European Commission

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SAR/Galileo Service Status

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ICG, Vienna, 6 June 2016

Outline

- SAR/Galileo Service Definition
- SAR/Galileo Forward Link Service Overview
  - Infrastructure
  - Performances
- SAR/Galileo Return Link Service Overview
  - Infrastructure
  - Standardization
  - Beacon impacts
- SAR/Galileo Service Roadmap

- **The Search and Rescue (SAR) Service of Galileo consists of two distinct elements:**
  - **<u>The Forward Link Alert Service</u>:** Contribution to the *Cospas-Sarsat* MEOSAR Programme:
    - Contributes to MEOSAR Global coverage by providing space and ground segment contribution
    - Contributes to Cospas-Sarsat system by detection/localization data of 406MHz distress beacons
  - **<u>The Return Link Alert Service:</u>** it provides the users in distress an acknowledgment message informing them that the alert has been detected and located

SAR/Galileo Forward Link Service - 1

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SAR/Galileo Forward Link Service

Contribution to Cospas-Sarsat MEOSAR Programme with an operational infrastructure qualified according to Cospas-Sarsat Standards

Ground Segment Component:
3 EU MEOLUTs in Network

- EU/Maspalomas MEOLUT
- EU/Spitzbergen MEOLUT
- EU/Larnaca MEOLUT

- MEOLUT Tracking Coordination Facility in Toulouse

Space Segment Component:
SAR Repeaters on board each Galileo satellite:

- 2 IOV SARR (No SARR on IOV FM1/FM2)
- 22 FOC SARR (in deployment)

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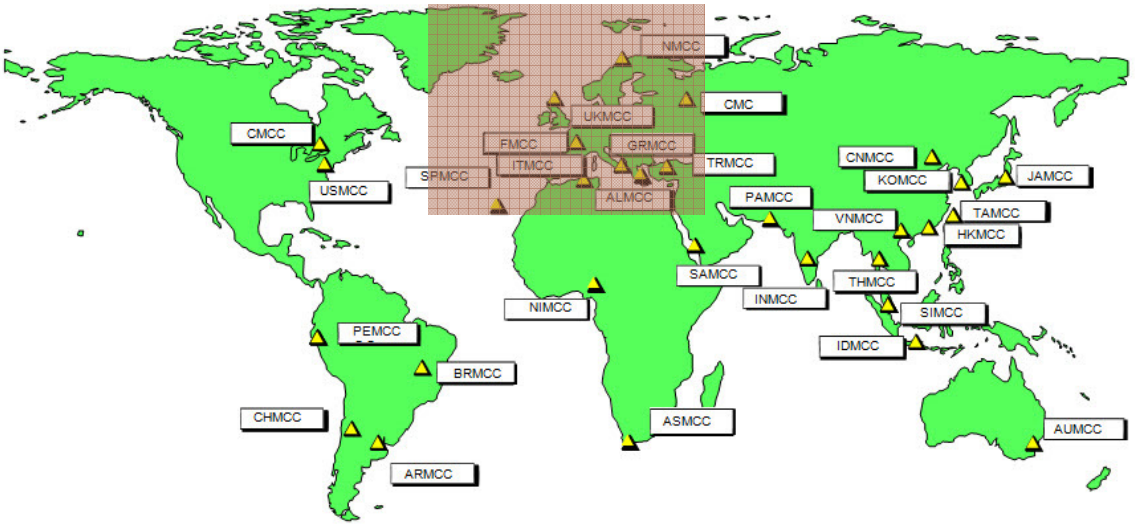
★ SAR/Galileo Forward Link Service Users:

- ★ All Cospas-Sarsat MEOLUTs: MEOLUTs are directly receiving the distress signals relayed by the SARR
- ★ Cospas-Sarsat MCC: All the MCCs which are at least partially within the European SAR Coverage Area of Galileo
- ★ Indirectly: all beacon owners



