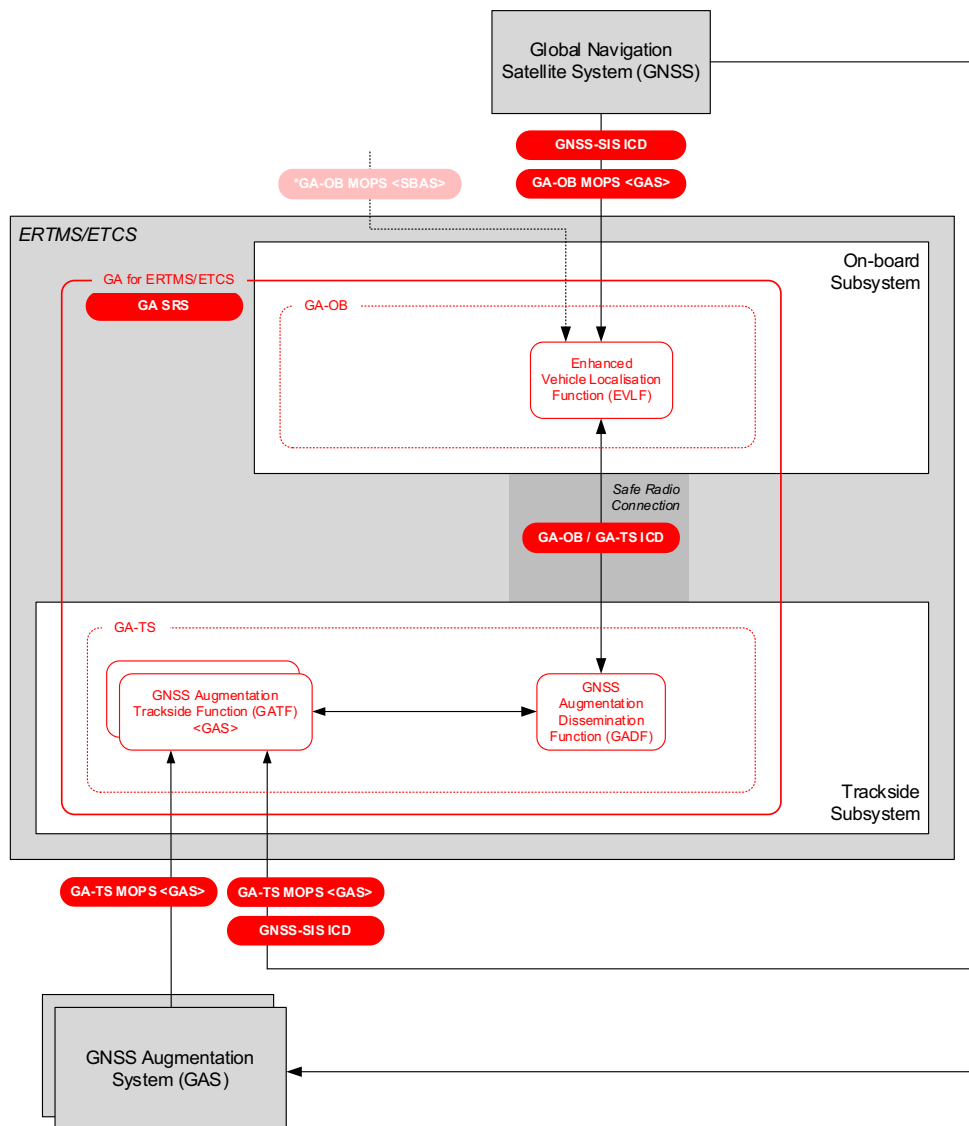


Figure 1. GNSS Augmentation Reference Functional Architecture for ERTMS/ETCS

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 specific GNSS augmentation channel.

- 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
[EUG-20E086]	EUG, "GNSS Augmentation for ERTMS/ETCS – System Functional Hazard Analysis. Version 0f." 2022.
[EUG-20E085]	EUG, "GNSS Augmentation for ERTMS/ETCS – System Requirement Specification. Version 0f." 2022.
[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 (v0.11) – 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. M." 2021.
[IS-GPS-705]	GPS Directorate, "Interface Specification – NAVSTAR GPS Space Segment / User Segment L5 Interfaces – IS-GPS-705. Rev. H." 2021.
[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:

BDSBAS	BeiDou Satellite Based Augmentation System (SBAS developed by Chinese Government)
CEI	Clock, Ephemeris, Integrity (data set)
CRC	Cyclic Redundancy Check
DFMC	Dual Frequency Multiple Constellation
DNU	Do Not Use
ED	Elevation Dependent
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)
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
FFFIS	Form-Fit Functional Interface Specification
FIS	Functional Interface Specification
FMEA	Failure Modes and Effects Analysis
FRMCS	Future Railway Mobile Communication System

GADF	GNSS Augmentation Dissemination Function
GAGAN	GPS Aided GEO Augmented Navigation (SBAS developed by Indian Government)
GA-OB	GNSS Augmentation On-board
GATF	GNSS Augmentation Trackside Function
GA-TS	GNSS Augmentation Trackside
GEO	Geostationary Earth Orbit
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSA	European GNSS Agency
GSM-R	Global System for Mobile Communications – Railway
ICD	Interface Control Document
KASS	Korea Augmentation Satellite System (SBAS developed by Korean Government)
LSBs	Least Significant Bits
MOPS	Minimum Operation Performance Standard
MSAS	Multi-functional Satellite Augmentation System (SBAS developed by Japanese Government)
MT	Message Type
NED	Non-Elevation-Dependent
OBAD	Old But Active Data
OBU	On-Board Unit
OS	Open Service
PDM	Position Domain Monitor
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



SDCM	System for Differential Corrections and Monitoring (SBAS developed by Russian Federation)
SIS	Signal in Space
SoL	Safety of Life
SPS	Standard Positioning Service
SV	Satellite Vehicle
TBC	To Be Confirmed
TTA	Time To Alert
URA	User Range Accuracy
UTC	Universal Time Coordinate
WAAS	Wide Area Augmentation System (SBAS developed by the USA)

## 2 List of Fixed Value Data

2.1.1.1 The following Fixed Values are specific to the GNSS augmentation service.

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

National / Default Data	Default Value	Name
GA maximum system TTA budget	5200 ms (for EGNOS)	T_NVGAMAXSYSTTA
Maximum GA TTA	12000 ms [TBC]	T_NVGAMAXTTA
GA Broadcast Update Rate	1000 ms (for EGNOS)	T_NVGAMBUR

## 4 Packets

### 4.1 List of Packets

#### 4.1.1 Track to Train

Packet Number	Packet Name	Page N°
210	GA Service National Values	12
212	GA Message	12
215	GPS L1 LNAV CEI Data	12
216	GPS L5 CNAV CEI Data	14
217	Galileo E1-B I/NAV CEI Data	15
218	Galileo E5a F/NAV CEI Data	17
219-239	Reserved for other navigation data / from other GNSS	N/A

#### 4.1.2 Train to Track

4.1.2.1 The standard format of radio messages in this ICD is consistent with messages defined in the ERTMS/ETCS SRS [SS026-8]. Train to track messages contain either a Packet 0 or Packet 1 (refer to Section 5.1.3), which has been included in the following table for consistency with ERTMS/ETCS messages. Refer to [SS026-7] for definitions of Packet 0 and 1.

Packet Number	Packet Name	Page N°
0	Position Report (refer to ERTMS/ETCS SRS section 7.4.3.1 [SS026-7])	N/A
1	Position Report based on two balise groups (refer to ERTMS/ETCS SRS section 7.4.3.2 [SS026-7])	N/A
50	GA Versions Supported by On-board	19
51	GA Services Supported by On-board	19
52	GNSS Navigation Data Request Parameters	19

**4.2 Packets: Track to Train**

**4.2.1 Packet Number 210: GA Service National Values**

<b>Description</b>	This packet provides a set of National Values related to a specific GNSS augmentation service		
<b>Transmitted by</b>	Trackside		
<b>Content</b>	<b>Variable</b>	<b>Length</b>	<b>Comment</b>
	NID_PACKET	8	
	Q_DIR	2	
	L_PACKET	13	
	T_NVGAMAXTTA	16	GA maximum TTA
	T_NVGAMAXSYSTTA	16	GA maximum system TTA budget
	T_NVGAMBUR	16	GA broadcast update rate

**4.2.2 Packet Number 212: GA Message**

<b>Description</b>	This packet encapsulates a GNSS augmentation message (e.g., SBAS legacy or DFMC messages in the case of EGNOS) and is used to disseminate GNSS augmentation message streams to the on-board.		
<b>Transmitted by</b>	Trackside		
<b>Content</b>	<b>Variable</b>	<b>Length</b>	<b>Comment</b>
	NID_PACKET	8	
	Q_DIR	2	
	L_PACKET	13	
	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	$n \leq 3941$	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) 4.2.2.1 [SS040].

