NAVIGATION MADE IN EUROPE

EUROPEAN GNSS (GALILEO)

SAR/GALILEO SERVICE DEFINITION DOCUMENT

DOCUMENT CHANGE RECORD

Reason For Change	Issue / Version	Date
First Issue of the Document for the Galileo Initial Services	1.0	December 2016
Second Issue of the Document for the SAR/Galileo Enhanced Services	2.0	January 2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1: INTRODUCTION

1.1 TERMS AND CONDITIONS

The SAR/Galileo Services have been designed in order to support the Cospas-Sarsat (C/S) International Satellite System for Search and Rescue (SAR) in the context of the MEOSAR system (Medium Earth Orbit Search And Rescue). The Galileo SAR Enhanced Service is Europe's contribution to the MEOSAR System and introduces a unique Galileo feature, the SAR/Galileo Return Link Service (RLS).

Users of these SAR/Galileo Services are primarily the national SAR administrations participating in the Cospas-Sarsat programme for the SAR/Galileo Forward Link service (FLS), and also the users of the Galileo Return Link Service (RLS) with suitably enabled distress beacons. How Galileo SAR Services are used by those conducting search and rescue operations remains their sole responsibility.

• Scope of Galileo SAR Commitment

The main infrastructure providing the SAR/Galileo Enhanced Service conforms to the Cospas-Sarsat standards applicable at the date of the start of the Enhanced Service provisioning for the MEOSAR Initial Operational Capability (IOC). Although care has been taken in designing, implementing and operating the system, as well as in providing the Galileo SAR capabilities, the Galileo SAR Services offer no service guarantee to users.

The minimum performance levels (MPLs) against which the system has been validated and is operated, as well as data of actual performance of the SAR, are expressed in this document in statistical values that are valid under the assumptions described per target group (FL and RL) in the Galileo SAR SDD. The European Commission reserves the right to revise the Galileo SAR SDD should these assumptions change or to reflect changes in performance during the deployment of the Galileo infrastructure.

This commitment regarding the minimum performance levels shall be without prejudice to the disclaimer of liability below, measures potentially affecting service availability that may be taken either by the Galileo Security Accreditation Board, or according to Council decision 2014/496/ CSFP, or in the interests of Member States' national security. The European Union plans to take all necessary measures for the foreseeable future to maintain or exceed the minimum levels of the SAR performance described herein. The Galileo SAR MPL, as specified in this document (Galileo SAR SDD), are obtained under the condition that the user equipment complies with the Cospas-Sarsat standard for 406 MHz distress beacons as defined in [RD5] (1st generation of C/S beacons). The specific provision of the Return Link Service is provided for all RLS capable beacons compliant with the [RD5] or [RD13] documents (1st and 2nd generation C/S beacons, respectively).

Users are reminded that important service notices (Notice Advisory to Galileo Users – NAGUs, SARR Status, SAR Service Status) are published by the Galileo Service Centre (GSC website) or distributed by the French Mission Control Centre (distribution of specific status messages) and shall be taken into account when planning to use the Galileo SAR service.

• User Responsibilities

Users retain their responsibility to exercise a level of care appropriate with respect to their intended use of the Galileo SAR Services, taking into account the considerations outlined above. Users are reminded that the achieved location probability and accuracy performance is also driven by other parameters outside the control of the Galileo SAR provider (e.g. interferer induced errors, outage of Search and Rescue transponders from other GNSS constellations), which have to be taken into account when deciding to use the Galileo SAR Services for a given purpose. Before any use of Galileo SAR Services, users should study this document in order to understand how they can use the service, as well as to familiarise themselves with performance levels and other aspects of the service.

Users shall be aware of the potential variation of the end-to-end Return Link Service performance in terms of latency, depending on the areas where the Cospas-Sarsat MEOSAR coverage is provided.

In case of doubt, users and other parties should contact the appropriate helpdesk for the Galileo SAR Service (see Annex F for contact details).

• Disclaimer of Liability

As the owner of the Galileo system, the European Union - including any of its institutions, offices or agencies, such as the European Commission (EC), the European GNSS Agency (GSA), and other entities acting on the basis of a contract or agreement with the European Union involved in the Galileo SAR service provision - offers no warranties of any kind (whether expressed or implied) with respect to the Galileo SAR Service, including, but not limited to, the warranties regarding availability, continuity, accuracy,

integrity, reliability and fitness for a particular purpose or meeting user requirements. No advice or information, whether oral or written, obtained from the European Union - including any of its institutions, offices or agencies, such as the European Commission, the European GNSS Agency (GSA), and other entities acting on the basis of a contract or agreement with the European Union involved in the Galileo SAR service provision - shall create any such warranty.

By using the Galileo Search and Rescue Service, the user accepts and agrees that the European Union - including any of its institutions, offices or agencies, such as the European Commission, the European GNSS Agency (GSA), and other entities acting on the basis of a contract or agreement with the European Union involved in the Galileo SAR service provision - shall not be held responsible or liable for any damages resulting from the use of, misuse of, or the inability to use the Galileo Search and Rescue Service, including, but not limited to, direct, indirect, special or consequential damages, including, but not limited to, damages for interruption of business, loss of profits, goodwill or other intangible losses, other than in accordance with Article 340 of the Treaty on the Functioning of the European Union.

1.2 REFERENCE DOCUMENTS

TYPE	TITLE	REFERENCE
RD1	C/S MCC Standard Interface Description (latest available)	C/S A.002
RD2	C/S Data Distribution Plan (latest available)	C/S A.001
RD3	Cospas-Sarsat History, January 2019	N/A
RD4	C/S 406 MHz MEOSAR Implementation Plan (latest available)	C/S R.012
RD5	Specification for C/S 406 MHz Distress Beacons. (latest available)	C/S T.001
RD6	Description of the 406 MHz Payload Used in the C/S MEOSAR System Issue (latest available)	C/S T.016
RD7	C/S MEOSAR Space Segment Commissioning Standard. (latest available)	C/S T.017
RD8	C/S MEOLUT Performance Specification and Design Guidelines, (latest available)	C/S T.019
RD9	C/S MEOLUT Commissioning Standard (latest available)	C/S T.020
RD10	Galileo Open Service Definition Document	OS SDD
RD11	Galileo Open Service Signal-in-Space ICD	OS SIS ICD
RD12	NMEA 0183/IEC 61162-1 Sentence for Return Link Service	NMEA0183
RD13	Specification for Second Generation of C/S 406 MHz Distress Beacons (latest available)	C/S T.018

Table 1 - Reference Documents

1.3 FOREWORD

Galileo is the European Global Navigation Satellite System (EGNSS), under civil control, that provides satellite positioning and timing information services to European citizens and worldwide. The Galileo Programme provides Europe and European citizens with independence and sovereignty from other satellite navigation systems and once fully operational, will offer five high-performance services (Open Service, Commercial Authentication Service, High Accuracy Service, Public Regulated Service and Search and Rescue Service).

This document supersedes the “Galileo Service – SAR Service – Service Definition Document” (SAR SDD) and defines the Minimum Performance Levels of the Galileo Forward Link and Return Link Services to be provided during the Galileo Enhanced Service provision phase.

The document will be updated in the future to reflect further changes and improvements of the Galileo SAR Services, in particular during the deployment of the Galileo System infrastructure, until the Full Operational Capability (FOC) is achieved.

1.4 PURPOSE AND SCOPE OF THE DOCUMENT

The purpose of this "Galileo Enhanced Service, SAR Service Definition Document" (SAR SDD) is to describe Galileo's contribution to the Cospas-Sarsat MEOSAR programme by presenting the SAR/Galileo Service characteristics, the associated infrastructure as well as the Minimum Performance Levels (MPL) targeted and the conditions under which such MPLs can be reached.

This document does not address any Galileo restricted information nor the Galileo Open Service or the Galileo Signal In Space characteristics, as the latter are described in dedicated Programme reference documents[1].

The document comprises the following sections:

- Section 1 "Introduction", this section.
- Section 2 "Cospas-Sarsat System Overview" describes the context of the Cospas-Sarsat MEOSAR programme in which the SAR/Galileo Enhanced Service are contributing.
- Section 3 "SAR/Galileo Enhanced Services" the purpose of this section is to provide a general description and main characteristics of the Galileo SAR Enhanced Forward Link and Return Link Services.
- Section 4 "SAR/Galileo Enhanced Service Characteristics and Usage Assumptions" provides further details on the Service characteristics while also listing certain conditions, exclusions and assumptions to be taken by users.
- Section 5 "SAR/Galileo Enhanced Minimum Performance Levels" provides the Galileo SAR Minimum Performance Levels that can be expected by end users.

The following Annexes conclude the document:

- Annex A "SAR/Galileo Enhanced Service Operations" provide further details on how the SAR/Galileo operations are conducted and list the involved entities and interfaces.
- Annex B "Observed and Simulated SAR/Galileo Enhanced Service Performance" provide simulated FL and RL as well as observed performance in the Service Validation phase.
- Annex C "External MEOLUT Connection and Data Exchange" lists the set of conditions required for an external MEOLUT in order to share TOA/FOA with the SAR/Galileo.
- Annex D "Sample Narrative Message SIT 605" provides an example of an operational notification message to SAR/Galileo Service Users (SIT605) that shall be distributed to inform the Cospas-Sarsat MCCs about SAR/Galileo Service Status.
- Annex E "SAR/Galileo Server User Manual and Interfaces" provides further details and the procedure to request access to the Galileo satellites Orbit Data Server .
- Annex F "Further Information on the SAR/Galileo Services" lists the contact points for additional information requests related to the SAR/Galileo Services and provide further details to beacon users and manufacturers.
- Annex G "Abbreviations and Acronyms" list the abbreviation and acronyms used.

1..... Refer to [RD10] for the Galileo OS SDD and [RD11] for the Galileo SIS ICD

SECTION 2: COSPAS-SARSAT SYSTEM

2.1 BACKGROUND

Cospas-Sarsat (C/S) is an international satellite system for search and rescue (SAR) distress alerting that was established in 1979 by Canada, France, the USA and the former USSR. Since its inception, the Cospas-Sarsat programme has continually progressed at the technical level but also in terms of participating countries, currently the treaty-based non-profit international organisation is composed of 45 countries[2].

2.2 OVERVIEW

The international cooperation resulted in the implementation of a free of charge international satellite distress alerting system using a variety of space and ground segment components providing distress alert and location information to connected SAR authorities throughout the world for maritime, aviation and land users in distress (e.g. distress beacons).

The Cospas-Sarsat system was originally conceived with satellites in low Earth orbits (hereinafter LEOSAR) and associated compatible ground stations. It was first complemented with geostationary orbit satellites (hereinafter GEOSAR), and since the year 2000, C/S is transitioning to benefit from SAR instruments in medium Earth Orbit (hereinafter MEOSAR). In order to fulfil its main mission, the System is composed of four components:

- **Beacons:** 406 MHz radio transmitting devices that conform to specifications[3] and construction requirements according to its intended use (Emergency Position Indicating Radio Beacons (EPIRBs) and Ship Security Alert System (SSAS) for maritime applications, the Emergency Locator Transmitters (ELTs) and ELT Distress Tracking (ELT(DT)) for aviation applications, or Personal Locator Beacons (PLBs) for personal use).
- **A Space Segment:** Encompassing satellites in low Earth orbit, geostationary orbit and medium Earth orbit (subject of this document) that process and / or relay the signals transmitted by beacons;
- **A Ground Segment:** A verified[4] and geographically distributed set of ground receiving stations called Local User Terminals (e.g. MEOLUTs, for the MEOSAR service) provide the ground segment coverage with the capability to track the satellites, process the broadcast signals and generate independent location estimations of the user in distress (i.e. beacon);
- **Mission Control:** The mission is assured by the Mission Control Centres (MCCs) strategic ground segment elements contributing to the distribution of Cospas-Sarsat distress alerts generated by the LUTs throughout the world via dedicated network connections and data distribution plan to other Cospas-Sarsat MCC participants that have agreed to receive such services and more importantly to the relevant Rescue Co-ordination Centre (RCC) in charge of the Search and Rescue mission.

Figure 1 illustrates the interaction between all four components to deliver the service.

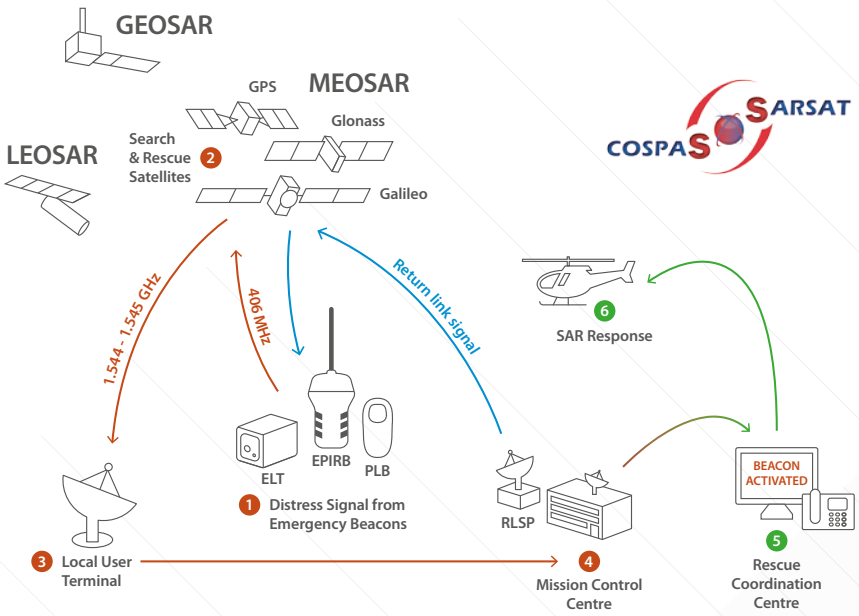


Figure 1 - The Cospas-Sarsat MEOSAR system (based on: Cospas-Sarsat)

2..... *Refer to Cospas-Sarsat History [RD3] and website [www.cospas-sarsat.int] for further information.*

3..... *Refer to Specification for C/S 406 MHz Distress Beacons [RD5] for further information.*

4..... *Refer to C/S MEOLUT Performance Specification and Design Guidelines [RD8] for further information.*

SECTION 3: SAR/GALILEO ENHANCED SERVICE

Since the declaration of Galileo Initial Services on 15 December 2016, the Galileo Programme has continuously provided the Galileo SAR Service and incrementally upgraded the Galileo infrastructure, resulting in the SAR/Galileo Enhanced Service. This is essentially an enriched version of the Galileo Initial Services in contribution to the Cospas-Sarsat MEOSAR IOC phase, with:

1. Space Segment: larger number of SAR payloads available from the Galileo constellation (see Table 2)

2. Ground Segment: An enhanced SAR/Galileo Ground Segment (SGS) infrastructure, with the addition of a new Galileo Service Facility enabling the introduction of the Galileo Return Link Service. This is currently service unique to Galileo that enables Galileo compatible equipment to receive an acknowledgment that its distress alert has been received.

3. Service Performance: The new Galileo infrastructure entails a performance increase that is in accordance with the Cospas-Sarsat MEOSAR IOC standards[5].

3.1 SAR/GALILEO FORWARD LINK SERVICE

The SAR/Galileo Enhanced Forward Link Service is Galileo's capability to pick up signals emitted from Cospas-Sarsat compatible 406 MHz distress beacons and relay this information to a geographically distributed twelve-channel European MEOLUT. Based on specific levels of performance defined in section 5, the MEOLUT can in turn provide beacon identification and location estimation information to the associated Cospas-Sarsat MCCs.

The SAR/Galileo Enhanced Forward Link Service is supported by a ground segment infrastructure, depicted in Figure 2, which consists of:

- Three European MEOLUT Facilities deployed in: Maspalomas (Spain), Spitsbergen (Norway) and Larnaca (Cyprus);
- One MEOLUT Tracking Coordination Facility (MTCF) located in the SAR/Galileo Service Centre (SGSC) in Toulouse (France);
- Five SAR/Galileo reference beacons (REFBE) located in Maspalomas (Spain), Spitsbergen (Norway), Larnaca (Cyprus), Toulouse (France), Santa Maria (Portugal), suited for FLS and RLS Service monitoring;
- A SAR Server, providing an alternative source of precise Galileo orbital parameters (e.g. ephemeris, almanacs, clock corrections) to both the SAR/Galileo and other interested Cospas-Sarsat operational entities.

The signals relayed by the Galileo satellites[6] are received by the three European MEOLUTs, which ensures the provision of the Forward Link Service over the coverage area of 40 million square kilometres that is referred to as the "European SAR/Galileo Coverage Area". This includes as a minimum all SAR areas under the responsibilities of European territories.

The European SAR/Galileo Coverage represented by the red contour line on Figure 3, is the coverage area declared to Cospas-Sarsat as a result of the 12-channel European MEOLUT, and is bounded by the following four geographic coordinates:

- **SGC1:** 85.00° N 41.20° E in the Arctic Ocean
- **SGC2:** 29.18° N 37.07° E in Saudi Arabia
- **SGC3:** 05.00° N 38.00° W in the Atlantic Ocean
- **SGC4:** 75.76° N 77.87° W in the Baffin Bay

5..... Refer to [RD8] for MEOSAR IOC minimum performance levels specifications.