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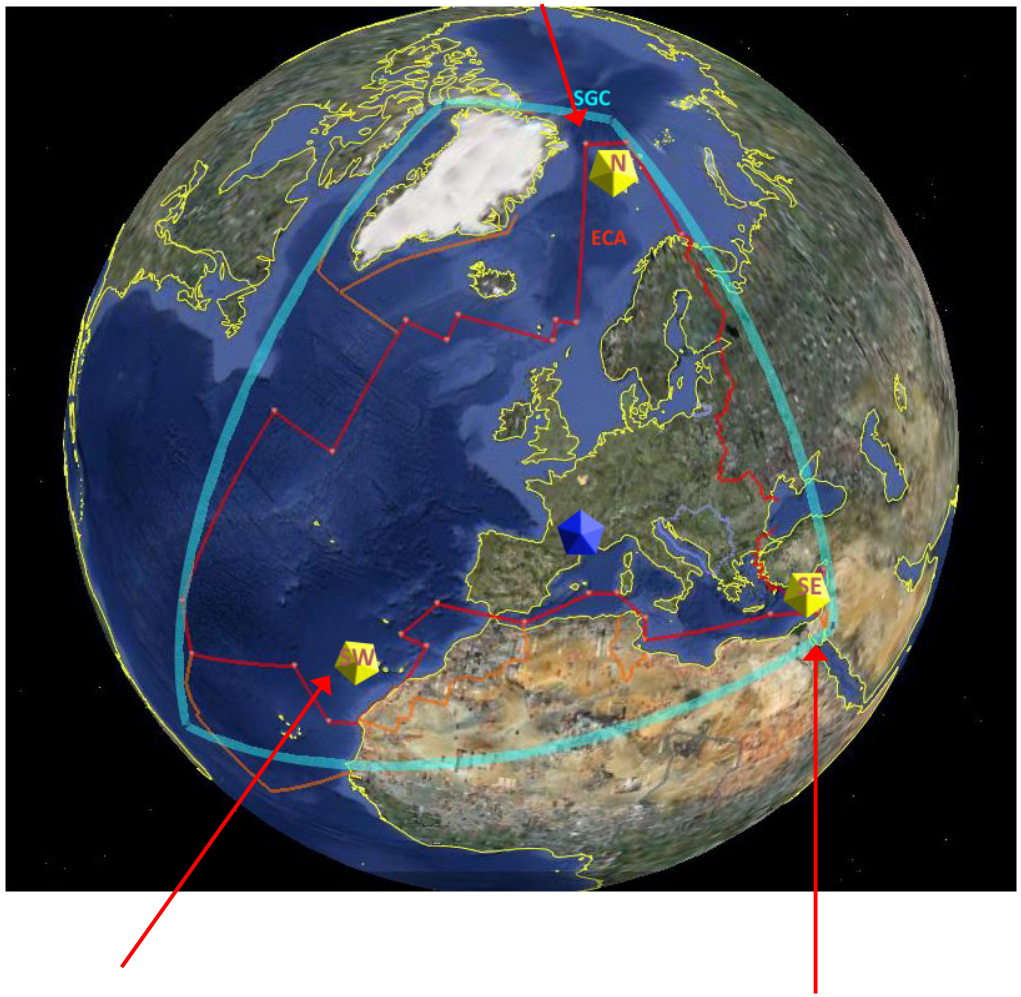
- **3 MEOLUTs to cover SAR areas over geographical Europe**
  1. **EU/ MASPALOMAS MEOLUT**
  2. **EU/LARNACA MEOLUT**
  3. **EU/SPITZBERGEN MEOLUT**
- **Infrastructure compliant with Cospas-Sarsat Standard**