**4.2.3 Packet Number 215: GPS L1 LNAV CEI Data**

<b>Description</b>	This packet is used to disseminate GPS L1 LNAV core Clock, Ephemeris, Integrity (CEI) data set to the on-board. Note: integrity status flag is not included as it is a forbidden core constellation parameter that cannot be used by the on-board equipment.		
<b>Transmitted by</b>	Trackside		
<b>Content</b>	<b>Variable</b>	<b>Length</b>	<b>Comment</b>
	NID_PACKET	8	
	Q_DIR	2	

L_PACKET	13	
N_ITER	5	
NID_GSV(k)	8	GNSS SV ID
M_LNAVSVHEALTH(k)	6	SV health
NID_LNAVIODC(k)	10	Issue of data, clock
M_LNAVURA(k)	4	URA index
N_LNAVWN(k)	10	Data sequence propagation week number
M_LNAVTDG(k)	10	Group delay differential
M_LNAVAF0(k)	22	SV clock bias correction coefficient
M_LNAVAF1(k)	16	SV clock drift correction coefficient
M_LNAVAF2(k)	8	Drift rate correction coefficient
T_LNAVTOC(k)	16	Time of clock
M_LNAVSQRTA(k)	32	Square root of the semi-major axis
M_LNAVDELTA(k)	16	Mean motion difference from computed value
M_LNAVFI(k)	1	Fit interval flag
M_LNAVE(k)	32	Eccentricity
M_LNAVMO(k)	32	Mean anomaly at reference time
T_LNAVTOE(k)	16	Time of ephemeris
M_LNAVCRS(k)	16	Amplitude of the sine correction term to the orbit radius
M_LNAVCUC(k)	16	Amplitude of cosine harmonic correction term to the argument of latitude
M_LNAVCUS(k)	16	Amplitude of sine harmonic correction term to the argument of latitude
NID_LNAVIODE(k)	8	Issue of data, ephemeris
M_LNAVOMEGA(k)	32	Argument of perigee
M_LNAVOMEGADOT(k)	24	Rate of right ascension
M_LNAVOMEGA0(k)	32	Longitude of ascending node of orbit plan at weekly epoch
M_LNAVI0(k)	32	Inclination angle at reference time
M_LNAVIDOT(k)	14	Rate of inclination angle
M_LNAVCIC(k)	16	Amplitude of the cosine harmonic correction term to the angle of inclination
M_LNAVCIS(k)	16	Amplitude of the sine harmonic correction term to the angle of inclination
M_LNAVCRC(k)	16	Amplitude of the cosine harmonic correction term to the orbit radius
M_LNAVALERT(k)	1	Alert flag

4.2.4 Packet Number 216: GPS L5 CNAV CEI Data

<b>Description</b>	<p>This packet is used to disseminate GPS L5 CNAV core Clock, Ephemeris, Integrity (CEI) data set to the on-board.</p> <p>Note: integrity status flag, L2 signal health, inter-signal correction for L5-I5 and inter-signal correction for L2C are not included as these are forbidden core constellation parameters that cannot be used by the on-board equipment.</p> <p>In the case of SBAS L5-provided integrity, GPS L5 CNAV data is not required for DFMC SBAS users (GPS L1 LNAV is used); however, GPS L5 CNAV data is provided to support degraded operating modes (i.e., not using SBAS) if required.</p>		
<b>Transmitted by</b>	Trackside		
<b>Content</b>	<b>Variable</b>	<b>Length</b>	<b>Comment</b>
	NID_PACKET	8	
	Q_DIR	2	
	L_PACKET	13	
	N_ITER	5	
	NID_GSV(k)	8	GNSS SV ID
	M_CNAVADOT(k)	25	Change rate in semi-major axis
	M_CNAVDELTA(k)	26	Semi-major axis difference at reference time
	M_CNAVDELTA0(k)	17	Mean motion difference from computed value at reference time
	M_CNAVDELTA0DOT(k)	23	Rate of mean motion difference from computed value
	M_CNAVOMEGA(k)	33	Argument of perigee
	M_CNAVE(k)	33	Eccentricity
	M_CNAVSIGHEALTH(k)	3	Signal health (L1/L5)
	M_CNAVMO(k)	33	Mean anomaly at reference time
	M_CNAVURAED(k)	5	Elevation dependent user range accuracy
	N_CNAVWN(k)	13	Data sequence propagation week number
	T_CNAVTOE(k)	11	Ephemeris data reference time of week
	T_CNAVTOP(k)	11	CEI data sequence propagation time of week
	M_CNAVDELTAOMEGADOT(k)	17	Rate of right ascension difference
	M_CNAVOMEGA0(k)	33	Longitude of ascending node of orbit plane at weekly epoch
	M_CNAVVIC(k)	16	Amplitude of the cosine harmonic correction term to the angle of inclination
	M_CNAVVICIS(k)	16	Amplitude of the sine harmonic correction term to the angle of inclination

	M_CNAVCRG(k)	24	Amplitude of the cosine harmonic correction term to the orbit radius
	M_CNAVCRS(k)	24	Amplitude of the sine correction term to the orbit radius
	M_CNAVUC(k)	21	Amplitude of cosine harmonic correction term to the argument of latitude
	M_CNAVUCS(k)	21	Amplitude of sine harmonic correction term to the argument of latitude
	M_CNAVIO(k)	33	Inclination angle at reference time
	M_CNAVIDOT(k)	15	Rate of inclination angle
	M_CNAVISCL1CA(k)	13	Inter-signal correction L1 C/A
	M_CNAVISCL5Q5(k)	13	Inter-signal correction L5 Q5
	M_CNAVTDG(k)	13	Group delay differential
	M_CNAVAF0(k)	26	SV clock bias correction coefficient
	M_CNAVAF1(k)	20	SV clock drift correction coefficient
	M_CNAVAF2(k)	10	SV clock drift rate correction coefficient
	T_CNAVTOC(k)	11	Clock data reference time of week
	M_CNAVURANED0(k)	5	NED accuracy index
	M_CNAVURANED1(k)	3	NED accuracy change index
	M_CNAVURANED2(k)	3	NED accuracy change rate index
	M_CNAVALERT(k)	1	Alert flag

#### 4.2.5 Packet Number 217: Galileo E1-B I/NAV CEI Data

<b>Description</b>	<p>This packet is used to disseminate Galileo E1-B I/NAV core Clock, Ephemeris, Integrity (CEI) data set to the on-board.</p> <p>In the case of SBAS L5-provided integrity, Galileo E1-B I/NAV data is not required for DFMC SBAS users (Galileo E5a F/NAV is used); however, Galileo E1-B I/NAV data is provided to support degraded operating modes (i.e., not using SBAS) if required.</p>		
<b>Transmitted by</b>	Trackside		
<b>Content</b>	<b>Variable</b>	<b>Length</b>	<b>Comment</b>
	NID_PACKET	8	
	Q_DIR	2	
	L_PACKET	13	
	N_ITER	5	
	NID_GSV (k)	8	GNSS SV ID
	M_GALM0(k)	32	Mean anomaly at reference time

M_GALDELTAN(k)	16	Mean motion difference from computed value
M_GALE(k)	32	Eccentricity
M_GALSQRTA(k)	32	Square root of the semi-major axis
M_GALOMEGA0(k)	32	Longitude of ascending node of orbital plane at the weekly epoch
M_GALI0(k)	32	Inclination angle at reference time
M_GALOMEGA(k)	32	Argument of perigee
M_GALOMEGADOT(k)	24	Rate of change of right ascension
M_GALIDOT(k)	14	Rate of change of inclination angle
M_GALCUC(k)	16	Amplitude of the cosine harmonic correction term to the argument of latitude
M_GALCUS(k)	16	Amplitude of the sine harmonic correction term to the argument of latitude
M_GALCRC(k)	16	Amplitude of the cosine harmonic correction term to the orbit radius
M_GALCRS(k)	16	Amplitude of the sine harmonic correction term to the orbit radius
M_GALCIC(k)	16	Amplitude of the cosine harmonic correction term to the angle of inclination
M_GALCIS(k)	16	Amplitude of the sine harmonic correction term to the angle of inclination
T_GALT0E(k)	14	Ephemeris reference time
N_GALWN(k)	12	Week number
T_GALINAVT0C(k)	14	Clock correction data reference time of week (E1, E5b)
M_GALINAVAF0(k)	31	SV clock bias correction coefficient (E1, E5b)
M_GALINAVAF0(k)	21	SV clock drift correction coefficient (E1, E5b)
M_GALINAVAF0(k)	6	SV clock drift rate correction coefficient (E1, E5b)
M_GALBGDE1E5B(k)	10	E1-E5b broadcast group delay
M_GALSISAE1E5B(k)	8	SISA index for dual frequency E1-E5b
NID_GALIODNAV(k)	10	Issue of data for ephemeris, clock correction and SISA
M_GALE5BDVS(k)	1	E5b data validity status
M_GALE1BDVS(k)	1	E1-B data validity status
M_GALE5BHS(k)	2	E5b signal health status
M_GALE1BHS(k)	2	E1-B/C signal health status



4.2.6 Packet Number 218: Galileo E5a F/NAV CEI Data

<b>Description</b>	This packet is used to disseminate Galileo E5a F/NAV core Clock, Ephemeris, Integrity (CEI) data set to the on-board.		
<b>Transmitted by</b>	Trackside		
<b>Content</b>	<b>Variable</b>	<b>Length</b>	<b>Comment</b>
	NID_PACKET	8	
	Q_DIR	2	
	L_PACKET	13	
	N_ITER	5	
	NID_GSV (k)	8	GNSS SV ID
	M_GALM0(k)	32	Mean anomaly at reference time
	M_GALDELTA(k)	16	Mean motion difference from computed value
	M_GALE(k)	32	Eccentricity
	M_GALSQRTA(k)	32	Square root of the semi-major axis
	M_GALOMEGA0(k)	32	Longitude of ascending node of orbital plane at the weekly epoch
	M_GALI0(k)	32	Inclination angle at reference time
	M_GALOMEGA(k)	32	Argument of perigee
	M_GALOMEGADOT(k)	24	Rate of change of right ascension
	M_GALIDOT(k)	14	Rate of change of inclination angle
	M_GALCUC(k)	16	Amplitude of the cosine harmonic correction term to the argument of latitude
	M_GALCUS(k)	16	Amplitude of the sine harmonic correction term to the argument of latitude
	M_GALCRC(k)	16	Amplitude of the cosine harmonic correction term to the orbit radius
	M_GALCRS(k)	16	Amplitude of the sine harmonic correction term to the orbit radius
	M_GALCIC(k)	16	Amplitude of the cosine harmonic correction term to the angle of inclination
	M_GALCIS(k)	16	Amplitude of the sine harmonic correction term to the angle of inclination
	T_GALT0E(k)	14	Ephemeris reference time
	N_GALWN(k)	12	Week number
	M_GALFNAVTOC(k)	14	Clock correction data reference time of week (E1, E5a)
M_GALFNAVAF0(k)	31	SV clock bias correction coefficient (E1, E5a)	
M_GALFNAVAF0(k)	21	SV clock drift correction coefficient (E1, E5a)	