6..... The SAR/Galileo FLS fully exploits signals relayed by the other commissioned MEOSAR space segment providers (e.g. GPS/DASS, SAR/GLONASS)

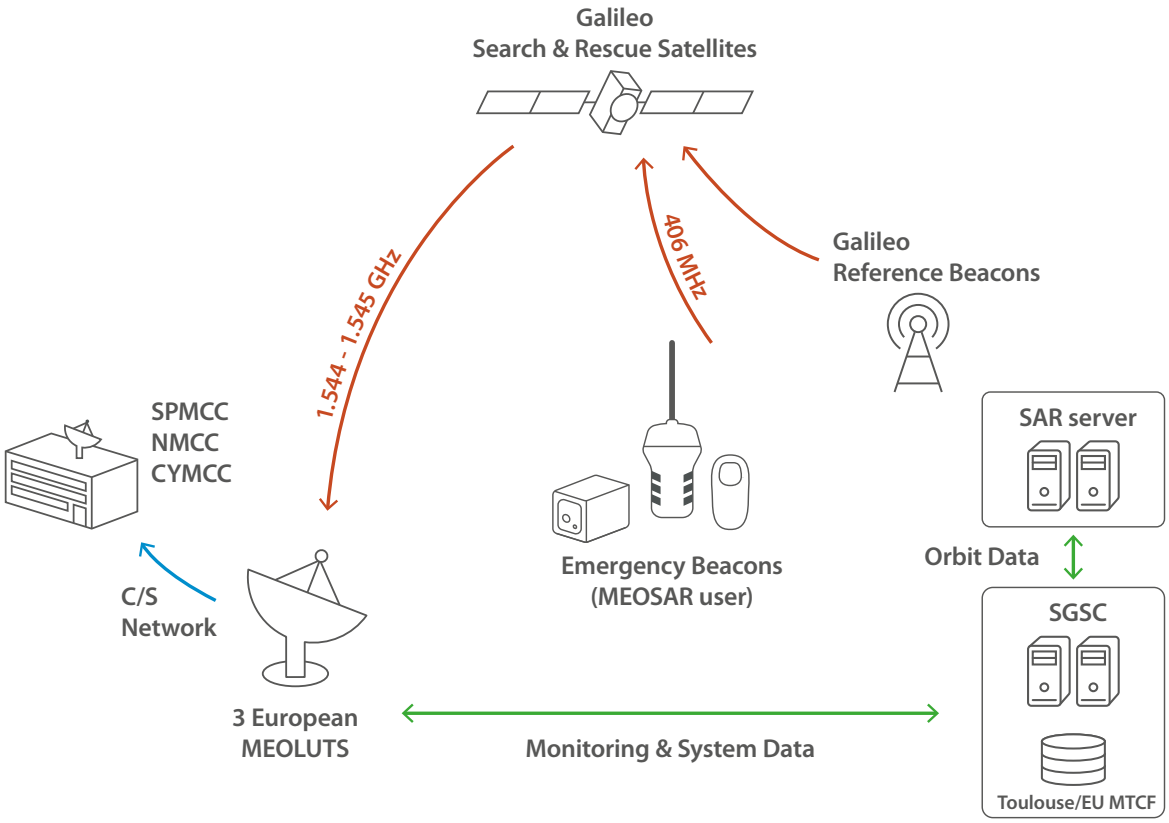


Figure 2 - SAR/Galileo architecture associated to the Forward Link Service

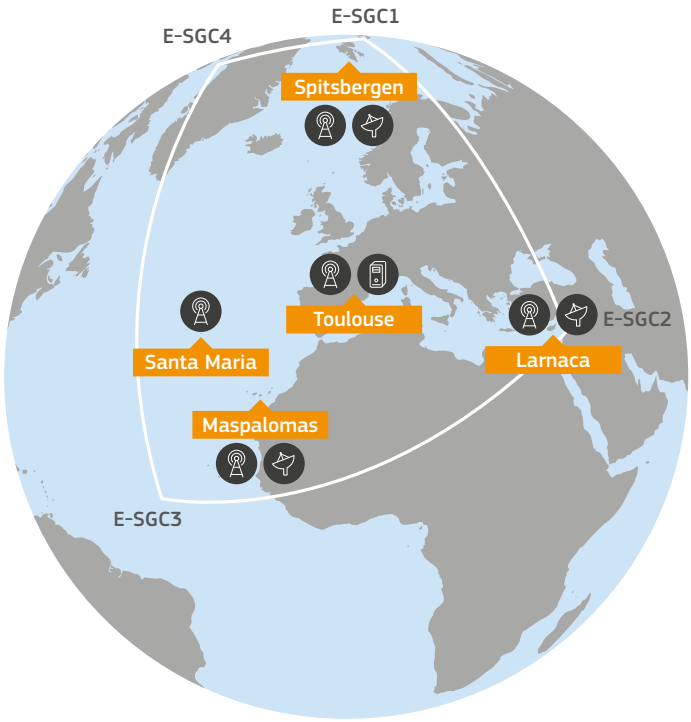


Figure 3 - European SAR/Galileo forward link service coverage and SAR/Galileo sites

3.2 SAR/GALILEO RETURN LINK SERVICE

The Galileo Return Link Service (RLS) is a free-of-charge global service implemented with the support of, and in cooperation with, Cospas-Sarsat and is available to 1st and 2nd generation 406 MHz C/S compatible beacons transmitting according to the RLS protocol[7].

The new functionality, today offered uniquely by Galileo, enables a communication link allowing the relay of data (Return Link Messages) back to the originating beacon. This link is irrespective of the C/S satellite system used for the independent location confirmation through the Galileo Signal in Space[8].

The first function of the Return Link Service, which is offered as part of the Galileo SAR Enhanced Service, is the automatic Acknowledgment Service also referred as Type-1 or System Acknowledgment. This service provides a confirmation to the distress beacon that the localisation of the alert has been confirmed by the Cospas-Sarsat system. Additional Return Link Services are foreseen in the future and dedicated service updates will then be provided.

The Return Link Acknowledgment Service is a joint effort between Cospas-Sarsat and the Galileo Programme, as it is supported on one hand by the existing Cospas-Sarsat system and on the other, by the new Galileo Service Facility called Return Link Service Provider (RLSP). The RLSP is in charge of securely providing the ground segment interface between the French MCC and Galileo Core Infrastructure, enabling the transmission of Return Link Messages (RLMs) to the appropriate Galileo satellites that are in view of the beacon, as depicted in the blue-dashed arrows in Figure 4.

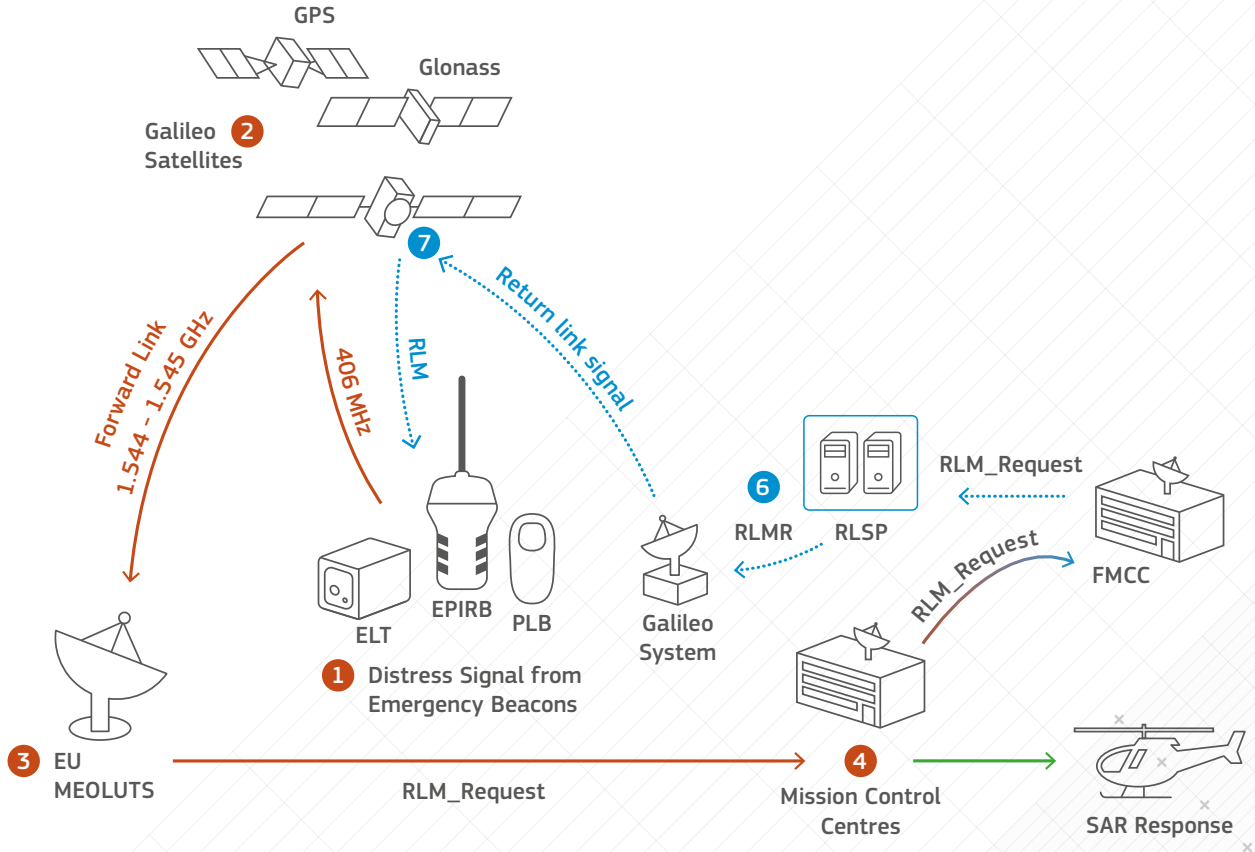


Figure 4 - SAR/Galileo Return Link Service Integration into Cospas-Sarsat

7..... RLS Protocol is defined in [RD5] and [RD13]
8..... OS I/NAV E1 signal further fined in the Galileo SIS ICD [RD11]

Based on the Return Link Message Request (RLM_Request) encoded in the Forward Link Alert Message (FLAM) and distributed by the Cospas-Sarsat MCC network to the RLSP, the Return Link Acknowledgement Service will automatically transmit (without human intervention) RLMs back to the person(s) in distress, allowing them to receive a confirmation of the detection and independent determination of its location by the Cospas-Sarsat system.

To enable this function, the beacon must transmit in the Forward Link Alert Message (FLAM) according to the Return Link Service Protocol[9], indicating that an acknowledgment of the distress alert is requested. Upon confirmation of the beacon location, a Return Link Message Request (RLM_Request) will be issued by the MCC whose service area covers the beacon's confirmed position and the request will be transmitted following the Cospas-Sarsat data distribution plan[10] to the FMCC (French Mission Control Centre), the designated interface between C/S ground segment and the RLSP.

In turn, the RLSP, which is connected to the Galileo Core Infrastructure, generates a RLM Transmission Request (RLMR) based on the contents of the original Forward Link Alert Message (FLAM) that is processed and uplinked to suitable Galileo satellites until the RLM is broadcast to the originating beacon via the Galileo E1 signal.

In order to maximise the RLM probability of reception, for each transmission slot the RLM are sent through two Galileo satellites in parallel (which is transparent from the beacon perspective) and repeated several times during each transmission slot in accordance with the Cospas-Sarsat RLS beacon GNSS operation[11]. The selection of the satellites to be used for the transmission is made by the Galileo RLSP through a specific algorithm and cannot be known in advance by the GNSS receiver embedded in the beacon, thus the beacon should track all Galileo satellites in view to achieve the best service performance.

After receipt of the return link message by the beacon, subsequent beacon transmissions activate an RLM receipt status flag in the FLAM, which is then distributed via the Cospas-Sarsat MCC network to the RLSP. Once notified, the Galileo system stops sending RLMs back to the beacon. If the RLM reception acknowledgment is not received, the transmission continues until 24 hours has elapsed since the first RLM_Request message was received by the RLSP.

3.2.1 SAR/GALILEO RLM CONTENT

The Return Link Acknowledgment Service is based on the RLM short format structure depicted in Figure 5 and its contents and correctness are ensured by Cospas-Sarsat.

The RLMs are then integrated in to the Galileo E1 signal (1575.42MHz) I/NAV message frames, as further detailed in the Galileo Open Service and the Galileo Signal in Space ICD documents[12]. The Galileo I/NAV message frame structure includes a SAR field in every odd page of the E1-B subframe. An odd page is transmitted every 2 seconds. Each SAR field is 22 bits long, which includes 2 signalling bits and 20 data bits. As a result, a short Return Link Message (80bits) is transmitted in 8 seconds.

The Return Link Message also includes a test message which is used for the testing of the RLS service with RLS Test Protocol coded beacons.

Return Link Service	Beacon ID			Message Code				Short-RLM Parameters Field																	
	60			4				16																	
	bit 1**	To...	Bit 60	Bit 61	Bit 62	Bit 63	Bit 64	Bit 65	Bit 66	Bit 67	Bit 68	Bit 69	Bit 70	Bit 71	Bit 72	Bit 73	Bit 74	Bit 75	Bit 76	Bit 77	Bit 78	Bit 79	Bit 80		
Acknowledgment Service Type-1	15 HEX ID			0	0	0	1	1	0	Spares														Parity	
Test Service	15 HEX ID			1	1	1	1	Spares																Parity	

Figure 5 - Return Link Message Content

9..... Defined in [RD05] and [RD13]

10.... Refer to [RD2] for further details on the Cospas-Sarsat Data Distribution Plan

11.... Refer to [RD5] and [RD13] for further details on the Cospas-Sarsat GNSS beacon receiver operation

12.... Refer to [RD10] and [RD11] for further details on the RLM contents broadcasted by the Galileo Navigation Signals

3.3 SAR/GALILEO ENHANCED SERVICE INFRASTRUCTURE

The Galileo System is composed of a Core Infrastructure and a number of Service Facilities. The Core Infrastructure, in turn, comprises a Space Segment (3.3.1) and a Ground Segment (3.3.2).

The following section describe the relevant Galileo infrastructure (Space, Forward Link and Return Link) involved in the SAR/Galileo Enhanced Service provision.

3.3.1 SAR/GALILEO SPACE SEGMENT

The Galileo space segment, once fully deployed, will consist of a 24/3/1 Walker constellation of 24 medium Earth orbit satellites plus spares arranged in 3 orbital planes, with their ascending nodes uniformly distributed at intervals of 120 degrees, inclined at 56 degrees with respect to the equator. With the satellites taking about 14 hours to orbit Earth at altitudes of 23.222 km, there will always be at least four satellites visible anywhere on the Earth's surface (subject to local geography and shadowing).

Galileo satellites, in addition to the Galileo Open Service (OS) navigation payload and in support of Cospas-Sarsat MEOSAR, are fitted with SAR Repeater instruments (SARR). The Galileo SARR comprises transparent bent pipe type SAR Transponders and SAR receiving and transmitting antennas. They receive Cospas-Sarsat compliant[13] 406 MHz distress signals and retransmit them in the L-band at 1544.1 MHz, without on-board processing, data storage, or demodulation, to any MEOLUT in view, worldwide[14]. Alternatively, the Return Link Message broadcast is done via the Galileo E1 navigation signal.

A detailed description of the SAR/Galileo payload is provided in [RD6] and the list of in-orbit Galileo satellites and associated operational capability to support the Forward and Return Link Service is provided in Table 2.

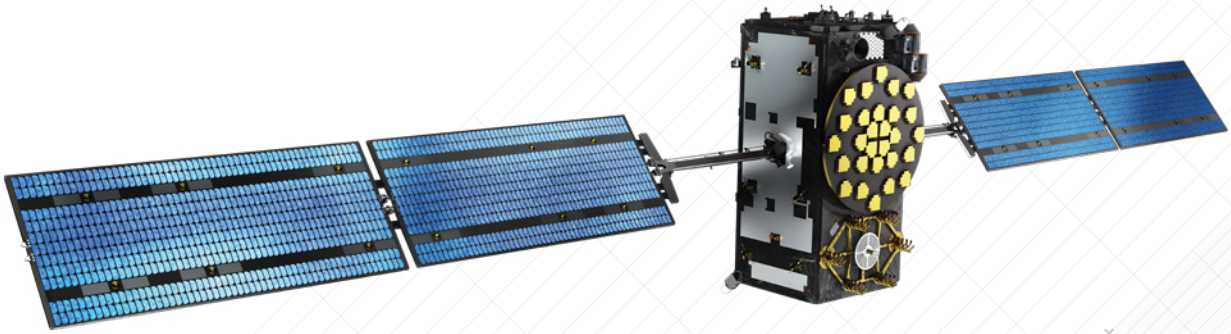


Figure 6 - Galileo FOC Satellite

13 ....Refer to [RD6] and [RD7] for Cospas-Sarsat Space Segment specifications.
14 .... Refer to [RD9] for Cospas-Sarsat MEOLUT commissioning standard.

SATELLITE CODE	SV ID (PRN)	COSPAS-SARSAT ID	ORBITAL SLOT	OPERATING MODE [KHZ]	FLS OPERATIONAL STATUS [1/06/2019]	RLS OPERATIONAL STATUS [1/06/2019]
GSAT-0101[15]	11	N/A	B5	-	N	Y
GSAT-0102[15]	12	N/A	B6	-	N	Y
GSAT-0103	19	419	C04	ALC90	Y	Y
GSAT-0104[16]	20	420	C05	ALC90	Y	N
GSAT-0201[17]	18	418	Ecc	ALC90	Y	N
GSAT-0202[17]	14	414	Ecc	ALC90	Y	N
GSAT-0203	26	426	B08	ALC90	Y	Y
GSAT-0204[18]	22	422	B03	OFF	N (Spare)	N (Spare)
GSAT-0205	24	424	A08	ALC90	Y	Y
GSAT-0206	30	430	C06	ALC90	Y	Y
GSAT-0207	07	407	C01	ALC90	Y	Y
GSAT-0208	08	408	C07	ALC90	Y	Y
GSAT-0209	09	409	C02	ALC90	Y	Y
GSAT-0210	01	401	A02	ALC90	Y	Y
GSAT-0211	02	402	A06	ALC90	Y	Y
GSAT-0212	03	403	C08	ALC90	Y	Y
GSAT-0213	04	404	C03	ALC90	Y	Y
GSAT-0214	05	405	C01	ALC90	Y	Y
GSAT-0215	21	421	A03	ALC90	Y	Y
GSAT-0216	25	425	A07	ALC90	Y	Y
GSAT-0217	27	427	A04	ALC90	Y	Y
GSAT-0218	31	431	A01	ALC90	Y	Y
GSAT-0219	36	436	B04	ALC90	Y	Y
GSAT-0220	31	413	B01	ALC90	Y	Y
GSAT-0221	15	415	B02	ALC90	Y	Y
GSAT-0222	33	433	B07	ALC90	Y	Y

Table 2 - Galileo FL and RL relevant constellation

3.3.1.1. REPEATER OPERATING MODES

The Galileo SAR repeater (SARR) has three modes and can operate in two bandwidth configurations. The operational modes include the Normal (90 kHz) and Narrow (50 kHz) bandwidth modes, as well as the possibility to operate with adjustable Fixed Gain Mode (FGM) or Automatic Level Control (ALC) mode. The operational modes of the SAR Repeater are as follow:

15.... Galileo IOV satellites GSAT-0101, GSAT-0102 are not fitted with a SARR payload.