COSPAS-SARSAT MEOLUT
COMMISSIONING STANDARD

C/S T.020
Issue 1
December 2015

COSPAS SARSAT



EU/MASPALOMAS MEOLUT

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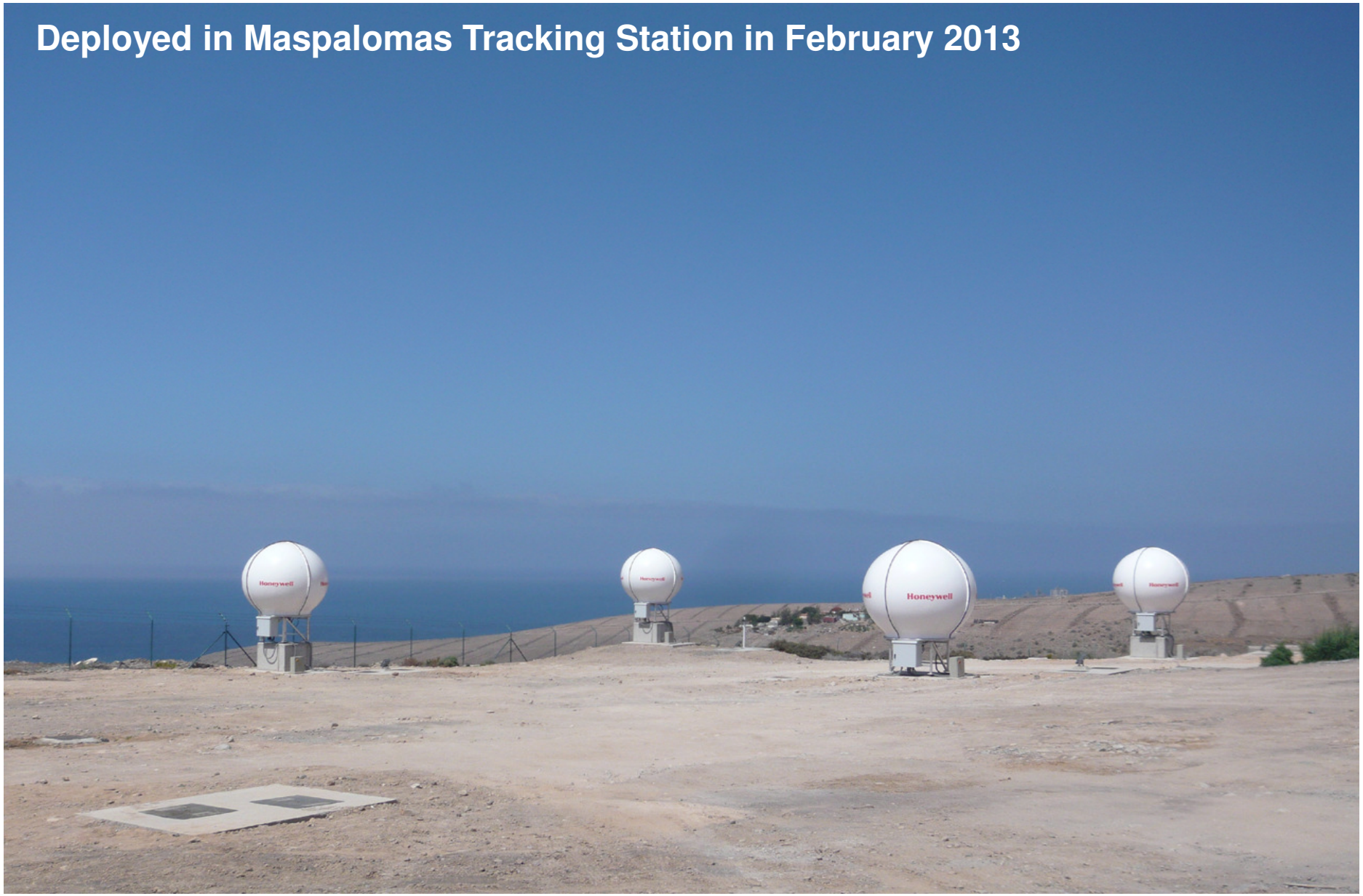
Deployed in Maspalomas Tracking Station in February 2013