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	M_GALFNAVAF0(k)	6	SV clock drift rate correction coefficient (E1, E5a)
	M_GALBGDE1E5A(k)	10	E1-E5a broadcast group delay
	M_GALSISAE1E5A(k)	8	SISA index for dual frequency E1-E5a
	NID_GALIODNAV(k)	10	Issue of data for ephemeris, clock correction and SISA
	M_GALE5ADVS(k)	1	E5a data validity status
	M_GALE5AHS(k)	2	E5a signal health status

### 4.3 Packets: Train to Track

#### 4.3.1 Packet Number 50: GA Versions Supported by On-board

<b>Description</b>	This packet provides trackside with the GNSS Augmentation (GA) versions supported by the on-board		
<b>Transmitted to</b>	Trackside		
<b>Content</b>	<b>Variable</b>	<b>Length</b>	<b>Comment</b>
	NID_PACKET	8	
	L_PACKET	13	
	N_ITER	5	Number of GA versions supported by on-board. If N_ITER is 0 then no variables follow
	M_GAVER(k)	16	GA version supported by on-board

#### 4.3.2 Packet Number 51 – GA Services Supported by On-board

<b>Description</b>	This packet provides trackside with the GNSS Augmentation (GA) services supported by the on-board		
<b>Transmitted to</b>	Trackside		
<b>Content</b>	<b>Variable</b>	<b>Length</b>	<b>Comment</b>
	NID_PACKET	8	
	L_PACKET	13	
	M_GAVER	16	GA version
	N_ITER	5	Number of GA services supported by on-board for GA version. If N_ITER is 0 then no variables follow
	NID_GAS(k)	5	Identifier for GA service supported by on-board for GA version
	N_ITER(k)	5	Number of versions supported by on-board for service(k) for GA version
	M_GASVER(k,l)	16	Version(l) of GA service(k) supported by on-board for GA version

#### 4.3.3 Packet Number 52 – GNSS Navigation Data Request Parameters

<b>Description</b>	This packet provides trackside with the GNSS navigation data request parameters		
<b>Transmitted to</b>	Trackside		
<b>Content</b>	<b>Variable</b>	<b>Length</b>	<b>Comment</b>
	NID_PACKET	8	
	L_PACKET	13	
	N_ITER	5	If N_ITER is 0 then no variables follow
	M_GSVMASK(k)	256	GNSS satellite vehicle mask to select satellites

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	Q_GNSSNDT(k)	8	Qualifier to indicate the GNSS navigation data set type to be requested
	N_LASTND(k)	3	Request for the N_LASTND last different sets of navigation data

## 4.4 Definitions of Variables

### 4.4.1 Variables Related to Standard Radio Message Format

4.4.1.1 The following variables related to the standard format of radio messages are consistent with the variables defined in the ERTMS/ETCS SRS [SS026-7].

#### 4.4.1.2 NID\_MESSAGE

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

#### 4.4.1.3 L\_MESSAGE

<b>Name</b>	Message length		
<b>Description</b>	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).		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
10 bits	0	1023	1 byte

#### 4.4.1.4 T\_TRAIN (refer to 7.5.1.154 [SS026-7])

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

#### 4.4.1.5 NID\_ENGINE (refer to 7.5.1.88 [SS026-7])

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

## 4.4.2 Variables Related to GNSS Augmentation

### 4.4.2.1 Q\_GAMSSUP

<b>Name</b>	Qualifier for number of GA message streams supported		
<b>Description</b>	Qualifier for number of GA message streams supported by on-board.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
3 bits			
<b>Special/Reserved Values</b>	0	Not supported	
	1	Processing of one GA message stream supported	
	2	Processing of two GA message streams supported	
	3 – 7	Reserved	

### 4.4.2.2 Q\_GAMT

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

### 4.4.2.3 Q\_GAT

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

### 4.4.2.4 Q\_GNSSNDT

<b>Name</b>	Qualifier to indicate the GNSS navigation data set type to be requested		
<b>Description</b>	Qualifier to indicate the type of GNSS navigation data that can be included in a request for GNSS navigation data.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
8 bits			
<b>Special/Reserved Values</b>	0	GPS L1 LNAV CEI data set	

	1	Galileo E5a F/NAV CEI data set
	2	Galileo E1-B I/NAV CEI data set*
	3	GPS L5 CNAV CEI data set*
	4 – 255	Spare

\*Note: these data sets / parameters are not required for EGNOS Railway SoL Service; however, they are provided to support degraded modes of operation.

4.4.2.5 NID\_GAMS

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

4.4.2.6 NID\_GAS

<b>Name</b>	GA service identifier		
<b>Description</b>	GNSS augmentation service identifier.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
5 bits			
<b>Special/Reserved Values</b>	0	EGNOS Railway SoL L1 Legacy Service (GPS L1)	
	1	EGNOS Railway SoL L5 DFMC Service (GPS L1/L5 and Galileo E1/E5a)	
	2 – 31	Spare*	

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

4.4.2.7 NID\_GAC

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

	255	Unknown
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4.4.2.8 NID\_GAP

<b>Name</b>	GA Provider Identifier		
<b>Description</b>	GNSS augmentation provider identifier. This includes identifiers for SBAS service providers (including proposed providers). Note that providers marked with (*) would need to provide commitments on pseudorange domain integrity consistent with the EGNOS service provision concept for railway. Current SBAS service providers for aviation are listed in the ICAO SARPs, Annex 10, Volume I, Appendix B.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
6 bits	0	63	
<b>Special/Reserved Values</b>	0	WAAS*	
	1	EGNOS	
	2	MSAS*	
	3	GAGAN*	
	4	SDCM*	
	5	BDSBAS* (proposed)	
	6	KASS* (proposed)	
	7	A-SBAS* (proposed)	
	8	AUSBAS* (proposed)	
	9 – 19	Spare regional GA service providers	
	20 – 59	Spare local GA service providers	
	60 – 62	Reserved	
	63	Unknown	

4.4.2.9 NID\_GSV

<b>Name</b>	Identity number of the GNSS satellite vehicle (SV)		
<b>Description</b>	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: for DFMC it is likely that upper GPS PRN range are to be used (on-going discussions on how this will be handled in PRN mask for DFMC aviation MOPS)		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
8 bits	0	255	
<b>Special/Reserved Values</b>	0 – 31	GPS PRNs 1 to 32	
	32 – 36	GPS reserved	
	37 – 73	Spare	
	74 – 109	Galileo SV IDs 1 to 36	
	110	Galileo reserved	
	111 – 255	Spare	



4.4.2.10 M\_GAVER

<b>Name</b>	GA version		
<b>Description</b>	Version of GNSS augmentation framework for ERTMS/ETCS		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits			
<b>Special/Reserved Values</b>	Bits 0 – 7	Major version (0 to 255)	
	Bits 8 – 15	Minor version (0 to 255)	

4.4.2.11 M\_GASVER

<b>Name</b>	GA service version		
<b>Description</b>	Version of GNSS augmentation service		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits			
<b>Special/Reserved Values</b>	Bits 0 – 7	Major version (0 to 255)	
	Bits 8 – 15	Minor version (0 to 255)	

4.4.2.12 M\_GSVMASK

<b>Name</b>	GNSS satellite vehicle (SV) mask		
<b>Description</b>	<p>Satellite slot number (maximum of 37 SVs for each GNSS constellation)</p> <p>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).</p> <p>Note: for DFMC it is likely that upper GPS PRN range are to be used (on-going discussions on how this will be handled in PRN mask for DFMC aviation MOPS)</p>		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
256 bits			Bitset
<b>Special/Reserved Values</b>	Bits 0 – 31	GPS PRNs 1 to 32	
	Bits 32 – 36	GPS reserved	
	Bits 37 – 73	Spare	
	Bits 74 – 109	Galileo SV IDs 1 to 36	
	Bit 110	Galileo reserved	
	Bits 111 – 255	Spare	

4.4.2.13 M\_GAERR

<b>Name</b>	GA Session Error Type		
<b>Description</b>	GNSS augmentation session error type		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
8 bits	0	255	

<b>Special/Reserved Values</b>	0	No compatible GA version supported by on-board
	1	No compatible GA service supported by on-board
	2	Unable to resume primary GA message stream
	3	Unable to resume secondary GA message stream
	4 – 254	Spare
	255	Unknown service error

4.4.2.14 M\_GAM

<b>Name</b>	GA Message		
<b>Description</b>	Encapsulates GNSS augmentation messages. SBAS legacy and DFMC messages are 250 bits. For Legacy SBAS messages: 8-bit preamble (24 bits over 3 blocks), 6-bit message type identifier, 212-bit data field and 24-bit CRC; for DFMC SBAS messages: 4-bit preamble (24 bits over 6 blocks), 6-bit message type identifier, 216-bit data field and 24 bit CRC.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
n bits		3941 bits*	

\*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].