16.... Galileo satellite GSAT-0104 is not used for the Galileo Open Service but the SART is active and used in operations.

17.... Galileo satellites GSAT-0201 and GSAT-0202 Galileo Open Service contribution is being tested.

18.... Galileo satellite GSAT-0204 is currently set in non-active spare mode for constellation management purposes

1. **ON mode:**
   - **ALC** (Automatic Level Control):

     The transponder gain in ALC mode is self-regulated to ensure stable EIRP, the operational gain is automatically adjusted to obtain a predefined power at the output of the SAR transponder.

     - **ALC90:** 90 kHz BW (normal bandwidth mode, default mode)
     - **ALC50:** 50 kHz BW (narrowband mode)

   - **FGM** (Fixed Gain Mode):

     The operational gain in FGM is set by telecommand in a 30 dB range, with nominal step size of 1dB. The range is adjusted so that when the transponder is in the 90 kHz bandwidth mode, and at the input of the repeater there is only thermal noise, the nominal output power of 7dBW is achieved for a gain step of 22 dB. Then, the overall gain of the SAR repeater in the reference gain setting in FGM (including the gains of the receiving and transmitting antennas) is around 182 dB at the edge of coverage.

     - **FGM90:** 90 kHz BW (normal bandwidth mode)
     - **FGM50:** 50 kHz BW (narrowband mode)

2. **STANDBY mode:** transponder is powered up, but RF power is OFF.

3. **OFF mode:** transponder is not powered.

The SAR Repeater main characteristics according to the bandwidth mode are shown in Table 3 and defined in detail in [RD6].

SAR/ GALILEO TRANS-PONDER PARAMETER	NORMAL MODE	NARROW-BAND MODE	UNIT
Bandwidth	90	50	kHz
Receive Centre frequency	406.050	406.043	MHz
Group delay GSAT0103/0104	27	38	µs
Group delay GSAT02xx	48	68	µs

Table 3 - Specific SAR/Galileo Transponder characteristics in normal and narrowband modes

3.3.2 GALILEO GROUND SEGMENT

An overview of the Galileo System is provided in Figure 7. It is essentially composed of the Ground Control Segment (GCS) and the Ground Mission Segment (GMS) as well as additional infrastructure specifically dedicated to the provision of the SAR/Galileo Services (Forward and Return link), which is in turn illustrated in Figure 8:

- Two Galileo Control Centres (GCC), implementing hot-redundant ground control (i.e. GCS) and ground mission (i.e. GMS) capabilities at each site.
- A worldwide dedicated real-time Galileo Data Distribution Network (GDDN) and an associated secure network for External Services (EDDN).
- A worldwide network of Galileo Sensor Stations (GSS), which collects and forwards Galileo SIS measurements and data to the GCCs in real time.
- A worldwide network of Galileo Uplink Stations (ULS), which distributes and uplinks the mission data (including the RLMs) to the Galileo constellation.
- A worldwide network of Telemetry, Tracking & Control stations (TTC stations), which collects and forwards telemetry data generated by the Galileo satellites, and distributes and uplinks the control commands required to maintain the Galileo satellites and constellation in nominal operational conditions.

The infrastructure specifically dedicated to the provision of the SAR/Galileo service is referred to as SAR/Galileo Ground Segment (SGS) and is further described in the following sections.

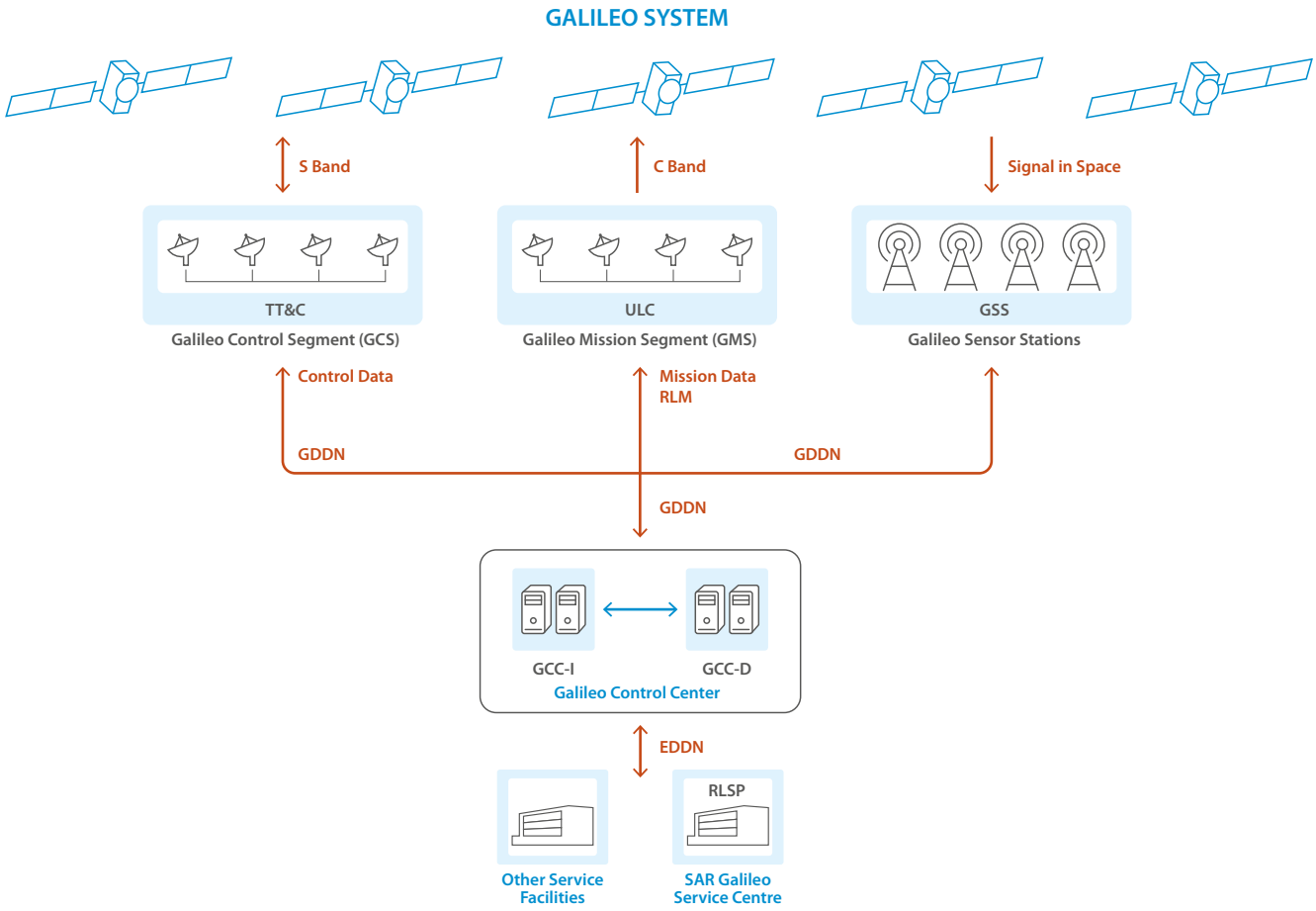


Figure 7 - Galileo System Overview and Interface with the SAR/Galileo Ground Infrastructure

3.3.3 SAR/GALILEO GROUND SEGMENT

The SAR/Galileo ground segment (hereinafter SGS) displayed in Figure 8 can be grouped in two, the Forward Link and the Return Link associated infrastructure:

- The SAR/Galileo FL Ground Segment is a geographically distributed segment consisting of three MEOLUTs sharing their twelve measurement channels (antennas and associated TOA/FOA signal measurement processor), a Service Centre hosting the MEOLUT Tracking Coordination Facility (MTCF), a set of distributed Reference Beacons (REFBE) and a dedicated network (SARN) for communication purposes.
- The SAR/Galileo RL Ground Segment is composed of the Return Link Service Provider (RLSP), which is the unique facility in charge of generating the Return Link Message. It is located in the SAR/Galileo Service Centre (SGSC) and interfaces on one side with the Cospas-Sarsat network through the French Mission Control Centre (collocated with the RLSP) and on the other side to the Galileo System.

The SAR/Galileo Service Centre (SGSC) located in CNES (Toulouse, France) is the designated centre for the management of the SAR/Galileo Service. The SGSC also hosts the MEOLUT Tracking Coordination Facility (3.3.3.1.2), a Reference Beacon (3.3.3.1.5), the Return Link Service Provider (3.3.3.2.1) which is the only element connected to the Galileo core infrastructure, and also the Central Warehouse for all the SAR Integrated Logistic Support (ILS) related processes.

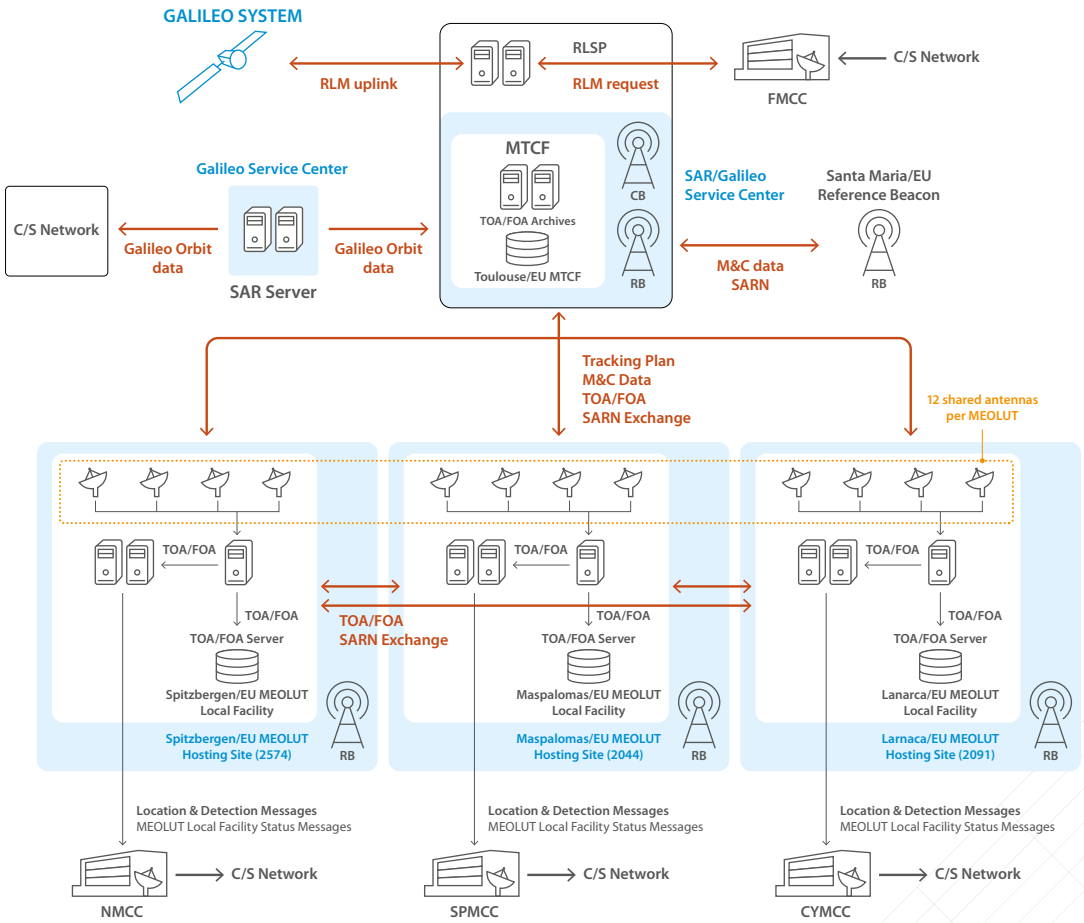


Figure 8 - SAR/Galileo FL and RL Ground Infrastructure Overview

3.3.3.1. FORWARD LINK INFRASTRUCTURE

3.3.3.1.1. SAR/GALILEO EUROPEAN MEOLUT

The European MEOLUT is essentially composed of three MEOLUT Local Facilities spread over three distinct locations in Maspalomas (Spain), Larnaca (Cyprus) and Spitsbergen (Norway). Each European MEOLUT Local Facility is fitted with four reception antennas (i.e. channels) whose tracking is coordinated by the MEOLUT Tracking Coordination Facility (3.3.3.1.2). The twelve coordinated antennas operate nominally through the exchange of signal measurement data (TOA/FOA) forming the European MEOLUT.

The coordinated tracking algorithm enables the optimisation of the FLS performance and the coverage of each MEOLUT, taking into account both Ground and Space Segment availabilities. In case of network or MTCF outage, the MEOLUT Local Facility is capable of generating detection and location data to their associated MCC (SPMCC, CYMCC and NMCC) based on a locally computed tracking plan. This mode of operation is however, not considered as an operational mode for the SAR Forward Link Service.

The role of the European MEOLUTs is to track the MEOSAR satellites in view, detect beacon distress alert messages, compute beacon location and provide alert messages to the associated MCC using standard Subject Indicator Types (SIT) messages as defined in C/S documentation [RD1] and [RD4]. In addition to the MEOLUT nominal functions, the SAR/Galileo MEOLUT Facilities have some specific features:

- Execution of a SAR/Galileo MEOSAR satellite coordinated tracking plan (generated by MTCF) or a locally generated one (generated by the MEOLUT Local Facility itself, without accounting for the other networked EU MEOLUT Facilities),

- Exchange of TOA/FOA measurements between SAR/ Galileo MEOLUT Local Facilities and with MTCF,
- Transmission of MEOLUT Operational, Warning and Alarm SIT status messages (SIT650,SIT652,SIT651 respectively) to the associated MEOLUT Local Facility MCCs (Table 4),
- Detection and Location of 406 MHz interferers (SIT 161),

It should be noted that in order to guarantee the MPL the European MEOLUT requires precise calibration means (see 3.3.3.1.7) and a permanent connectivity to the SAR server (3.3.3.1.6) as an alternative source of Galileo orbit data. Table 4 below lists the precise location and relevant details of the three European MEOLUT Local Facilities.

Figure 9 - Maspalomas EU/MEOLUT Local Facility

Figure 10 - Spitsbergen EU/MEOLUT Local Facility

Figure 11 - Larnaca EU/MEOLUT Local Facility

SAR/GALILEO MEOLUTS	C/S ID	ASSOCIATED MCC	LATITUDE [°]	LONGITUDE [°]	ALTITUDE [M]
Spitsbergen/EU MEOLUT (Norway)	2574	NMCC	78.2305	15.3707	430
Maspalomas/EU MEOLUT (Spain)	2244	SPMCC	27.7614	-15.6348	130
Larnaca/EU MEOLUT (Cyprus)	2091	CYMCC	34.8651	33.3838	277

Table 4 - SAR/Galileo MEOLUT locations

3.3.3.1.2. MEOLUT TRACKING COORDINATION FACILITY (MTCF)

The MEOLUT Tracking Coordination Facility is deployed in CNES (Toulouse) and is the designated SAR/Galileo Facility for monitoring and controlling the SGS infrastructure and Service. Its main functions are threefold:

1. Tracking Schedule management: The MTCF is in charge of receiving and processing MEOSAR satellite orbital data through the MEOSAR GNSS Signal in Space ephemeris, almanacs, the SAR server or 3rd party Two Line Elements. On that basis, it implements an efficient algorithm to generate an optimised and coordinated SGS tracking plan that is disseminated to the three EU/MEOLUT Local Facilities, taking advantage of the network configuration for optimal service performance and coverage. Moreover, the MTCF enables the addition of a number of external MEOLUTs in the tracking coordination process and for TOA/FOA exchange.
2. Data provision and archiving: The MTCF provides a redundant link for TOA/FOA files exchange with the three MEOLUT Local Facilities. Additionally, the MTCF is the designated long term data archive facility for the entire SAR/Galileo ground segment.
3. Performance and functional monitoring: The MTCF provides overall SAR mission (including RLS monitoring) and tracking performance statistics on the EU/MEOLUTs, as well as the repository for

beacon alert messages and TOA/FOA measurements from the European Reference Beacons detected by the European MEOLUT. It ensures the overall Forward Link Service and overall SGS infrastructure monitoring.

3.3.3.1.3. KPI COLLECTION PLATFORM (KCP)

The SAR/Galileo MPL are continuously collected and automatically generated by a dedicated infrastructure called KCP (KPIs Collection Platform) that is hosted within the MTCF.

The bursts transmitted by the SAR/Galileo reference beacons (see section 3.3.3.1.5) and dedicated RLMRs generated from the RLSP with a specific pattern are collected by the European MEOLUTs and periodically transferred to the KCP, which generates near real-time SAR/Galileo FL and RL Service key performance indicators used for the Service monitoring purposes.

3.3.3.1.4. SAR/GALILEO NETWORK

All communications between the different SAR/Galileo Facilities, namely the European MEOLUT Local Facilities, the Reference Beacons and MTCF are facilitated through the SAR/Galileo Network (SARN). Each hosting entity is connected to the SARN through its own country's National Research and Education Network (NREN), which are then connected together through a pan-European communications backbone infrastructure called GEANT (Gigabit European Advanced Network Technology).

