Galileo Update

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Galileo Services Overview

Galileo Open Service in Aviation

Galileo OS SDD V1.3

Galileo Space Segment Status

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ICAO EUR/MID Radio Navigation Symposium, Antalya, 6-8 February 2024

01: Galileo Services Overview

The services that are and will be provided by Galileo are:

- Open Service (**OS**), including Quasi-Pilot Space Service Volume and OSNMA ✓

- High Accuracy Service (**HAS**) ✓

- Commercial / Signal Authentication Service (**CAS/SAS**)

- Timing Service (**TS**)

- Public Regulated Service (**PRS**)

- Emergency Warning Service (**EWS**)

- Contribution to Search And Rescue support service (**SAR**) ✓

- Contribution to **Safety-of-Life** services (EGNOS and ARAIM) ✓

- Contribution to **Space weather** information

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02: Galileo OS in aviation

Standardisation (SARPS)

Galileo OS SARPs included in ICAO Annex 10 Volume I, amendment 93

- Applicable 2nd of November 2023

- Supports of the introduction of DFMC GNSS: provisions for additional frequencies of GPS, GLONASS and SBAS, and new BDS and Galileo systems

- ARAIM SARPs including Galileo signals approved by ICAO ANC, and are part of State Letter process for inclusion in Annex 10 Amdt 94 in 2025.
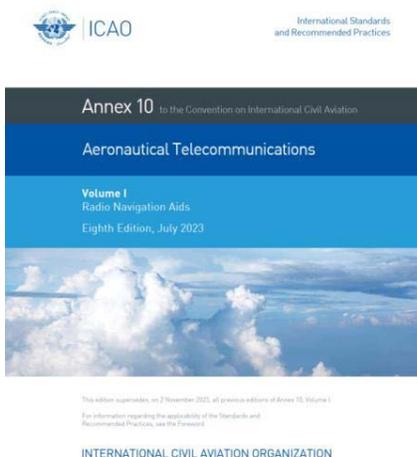
02: Galileo OS in aviation

Standardisation (MOPS)

- DFMC SBAS MOPS airborne receiver standard using GPS and Galileo signals developed by EUROCAE WG62 and RTCA SC159 WG2
  - Available on EUROCAE webstore as ED-259A and RTCA webstore as DO-401 since 25/9/23.
- Galileo OS requirements are continuously monitored to assess compliance to SBAS and ARAIM needs (e.g. EGNOS V3 safety case)

EUROCAE

ED-259A

MINIMUM OPERATIONAL PERFORMANCE STANDARD FOR DUAL-FREQUENCY MULTI-CONSTELLATION SATELLITE-BASED AUGMENTATION SYSTEM AIRBORNE EQUIPMENT

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SEPTEMBER 2023
SUPERSEDES ED-259

Metric	SARPS value	Characterized Performance since Dec. 2016 (Initial Services)
Slot Availability	0.95	0.9789
Slot Continuity	0.9996	0.9998
Rsat*	2E-5/h	6.3E-06/h
Rconst*	1E-4/h	1.8E-5/h
Psat	3E-5	<2E-6
Pconst	2E-4	<2E-4
URA**	DF: 6m SF: 6.5m (E1), 7.5 m (E5a)	<6m (DF), <6.5m (E1), <7.5m (E5a) BGDov=2.5m, characterized value <0.6 m

Example June/23

*New service parameters introduced in ARAIM SARPs
**Target SARPs values from ARAIM

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02: Galileo OS in aviation

Integrity Support Message & Message Generator

An ISM-G will be introduced in the Galileo 2nd Generation to support enhanced A-RAIM service levels.

The ARAIM Integrity Support Messages (ISMs), will be broadcast through the Galileo E1-B signal component, in the newly defined I/NAV WT22.

The structure of the ISM content is constellation-specific, and includes a CRC to protect the integrity of the data.

Allows A-RAIM receivers to benefit from Core Constellation improvements.

ISM-G will provide the means of calculating updated integrity parameters, and lower them (lower xPL compared to ones computed with receiver default/SARPS published values).