4.4.2.15 T\_GAM

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

4.4.2.16 T\_GATIMEOUT

<b>Name</b>	GNSS Augmentation Message Stream Timeout		
<b>Description</b>	Timeout when no valid GNSS augmentation message has been received for T_GATIMEOUT milliseconds indicating a probable communications link problem or unacknowledged alert sequence. $T\_GATIMEOUT = T\_NVGAMAXTTA - (T\_NVGAMAXSYSTTA + T\_GAMAXOBTTA)$		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	0 ms	65535 ms	1 ms

4.4.2.17 T\_GAMAXOBTTA

<b>Name</b>	GA Maximum On-board Equipment TTA Budget
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<b>Description</b>	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 localisation function within the on-board. For example, GNSS augmentation communication channel could include reception of GNSS augmentation messages by the ETCS kernel and forwarding on the internal bus (e.g., Profibus) to the enhanced localisation function, the endpoint.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	0 ms	65535 ms	1 ms

4.4.2.18 T\_NVGAMAXSYSTTA

<b>Name</b>	GA Maximum System TTA Budget		
<b>Description</b>	National value for the GNSS augmentation system TTA budget allocation for latency between start event (when pseudorange of satellite X in RIMS Y is affected) and end of reception of GNSS augmentation alert message at the trackside.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	0 ms	65535 ms	1 ms

4.4.2.19 T\_NVGAMAXTTA

<b>Name</b>	GA Maximum TTA		
<b>Description</b>	National value for the maximum TTA; the default value is 12000 ms (TBC). The dimensioning of this national value shall take into consideration the following: <ul style="list-style-type: none"> <li>• GNSS augmentation system TTA budget (e.g., 5200 ms in the case of SBAS);</li> <li>• Latency of GATF/GADF processing (including encapsulation of GA message);</li> <li>• GA-TS to GA-OB transfer delay over safe radio connection;</li> <li>• On-board equipment maximum TTA budget (T_GAMAXOBTTA); and</li> <li>• Margin to cope with variations in safe radio connection performance.</li> </ul> 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 on-board equipment to determine T_GATIMEOUT for supervision of the GNSS augmentation message stream and to ensure correct assumptions are made within the enhanced localisation function regarding time to detect and negate faulty measurements caused by GNSS errors or anomalies detected by the GNSS augmentation system.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	0 ms	65535 ms	1 ms

4.4.2.20 T\_NVGABUR

<b>Name</b>	GA Broadcast Update Rate		
<b>Description</b>	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, T_NVGABUR = 1000 ms)		

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

4.4.2.21 T\_GAMRTIMEOUT

<b>Name</b>	Timeout for retransmission of an unacknowledged <i>GA Message</i>		
<b>Description</b>	Fixed value for the timeout for retransmission of an unacknowledged <i>GNSS Augmentation Message</i> . 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).		
<i>Length of variable</i>	<i>Minimum Value</i>	<i>Maximum Value</i>	<i>Resolution/formula</i>
16 bits	0 ms	65535 ms	1 ms

4.4.2.22 T\_GAADSRTIMEOUT

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

4.4.2.23 T\_GNSSNDSRTIMEOUT

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

4.4.2.24 N\_GAADSMAXRETRIES

<b>Name</b>	Maximum number of retries for retransmission of an unacknowledged <i>GA Active Data Set</i> message		
<b>Description</b>	Fixed value for the maximum number of retries for retransmission of an unacknowledged <i>GA Active Data Set</i> message.		
<i>Length of variable</i>	<i>Minimum Value</i>	<i>Maximum Value</i>	<i>Resolution/formula</i>
8 bits	0	255	

4.4.2.25 N\_GNSSNDSMAXRETRIES

<b>Name</b>	Maximum number of retries for retransmission of an unacknowledged <i>GNSS Navigation Data Set</i> message		
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<b>Description</b>	Fixed value for the maximum number of retries for retransmission of an unacknowledged <i>GNSS Navigation Data Set</i> message.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
8 bits	0	255	

### 4.4.3 Variables Related to GPS L1 LNAV CEI Data

#### 4.4.3.1 M\_LNAVSVHEALTH

<b>Name</b>	LNAV SV Health		
<b>Description</b>	SV health		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
6 bits	(MSB LSB)		
<b>Special/Reserved Values</b>	1xxxxx	Indicates a summary of the health of the LNAV data, where 0 = all LNAV data are OK, 1 = some or all LNAV data are bad.	
	X00000	All Signals OK	
	x00001	All Signals Weak (3 to 6 dB below specified power level due to reduced power output, excess phase noise, SV attitude, etc.)	
	x00010	All Signals Dead	
	x00011	All Signals Have No Data Modulation	
	x00100	L1 P Signal Weak	
	x00101	L1 P Signal Dead	
	x00110	L1 P Signal Has No Data Modulation	
	x00111	L2 P Signal Weak	
	x01000	L2 P Signal Dead	
	x01001	L2 P Signal Has No Data Modulation	
	x01010	L1C Signal Weak	
	x01011	L1C Signal Dead	
	x01100	L1C Signal Has No Data Modulation	
	x01101	L2C Signal Weak	
	x01110	L2C Signal Dead	
	x01111	L2C Signal Has No Data Modulation	
	x10000	L1 & L2 P Signal Weak	
	x10001	L1 & L2 P Signal Dead	
	x10010	L1 & L2 P Signal Has No Data Modulation	
x10011	L1 & L2C Signal Weak		
x10100	L1 & L2C Signal Dead		
x10101	L1 & L2C Signal Has No Data Modulation		
x10110	L1 Signal Weak (3 to 6 dB below specified power level due to reduced power output, excess phase noise, SV attitude, etc.)		

	x10111	L1 Signal Dead
	x11000	L1 Signal Has No Data Modulation
	x11001	L2 Signal Weak (3 to 6 dB below specified power level due to reduced power output, excess phase noise, SV attitude, etc.)
	x11010	L2 Signal Dead
	x11011	L2 Signal Has No Data Modulation
	x11100	SV Is Temporarily Out (Do not use this SV during current pass)** (see definition for health code x11111)
	x11101	SV Will Be Temporarily Out (Use with caution)** (see definition for health code x11111)
	x11110	One or more signals are deformed, however the relevant URA parameters are valid (Note: Deformed means one or more signals do not meet the requirements in IS-GPS-200 Section 3)
	x11111	More than one combination would be required to describe anomalies (not including those marked with “**”)

4.4.3.2 M\_LNAVURA

<b>Name</b>	LNAV URA		
<b>Description</b>	SV accuracy		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
4 bits	0	15	
<b>Special/Reserved Values</b>	0	0.00 < URA ≤ 2.40 meters	
	1	2.40 < URA ≤ 3.40 meters	
	2	3.40 < URA ≤ 4.85 meters	
	3	4.85 < URA ≤ 6.85 meters	
	4	6.85 < URA ≤ 9.65 meters	
	5	9.65 < URA ≤ 13.65 meters	
	6	13.65 < URA ≤ 24.00 meters	
	7	24.00 < URA ≤ 48.00 meters	
	8	48.00 < URA ≤ 96.00 meters	
	9	96.00 < URA ≤ 192.00 meters	
	10	192.00 < URA ≤ 384.00 meters	
	11	384.00 < URA ≤ 768.00 meters	
	12	768.00 < URA ≤ 1536.00 meters	
	13	1536.00 < URA ≤ 3072.00 meters	
	14	3072.00 < URA ≤ 6144.00 meters	
	15	6144.00 < URA (or no accuracy prediction available – standard positioning service users are advised to use the SV at their own risk)	

4.4.3.3 M\_LNAVTGD

<b>Name</b>	LNAV $T_{GD}$		
<b>Description</b>	Group delay differential		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
10 bits	$-2.37952 \times 10^{-7}$	$2.37952 \times 10^{-7}$	Scale factor: $2^{-31}$ Units: seconds

4.4.3.4 M\_LNAVAF0

<b>Name</b>	LNAV $a_{f0}$		
<b>Description</b>	SV clock bias correction coefficient		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
22 bits	$-9.76562 \times 10^{-4}$	$9.76562 \times 10^{-4}$	Scale factor: $2^{-31}$ Units: seconds

4.4.3.5 M\_LNAVAF1

<b>Name</b>	LNAV $a_{f1}$		
<b>Description</b>	SV clock drift correction coefficient		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-3.72517 \times 10^{-9}$	$3.72517 \times 10^{-9}$	Scale factor: $2^{-43}$ Units: seconds / second

4.4.3.6 M\_LNAVAF2

<b>Name</b>	LNAV $a_{f2}$		
<b>Description</b>	Drift rate correction coefficient		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
8 bits	$-3.52495 \times 10^{-15}$	$3.52495 \times 10^{-15}$	Scale factor: $2^{-55}$ Units: seconds / second <sup>2</sup>

4.4.3.7 M\_LNAVSQRTA

<b>Name</b>	LNAV $\sqrt{A}$		
<b>Description</b>	Square root of the semi-major axis		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	2530	8192	Scale factor: $2^{-19}$ Units: $\sqrt{meters}$

4.4.3.8 M\_LNAVDELTAN

<b>Name</b>	LNAV $\Delta n$		
<b>Description</b>	Mean motion difference from computed value		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>

16 bits	$-3.72517 \times 10^{-9}$	$3.72517 \times 10^{-9}$	Scale factor: $2^{-43}$ Units: semi-circles / second
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4.4.3.9 M\_LNAVIF

<b>Name</b>	LNAV fit interval flag		
<b>Description</b>	Fit interval flag Indicates the curve-fit interval used by the CS (Block II/Block IIA/IIR/IIR-M/IIF) and SS (GPS III) in determining the ephemeris parameters		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
1 bit	0	1	
<b>Special/Reserved Values</b>	0	Curve-fit interval = 4 hours	
	1	Curve-fit interval > 4 hours	

4.4.3.10 M\_LNAVE

<b>Name</b>	LNAV $e$		
<b>Description</b>	Eccentricity		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	0.0	0.03	Scale factor: $2^{-33}$ Units: dimensionless