The NRENs involved in the SARN are:

- CYNET for Cyprus
- REDIRIS for Spain
- NORDUNET for Norway
- RENATER for France
- RCTS for Portugal

3.3.3.1.5. SAR/GALILEO REFERENCE BEACONS

The SAR/Galileo Service is supported by a network of five Reference Beacons (REFBE) geographically distributed across the service area in Toulouse (France), Spitsbergen (Norway), Santa Maria (Portugal), Maspalomas (Spain), Larnaca (Cyprus).

These reference beacons deployed over the European Coverage Area are used to continuously monitor the performance of the SAR/Galileo Services (KPI collection, refer to 3.3.3.1.3). Each REFBE, whose main parameters are provided in Table 5, is fitted with a vertical linear polarised antenna with a radiation pattern equivalent to a standard C/S beacon [RD5]. The REFBEs are synchronised with Universal Coordinated Time and each one transmits 1 burst every 50 seconds, according to a specific scheme on a permanent basis, as depicted in Figure 12.

SGS REFBE	BEACON ID	FREQUENCY [MHZ]	SYNCH START TIME	LATITUDE [°]	LONGITUDE [°]	ALTITUDE[19] [M]
GAL-EU1 Toulouse-France	9C62BE29630F1D0	406.034	HH : 00': 07"	43.5603	1.4803	209
GAL-EU2 Spitsbergen-Norway	A042BE29630F190	406.034	HH : 10': 19"	78.2308	15.3706	486
GAL-EU3 Santa Maria-Portugal	9982BE29630F100	406.034	HH : 20': 31"	36.9966	-25.1362	348
GAL-EU4 Maspalomas-Spain	9C02BE29630F0A0	406.034	HH : 00': 43"	27.7615	-15.6343	180
GAL-EU5 Larnaca-Cyprus	9A22BE29630F010	406.034	HH : 10': 54"	34.8654	33.3838	322

Table 5 - SAR/Galileo REFBE details

19.... Altitude above WGS84 ellipsoid

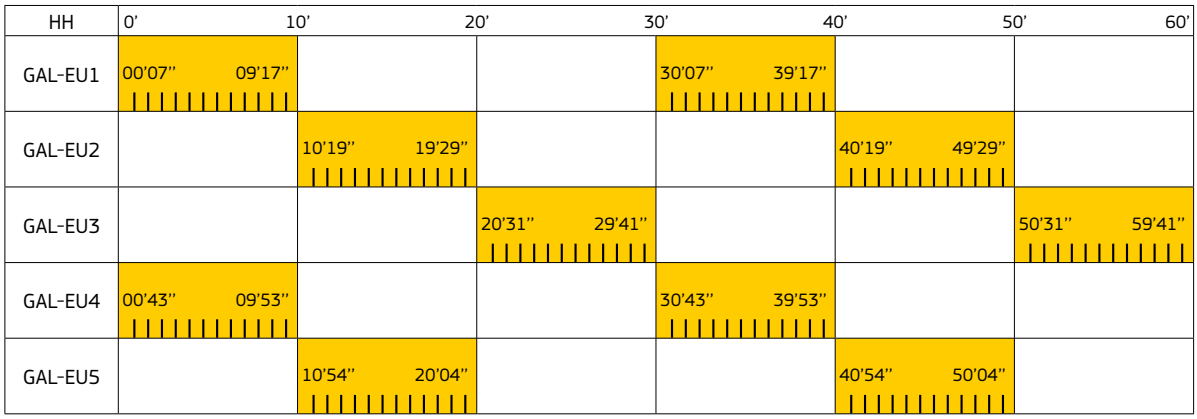


Figure 12 - Reference beacons transmission schedule within 1 hour

Figure 12 below illustrates the SAR/Galileo REFBE transmission pattern. At the "Synchronisation Start Time" (see 4th column of Table 5 above), the transmission starts for a duration of 10 minutes, then stops and resumes after 30 minutes (2x10 minutes of transmission per hour or alternatively, 2x12 bursts per hour).

3.3.3.1.6. GALILEO SAR SERVER

The Galileo SAR Server is a complementary Galileo infrastructure hosted and operated by the European GNSS Service Centre that provides support to the SAR/Galileo Service and worldwide SAR community by offering Galileo constellation orbital products in a precise and timely manner.

The SAR Server can be accessed worldwide through a secure FTP connection and its products serve as a redundant source of Galileo constellation orbital parameters in case they are not nominally broadcast through the Galileo Signal in Space (L-Band navigation signals) or could not be recovered from the local GNSS receivers.

The MTCF interfaces permanently with the SAR server, retrieving the most up-to-date Galileo ephemeris and broadcasting them to the three European MEOLUT Facilities.

There are currently no minimum performance levels guaranteed for the provision of this complementary service, therefore it is offered on a best-effort basis. Nevertheless, the performance and availability of the Galileo SAR Server is monitored by the GSA and reported monthly.

3.3.3.1.7. CALIBRATION BEACONS

The European MEOLUT requires precise and continuous frequency calibration transmissions in co-visibility to achieve the minimum performance levels defined in section 5. The SAR/Galileo Forward Link Service benefits from available Cospas-Sarsat calibration means (which are outside the control of the Galileo Programme) to fulfil this need, in particular two calibration beacons deployed in Toulouse hosted and operated by CNES:

- Toulouse-1 (Beacon ID: 9C6000000000001) for time calibration
- Toulouse-2 (Beacon ID: 9C634E2AB509240) for time and frequency calibration.

Upcoming upgrades of the SGS infrastructure will incorporate three calibration beacons collocated with the three European MEOLUT Local Facilities.

3.3.3.2. RETURN LINK SERVICE INFRASTRUCTURE

3.3.3.2.1. RETURN LINK SERVICE PROVIDER

The Return Link Service Provider (RLSP) is a new SAR/Galileo Facility introduced with the SAR/Galileo Enhanced Service deployed in CNES (Toulouse) and collocated with the MTCF and FMCC within the SAR/Galileo Service Centre.

The RLSP enables the provision of the SAR/Galileo Return Link Service interfacing on one side with the Cospas-Sarsat system through the French Mission Control Centre (FMCC) and on the other side, with the Galileo system (Ground Mission Segment) for Return Link Messages uplink to the Galileo satellites.

The RLSP infrastructure has been designed for unmanned continuous operation with a high level of redundancy. It includes an Operational chain and a Validation chain, used for software verification, operation validation and training. The main functionalities of RLSP are threefold:

1. Management of the Return Link Messages:

   Receive and manage the RLM Requests (RLM_Request) from its different interfaces and send the RLM Transmission Requests (RLMR) to the Galileo system according to the Galileo spacecraft selection algorithm defined.

   It also ensures the synchronisation of the transmissions of the RLM in the right transmission slots according to the C/S beacon activation strategy defined in [RD4] to maximise the probability of reception of the RLM by the distress beacons.

2. Management of the Interfaces:

   The RLSP acts as the single interface between the systems involved in the RLM distribution chain, implementing seamless and secure end-to-end dataflow connectivity (e.g. receiving RLM_Request SIT formatted from FMCC and generating a Galileo RLMR formatted packet for final broadcast).

3. Monitoring and Management of the Data:

   The RLSP is designed to work autonomously without human intervention. To ensure a high availability of the RLS service, it is monitored on a 24/7 basis. Additionally, it also collects and archives the relevant data flows between the interfaces involved (traffic, logs, distress event data) for the purpose of service monitoring, troubleshooting, accountability and for the generation of statistical data relative to the SAR/Galileo RLS.

Details of the Galileo Return Link Facility are provided in the table below:

SAR/GALILEO FACILITY	ASSOCIATED MCC	LATITUDE [°]	LONGITUDE [°]
Return Link Service Provider (France)	FMCC	43.5605	1.4809

Table 6 - RLSP Facility location

SECTION 4: SAR/GALILEO ENHANCED SERVICE CHARACTERISTICS AND USAGE ASSUMPTIONS

The SAR/Galileo Enhanced Service Minimum Performance Levels (MPL) contained in this document target only the service contributors that are under full control of the Galileo Programme. Typical performance levels achieved considering service contributors outside the Galileo Programme, such as other MEOSAR providers, are also highlighted in this document. This section provides further details on the service characteristics while also listing certain conditions, exclusions and assumptions to be taken by users.

4.1 SPACE SEGMENT

The SAR/Galileo Forward Link Service can fully exploit signals relayed by the other commissioned and operationally available MEOSAR payloads (e.g. GPS/DASS S-Band, SAR/GLONASS) for an increased FL Service availability, performance and coverage.

The MPLs contained in this document do not depend on the use of external Galileo means, however the following MEOSAR space segment assets are assumed to contribute during the SAR/Galileo Enhanced Service Provision phase:

- Availability of 23 Galileo SAR repeaters and 22 Galileo satellites transmitting the Galileo navigation signals (for the broadcasting of the Return Link Message) as described in section 3.3.1
- Availability of 1 GLONASS L-Band payload
- Availability of 20 DASS S-Band payloads

The Galileo constellation information is available from the European GNSS Service Centre website where up to date status and active Notice Advisory To Galileo User (NAGU) notifications are published.

The operational status of the Galileo SAR repeaters is notified to the end users through the Cospas-Sarsat operational network from the French MCC on behalf of the SGDSP (see section A.3) and is available on the European GNSS Service Centre[20] and at the Cospas-Sarsat website MEOSAR system status section[21].

20.... *GNSS Service Centre Constellation information: www.gsc-europa.eu*
21.... *Cospas-Sarsat website: www.cospas-sarsat.int/en/system/space-segment-status-pro/current-space-segment-status-and-sar-payloads-pro*

4.2 SAR/GALILEO FORWARD LINK SERVICE STATES

The availability of the SAR/Galileo Ground Segment to support the Forward Link Service depends on the different operational status combinations of its constituent elements (European MEOLUT Facilities, SARN, MTCF, REFBE).

Three Forward Link States are defined for the SAR/Galileo Forward Link Service: Nominal, Degraded and Severely Degraded, which are detailed in Table 7 below:

FORWARD LINK SERVICE STATES	DESCRIPTION
Nominal	The SAR/Galileo Forward Link Service is considered in **Nominal** status when **the following conditions are met:** • The three European MEOLUTs have access to a minimum of 11 antennas through the exchange of TOA/FOA measurements amongst the 12 antennas available. • Alert data is being distributed to all the associated MCCs. • A valid coordinated tracking plan (not older than 10 days) is available and being executed • At least two REFBEs are operational • Availability of 20 or more Galileo Search and Rescue repeaters
Degraded	The SAR/Galileo Forward Link Service is considered in **Operational Degraded** status when it is not in Nominal, and **the following conditions are met:** • The three European MEOLUTs have access to a minimum of 8 antennas through the exchange of TOA/FOA measurements amongst the 12 antennas available. • Alert data is being distributed to at least one of the three associated MCCs. • A valid coordinated tracking plan (not older than 10 days) is available • One REFBE is operational • Availability of 15 to 19 Galileo Search and Rescue repeaters
Severely Degraded	The SAR/Galileo Forward Link Service is considered in **Severely Degraded** status when **one of the following conditions is met:** • The three European MEOLUTs have access to less than 8 antennas through the exchange of TOA/FOA measurements amongst the 12 antennas available. • The SARN links are not available resulting in the complete isolation of the three MEOLUT Local Facilities from each other and / or no alert data is distributed to any associated MCC. • No valid coordinated tracking plan is available • No Galileo REFBEs are operational • Availability of less than 15 Galileo Search and Rescue repeaters

Table 7 - SAR/Galileo Forward Link status and operating modes definitions

4.3 SAR/GALILEO RETURN LINK ROLES AND COMMITMENTS

The Return Link Acknowledgment Service is technically fully integrated within the Cospas-Sarsat system as it relies on a specific beacon transmission protocol to identify the RLS capability, on the different C/S LUT to reach the global coverage and on the capability of the C/S MCCs to process and relay any return link message request worldwide to the Galileo system.

As a consequence, the overall Return Link Acknowledgment Service performance level experienced by the end user depends both on the performance of the Cospas-Sarsat system, which is responsible for detecting and locating the distress alert and relaying the RLM request to the identified Galileo interface (i.e. RLSP), and on the performance of the Galileo system, which is in charge of broadcasting the RLM to the distress beacon estimated location provided by C/S.

The roles and responsibilities of the two different organisations involved in the RLS provision are as follow:

- Cospas-Sarsat is responsible for the performance of its ground segment, linked to the detection and localisation of the alert and the processing of the RLM request to the appointed Galileo interface.
- The Galileo Programme is responsible for the broadcast of the RLM towards the beacon location as estimated by Cospas-Sarsat.

Therefore, the responsibility for the end-to-end Return Link Service performance is shared between Cospas-Sarsat and the Galileo Programme.

4.4 SAR/GALILEO RETURN LINK LATENCY AND MONITORED LOOPS

The following naming conventions are used to clearly identify the MPLs on the RLS latency defined in section 5.2.2 and on the stakeholders involved in the end-to-end Return Link Service Provision as reflected in Figure 13 above.

- **Cospas-Sarsat Front End Loop (or C/S Return Link Service Component):**

  Encompasses the beacon FLAM transmission domain, the LUT data processing (alert detection and localisation), the MCC processing (until confirmation of alert location) and routing to the FMCC.

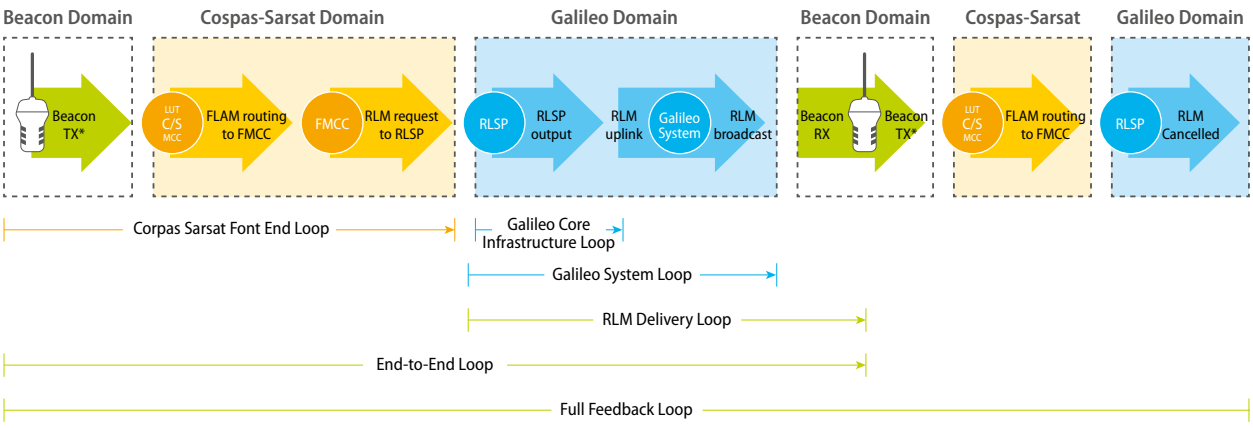


Figure 13 - Return Link delivery chain and stakeholder domain of responsibility

The latency of the Cospas-Sarsat Front End Loop depends on several factors:

- MEOSAR and/or LEOSAR coverage available at the position of the distress beacon. Locations on the Earth that are covered only by LEOSAR will experience much longer latencies than those that are also covered by MEOSAR.
- Time to achieve a confirmed position of the alert at the MCC.
- Routing latency of the RLM_Request between the MCC responsible for the area where the alert is located and the FMCC.

- **Galileo System Loop:**
  The Galileo System loop identifies the segment of the RLS processing chain that is entirely under the control of the Galileo Programme and for which the configuration, availability and minimum performance levels can be guaranteed. It includes from the RLSP input interface up to where the selected Galileo satellite broadcasts all the navigation frames, allowing decoding of the RLM by the target beacon.
- **Galileo Core Infrastructure Loop:**
  The Core Infrastructure Loop is an inner subset of the Galileo System Loop that characterises only the RLM uplink latency within the Galileo Core Infrastructure (i.e. not accounting for the RLSP processing time).
- **RLM Delivery Loop:**
  The RLM Delivery Loop complements the Galileo System Loop and includes up to the time that the RLM is properly received and decoded by one of the Galileo Reference Beacons (see 3.3.3.1.5).
- **End to End Loop:**
  The End to End Return Link Service Loop is the joint effort of both Cospas-Sarsat and Galileo Systems. It starts at the first FLAM transmission by the beacon and ends at the time of successful reception by the beacon of an RLM transmitted through the Galileo SIS.
- **Full Feedback Loop:**
  The Full Feedback loop is the scenario whereby the originating RLS beacon has received the Galileo Return Link acknowledgment message (e.g. End to End loop) and notifies the Galileo System (i.e. RLSP) to cease the broadcast of RLMs by updating the RLM receipt status flag in subsequent FLAM transmissions.

4.5 SAR/GALILEO RETURN LINK SERVICE BEACON RECEPTION AND TIMING STRATEGIES

To receive SAR/Galileo Return Link Messages, Cospas-Sarsat 406 MHz beacons require an embedded Galileo compatible GNSS receiver that is compliant with the IEC interface standard defined for the RLS[22] and Cospas-Sarsat Return Link beacon specifications[23]. A particular Return Link protocol shall be used for a RLS beacon to request an acknowledgment message (RLM). For the purpose of proper and timely RLM decoding, the beacon should track all visible Galileo satellites, disregarding the three Galileo SIS status flags (SHS,DVS,SISA) encoded within the Galileo SIS L1 Navigation Message (because an invalid navigation message will still contain a valid RLM).

To minimise power consumption, the embedded Galileo receiver will not continuously scan for its beacon ID in the Galileo SIS Navigation Message. Instead RLMs are transmitted with a Cospas-Sarsat agreed timing schedule defined in the RLS GNSS receiver operations strategy[23]. As such, this timing strategy allows the RLM transmissions for a given beacon to be synchronised with the activation of the beacon's Galileo receiver.