Bits	Field
6	Type=22
3	GNSS Constellation ID = 1 (Galileo)
3	SL ID = 2 (Service Level 3)
12	WN_{ISM}
9	t_{0ISM}
1	Mask – MSB
32	Mask
4	P_{const}
4	P_{sat}
4	URA
4	URE
4	b_{nom}
4	$T_{validity}$
6	Spare
32	ISM CRC
128	**Total (bits)**

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02: Galileo OS in aviation

OS Navigation Message Authentication (OSNMA)

Verify authenticity of INAV OS Navigation Messages

- Specific data blocks broadcast in SIS

- **Backwards compatible** with legacy receivers

Digital signature with **TESLA protocol**

- Root key to be retrieved from GSC

Transmission of SiS as per OSNMA SiS ICD (final format) since August 2023

OSNMA test signal (almost) continuously broadcast, global coverage

Performance available in quarterly OS reports

Final SIS ICD and Receiver Guidelines published at GSC website

Initial Service Declaration (Service Definition Document publication and signal switch to 'operational' mode) **Q1'24**

GALILEO OPEN SERVICE NAVIGATION
MESSAGE AUTHENTICATION (OSNMA)
USER ICD FOR THE TEST PHASE

03: Galileo OS SDD V1.3

Support to A-RAIM

SDD: MPLs (and associated conditions and constraints) also provided for:

- Positioning Accuracy (WUL, AUL)
- Ranging Accuracy 99.9% (WUL, AUL)
- Range Rate Accuracy
- Time Determination Accuracy

ISM-related MPLs included: upperbounds for Psat, Pconst, URA as per Amdt 93 SARPS

Initial Services
Declaration

OS SIS ICD 1.3

OS SDD 1.0

Dec 2016

OS SIS ICD 2.0

Jan 2021

OS SDD 1.3

OS SIS ICD 2.1

Nov 2023

New features is OS SDD 1.3 related to ARAIM

OS SDD 1.1

May 2019

OS SDD 1.2

Nov 2021

Full
Operational
Capability

OS FOC SDD
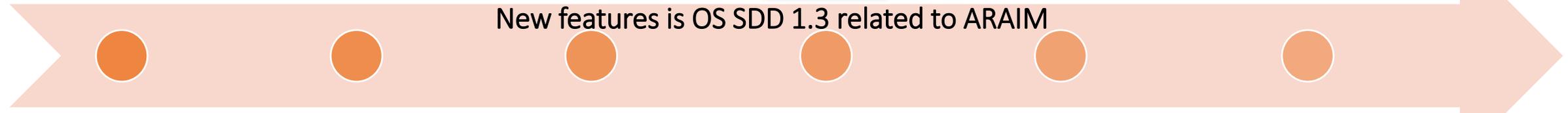
03: Galileo OS SDD V1.3

Support to A-RAIM

Table 56: Generic Galileo ISM I/NAV Word Layout

Type=22	GNSS Constellation ID = 1 (Galileo)	SL ID	Galileo SL ISM content	ISM CRC	Total (bits)
6	3	3	84	32	128

Type=22	GNSS Constellation ID = 1 (Galileo)	SL ID = 2 (Service Level 3)	WN_{ISM}	$t0_{ISM}$	Mask - MSB	Mask	P_{const}	P_{sat}	URA	URE	b_{nom}	$T_{validity}$	Spare	ISM CRC	Total (bits)
6	3	3	12	9	1	32	4	4	4	4	4	4	6	32	128

Table 91: ARAIM ISM GNSS Constellation ID

| Parameter	Definition	Bits	Scale factor	Units
GNSS Constellation ID	Integrity Support Message GNSS Constellation Identifier	3	N/A	dimensionless

Table 92: GNSS Constellation ID Bit Values

GNSS Constellation ID	Description
0	ISM in Test
1	Galileo
2	Reserved
3	Beidou
4	GPS
5	Spare
6	Spare
7	Spare

- SL1 (receiver default values) and SL3 (H-ARAIM enhanced integrity parameters) defined in ICD, with placeholders for definition of additional 6 ISM formats.
- Inclusion of Constellation ID for GPS, allowing cross-dissemination

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04: Galileo Space Segment Status