4.4.3.11 M\_LNAVMO

<b>Name</b>	LNAV $M_0$		
<b>Description</b>	Mean anomaly at reference time		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-31}$ Units: semi-circles

4.4.3.12 M\_LNAVCRS

<b>Name</b>	LNAV $C_{rs}$		
<b>Description</b>	Amplitude of the sine harmonic correction term to the orbit radius		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-1.02396 \times 10^3$	$1.02396 \times 10^3$	Scale factor: $2^{-5}$ Units: meters

4.4.3.13 M\_LNAVCUC

<b>Name</b>	LNAV $C_{uc}$		
<b>Description</b>	Amplitude of cosine harmonic correction term to the argument of latitude		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-6.10332 \times 10^{-5}$	$6.10332 \times 10^{-5}$	Scale factor: $2^{-29}$



			Units: radians
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4.4.3.14 M\_LNAVCUS

<b>Name</b>	LNAV $C_{US}$		
<b>Description</b>	Amplitude of sine harmonic correction term to the argument of latitude		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-6.10332 \times 10^{-5}$	$6.10332 \times 10^{-5}$	Scale factor: $2^{-29}$ Units: radians

4.4.3.15 M\_LNAVOMEGA

<b>Name</b>	LNAV $\omega$		
<b>Description</b>	Argument of perigee		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-31}$ Units: semi-circles

4.4.3.16 M\_LNAVOMEGADOT

<b>Name</b>	LNAV $\dot{\Omega}$		
<b>Description</b>	Rate of right ascension		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
24 bits	$-6.33 \times 10^{-7}$	0	Scale factor: $2^{-43}$ Units: semi-circles / second

4.4.3.17 M\_LNAVOMEGA0

<b>Name</b>	LNAV $\Omega_0$		
<b>Description</b>	Longitude of ascending node of orbit plane at weekly epoch		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-31}$ Units: semi-circles

4.4.3.18 M\_LNAVIO

<b>Name</b>	LNAV $i_0$		
<b>Description</b>	Inclination angle at reference time		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-31}$ Units: semi-circles

4.4.3.19 M\_LNAVIDOT

<b>Name</b>	LNAV IDOT		
<b>Description</b>	Rate of inclination angle		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
14 bits	$-9.31208 \times 10^{-10}$	$9.31208 \times 10^{-10}$	Scale factor: $2^{-43}$ Units: semi-circles / second

4.4.3.20 M\_LNAVCIC

<b>Name</b>	LNAV $C_{ic}$		
<b>Description</b>	Amplitude of the cosine harmonic correction term to the angle of inclination		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-6.10332 \times 10^{-5}$	$6.10332 \times 10^{-5}$	Scale factor: $2^{-29}$ Units: radians

4.4.3.21 M\_LNAVCIS

<b>Name</b>	LNAV $C_{is}$		
<b>Description</b>	Amplitude of the sine harmonic correction term to the angle of inclination		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-6.10332 \times 10^{-5}$	$6.10332 \times 10^{-5}$	Scale factor: $2^{-29}$ Units: radians

4.4.3.22 M\_LNAVCRC

<b>Name</b>	LNAV $C_{rc}$		
<b>Description</b>	Amplitude of the cosine harmonic correction term to the orbit radius		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-1.02396 \times 10^3$	$1.02396 \times 10^3$	Scale factor: $2^{-5}$ Units: meters

4.4.3.23 M\_LNAVALERT

<b>Name</b>	LNAV alert		
<b>Description</b>	Alert flag		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
1 bit	0	1	
<b>Special/Reserved Values</b>	0	Nominal	
	1	Indicates to the standard positioning service (SPS) user that the signal URA may be worse than indicated in subframe 1 and that he shall use that SV at his own risk.	

4.4.3.24 N\_LNAVWN

<b>Name</b>	LNAV WN		
<b>Description</b>	Data sequence propagation week number		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
10 bits	0	1023	week

4.4.3.25 NID\_LNAVIODC

<b>Name</b>	LNAV IODC		
<b>Description</b>	Issue of data, clock		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
10 bits	0	1023	

4.4.3.26 NID\_LNAVIODE

<b>Name</b>	LNAV IODE		
<b>Description</b>	Issue of data, ephemeris The IODE is an 8-bit number equal to the 8 LSBs of the 10-bit IODC of the same CEI data set.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
8 bits	0	255	

4.4.3.27 T\_LNAVTOC

<b>Name</b>	LNAV $t_{oc}$		
<b>Description</b>	Time of clock		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	0	604784	Scale factor: $2^4$ Units: seconds

4.4.3.28 T\_LNAVTOE

<b>Name</b>	LNAV $t_{oe}$		
<b>Description</b>	Time of ephemeris		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	0	604784	Scale factor: $2^4$ Units: seconds

4.4.4 Variables Related to GPS L5 CNAV CEI Data

4.4.4.1 M\_CNAVADOT

<b>Name</b>	CNAV $\dot{A}$		
<b>Description</b>	Change rate in semi-major axis		

<i>Length of variable</i>	<i>Minimum Value</i>	<i>Maximum Value</i>	<i>Resolution/formula</i>
25 bits	-7.9999995	7.9999995	Scale factor: $2^{-21}$ Units: meters / second

4.4.4.2 M\_CNAVDELTA

<b>Name</b>	CNAV $\Delta A$		
<b>Description</b>	Semi-major axis difference at reference time, relative to $A_{REF} = 26559710$ meters		
<i>Length of variable</i>	<i>Minimum Value</i>	<i>Maximum Value</i>	<i>Resolution/formula</i>
26 bits	$-6.55359 \times 10^4$	$6.55359 \times 10^4$	Scale factor: $2^{-9}$ Units: meters

4.4.4.3 M\_CNAVDELTA0

<b>Name</b>	CNAV $\Delta n_0$		
<b>Description</b>	Mean motion difference from computed value at reference time		
<i>Length of variable</i>	<i>Minimum Value</i>	<i>Maximum Value</i>	<i>Resolution/formula</i>
17 bits	$-3.72523 \times 10^{-9}$	$3.72523 \times 10^{-9}$	Scale factor: $2^{-44}$ Units: semi-circles / second

4.4.4.4 M\_CNAVDELTA0DOT

<b>Name</b>	CNAV $\Delta \dot{n}_0$		
<b>Description</b>	Rate of mean motion difference from computed value		
<i>Length of variable</i>	<i>Minimum Value</i>	<i>Maximum Value</i>	<i>Resolution/formula</i>
23 bits	$-2.91038 \times 10^{-11}$	$2.91038 \times 10^{-11}$	Scale factor: $2^{-57}$ Units: semi-circles / second <sup>2</sup>

4.4.4.5 M\_CNAVOMEGA

<b>Name</b>	CNAV $\omega$		
<b>Description</b>	Argument of perigee		
<i>Length of variable</i>	<i>Minimum Value</i>	<i>Maximum Value</i>	<i>Resolution/formula</i>
33 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-32}$ Units: semi-circles

4.4.4.6 M\_CNAVE

<b>Name</b>	CNAV $e$		
<b>Description</b>	Eccentricity		
<i>Length of variable</i>	<i>Minimum Value</i>	<i>Maximum Value</i>	<i>Resolution/formula</i>
33 bits	0.0	0.03	Scale factor: $2^{-34}$ Units: dimensionless

4.4.4.7 M\_CNAVSIGHEALTH

<b>Name</b>	CNAV Signal Health		
<b>Description</b>	Signal health (L1/L5)		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
2 bits	(MSB LSB)		
<b>Special/Reserved Values</b>	1x	0 = L1 Signal OK, 1 = L1 Signal bad or unavailable.	
	X1	0 = L5 Signal OK, 1 = L5 Signal bad or unavailable.	

4.4.4.8 M\_CNAVM0

<b>Name</b>	CNAV $M_0$		
<b>Description</b>	Mean anomaly at reference time		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
33 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-32}$ Units: semi-circles

4.4.4.9 M\_CNAVURAED

<b>Name</b>	CNAV $URA_{ED}$		
<b>Description</b>	Elevation dependent user range accuracy		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
5 bits	-16	15	
<b>Special/Reserved Values</b>	15	6144.00 < $URA_{ED}$ (or no accuracy prediction is available)	
	14	3072.00 < $URA_{ED}$ ≤ 6144.00 meters	
	13	1536.00 < $URA_{ED}$ ≤ 3072.00 meters	
	12	768.00 < $URA_{ED}$ ≤ 1536.00 meters	
	11	384.00 < $URA_{ED}$ ≤ 768.00 meters	
	10	192.00 < $URA_{ED}$ ≤ 384.00 meters	
	9	96.00 < $URA_{ED}$ ≤ 192.00 meters	
	8	48.00 < $URA_{ED}$ ≤ 96.00 meters	
	7	24.00 < $URA_{ED}$ ≤ 48.00 meters	
	6	13.65 < $URA_{ED}$ ≤ 24.00 meters	
	5	9.65 < $URA_{ED}$ ≤ 13.65 meters	
	4	6.85 < $URA_{ED}$ ≤ 9.65 meters	
	3	4.85 < $URA_{ED}$ ≤ 6.85 meters	
	2	3.40 < $URA_{ED}$ ≤ 4.85 meters	
	1	2.40 < $URA_{ED}$ ≤ 3.40 meters	
	0	1.70 < $URA_{ED}$ ≤ 2.40 meters	
-1	1.20 < $URA_{ED}$ ≤ 1.70 meters		