This transmission strategy is based on a first activation window of 30 minutes starting with the transmission of the first burst, followed by an activation window of 15 minutes every UTC hour starting at a beacon specific epoch that depends on the beacon ID. Inside each activation window of a given distress beacon, the RLSP broadcasts the RLM several times according to a repetition algorithm.

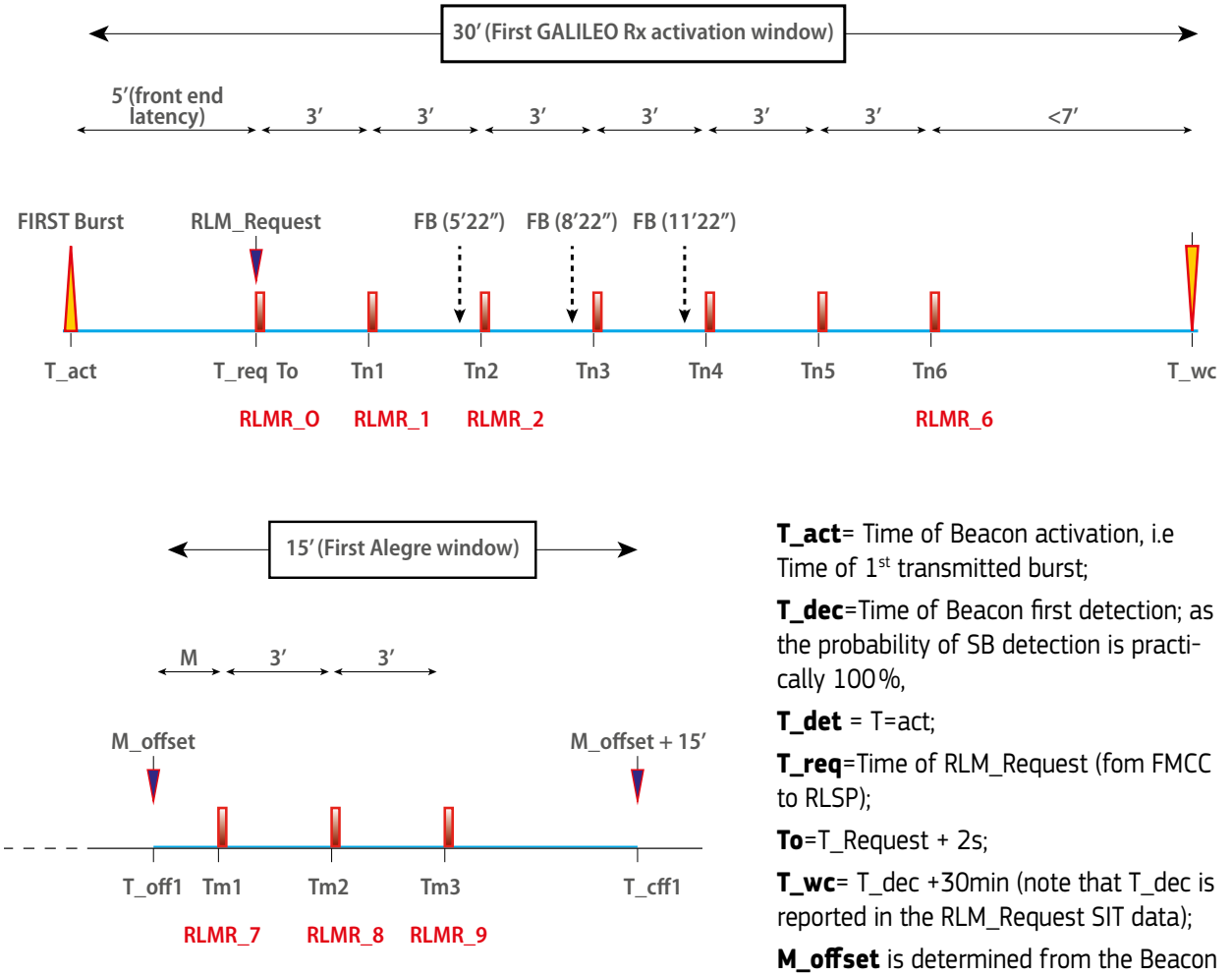
The RLSP repetition algorithm dynamically adapts the number of repetitions and interval between them as a result of different scenarios (accounting for possible Galileo system saturation, low traffic, type of service (future) or type of beacon) with the aim of maximising the RLM reception probability in the available slots.

22.... NMEA0183 [RD12].
23.... Cospas-Sarsat T.001 [RD05] or T.018 [RD13].

Each RLM repetition within a given activation window has a defined priority as a function of its RLM ID (beacon-dependent ID and repetition ID). The lower the repetition ID, the greater the priority, allowing new RLM requests to have priority over existing ones or repetitions (i.e. FIFO with priority).

Additionally, the RLSP always retransmits the same RLM (including subsequent repetitions as per the repetition strategy) two times with one minute apart to the Galileo System for reliability reasons, however only one of each will be uplinked.

Note: once activated, if an RLS capable beacon is turned off before receiving an RLM, or switched on/off momentarily (either before or after receiving a RLM),



T_act= Time of Beacon activation, i.e Time of 1st transmitted burst;

T_dec=Time of Beacon first detection; as the probability of SB detection is practically 100%,

T_det = T=act;

T_req=Time of RLM_Request (fom FMCC to RLSP);

To=T_Request + 2s;

T_wc= T_dec +30min (note that T_dec is reported in the RLM_Request SIT data);

M_offset is determined from the Beacon ID 15 HEX;

T_off1 and **T_off2** are determined from M_offset;

M= Tm1 – T_off1 (margin)-

Figure 14 - RLMR timing strategy

there is no guarantee that a RLM can be provided with RLS latency performance as described in section 5.2.2 of this document. This is because the beacon's nominal GNSS receiver operating cycle timing and the Galileo RLM Repetition timing strategy may not be synchronised.

To avoid RLS performance degradation due to non-nominal scenarios, RLS users are advised to follow the beacon manufacturer's operational manual. Also if an RLS beacon is activated, it is recommended that it should be left on until a rescue has been completed, or until advised differently by a relevant authority.

4.6 SAR/GALILEO RETURN LINK SERVICE CAPACITY

The capacity of the current infrastructure supporting the SAR/Galileo Return Link Service is considered sufficient to avoid any saturation either in the Space Segment or in the Ground Segment.

At Galileo System level (including RLSP) the capacity is constrained mainly by the following two factors:

- Maximum number of RLM accepted by the Galileo infrastructure:
  - Limited by design to 30 RLM /minute
- Maximum data rate allowed for the Return Link Service by Galileo satellites:
  - Fixed at 10 bits/s per each satellite

Based on the above factors and assuming a global distribution of beacons to which RLMs would need to be sent, a peak of 150 activated beacons can be served in the SAR antenna footprint of any one satellite. This is equivalent to a peak of approximately 450 active beacons world-wide and a mean of 50 active beacons, corresponding to a total beacon population of roughly 3 million beacons.

4.7 SAR/GALILEO RETURN LINK SERVICE COVERAGE

The SAR/Galileo Return Link Service (RLM Delivery Loop) is provided worldwide thanks to the global coverage of the Galileo constellation.

The provision on a global scale of the end-to-end RLS and the associated performance defined in section 5 depend also on the capability of the Cospas-Sarsat MEOSAR system to locate the alert distresses and relay the RLM Request (RLM_Request) to the RLSP for any beacon position on Earth. The currently deployed and commissioned MEOSAR infrastructure offers fast localisation of distress alerts (98% within 10 minutes) and therefore guarantees a low latency of the end-to-end RLS over the MEOSAR coverage (non-global) depicted in Figure 15.

In areas where MEOSAR coverage for RLS cannot be guaranteed, the End-to-End expected latency may reach higher values than those presented in Table 17, as the end user will have to rely on standard LEOSAR performance for distress location, potentially increasing on average the latency experienced at user level but still ensuring the delivery of the RLM to the user.

The coverage area over which the end-to-end RLS latency performance as defined in Table 17 is expected to be met has been assessed to cover more than 95% of any potential beacon activation point worldwide, based on historical statistics of beacon activity.

It is anticipated that low-latitude coverage will improve very quickly in the course of 2020, with the deployment and commissioning of new MEOSAR ground segment assets, particularly in South America.

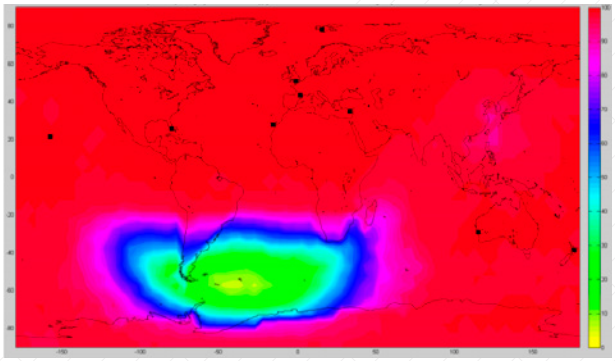


Figure 15 – Multi Burst Accuracy better than 20km (MEOSAR RLS compatible Ground Segment Q4 2019)

Users should refer to Cospas-Sarsat published information to get the latest information on MEOSAR coverage.

4.8 SAR/GALILEO RETURN LINK SERVICE ROBUSTNESS

The end-to-end Return Link Service provision is a shared effort between Cospas-Sarsat (location and routing of the RLM request), the French Mission Control Centre (interface with the RLSP) and the Galileo system including the RLSP (broadcast of the RLM) and therefore, its robustness and reliability is also shared and supported by the involved entities:

- **Cospas-Sarsat Ground Segment and FMCC**

  The Cospas-Sarsat ground segment is a system achieved by the joint contribution of different participating administrations offering a variety of interoperable ground segment components (i.e. LUTs) that reinforce and provide redundancy to an already very robust ground segment.

  The FMCC has historical uptime availability values over 99.9%[24], which is significantly above the requirements to achieve the SAR/Galileo RLS MPLs. However in the current configuration, its unavailability would result in service interruption.

- **Galileo System:**

  The Galileo Services have been designed to be independent from one another. The following list provides further details on the Galileo RLS robustness per element:

1. RLSP

   The current SAR/Galileo configuration includes a single RLSP infrastructure and site. Nonetheless high availability has been a design driver for the development of the RLSP resulting in a very reliable secure, modular, scalable and virtualised infrastructure capable of sustaining single failures on the basis that a failure in one subsystem would not result in a failure of another subsystem. In this line, it should be highlighted that the RLSP architecture is not only robust to failures but also the data management preservation is built-in.

2. The Galileo Data Dissemination Network

   The connectivity between the RLSP and Galileo is provided by the Galileo Data Dissemination Network (GDDN), a dedicated network, controlled and managed end-to-end by the Galileo Programme (no dependency on the Internet) and which gives continuous availability.

3. The Galileo Ground Mission Segment

   The Ground Mission Segment (GMS) is the subsystem within the Galileo Core Infrastructure tasked with receiving the RLMR from RLSP and injecting them into the allocated SAR fields in the Galileo signal in space. The GMS infrastructure is deployed in two different sites, which ensure a high availability for all the Galileo services.

4. The Galileo Space Segment

   The RLMs are uplinked to two separate Galileo spacecraft that are in-view of the particular beacon. From the Galileo System perspective this ensures that the RLM broadcast can be received by the beacon in distress.

4.9 SAR/GALILEO RETURN LINK SERVICE STATES

The SAR/Galileo Return Link Service States are defined as Nominal, Degraded or Severely Degraded according to the conditions detailed in the Table 8.

24.... Refer to Cospas-Sarsat QMS conforming means reporting from French Mission Control Centre.

RETURN LINK STATES	DESCRIPTION
Nominal	The SAR/Galileo Return Link Service is considered in Nominal State when **the following conditions are met:** ● The RLSP is operational ● The RLM messages are delivered in compliance with the latency and message reception probability requirements defined in 5.2
Degraded	The SAR/Galileo Return Link Service is considered in Degraded State when **one the following conditions is met:** ● The RLSP is not operational up to 7 hours cumulated over the calendar month ● The RLM messages are delivered but not in compliance with the latency requirements defined in 5.2 ● The RLM messages are not delivered up to 7 hours cumulated over the calendar month
Severely Degraded	The SAR/Galileo Return Link Service is considered in Severely Degraded State when **one of the following conditions is met:** ● The RLSP is not operational for more than 7 hours cumulated over the calendar month ● The RLM messages are not delivered for more than 7 hours cumulated over the calendar month

Table 8 - SAR/Galileo Return Link Service states

SECTION 5: SAR/GALILEO ENHANCED SERVICE MINIMUM PERFORMANCE LEVELS

This section specifies the SAR/Galileo Enhanced Service performance in terms of Minimum Performance Levels (MPL) for the Galileo-only contribution to the SAR Forward Link and Return Link Services and lists the potential conditions or constraints that are applicable for each one of them for the duration of the SAR/Galileo service provision.

In addition to the Galileo MPLs, this section also provides three Expected Values. One SAR/Galileo Forward Link MPL related to the 2km location accuracy in Table 13 and two SAR/Galileo Return Link Service MPLs linked to the End to End RLS Availability and the End to End Message Delivery Loop Latency listed in Table 17 and Table 18 respectively.

The RLS Expected Values are conditioned upon certain assumptions that are not under the control of the Galileo System (assumptions reliant on Cospas-Sarsat) and therefore are not considered as Galileo MPLs. As per the delineation of roles between Cospas-Sarsat and the Galileo Programme described in section 4.3, the Expected Values are presented for information purposes only and the assumptions and conditions under which such Expected Values can be reached are indicated and further detailed in the sections below.

5.1 SAR/GALILEO FORWARD LINK SERVICE MPL

The SAR/Galileo Forward Link Enhanced Service target MPLs are defined assuming that only Galileo is used (Ground Segment and Space Segment). However, taking advantage of the compatibility implemented in the on-board SAR instruments by other MEOSAR space segment providers (e.g. GPS/DASS and SAR/GLONASS), their contributions can be fully utilised, to increase FLS availability, coverage and overall performance.

5.1.1 FORWARD LINK SERVICE AVAILABILITY

The SAR/Galileo Forward Link Service shall be available at least 99% of the time over a period of any one year in the entire SAR/Galileo Coverage Area specified in Figure 3 and defined in Table 9.

The SAR/Galileo Forward Link Service is considered unavailable when operating in Severe Degraded mode as defined in 4.2, resulting in detection and localisation performance that is below the defined MPLs.

SAR/GALILEO FORWARD LINK SERVICE AVAILABILITY	MPL	CONDITIONS AND CONSTRAINS
Forward Link Service Availability	> 99 %	• Normalised annually. • From any point in the European SAR service coverage area defined in Figure 3. • Including planned and un-planned outages.

Table 9 - SAR/Galileo FLS Availability

5.1.2 EUROPEAN MEOLUT FACILITY AVAILABILITY

As the European MEOLUT Facilities are integral to providing FLS to users (i.e. associated MCC), their associated availability is relevant and presented in Table 10 below. The MEOLUT Local Facility availability is characterised by two parameters corresponding to the European MEOLUT operational working modes named Nominal and Degraded, and is considered Not Operational for all other cases.

SAR/GALILEO EUROPEAN MEOLUT AVAILABILITY	MPL	CONDITIONS AND CONSTRAINS
European MEOLUT Facility Availability in Nominal Mode	> 95 %	• For every MEOLUT Local Facility, when all MEOLUT Local Facility receiver chains are available and are correctly working and all the other components involved in detection, location, TOA/FOA estimation, acquisition and dissemination are also working correctly. • Normalised annually. • Including planned and un-planned outages
European MEOLUT Facility Availability in Nominal or Degraded Mode	> 97.5 %	• For every MEOLUT Local Facility in Nominal mode plus the periods when only one out of four receiver chains is not available. • Normalised annually. • Including planned and un-planned outages

Table 10 - European MEOLUT Facility Availability

5.1.3 DETECTION PERFORMANCE

The detection performance represents the probability of detecting the transmissions of 406 MHz beacons within the European SAR/Galileo Coverage and receiving a valid beacon message by the European MEOLUT (any EU/MEOLUT Facility).

The SAR/Galileo FLS detection performance MPL is presented in Table 11:

SAR/GALILEO SERVICE DETECTION PERFORMANCE	MPL	CONDITIONS AND CONSTRAINS
Detection probability after 1 transmitted burst	> 99 %	• From any point in the European SAR service coverage area defined in Figure 3 • Calculated over a calendar month

Table 11 - SAR/Galileo Service detection MPL

The MPL for detection probability after one transmitted burst for a given beacon over a period is computed as follows: **N** is the number of transmission sequences (each sequence consists of 12 bursts) during the period that produced at least one valid message after the first transmitted burst. **M** is the total number of transmission sequences for that beacon (two sequences per hour are sent by the REFBE, see section 3.3.3.1.5). The valid message detection probability after 1 burst is given by the ratio **N/M**.

5.1.4 LOCATION PERFORMANCE

The location performance is presented after 1 transmitted burst (single burst) and after 12 transmitted bursts (multi-burst) for the following MPLs:

- The Location Probability: Refers to the probability of having a localisation computed by the European MEOLUT.

- The Location Accuracy: Measures the probability that the localisation calculated by the European MEOLUT has a localisation error (difference between the real position and the one calculated by the MEOLUT) below a certain threshold defined in kilometres.

SAR/GALILEO FORWARD LINK SERVICE LOCATION PERFORMANCE	MPL	CONDITIONS AND CONSTRAINS
Location Probability after 1 transmitted burst	> 90 %	• Calculated over a calendar month • From any point in the European SAR service coverage area defined in Figure 3.
Location Probability after 12 transmitted bursts	> 98 %	
Location Accuracy after 1 transmitted burst within 5 km	> 90 %	
Location Accuracy after 12 transmitted bursts within 5 km	> 95 %	

Table 12 - SAR/Galileo Forward Link Service Location Quality MPLs

Additionally, the location accuracy with an error below 2km in multi-burst mode is also considered and monitored for information only purposes. The metric is not a Galileo MPL but an Expected Value anticipated to be over 90% applying the conditions and constrains listed in Table 12 above.