Current Status
Space Segment: 28 Satellites in Orbit
- 23 in service for Navigation (1 from spare slot)
- 24 in service for Search and Rescue
- 2 Auxiliary not in Service (L3)
- 1 Inactive Spare in nominal slot
- 1 Inactive Spare in spare slot
- 1 Nominal Slot **not** occupied (L12)
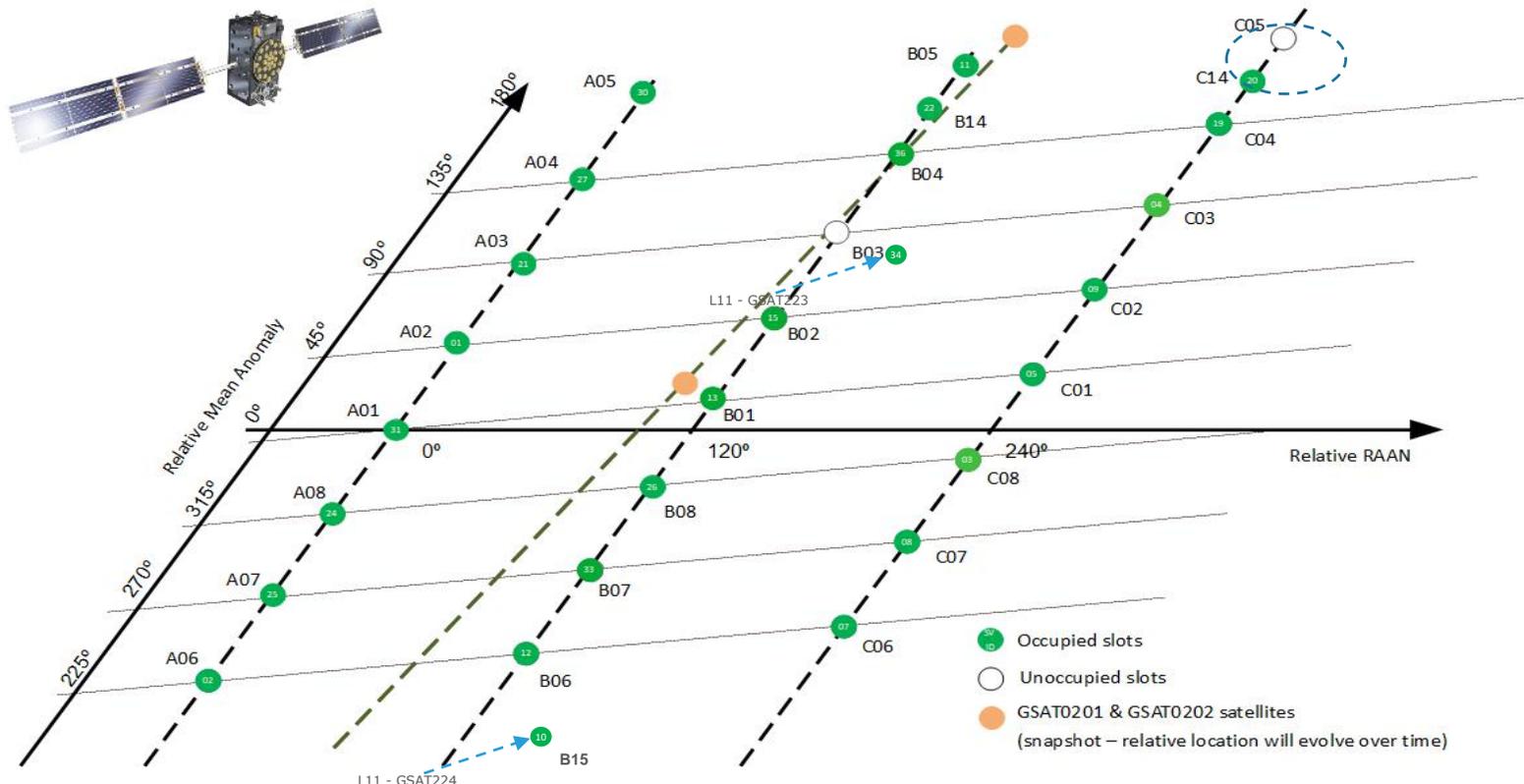
Plane A	Plane B	Plane C
L13	✓ L11	L12

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04: Galileo Space Segment Status

Satellite Launches

Two Galileo Soyuz launches foreseen in April and September 2022 were cancelled due to the withdrawal of Russian Roscosmos subcontractors from Kourou in February 2022.

- Committed Galileo service performances have not been affected

The Galileo Programme relies on Ariane-6 as baseline launcher to complete the deployment of the constellation and to ensure its replenishment

Alternative launch options are also being assessed

Two dual-satellite launches are required to bring the constellation to Final Operational Capability (FOC) with sufficient in-orbit redundancy to ensure performance over the long term.

- launch planned in 2024

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Thank You!