	-2	$0.85 < \text{URA}_{\text{ED}} \leq 1.20$ meters
	-3	$0.60 < \text{URA}_{\text{ED}} \leq 0.85$ meters
	-4	$0.43 < \text{URA}_{\text{ED}} \leq 0.60$ meters
	-5	$0.30 < \text{URA}_{\text{ED}} \leq 0.43$ meters
	-6	$0.21 < \text{URA}_{\text{ED}} \leq 0.30$ meters
	-7	$0.15 < \text{URA}_{\text{ED}} \leq 0.21$ meters
	-8	$0.11 < \text{URA}_{\text{ED}} \leq 0.15$ meters
	-9	$0.08 < \text{URA}_{\text{ED}} \leq 0.11$ meters
	-10	$0.06 < \text{URA}_{\text{ED}} \leq 0.08$ meters
	-11	$0.04 < \text{URA}_{\text{ED}} \leq 0.06$ meters
	-12	$0.03 < \text{URA}_{\text{ED}} \leq 0.04$ meters
	-13	$0.02 < \text{URA}_{\text{ED}} \leq 0.03$ meters
	-14	$0.01 < \text{URA}_{\text{ED}} \leq 0.02$ meters
	-15	$\text{URA}_{\text{ED}} \leq 0.01$ meters
	-16	No accuracy prediction available – use at own risk

4.4.4.10 M\_CNAVWN

<b>Name</b>	CNAV $\text{WN}_h$		
<b>Description</b>	Data sequence propagation week number		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
13 bits	0	8191	Scale factor: 1 Units: weeks

4.4.4.11 M\_CNAVTOE

<b>Name</b>	CNAV $t_{oe}$		
<b>Description</b>	Ephemeris data reference time of week		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
11 bits	0	604500	Scale factor: 300 Units: seconds

4.4.4.12 M\_CNAVTOP

<b>Name</b>	CNAV $t_{op}$		
<b>Description</b>	CEI data sequence propagation time of week		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
11 bits	0	604500	Scale factor: 300 Units: seconds

4.4.4.13 M\_CNAVDELTAOMEGADOT

<b>Name</b>	CNAV $\Delta\dot{\Omega}$		
<b>Description</b>	Rate of right ascension difference, relative to $\dot{\Omega}_{REF} = -2.6 \times 10^{-9}$ semi-circles / second		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
17 bits	$-3.72523 \times 10^{-9}$	$3.72523 \times 10^{-9}$	Scale factor: $2^{-44}$ Units: semi-circles / second

4.4.4.14 M\_CNAVOMEGA0

<b>Name</b>	CNAV $\Omega_0$		
<b>Description</b>	Longitude of ascending node of orbit plane at weekly epoch		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
33 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-32}$ Units: semi-circles

4.4.4.15 M\_CNAVCIC

<b>Name</b>	CNAV $C_{ic}$		
<b>Description</b>	Amplitude of the cosine harmonic correction term to the angle of inclination		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-3.81458 \times 10^{-6}$	$3.81458 \times 10^{-6}$	Scale factor: $2^{-30}$ Units: radians

4.4.4.16 M\_CNAVCIS

<b>Name</b>	CNAV $C_{is}$		
<b>Description</b>	Amplitude of the sine harmonic correction term to the angle of inclination		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-3.81458 \times 10^{-6}$	$3.81458 \times 10^{-6}$	Scale factor: $2^{-30}$ Units: radians

4.4.4.17 M\_CNAVCRC

<b>Name</b>	CNAV $C_{rc}$		
<b>Description</b>	Amplitude of the cosine harmonic correction term to the orbit radius		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
24 bits	$-3.27679 \times 10^4$	$3.27679 \times 10^4$	Scale factor: $2^{-8}$ Units: meters

4.4.4.18 M\_CNAVCRS

<b>Name</b>	CNAV $C_{rs}$		
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<b>Description</b>	Amplitude of the sine correction term to the orbit radius		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
24 bits	$-3.27679 \times 10^4$	$3.27679 \times 10^4$	Scale factor: $2^{-8}$ Units: meters

4.4.4.19 M\_CNAVCUC

<b>Name</b>	CNAV $C_{uc}$		
<b>Description</b>	Amplitude of cosine harmonic correction term to the argument of latitude		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
21 bits	$-9.76561 \times 10^{-4}$	$9.76561 \times 10^{-4}$	Scale factor: $2^{-30}$ Units: radians

4.4.4.20 M\_CNAVCUS

<b>Name</b>	CNAV $C_{us}$		
<b>Description</b>	Amplitude of sine harmonic correction term to the argument of latitude		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
21 bits	$-9.76561 \times 10^{-4}$	$9.76561 \times 10^{-4}$	Scale factor: $2^{-30}$ Units: radians

4.4.4.21 M\_CNAVI0

<b>Name</b>	CNAV $i_0$		
<b>Description</b>	Inclination angle at reference time		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
33 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-32}$ Units: semi-circles

4.4.4.22 M\_CNAVIDOT

<b>Name</b>	CNAV IDOT		
<b>Description</b>	Rate of inclination angle		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
15 bits	$-9.31265 \times 10^{-10}$	$9.31265 \times 10^{-10}$	Scale factor: $2^{-44}$ Units: semi-circles / second

4.4.4.23 M\_CNAVISCL1CA

<b>Name</b>	CNAV ISCL1C/A		
<b>Description</b>	Inter-signal correction L1 C/A		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
13 bits	$-1.19180 \times 10^{-7}$	$1.19180 \times 10^{-7}$	Scale factor: $2^{-35}$ Units: seconds



4.4.4.24 M\_CNAVISCL5Q5

<b>Name</b>	CNAV ISCL <sub>L5Q5</sub>		
<b>Description</b>	Inter-signal correction L5Q5		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
13 bits	$-1.19180 \times 10^{-7}$	$1.19180 \times 10^{-7}$	Scale factor: $2^{-35}$ Units: seconds

4.4.4.25 M\_CNAVTGD

<b>Name</b>	CNAV T <sub>GD</sub>		
<b>Description</b>	Group delay differential		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
13 bits	$-1.19180 \times 10^{-7}$	$1.19180 \times 10^{-7}$	Scale factor: $2^{-35}$ Units: seconds

4.4.4.26 M\_CNAVAF0

<b>Name</b>	CNAV $a_{f0}$		
<b>Description</b>	SV clock bias correction coefficient		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
26 bits	$-9.76562 \times 10^{-4}$	$9.76562 \times 10^{-4}$	Scale factor: $2^{-35}$ Units: seconds

4.4.4.27 M\_CNAVAF1

<b>Name</b>	CNAV $a_{f1}$		
<b>Description</b>	SV clock drift correction coefficient		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
20 bits	$-1.86264 \times 10^{-9}$	$1.86264 \times 10^{-9}$	Scale factor: $2^{-48}$ Units: seconds / second

4.4.4.28 M\_CNAVAF2

<b>Name</b>	CNAV $a_{f2}$		
<b>Description</b>	SV clock drift rate correction coefficient		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
10 bits	$-4.43221 \times 10^{-16}$	$4.43221 \times 10^{-16}$	Scale factor: $2^{-60}$ Units: seconds / second <sup>2</sup>

4.4.4.29 M\_CNAVURANED0

<b>Name</b>	CNAV URANED <sub>0</sub>
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<i>Description</i>	NED accuracy index		
<i>Length of variable</i>	<i>Minimum Value</i>	<i>Maximum Value</i>	<i>Resolution/formula</i>
5 bits	-16	15	
<b>Special/Reserved Values</b>	15	6144.00 < URA <sub>NED0</sub> (or no accuracy prediction is available)	
	14	3072.00 < URA <sub>NED0</sub> ≤ 6144.00 meters	
	13	1536.00 < URA <sub>NED0</sub> ≤ 3072.00 meters	
	12	768.00 < URA <sub>NED0</sub> ≤ 1536.00 meters	
	11	384.00 < URA <sub>NED0</sub> ≤ 768.00 meters	
	10	192.00 < URA <sub>NED0</sub> ≤ 384.00 meters	
	9	96.00 < URA <sub>NED0</sub> ≤ 192.00 meters	
	8	48.00 < URA <sub>NED0</sub> ≤ 96.00 meters	
	7	24.00 < URA <sub>NED0</sub> ≤ 48.00 meters	
	6	13.65 < URA <sub>NED0</sub> ≤ 24.00 meters	
	5	9.65 < URA <sub>NED0</sub> ≤ 13.65 meters	
	4	6.85 < URA <sub>NED0</sub> ≤ 9.65 meters	
	3	4.85 < URA <sub>NED0</sub> ≤ 6.85 meters	
	2	3.40 < URA <sub>NED0</sub> ≤ 4.85 meters	
	1	2.40 < URA <sub>NED0</sub> ≤ 3.40 meters	
	0	1.70 < URA <sub>NED0</sub> ≤ 2.40 meters	
	-1	1.20 < URA <sub>NED0</sub> ≤ 1.70 meters	
	-2	0.85 < URA <sub>NED0</sub> ≤ 1.20 meters	
	-3	0.60 < URA <sub>NED0</sub> ≤ 0.85 meters	
	-4	0.43 < URA <sub>NED0</sub> ≤ 0.60 meters	
-5	0.30 < URA <sub>NED0</sub> ≤ 0.43 meters		
-6	0.21 < URA <sub>NED0</sub> ≤ 0.30 meters		
-7	0.15 < URA <sub>NED0</sub> ≤ 0.21 meters		
-8	0.11 < URA <sub>NED0</sub> ≤ 0.15 meters		
-9	0.08 < URA <sub>NED0</sub> ≤ 0.11 meters		
-10	0.06 < URA <sub>NED0</sub> ≤ 0.08 meters		
-11	0.04 < URA <sub>NED0</sub> ≤ 0.06 meters		
-12	0.03 < URA <sub>NED0</sub> ≤ 0.04 meters		
-13	0.02 < URA <sub>NED0</sub> ≤ 0.03 meters		
-14	0.01 < URA <sub>NED0</sub> ≤ 0.02 meters		
-15	URA <sub>NED0</sub> ≤ 0.01 meters		
-16	No accuracy prediction available – use at own risk		

4.4.4.30 M\_CNAVURANED1

<b>Name</b>	CNAV URA <sub>NED1</sub>
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<b>Description</b>	NED accuracy change index		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
3 bits	0	7	

4.4.4.31 M\_CNAVURANED2

<b>Name</b>	CNAV URANED2		
<b>Description</b>	NED accuracy change rate index		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
3 bits	0	7	

4.4.4.32 M\_CNAVALERT

<b>Name</b>	CNAV alert		
<b>Description</b>	Alert flag		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
1 bit	0	1	
<b>Special/Reserved Values</b>	0	Nominal	
	1	Indicates to the user that the signal URA components may be worse than indicated in the associated message types and that he shall use at his own risk.	