SAR/GALILEO FORWARD LINK SERVICE LOCATION PERFORMANCE	EXPECTED VALUE	CONDITIONS AND CONSTRAINS
Location Accuracy after 12 transmitted bursts within 2 km	> 90 %	• Calculated over a calendar month • From any point in the European SAR service coverage area defined in Figure 3.

Table 13 - SAR/Galileo Forward Link Service Location Accuracy within 2[km] Expected Value

The above MPLs are computed as follows:

- If there is 1 burst location between the *first emission date* and *first emission date + 180s*, consider the sequence located after 1 burst, and the linked locations will belong to the "*after 1 transmitted burst*" class.
- If there is up to 12 bursts location between the *first emission date* and *First emission date + 11* burst_rate + 22.5s*, consider the sequence located after 12 bursts, and the linked locations will belong to the "*after 12 transmitted bursts*" class.
- The location probability after K (K = 1 or 12) bursts for a beacon is equal to the ratio **N/M** with **N** number of transmitting sequences localised for this class K and **M** the total number of sequences for that beacon (2 sequences per hour, see section 3.3.3.1.5).
- The location accuracy probability within X kilometres is given by the ratio **Q/R** with **Q** the number of localisations with accuracy better than or equal to X km. **R** is the total number of computed localisations in the class (i.e. either “after 1 transmitted burst” or “after 12 transmitted bursts” classes).

5.2 SAR/GALILEO RETURN LINK SERVICE PERFORMANCE

5.2.1 RETURN LINK SERVICE AVAILABILITY

The SAR/Galileo Return Link Service is considered not available when it is operating in Severely Degraded as defined in Table 8, resulting in RLMs not transmitted or with a performance below the defined MPLs in the Table 16.

The SAR/Galileo RLS availability does not take into account any unavailability associated with Galileo external elements of the End-to-End loop (e.g. C/S MCC routing network, beacon malfunctioning, etc.) and shall be 95% for any beacon location around the globe for the first RLM received by the beacon, independently of the Galileo satellite used for broadcast.

SAR/GALILEO RETURN LINK SERVICE AVAILABILITY PERFORMANCE	MPL	CONDITIONS AND CONSTRAINS
SAR/Galileo Return Link Service Availability	> 95 %	• Accounting for the Galileo contribution only. • Normalised annually. • For an average beacon location[25] worldwide

Table 14 - SAR/Galileo Return Link Service Availability MPL

The End-to-End RLS availability Expected Value, presented in the table below, is based on the Cospas-Sarsat specification for MEOSAR/LEOSAR ground segment availability, assumed at 95%, and the Galileo RLS Availability MPL at 95%. The Expected Value (which is not a Galileo MPL) is the result of the combination of both contributor’s availabilities and shall be at least 90% for an average beacon location around the globe, independently of the system (MEO or LEO) used to determine the beacon location.

25.... Average beacon location: location(s) computed as providing average performance (figures) over all user locations.

END-TO-END RETURN LINK SERVICE AVAILABILITY PERFORMANCE	EXPECTED VALUE[26]	CONDITIONS AND CONSTRAINS
End-to-End Return Link Service Availability	> 90 %	• The End-to-End RLS Availability is the aggregation of the Galileo RLS availability specified at 95% (MPL in Table 14) and the Cospas-Sarsat MEOSAR System Performance Availability (MEOLUT and MCC availability) assumed to be 95%.

Table 15 – End-to-End Return Link Service Availability Expected Performances

5.2.2 RETURN LINK GALILEO SYSTEM MESSAGE DELIVERY LATENCY AND RECEPTION PROBABILITY PERFORMANCE

The Galileo System delivery latency and RLM Reception Probability MPLs always refer to the percentage of time that the RLS is available and are bounded by transmission of the Galileo Navigation Message in the SIS and the probability of an error free decoding of the RLM fields of the Galileo Navigation Message retrieved from the SIS at the GNSS receiver in, or connected to, the originating alert beacon.

SAR/GALILEO RETURN LINK SERVICE PERFORMANCE	MPL	CONDITIONS AND CONSTRAINS
Galileo System Message Delivery Latency within 15 min	> 99 %	• Calculated over a calendar month • Including the RLSP processing time up to Galileo satellite broadcast. • From any point in the Service coverage area • Refer to section 4.4 for the boundaries of the monitored Loop. • RLM beacon decoding is outside the perimeter of the Galileo.
Return Link Message Reception Probability	> 99 %	• Calculated over a calendar month • From any point in the Service coverage area • Refer to section 4.4 for the boundaries of the monitored Loop. • RLM beacon decoding is outside the perimeter of the Galileo.

Table 16 - SAR/Galileo Return Link Service Latency and Reception Probability MPLs

The End-to-End Return Link Service Latency (defined in section 4.4) is not a Galileo MPL but an expected value as it requires the contribution of the Cospas-Sarsat Forward Link Service. The End-to-End RLS latency is expected to be within 30 minutes, for 95% of the time, for an average beacon location[27] around the globe, when MEOSAR is the Cospas-Sarsat system used to determine the beacon location, with a time allocation of 15min for Cospas-Sarsat and 15min for the Galileo Return Link Delivery Loop. However, in case the beacon location confirmation can only be achieved using LEOSAR, the expected End-to-End latency grows significantly (up to several hours).

26.... End-to-End Return Link Service Availability is not a Galileo MPL as requires the contribution of the MEOSAR System availability (assumed at 95%) and is presented for information purposes only.

27.... Average beacon location: location(s) computed as providing average performance (figures) over all user locations.

END-TO-END RETURN LINK SERVICE PERFORMANCE	EXPECTED VALUE[28]	CONDITIONS AND CONSTRAINS
End to End Message Delivery Loop Latency within 30 min	>95 %	• The expected End-to-End RLS latency within 30min is the arithmetical sum of the Cospas-Sarsat and Galileo performance contributions with 15 minutes allocated to the Cospas-Sarsat Front End Loop and 15 minutes for the Galileo RLM Delivery Loop. • The expected value assumes a beacon position within the MEOSAR RLS service coverage. In case the beacon location confirmation can only be achieved by LEOSAR, the expected End-to-End latency will grow on average. Refer to sec. 4.7 for a further usage assumption regarding RLS coverage.

Table 17 – End-to-End Return Link Service Delivery Loop Latency Expected Performance

GALILEO SAR REPEATER AVAILABILITY	MPL	CONDITIONS AND CONSTRAINS
SAR Repeater Availability	> 95 %	• Per satellite in Service in Table 2 • Normalized annually • Including planned and un-planned outages

Table 18 - Galileo SAR Repeater Availability MPL

5.3 SAR/GALILEO SPACE SEGMENT AVAILABILITY

This section provides the MPLs associated with the availability of the Galileo SAR instruments involved in the SAR/Galileo FLS as defined in Table 2. The SAR instruments on board Galileo satellites are considered unavailable when any indication from the satellite (e.g. telemetry) is such that the SAR payload cannot be considered for the Service Provision.

28.... The End-to-End RLM Delivery Loop Latency within 30min is not a Galileo MPL but an Expected MPL as it requires the contribution from the MEOSAR System for the Location and confirmation of the Alert (assumed to be within 15min) and the Galileo System Delivery Loop as per MPL in Table 17 (15min).

ANNEX A: SAR/GALILEO ENHANCED SERVICE OPERATIONS

A.1 SAR/GALILEO DATA SERVICE PROVIDER

The SAR/Galileo Data Service Provider (hereinafter SGDSP) is the entity in charge of the coordination of the operations related to the SAR/Galileo Services. SGDSP operations are executed from the SAR/Galileo Service Centre and the following are SGDSP's main responsibilities:

1. Management and coordination of SAR/Galileo Ground Segment operations,

2. Monitoring of the SAR/Galileo Service Performance through Key Performance Indicators,

3. Management and coordination of the SAR/Galileo Ground Segment Maintenance and execution of level 2 maintenance.

In order to guarantee the SAR/Galileo Service provision, the SGDSP interfaces with various entities by means of operational interfaces, in particular with:

- The European GNSS Agency (GSA): For programme management purposes.
- The Galileo Operator: For operational aspects related to the Return Link.
- The SAR/Galileo Hosting Entities: For operational aspects related to the Forward Link and Return Link.
- The Cospas-Sarsat Operators: For the notification of planned or unplanned SAR/Galileo Service outages (Space Segment, Forward Link or Return Link) through the French Mission Control Centre via SIT605 (refer to Annex D:).

A.2 SAR/GALILEO HOSTING SITES

The SAR/Galileo Hosting Entities (HE) are both providers of the required ancillary services of the SAR/Galileo infrastructure as well as the responsible entities for the execution of the required on-site operations (L1).

The following table lists the HE for both the FL and RL services.

NAME	ELEMENT	RESPONSBILE FOR
KSAT	Spitsbergen/EU MEOLUT Local Facility and Spitsbergen/REFBE	Hosting and L1 Operations
CYTA	Larnaca/EU MEOLUT Local Facility and Larnaca/REFBE	Hosting and L1 Operations
INTA	Maspalomas/EU MEOLUT Local Facility; Maspalomas/REFBE	Hosting and L1 Operations
EDISOFT	Santa Maria/REFBE	Hosting and L1 Operations
CNES	SGSC (Including MTCF, Central Warehouse, Toulouse/REFBE, SGDSP and RLSP)	ILS, Hosting, L1 and L2 Operations

Table 19 - SAR/Galileo hosting entities

A.3 COMMUNICATION TO SAR/GALILEO SERVICE USERS

Major events are notified to the Cospas-Sarsat community by means of the SIT 605 messages over the operational MCC network. The distribution is initiated by the Galileo Programme towards SGDSP, that on its behalf will relay the notification via the French Mission Control Centre to all MEOSAR enabled Cospas-Sarsat MCCs. An example of SIT 605 is given in Annex D.

The main operational notifications that can be expected are related to Space Segment changes or Service outages:

- New Galileo SARR availability;
- SARR planned or unplanned outage;
- Forward Link or Return Link Service Severe Degradation (planned or unplanned outages).

On top of the operational notifications, the European GNSS Service Centre, as the designated interface between Galileo and the different user communities, provides relevant SAR/Galileo up-to-date information on its website.

GNSS SERVICE CENTRE WEB RESOURCES WWW.GSC-EUROPA.EU	
SAR Service Information	Under System & Service Status select "SAR Information" for SAR Repeater, REFBE and SAR Server operational status.
Open Service Constellation Information	Under System & Service Status select "Constellation Information"
Active User Notifications	Under System & Service Status select "NAGUS (Notice Advisory to Galileo Users)
Reference Constellation Orbital and Technical Parameters	Under System & Service Status select Constellation Information
Galileo Incidents Report Form	Use the HelpDesk and select "Report a Galileo Incident"
Interactive support to users	Use the HelpDesk and select "Raise your questions"
SAR Service Performance Public Reports	Under Electronic Library select "Performance Reports".
The user is reminded of the importance to access detailed Galileo satellites orbit from the SAR server accessible. Access can be requested via the Galileo Help Desk, refer to Annex E: for further details.	

Table 20 – European GNSS Service Centre website resources

ANNEX B: OBSERVED AND SIMULATED SAR/GALILEO ENHANCED SERVICE PERFORMANCES

This Annex B: provides further details on the SAR/Galileo MPL achievement, providing both performance simulation results and performance measurements as observed during the SAR/Galileo Service validation campaign.

B.1 SIMULATED SAR/GALILEO ENHANCED SERVICE PERFORMANCES

The following simulations are based on a fully deployed Galileo Walker 24/3/1 constellation for the nominal case, with up to 79 combined SAR/Galileo Space Segment and SAR/Galileo Ground Segment states (e.g. failure scenarios) taken into account, covering a total of 99.946% of all possible scenarios.

B.1.1 SIMULATED FLS DETECTION PERFORMANCE

The Forward Link Service detection performance is always above 99.9% for the single burst as displayed in Figure 16 for the European SAR/Galileo Coverage.

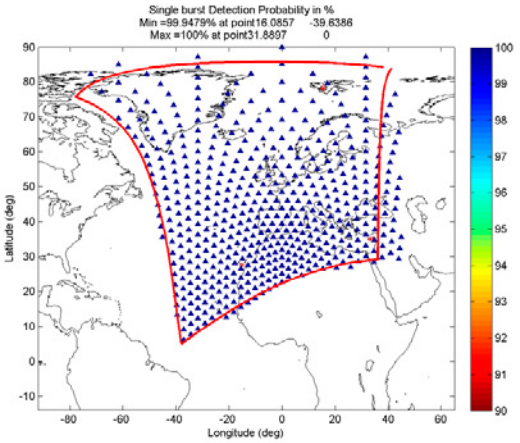


Figure 16 - Detection probability [%] for Single Burst

B.1.2 SIMULATED FLS LOCATION PERFORMANCE

The SAR/Galileo performance of the localisation is computed for the worst beacon location within the SGC area and provide the percentage of time that a 5km accuracy location can be achieved. The simulation results presented in Figure 17 and Figure 18 show compliance to the expected MPL performance for the 5km location accuracy in both single burst and multi burst after 10 minutes or 12 transmitted bursts using a 95% confidence factor.

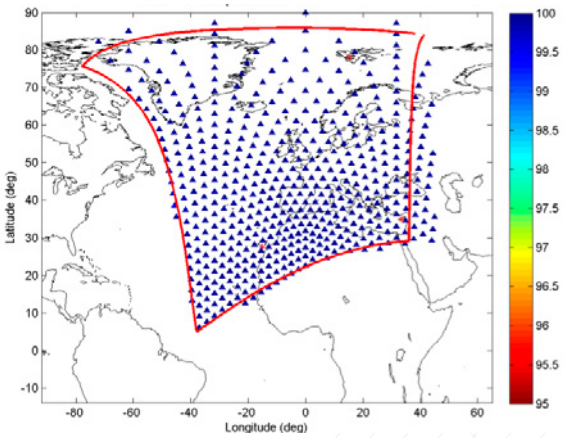


Figure 17 - Location Accuracy within 5 [km] for Multi Burst Transmissions.

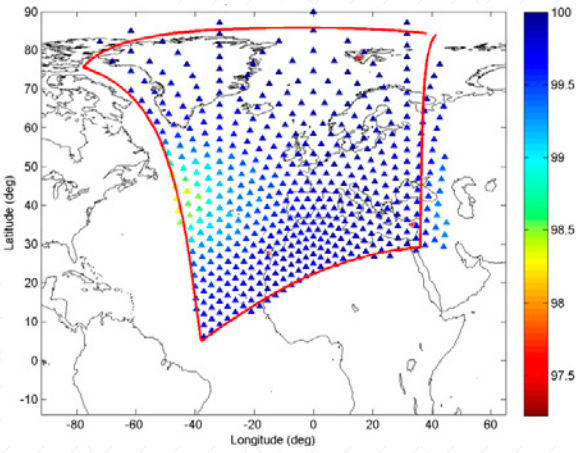


Figure 18 - Location Accuracy within 5 [km] for Single Burst Transmissions.

B.1.3 SIMULATED RLS PERFORMANCE

Simulations show that the Return Link Service Availability is not expected to be limited by any saturation at the Galileo System level (i.e. Core Infrastructure or Space Segment). For a nominal scenario, with no failure of uplink station or Galileo satellite, a service availability greater than 99% can be achieved for an average beacon location[29] worldwide.

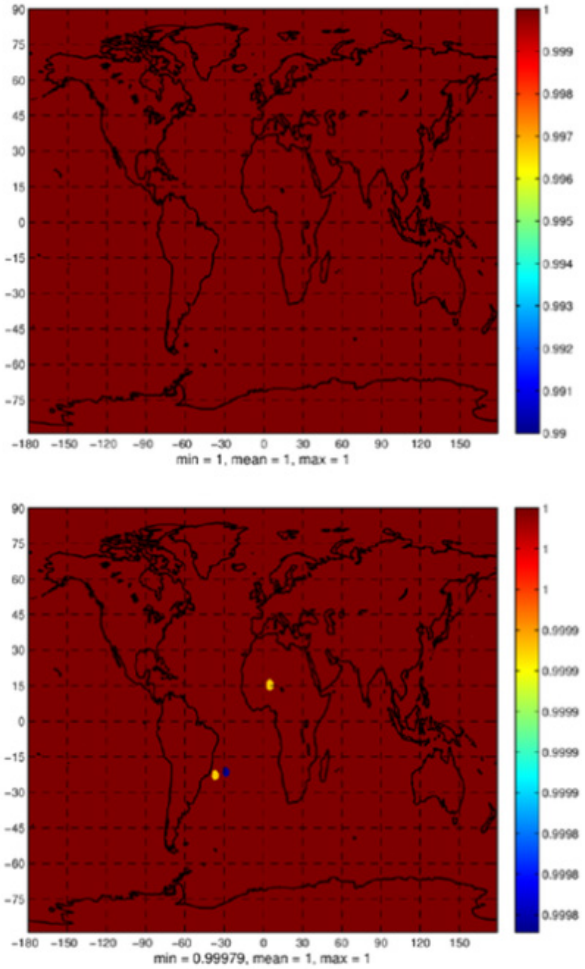


Figure 19 - RLS availability for 1(left) or 2(right) Galileo Satellites within 12min from the RLM dissemination

B.2 OBSERVED SAR/GALILEO ENHANCED SERVICE PERFORMANCES

The SAR/Galileo Forward Link MPLs as observed during the different validation campaigns are reported in the following sections. The user can refer to the European GNSS Service Centre performance reports for a quarterly up-to-date SAR/Galileo service performance report (see Table 20).

During this observed period spanning from 01/06/2019 to 30/06/2019, the configured MEOSAR Space Segment is in accordance with the Space Segment listed in Table 2 and the SGS operated in Nominal mode (e.g. three European MEOLUT Facilities sharing 12 antennas through TOA/FOA networking and with the use of coordinated tracking plans).

These results listed below are computed by the Key Performance Indicators Collection Platform (see 3.3.3.1.3) using the transmission capability of the five SAR/Galileo European Reference Beacons (see 3.3.3.1.5).

B.2.1 OBSERVED FLS DETECTION PERFORMANCE

Table 21 presents the Forward Link Service Detection Performance per Reference Beacon in Single Burst (SB) only.

PERFORMANCE PARAMETERS	TARGET VALUE	SGS KPI RESULT OVER THE PERIOD
Detection probability Single Burst (Valid message)	99%	• GAL-EU1: **100%** • GAL-EU2: **100%** • GAL-EU3: **100%** • GAL-EU4: **100%** • GAL-EU5: 1**00%**

Table 21 – FLS Detection Service Performance in SB (01/06/2019 to 30/06/2019)

29….*Average beacon location: location(s) computed as providing average performance (figures) over all user locations.*

B.2.2 OBSERVED FLS LOCATION PERFORMANCE

Table 22 presents the Forward Link Service Quality of location per Reference Beacon, including the Location Probability and Accuracy after 1 transmitted burst (SB) and after 12 transmitted bursts (Multi-Burst) during the KPI collection period (June 2019).

PERFORMANCE PARAMETERS	TARGET VALUE	SGS KPI RESULT OVER THE PERIOD
Location probability after 1 transmitted burst	90%	• GAL-EU1: **99.9%** • GAL-EU2: **100%** • GAL-EU3: **99.4%** • GAL-EU4: **99.7%** • GAL-EU5: **99.7%**
Location probability after 12 transmitted bursts	98%	• GAL-EU1: **100%** • GAL-EU2: **100%** • GAL-EU3: **99.4%** • GAL-EU4: **100%** • GAL-EU5: **99.7%**
Location accuracy within 5 km after 1 transmitted burst	90%	• GAL-EU1: **99.4%** • GAL-EU2: **99.6%** • GAL-EU3: **98.9%** • GAL-EU4: **99.5%** • GAL-EU5: **98.9%**
Location accuracy within 5 km after 12 transmitted bursts	95%	• GAL-EU1: **99.9%** • GAL-EU2: **99.6%** • GAL-EU3: **99.4%** • GAL-EU4: **99.9%** • GAL-EU5: **99.9%**

Table 22 – FLS Quality of Location Performance (01/06/2019 to 30/06/2019)

B.2.3 OBSERVED FL PERFORMANCE IN L-BAND ONLY

The SAR/Galileo Performance using Galileo-only L-Band MEOSAR instruments are presented in Table 23. The results below are obtained are for all five REFBE, the French simulator and the ESTEC simulator during a period of 48 hours in February 2019.

PERFORMANCE PARAMETERS	MPL	OBTAINED RESULTS
Detection probability Valid Message in Single Burst	90%	• GAL-EU1: **100%** • GAL-EU2: **100%** • GAL-EU3: **100%** • GAL-EU4: **100%** • GAL-EU5: **100%**
Location probability after 1 transmitted burst	98%	• GAL-EU1: **99.6%** • GAL-EU2: **99.4%** • GAL-EU3: **99.8%** • GAL-EU4: **99.9%** • GAL-EU5: **99.7%**
Location probability after 12 transmitted bursts	90%	• GAL-EU1: **100%** • GAL-EU2: **100%** • GAL-EU3: **100%** • GAL-EU4: **100%** • GAL-EU5: **100%**
Location accuracy within 5 km after 1 transmitted burst	95%	• GAL-EU1: **98.1%** • GAL-EU2: **93.2%** • GAL-EU3: **95.5%** • GAL-EU4: **95.9%** • GAL-EU5: **98.0%**
Location accuracy within 5 km after 12 transmitted bursts	90%	• GAL-EU1: **99.7%** • GAL-EU2: **96.7%** • GAL-EU3: **98.5%** • GAL-EU4: **97.9%** • GAL-EU5: **99.7%**

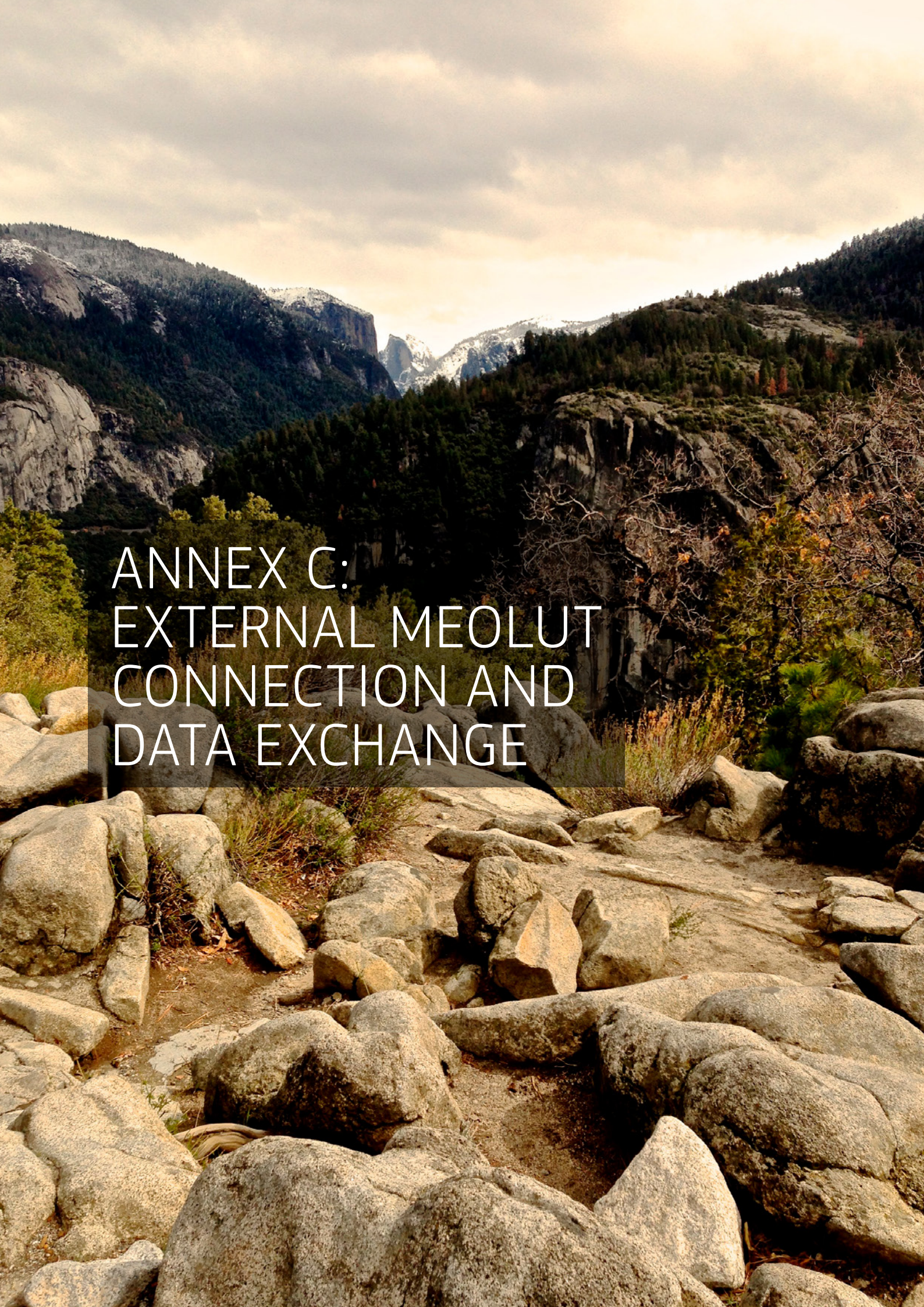
Table 23 – Galileo-Only FLS Detection and Location Performance (26/02/2019 – 27/02/2019)

B.2.4 RETURN LINK PERFORMANCE

Table 24 presents the Return Link Service performance obtained using the KPI tool and the RLSP infrastructure for the generation of synthetic RLMs intended for the five European Reference Beacons during the RLS dedicated KPI collection period from 02/08/2019 to the 18/08/2019.

SAR/GALILEO RETURN LINK SERVICE PERFORMANCE	MPL	OBTAINED RESULTS
SAR/Galileo Return Link Service Availability	95%	**100%**
Return Link Message Reception Probability	99%	**100%**
Galileo System Message Delivery Latency within 15 min	99%	**100%** (median latency of 0.95min all beacons considered)

Table 24 - RLS Observed Performances during KPI collection (02/08/2019 – 18/08/2019)



ANNEX C: EXTERNAL MEOLUT CONNECTION AND DATA EXCHANGE

The SAR/Galileo Ground Segment offers the possibility to connect an external MEOLUT to the current system in order to gain access to its TOA/FOA data. Nevertheless, ad hoc agreements and conditions have to be established and a set of pre-requisites fulfilled in order to enable the connectivity.

In particular, the External MEOLUT must comply with Cospas-Sarsat specifications in terms of file data format (refer to RD1) and potential networking architectures (refer to RD8). The External MEOLUT must also have a dedicated network access through a secure VPN link to connect to the designated SGS interface (MTCF or European MEOLUT Facility).

Additionally, depending on the type of External MEOLUT and architecture, the SAR/Galileo Ground Segment can also offer the exchange and coordination of tracking plans via dedicated protocols.

ANNEX D: SAMPLE OF NARRATIVE MESSAGE SIT 605

The below is a sample of a narrative message SIT 605 with conditions and format compliant to the Cospas-Sarsat directives[30] that should be used for any Galileo communications to the Cospas-Sarsat system.

....5....1....5....2....5....3....5....4....5....5....5....6....5..69

/50227 00000/2270/14 322 1350

/605/2240

/ADDITION OF GSAT NOTIFICATION MESSAGE

DATE: 0900 UTC, 20 SEPT 2019

FROM: FMCC ON BEHALF OF SGDSP

TO ALL MCCS MEO

SUBJECT: SAR/GALILEO SPACE SEGMENT CONFIGURATION CHANGE.

A. OBJECTIVE: PLANNED OUTAGE OF GSAT 0214.

B. DESCRIPTION: TODAY, STARTING FROM 15:00 UTC,

GSAT 0214 (C/S ID 405) WILL BE ADDED TO THE SGS CONFIGURATION.

SUCCESSFUL INTEGRATION WILL BE NOTIFIED VIA SIT 605 LATER ON.

C.POINT OF CONTACT: SGDSP

SGDSP_OPS@CNES.FR

+33 561 2xx xxx

BEST REGARDS

FMCC

QQQQQ

/LASSIT

/ENDMSG

30.... SIT fields are specified in [RD1]

ANNEX E: SAR/GALILEO SERVER USER MANUAL AND ACCESS PROCEDURE

E.1 USER INTERFACE

E.1.1 USER ACCESS REQUEST PROCEDURE

Access to the SAR Server is restricted to accredited users only. In order to get these credentials, the SAR Server users must access the GSC web portal and, after registration, must request, by using the Helpdesk service, a user and password for accessing the server. An email will be received by the requestor stating that the request is being processed.

Note that all user accounts must be related to a physical person (as requested in the form below) who will be responsible for the proper use of the account. During the registration process, the user will have to provide a signed version of a Non-Disclosure Undertaking (NDU) on the server connection details (SAR server IP address, user and password) and the proper use of the server account (data reading purposes only).

Users must follow these steps in order to request a user account in the SAR Server:

If the User does not already have a GSC web portal account, this must first be requested at the following address: www.gsc-europa.eu/user/register

1. Login to the GSC web portal and access the Galileo Helpdesk: http://gsc-europa.eu/helpdesk
2. Fill in the helpdesk form, as specified in Table 25,
3. The User will receive an email acknowledging the access request. In order to proceed with the request, the user will be requested to sign an NDU form. Note that, if the User is represented by somebody else, the signatory must also enclose a document providing his/her empowerment to sign on behalf of the User.

   The signed copy of the NDU must be sent by the user to the email address helpdesk@gsc-europa.eu (subject: NDU for SAR server access) in order to proceed with the registration process.
4. If the user request is approved, the SAR server login credentials will be provided by email. And finally the server IP address and user password will be provided by telephone on the number provided during the registration process.

Note that all user passwords will expire after 6 months and renewed passwords will be provided by the GSC to the user before the expiration date. Users will be contacted in advance before the password expiration to receive a new password.

The Helpdesk form to be filled in is displayed in Figure 20 below:

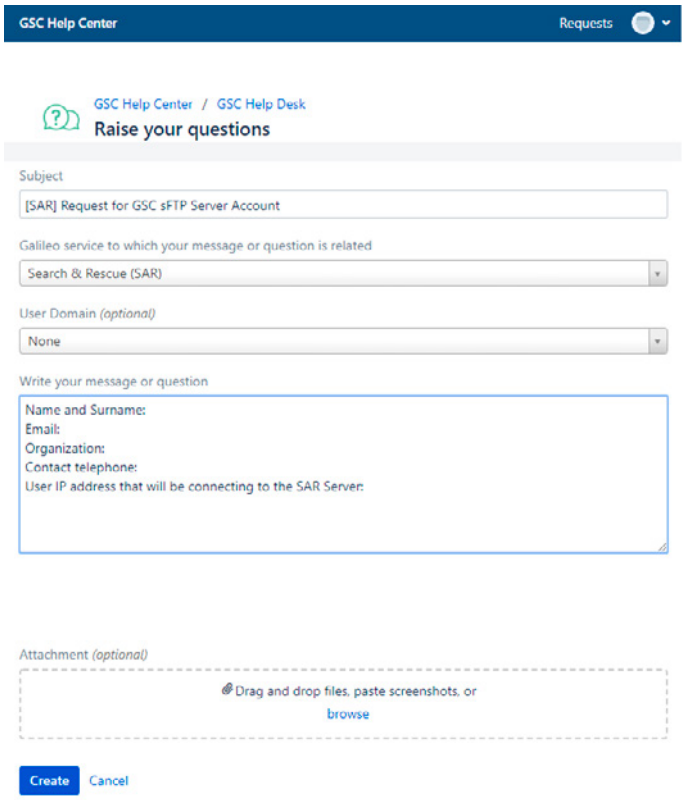


Figure 20 - SAR Server - User Access Request

Note that it is mandatory to fill in the following fields as follows:

SAR USER REQUEST FORM EXPLANATION	
Subject	Please enter: "[SAR] Request for GSC sFTP server account"
Galileo service to which your message or question is related:	Select: "Search & Rescue (SAR)"
User Domain:	(optional)
Write your message or question	The following fields must be provided in the field **"Write your message or question"**: • Name and surname, • Email, • Organization. • Contact telephone. • User IP address to be used for the connection to the SAR server[31].
Attachment	(optional)

Table 25 - SAR Server User Registration form content

E.1.2 SERVICE NOTIFICATION

In case of planned or unplanned outage of the SAR server, service notifications will be sent to the SAR Server users.

For planned events, the notification is sent at least 1 day before the start time of the outage. For unplanned events, the notification is sent not more than 4 working days after the detection of the event.

This service will be implemented by means of an email communication to the address provided during the registration process.

The interface is an email with the following format:

- Subject: [SAR][GSC][SERVICE NOTIFICATION] "Free text with details on the service notification"
- From: helpdesk@gsc-europa.eu
- To: SAR Server Users email addresses
- CC: galileo_operations@gsa.europa.eu
- Content: information on the service notification: description, impact, start and end times.

It is not expected that SAR Users provide any answer to the Service Notification.

E.1.3 SAR/GALILEO SERVICE INVESTIGATION REQUEST

SAR Server users can submit an investigation request (IR) about the SAR orbital products service provision (e.g missing products, wrong product content, connection problems with the server...). For this, the user must go to the GSC web portal and send their IR using the Helpdesk form following the guidelines detailed below. This interface should not be addressed for other requests than those related to the SAR Server orbital product service provision.

For a SAR Server user, to submit an investigation request it is needed to fill in the www.gsc-europa.eu/helpdesk as follows:

- **Subject:** [GSC][IR] "title"; Please note that "title" field should reflect the scope of the Investigation Request, as provided by the user.
- **Galileo service to which your message or question is related:** Search & Rescue (SAR)
- Fill in the "Write your message or question" field following the structure in Table 28 below:

FIELD NAME	DESCRIPTION
Requester Name	Name of the requester
Requester Contacts	Email of the requester
Requester Organisation	Name of the IR requester organisation
Title	Title of the IR
Submittal date	Date of IR submission
Urgency	("Urgent" or "Not Urgent")
Affected Products	(If applicable)
Observed Start/End Dates and Times	Event start and finish dates
Description	Detailed description

Table 26 - SAR Community Investigation Request

31.... For security reasons, the SAR server will reject connections from non-authorized IP addresses

E.2 ORBITAL PRODUCTS

Via this interface, SAR users can retrieve the following information and data by means of the sFTP protocol:

- Galileo orbital products.
- MD5 hash files associated with each orbital product.
- Validity log file and welcome message.
- Additional SAR Server information.