4.4.4.33 T\_CNAVTOC

<b>Name</b>	CNAV $t_{oc}$		
<b>Description</b>	Clock data reference time of week		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
11 bits	0	604500	Scale factor: 300 Units: seconds

4.4.5 Variables Related to Galileo CEI Data

4.4.5.1 M\_GALMO

<b>Name</b>	Galileo $M_0$		
<b>Description</b>	Mean anomaly at reference time		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-31}$ Units: semi-circles

4.4.5.2 M\_GALDELTAN

<b>Name</b>	Galileo $\Delta n$
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<b>Description</b>	Mean motion difference from computed value		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-3.72517 \times 10^{-9}$	$3.72517 \times 10^{-9}$	Scale factor: $2^{-43}$ Units: semi-circles / second

4.4.5.3 M\_GALE

<b>Name</b>	Galileo $e$		
<b>Description</b>	Eccentricity		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	0.0	0.03	Scale factor: $2^{-33}$ Units: dimensionless

4.4.5.4 M\_GALSQRTA

<b>Name</b>	Galileo $\sqrt{A}$		
<b>Description</b>	Square root of the semi-major axis		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	2530	8192	Scale factor: $2^{-19}$ Units: $\sqrt{meters}$

4.4.5.5 M\_GALOMEGA0

<b>Name</b>	Galileo $\Omega_0$		
<b>Description</b>	Longitude of ascending node of orbital plane at weekly epoch		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-31}$ Units: semi-circles

4.4.5.6 M\_GALIO

<b>Name</b>	Galileo $i_0$		
<b>Description</b>	Inclination angle at reference time		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-31}$ Units: semi-circles

4.4.5.7 M\_GALOMEGA

<b>Name</b>	Galileo $\omega$		
<b>Description</b>	Argument of perigee		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
32 bits	-0.9999999995	0.9999999995	Scale factor: $2^{-31}$ Units: semi-circles

4.4.5.8 M\_GALOMEGADOT

<b>Name</b>	Galileo $\dot{\Omega}$		
<b>Description</b>	Rate of change of right ascension		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
24 bits	$-6.33 \times 10^{-7}$	0	Scale factor: $2^{-43}$ Units: semi-circles / second

4.4.5.9 M\_GALIDOT

<b>Name</b>	Galileo IDOT		
<b>Description</b>	Rate of change of inclination angle		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
14 bits	$-9.31208 \times 10^{-10}$	$9.31208 \times 10^{-10}$	Scale factor: $2^{-43}$ Units: semi-circles / second

4.4.5.10 M\_GALCUC

<b>Name</b>	Galileo $C_{uc}$		
<b>Description</b>	Amplitude of cosine harmonic correction term to the argument of latitude		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-6.10332 \times 10^{-5}$	$6.10332 \times 10^{-5}$	Scale factor: $2^{-29}$ Units: radians

4.4.5.11 M\_GALCUS

<b>Name</b>	Galileo $C_{us}$		
<b>Description</b>	Amplitude of sine harmonic correction term to the argument of latitude		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-6.10332 \times 10^{-5}$	$6.10332 \times 10^{-5}$	Scale factor: $2^{-29}$ Units: radians

4.4.5.12 M\_GALCRC

<b>Name</b>	Galileo $C_{rc}$		
<b>Description</b>	Amplitude of the cosine harmonic correction term to the orbit radius		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-1.02396 \times 10^3$	$1.02396 \times 10^3$	Scale factor: $2^{-5}$ Units: meters

4.4.5.13 M\_GALCRS

<b>Name</b>	Galileo $C_{rs}$
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<b>Description</b>	Amplitude of the sine harmonic correction term to the orbit radius		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-1.02396 \times 10^3$	$1.02396 \times 10^3$	Scale factor: $2^{-5}$ Units: meters

4.4.5.14 M\_GALCIC

<b>Name</b>	Galileo $C_{ic}$		
<b>Description</b>	Amplitude of the cosine harmonic correction term to the angle of inclination		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-6.10332 \times 10^{-5}$	$6.10332 \times 10^{-5}$	Scale factor: $2^{-29}$ Units: radians

4.4.5.15 M\_GALCIS

<b>Name</b>	Galileo $C_{is}$		
<b>Description</b>	Amplitude of the sine harmonic correction term to the angle of inclination		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
16 bits	$-6.10332 \times 10^{-5}$	$6.10332 \times 10^{-5}$	Scale factor: $2^{-29}$ Units: radians

4.4.5.16 M\_GALFNAVAF0

<b>Name</b>	Galileo F/NAV $a_{f0}$		
<b>Description</b>	SV clock bias correction coefficient (E1, E5a)		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
31 bits	$-6.24999 \times 10^{-2}$	$6.24999 \times 10^{-2}$	Scale factor: $2^{-34}$ Units: seconds

4.4.5.17 M\_GALFNAVAF1

<b>Name</b>	Galileo F/NAV $a_{f1}$		
<b>Description</b>	SV clock drift correction coefficient (E1, E5a)		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
21 bits	$-1.49011 \times 10^{-8}$	$1.49011 \times 10^{-8}$	Scale factor: $2^{-46}$ Units: seconds / second

4.4.5.18 M\_GALFNAVAF2

<b>Name</b>	Galileo F/NAV $a_{f2}$		
<b>Description</b>	SV clock drift rate correction coefficient (E1, E5a)		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
6 bits	$-5.37764 \times 10^{-17}$	$5.37764 \times 10^{-17}$	Scale factor: $2^{-59}$ Units: seconds / second <sup>2</sup>

4.4.5.19 M\_GALINAVAF0

<b>Name</b>	Galileo I/NAV $a_{f0}$		
<b>Description</b>	SV clock bias correction coefficient (E1, E5b)		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
31 bits	$-6.24999 \times 10^{-2}$	$6.24999 \times 10^{-2}$	Scale factor: $2^{-34}$ Units: seconds

4.4.5.20 M\_GALINAVAF1

<b>Name</b>	Galileo I/NAV $a_{f1}$		
<b>Description</b>	SV clock drift correction coefficient (E1, E5b)		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
21 bits	$-1.49011 \times 10^{-8}$	$1.49011 \times 10^{-8}$	Scale factor: $2^{-46}$ Units: seconds / second

4.4.5.21 M\_GALINAVAF2

<b>Name</b>	Galileo I/NAV $a_{f2}$		
<b>Description</b>	SV clock drift rate correction coefficient (E1, E5b)		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
6 bits	$-5.37764 \times 10^{-17}$	$5.37764 \times 10^{-17}$	Scale factor: $2^{-59}$ Units: seconds / second <sup>2</sup>

4.4.5.22 M\_GALBGDE1E5A

<b>Name</b>	Galileo BGD(E1, E5a)		
<b>Description</b>	IE1-E5a broadcast group delay		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
10 bits	$-1.18976 \times 10^{-7}$	$1.18976 \times 10^{-7}$	Scale factor: $2^{-32}$ Units: seconds

4.4.5.23 M\_GALBGDE1E5B

<b>Name</b>	Galileo BGD(E1, E5b)		
<b>Description</b>	IE1-E5b broadcast group delay		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
10 bits	$-1.18976 \times 10^{-7}$	$1.18976 \times 10^{-7}$	Scale factor: $2^{-32}$ Units: seconds

4.4.5.24 M\_GALSISAE1E5A

<b>Name</b>	Galileo SISA(E1, E5a)		
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<b>Description</b>	SISA index for dual frequency E1-E5a. Signal in Space Accuracy (SISA) is a prediction of the minimum standard deviation (1-sigma) of the unbiased Gaussian distribution which overbounds the Signal-in-Space Error (SISE) predictable distribution for all possible user locations within the satellite coverage area. When no accurate prediction is available (SISA = NAPA), this is an indicator of a potential anomalous SIS.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
8 bits	0	255	
<b>Special/Reserved Values</b>	0...49	0cm to 49cm with 1cm resolution	
	50...74	50cm to 0.98m with 2cm resolution	
	75...99	1m to 2m with 4cm resolution	
	100...125	2m to 6m with 16cm resolution	
	126...254	Spare	
	255	No accuracy prediction available (NAPA)	

4.4.5.25 M\_GALSISAE1E5B

<b>Name</b>	Galileo SISA(E1, E5b)		
<b>Description</b>	SISA index for dual frequency E1-E5a. Signal in Space Accuracy (SISA) is a prediction of the minimum standard deviation (1-sigma) of the unbiased Gaussian distribution which overbounds the Signal-in-Space Error (SISE) predictable distribution for all possible user locations within the satellite coverage area. When no accurate prediction is available (SISA = NAPA), this is an indicator of a potential anomalous SIS.		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
8 bits	0	255	
<b>Special/Reserved Values</b>	0...49	0cm to 49cm with 1cm resolution	
	50...74	50cm to 0.98m with 2cm resolution	
	75...99	1m to 2m with 4cm resolution	
	100...125	2m to 6m with 16cm resolution	
	126...254	Spare	
	255	No accuracy prediction available (NAPA)	

4.4.5.26 M\_GALE5ADVS

<b>Name</b>	Galileo E5a <sub>DVS</sub>		
<b>Description</b>	E5a data validity status		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
1 bit			
<b>Special/Reserved Values</b>	0	Navigation data valid	
	1	Working without guarantee	

4.4.5.27 M\_GALE5BDVS

<b>Name</b>	Galileo E5b <sub>DVS</sub>		
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<b>Description</b>	E5b data validity status		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
1 bit			
<b>Special/Reserved Values</b>	0	Navigation data valid	
	1	Working without guarantee	

4.4.5.28 M\_GALE1BDVS

<b>Name</b>	Galileo E1-B <sub>DVS</sub>		
<b>Description</b>	E1-B data validity status		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
1 bit			
<b>Special/Reserved Values</b>	0	Navigation data valid	
	1	Working without guarantee	

4.4.5.29 M\_GALE5AHS

<b>Name</b>	Galileo E5a <sub>HS</sub>		
<b>Description</b>	E5a signal health status		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
2 bits			
<b>Special/Reserved Values</b>	0	Signal OK	
	1	Signal out of service	
	2	Signal will be out of service	
	3	Signal component currently in test	

4.4.5.30 M\_GALE5BHS

<b>Name</b>	Galileo E5b <sub>HS</sub>		
<b>Description</b>	E5b signal health status		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
2 bits			
<b>Special/Reserved Values</b>	0	Signal OK	
	1	Signal out of service	
	2	Signal will be out of service	
	3	Signal component currently in test	

4.4.5.31 M\_GALE1BHS

<b>Name</b>	Galileo E1-B <sub>HS</sub>		
<b>Description</b>	E1-B signal health status		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>

2 bits			
<b>Special/Reserved Values</b>	0	Signal OK	
	1	Signal out of service	
	2	Signal will be out of service	
	3	Signal component currently in test	

4.4.5.32 NID\_GALIODNAV

<b>Name</b>	Galileo IOD <sub>nav</sub>		
<b>Description</b>	Issue of data for ephemeris, clock correction and SISA		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
10 bits	0	1023	Scale factor: 1 Units: dimensionless

4.4.5.33 T\_GALT0E

<b>Name</b>	Galileo $t_{0e}$		
<b>Description</b>	Ephemeris reference time		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
14 bits	0	604980	Scale factor: 60 Units: seconds

4.4.5.34 T\_GALWN

<b>Name</b>	Galileo WN		
<b>Description</b>	Week number		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
12 bits	0	4095	Scale factor: 1 Units: weeks

4.4.5.35 T\_GALFNAVTOC

<b>Name</b>	Galileo F/NAV $t_{0c}$		
<b>Description</b>	Clock correction data reference time of week (E1, E5a)		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>
14 bits	0	604980	Scale factor: 60 Units: seconds

4.4.5.36 T\_GALINAVTOC

<b>Name</b>	Galileo I/NAV $t_{0c}$		
<b>Description</b>	Clock correction data reference time of week (E1, E5b)		
<b>Length of variable</b>	<b>Minimum Value</b>	<b>Maximum Value</b>	<b>Resolution/formula</b>

EEIG ERTMS Users Group

14 bits	0	604980	Scale factor: 60 Units: seconds
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## 5 Messages

### 5.1 Standard Format of Radio Messages

5.1.1.1 The standard format of radio messages in this ICD is consistent with messages defined in the ERTMS/ETCS SRS [SS026-8]. Note: not all fields are required for messages exchanged between GA-OB and GA-TS; however, some have been retained for consistency with ERTMS/ETCS messages (i.e., NID\_LRBG for track to train messages, and Packet 0 or 1 for train to track messages).

#### 5.1.2 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 (message 146)
5	NID_LRBG	Timestamp contained in the message that is acknowledged
...	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.

#### 5.1.3 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.
5	Packet 0 or 1	Position Report or Position Report based on two balise groups
...	Packets as required by NID_MESSAGE	If needed for this message.
	Optional packets	
	Padding	If required.

## 5.2 List of Radio Messages

### 5.2.1 Train to Track Radio Messages

Mes. Id.	Message Name	Type	Invariant	Transmitted to
146	Acknowledgement	N	No	GA-TS
170	Initiate GA Session	N	No	GA-TS
171	GA Active Data Request	N	No	GA-TS
172	GNSS Navigation Data Request	N	No	GA-TS
173	Terminate GA Session	N	No	GA-TS
174	Allocate GA Message Stream	N	No	GA-TS
175	Resume GA Message Stream	N	No	GA-TS
176	Suspend GA Message Stream	N	No	GA-TS

### 5.2.2 Track to Train Radio Messages

Mes. Id.	Message Name	Type	Invariant	Transmitted by
60	GA Session Established	N	No	GA-TS
61	GA Message Stream Allocated / Resumed	N	No	GA-TS
62	GA Message	N	No	GA-TS
63	GA Active Data Set	N	No	GA-TS
64	GNSS Navigation Data Set	N	No	GA-TS
65	GA Message Stream Suspended	N	No	GA-TS
66	GA Session Error	N	No	GA-TS
67	GA Session Terminated	N	No	GA-TS

### 5.3 Definition of Radio Messages from Train to Track

#### 5.3.1 Message 146: Acknowledgement

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

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	NID_ENGINE	
5	T_TRAIN	Timestamp contained in the message that is acknowledged

#### 5.3.2 Message 170: Initiate GA Session

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	NID_ENGINE	
5	Packet of type 50	GA Versions Supported by On-board

#### 5.3.3 Message 171: GA Active Data Request

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	NID_ENGINE	
5	NID_GAMS	Identifier for the GA message stream (primary or secondary)
6	Packet 0 or 1	Position Report or Position Report based on two balise groups

### 5.3.4 Message 172: GNSS Navigation Data Request

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	NID_ENGINE	
5	Packet 0 or 1	Position Report or Position Report based on two balise groups
6	Packet of type 52	GNSS Navigation Data Request Parameters

### 5.3.5 Message 173: Terminate GA Session

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	NID_ENGINE	

### 5.3.6 Message 174: Allocate GA Message Stream

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	NID_ENGINE	
5	NID_GAMS	GA message stream identifier
6	Packet 0 or 1	Position Report or Position Report based on two balise groups
7	Packet of type 51	GA services supported by on-board

### 5.3.7 Message 175: Resume GA Message Stream

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	NID_ENGINE	
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
8	Packet 0 or 1	Position Report or Position Report based on two balise groups

### 5.3.8 Message 176: Suspend GA Message Stream

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	NID_ENGINE	
5	NID_GAMS	GA message stream identifier
6	Packet 0 or 1	Position Report or Position Report based on two balise groups



## 5.4 Definition of Radio Messages from Track to Train

### 5.4.1 Message 60: GA Session Established

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	M_ACK	
5	NID_LRBG	
6	M_GAVER	GA version to be used

### 5.4.2 Message 61: GA Message Stream Allocated / Resumed

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	M_ACK	
5	NID_LRBG	
6	NID_GAMS	GA message stream identifier
7	NID_GAP	GA service provider identifier
8	NID_GAS	GA service identifier
9	NID_GAC	GA channel identifier
10	M_GASVER	GA service version
11	Packet of type 210	GA service National Values

### 5.4.3 Message 62: GA Message

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	M_ACK	
5	NID_LRBG	
6	NID_GAMS	GA message stream identifier
7	Packet(s) of type 212	GA message packet(s)

### 5.4.4 Message 63: GA Active Data Set

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	M_ACK	
5	NID_LRBG	
6	NID_GAMS	GA message stream identifier
7	Packet(s) of type 212	GA active data as a set of GA message packets.

### 5.4.5 Message 64: GNSS Navigation Data Set

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	M_ACK	
5	NID_LRBG	
6	Packet(s) of type 215-239	E.g., GPS L1 LNAV CEI data; Galileo E5a F/NAV CEI data; Galileo E1-B I/NAV CEI data; GPS L5 CNAV CEI data.

### 5.4.6 Message 65: GA Message Stream Suspended

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	M_ACK	
5	NID_LRBG	
6	NID_GAMS	GA message stream identifier

**5.4.7 Message 66: GA Session Error**

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	M_ACK	
5	NID_LRBG	
6	M_GAERR	GA session error type identifier

**5.4.8 Message 67: GA Session Terminated**

Field No.	VARIABLE	Remarks
1	NID_MESSAGE	
2	L_MESSAGE	
3	T_TRAIN	
4	M_ACK	
5	NID_LRBG	

## 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.

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	To be investigated by EUG / ERJU.	<p><b>Open.</b></p> <p>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).</p> <p>It is assumed that the safe radio connection between the GA-TS and GA-OB provides at least the same level of protection against message-level hazards as EURORADIO. The standard message format from the ERTMS/ETCS SRS has been utilised in this ICD; however, not all variables and packets in the standard format are necessary (e.g., NID_LRBG for track to train messages and Packet 0 or 1 for train to track messages).</p>
2	Reassess the approach for providing GNSS navigation data considering FRMCS	To be investigated by EUG / ERJU.	<p><b>Open.</b></p> <p>Specific packets have been 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 is very 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).</p> <p>The encapsulation approach has been raised again in review as it supports definition of packets that are agnostic to navigation data from specific constellations / signals, considering that in the context of FRMCS, bandwidth constraints may be less of an issue.</p>
3	Determine the need for GNSS navigation data in addition to CEI datasets to be provided to EVLF by trackside	To be investigated with support from ESA / EUSPA.	<p><b>Open.</b></p> <p>CEI datasets for GPS LNAV and Galileo F/NAV are provided in support of SBAS legacy and DFMC services. GPS C/NAV and Galileo I/NAV CEI datasets are supported for degraded modes of operation where SBAS is not available.</p> <p>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.</p>

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