In particular, the different Galileo orbital products with their respective file naming convention, format and nominal refresh rate are provided in the following table

PRODUCT	FILE NAMING CONVENTION	FILE CONTENT	FORMAT	NOMINAL REFRESH RATE
RINEX Navigation Message (NAVRE)	NAVRE_YYYYMMDDhhmmss_TGVFIYYDDDh_S.yyl.gz	Ephemeris data for Galileo satellites[32].	Rinex 3.0	Hourly
Predicted Satellite Orbits (PRDOB)	PRDOB_YYYYMMDDhhmmss_TGVFIYYDDDh_S.sp3.gz	Galileo predicted orbit for Galileo satellites.	Sp3	Hourly
Predicted Satellite Clock (PSATC)	PSATC_YYYYMMDDhhmmss_TGVFIYYDDDh_S.clk.gz	Galileo predicted clock file for Galileo satellites.	Rinex 3.0 (clock extensions)	Hourly
Almanac (INF_AlmanacData)	INF_AlmanacData_YYYYMMDDhhmmss_TGVFIYYDDDh_S.xml.gz	Almanac data for Galileo satellites[30].	XML	Hourly
Ephemeris Data (NAV_EphemToRlsp)	NAV_EphemToRlsp_YYYYMMDDhhmmss_TGVFIYYDDDh_SNN.xml.gz	Includes the following data for the Galileo constellation: - Ephemeris data - GST-UTC conversion parameters - Week Number and IOD of the ephemeris data (IODE)	XML	Hourly

Table 27 - SAR Server orbital products

The meaning of the acronyms used in the file naming convention is as follows:

- "DDD" stands for Day Of the calendar Year (DOY). Day of year ranges from 1 to 365 (366 for leap years).
- "YYYYMMDDhhmmss" refers to the start of the product validity time (it corresponds to the start of the prediction arc for the data contained in the file):
  - YYYY: 4-digit year
  - MM: 2-digit month
  - DD: 2-digit day
  - hh: 2-digit hour
  - mm: 2-digit minute
  - ss: 2-digit second

32.... Note that INF_AlmanacData does not correspond to the navigation messages broadcasted in the Galileo SIS.

- "yyl" stands for the data product year plus "l" character. E.g. for 2016: "16l".
- "TGVFIYYDDDh":
  - I values can be either 1 or 2. Not relevant for the content of the file.
  - YYDDDh: it corresponds to the start date of data set used for product generation.
    - YY: 2-digit year (16 for 2016),
    - DDD: Day Of the calendar Year (DOY).
    - h: An hour code (A=00:00, B=01:00, C=02:00 ...).
- "S" stands for Service identifier (F for F/NAV, I for I/NAV).
- "NN" stands for the data set identifier.

Each orbital product listed in Table 27 and available in the SAR server will be accompanied by a unique hash file computed following RFC 1321 norm and named as its associated product but with "md5" extension. The md5 file is intended for the SAR Server user to verify that the product was not corrupted during the user´s retrieval process.

E.2.1 SAR SERVER FOLDERS STRUCTURE

The SAR Server products are structured in a folders tree, containing all the products and additional information related to these products. There are two different types of folders:

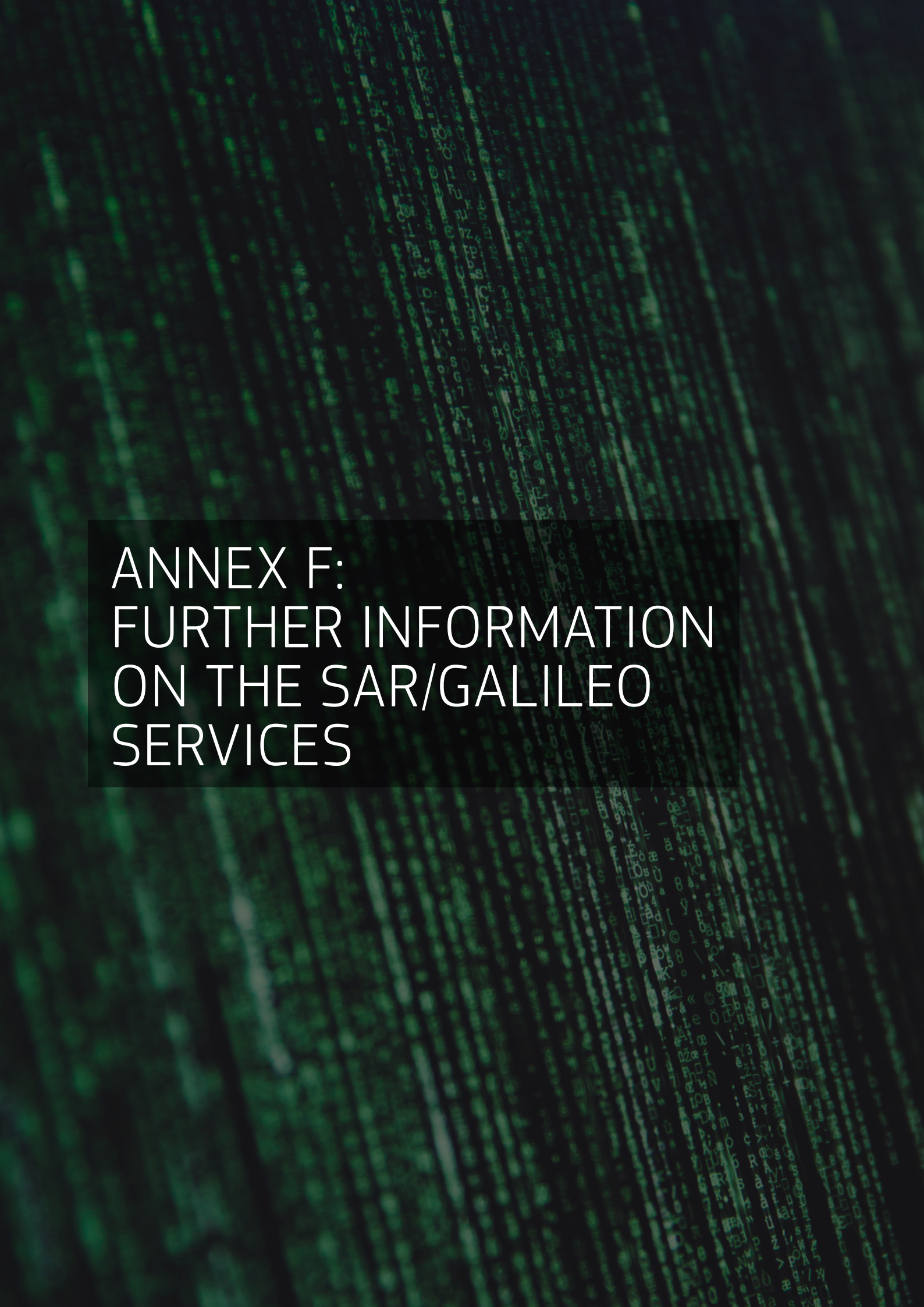
1. **"last" folder**: This folder contains the last available version of each product type according to the start of the product validity time.
2. **YYYY/DOY folders**: The YYYY/DOY folders are archives for the GSC products according to the SAR SERVER storage rules. They contain sub-folders per Day of Year (YYYY/DOY).

E.2.2 SATELLITE NAMING CONVENTION TABLE

The following table contains the identification numbers of the different Galileo satellites that should be used by the SAR Server Users to correctly process the products.

SATELLITE CODE	CCSDS ID		SISICD SV ID	COSPAS-SARSAT ID	IGS ID	NORAD ID	ORBITAL SLOT
	HEX	DEC					
GSAT-0101	3A5	933	11	411	E11	37846	B5
GSAT-0102	3A6	934	12	412	E12	37847	B6
GSAT-0103	3A7	935	19	419	E19	38857	C4
GSAT-0104	316	790	20	420	E20	38858	C5
GSAT-0201	261	609	18	418	E18	40128	N/A
GSAT-0202	262	610	14	414	E14	40129	N/A
GSAT-0203	263	611	26	426	E26	40544	B8
GSAT-0204	264	612	22	422	E22	40545	B3
GSAT-0205	265	613	24	424	E24	40889	A8
GSAT-0206	266	614	30	430	E30	40890	A5
GSAT-0207	267	615	07	407	E07	41859	C6
GSAT-0208	268	616	08	408	E08	41175	C7
GSAT-0209	269	617	09	409	E09	41174	C2
GSAT-0210	26A	618	01	401	E01	41550	A2
GSAT-0211	26B	619	02	402	E02	41549	A6
GSAT-0212	26C	620	03	403	E03	41860	C8
GSAT-0213	26D	621	04	404	E04	41861	C3
GSAT-0214	26E	622	05	405	E05	41862	C1
GSAT-0215	2C5	709	21	421	E21	43055	A3
GSAT-0216	2C6	710	25	425	E25	43056	A7
GSAT-0217	2C7	711	27	427	E27	43057	A4
GSAT-0218	2C8	712	31	431	E31	43058	A1
GSAT-0219	2C9	713	36	436	E36	43566	B4
GSAT-0220	2C0	704	13	413	E13	43567	B1
GSAT-0221	2C1	705	15	415	E15	43564	B2
GSAT-0222	2C2	706	33	433	E33	43565	B7

Table 28 - Galileo Satellite Identification Table



ANNEX F: FURTHER INFORMATION ON THE SAR/GALILEO SERVICES

F.1 SAR/GALILEO POINTS OF CONTACT

Users wishing to get in contact are invited to send their inquiries to the following entities:

- For general and programmatic questions on the SAR/Galileo Services, users can directly address them through the European GNSS Service Centre Help Desk at: www.gsc-europa.eu/helpdesk
- For technical questions related to SAR/Galileo performance or interfaces, users can directly address the SAR/Galileo Data Service Provider at the following email address: L-sgdsp-info@cnes.fr

F.2 SAR/GALILEO RETURN LINK BEACON PURCHASE LIMITATIONS

The SAR/Galileo Return Link is provided globally thanks to the joint LEOSAR and MEOSAR effort (performance limitations described in 4.7), but the Cospas-Sarsat Ground Segment has not yet reached full RLS maturity. In order to guarantee a timely delivery of the RLS distress alerts to relevant SAR national administrations, some restrictions have been introduced to the countries that permit the sale of RLS-enabled beacons during the Return Link Initial Operations Capability (IOC) phase.

The list of countries authorised to sell RLS beacons is maintained by Cospas-Sarsat and can be consulted at their website[33].

Even though RLS beacons can only be purchased in a limited number of countries, they can be used anywhere in the world, just like any other non RLS enabled Cospas-Sarsat 406 MHz beacon. These restrictions do not limit the usage or performance of the RLS-enabled beacons in any way.

F.3 SAR/GALILEO RETURN LINK IDENTITY

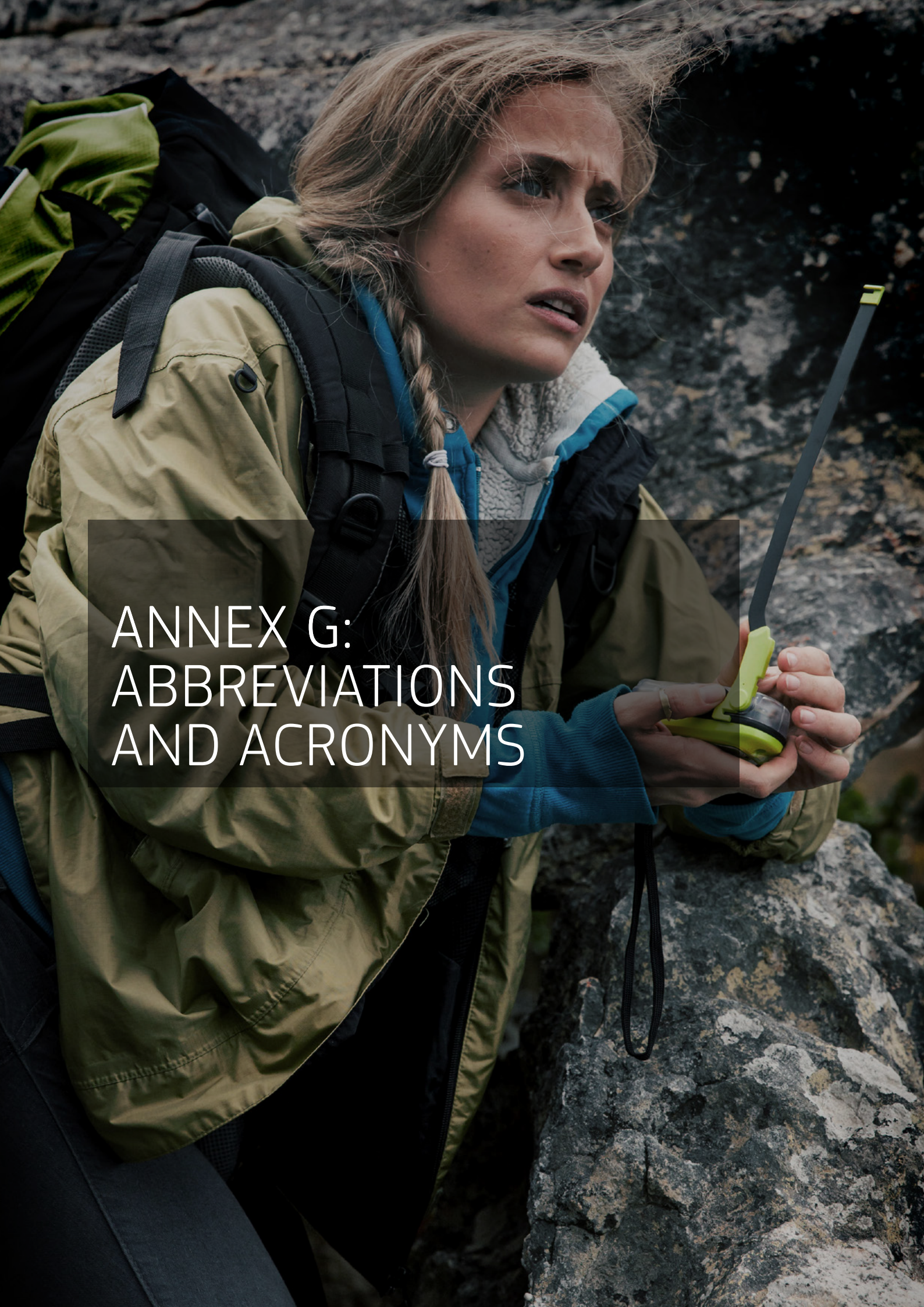
The SAR/Galileo Return Link marking and visual identity is a recognisable and coherent image univocally identifying the SAR/Galileo Return Link functionality.

Beacon manufacturers wishing to identify their Cospas-Sarsat Type-Approved RLS-enabled beacons are encourage to make use of the RLS marking below[34].

Figure 21 - SAR/GALILEO RETURN LINK VISUAL IDENTITY

33.... Refer to https://www.cospas-sarsat.int/en/beacon-ownership/rls-enabled-beacon-purchase

34.... High-resolution graphics can be provided upon request, follow instructions provided in section F.1



ANNEX G: ABBREVIATIONS AND ACRONYMS

ABBREVIATION	DEFINITION
ALC	Automatic Level Control
C/S	Cospas-Sarsat
CALBE	Calibration Beacon
CNES	Centre National d'Études Spatiales (French National Space Agency)
CYMCC	Cypriot Cospas-Sarsat Mission Control Centre
DASS	Distress Alerting Satellite System (based on GPS satellites)
EC	European Commission
EGNSS	European GNSS
EDDN	External Data Distribution Network
EIRP	Equivalent isotropic radiated power
ELT	Emergency Locator Transmitter
ELT(DT)	ELT Distress Tracking
EPIRB	Emergency Position-Indicating Radio Beacon
EU	European Union
FGM	Fix Gain Mode
FIFO	First in First Out
FL	Forward Link
FLS	FL Service
FLAM	Forward Link Alert Message
FMCC	French MCC
FOA	Frequency Of Arrival
FOC	Full Operational Capability
GCC	Galileo Control Centre
GCS	Galileo Control Segment
GEANT	Gigabit European Advanced Network Technology
GEO	Geostationary Earth Orbit
GEOSAR	GEO Search and Rescue (Satellite System)
GDDN	Galileo Data Distribution Network
GLONASS	Globalnaya Navigazionnaya Sputnikovaya Sistema
GMS	Galileo Mission Segment
GNSS	Global Navigation Satellite System
GPS	Navstar Global Positioning System (United States)
GSA	European GNSS Agency
GSC	European GNSS Service Centre
GSMC	Galileo Security Monitoring Centre
GSS	Galileo Sensor Stations
ICD	Interface Control Document
IEC	International Electrotechnical Commission
ILS	Integrated Logistics Support
IOC	Initial Operational Capability

ABBREVIATION	DEFINITION
IOV	In Orbit Validation
KCP	Key performance indicators Collection Platform (hosted by MTCF)
KPI	Key Performance Indicator
LAN	Local Area Network
LEO	Low Earth Orbit
LEOSAR	LEO Search And Rescue (satellite system)
LUT	Local User Terminal
MCC	Mission Control Centre
MEO	Medium Earth Orbit
MEOLUT	Medium Earth Orbit Local User Terminal
MEOSAR	MEO Search And Rescue
MPL	Minimum Performance Level
MTCF	MEOLUT Tracking Coordination Facility
NAGU	Notice Advisory to Galileo Users
NMCC	Norwegian Cospas-Sarsat Mission Control Centre
NREN	National Research and Education Network
PLB	Personal Locator Beacon
RCC	Rescue Coordination Centre
REFBE	Reference Beacon
RL	Return Link
RF	Radio Frequency
RLM	Return Link Message
RLMR	RLM Request from RLSP
RLM_Request	RLM Request from C/S
RLS	Return Link Service
RLSP	Return Link Service Provider
SAR	Search And Rescue
SARN	SAR/Galileo Network (for data distribution)
SART	SAR Transponder
SARR	SAR Repeater
SGDSP	SAR/Galileo Data Service Provider
SGS	SAR/Galileo Ground Segment
SGSC	SAR/Galileo Service Centre
SDD	Service Definition Document
SIS	(Galileo) Signal In Space
SIT	Subject Indicator Type
SPMCC	Spanish Cospas-Sarsat Mission Control Centre
TTC	Telemetry, Tracking & Control
TOA/FOA	Time Of Arrival / Frequency of Arrival
ULS	(Galileo) Uplink Station
USSR	Union of Soviet Socialist Republics
XML	eXtensible Markup Language

Table 29 – Abbreviations and Acronyms

NOTES