EU/LARNACA MEOLUT

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EU/SPITZBERGEN MEOLUT

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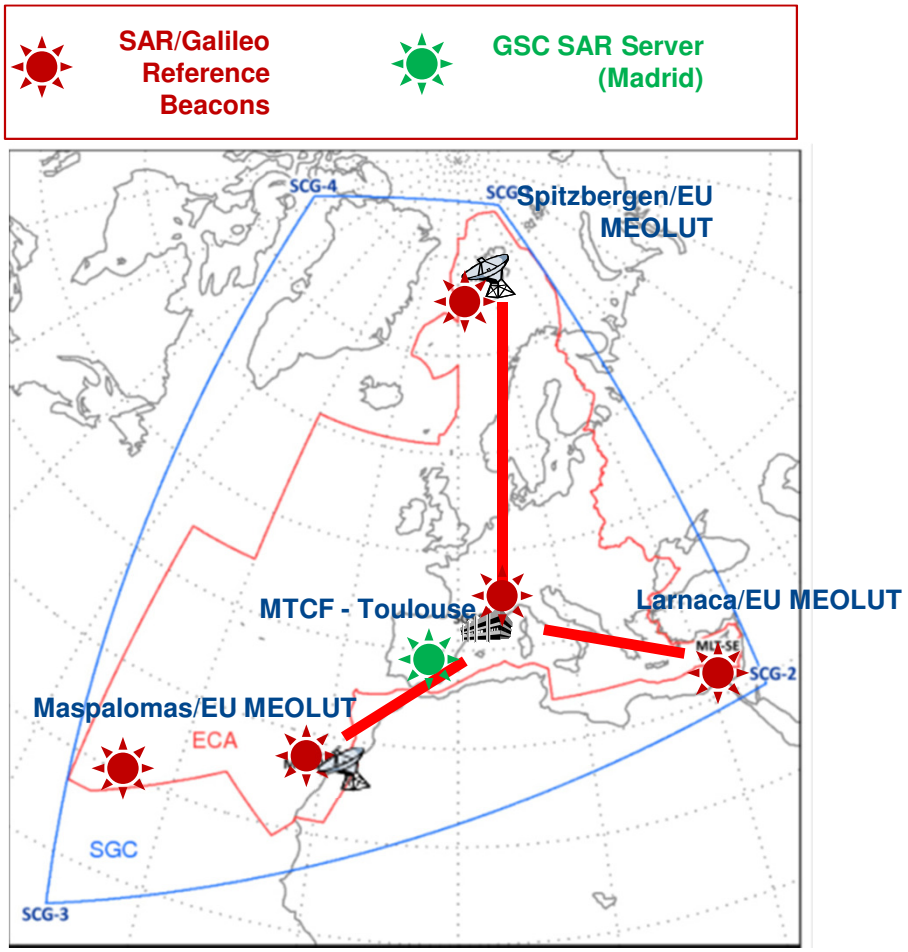
Deployed in Svalsat Station in November 2013

- ★ **MEOLUT Tracking Coordination Facility (MTCF)**
  - ★Coordinates the tracking of the MEOLUTs to improve the performances
  - ★Allow exchange of data with other MEOLUTs
- ★ **5 MEOSAR Reference Beacons**
  - ★Monitoring the performances of the services
- ★ **GSC SAR Server**
  - ★Distribution of orbit data to MEOSAR users



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- ★ **Search and Rescue Repeaters on board each Galileo satellite***
- ★ **Main Characteristics:**
  - ★ **Reception: RHCP in uplink frequency 406.05 MHz, G/T ~ -13 dB/K**
  - ★ **Transmission: LHCP in downlink frequency of 1544.1 MHz, EIRP ~17dBW**
  - ★ **Several operating modes**
    - ★ **Narrow Band (50kHz) / Wideband (90kHz)**
    - ★ **Automatic Level Control (ALC) / Fixed Gain Mode (FGM)**
    - ★ **Default Mode: ALC 90kHz**
- ★ **The SAR Repeaters are being commissioned following Cospas-Sarsat Standard**
- ★ **Full description provided under Cospas-Sarsat T.16 Document**

*** (except IOV FM1/FM2)**

SAR/Galileo Forward Link Service Space Segment

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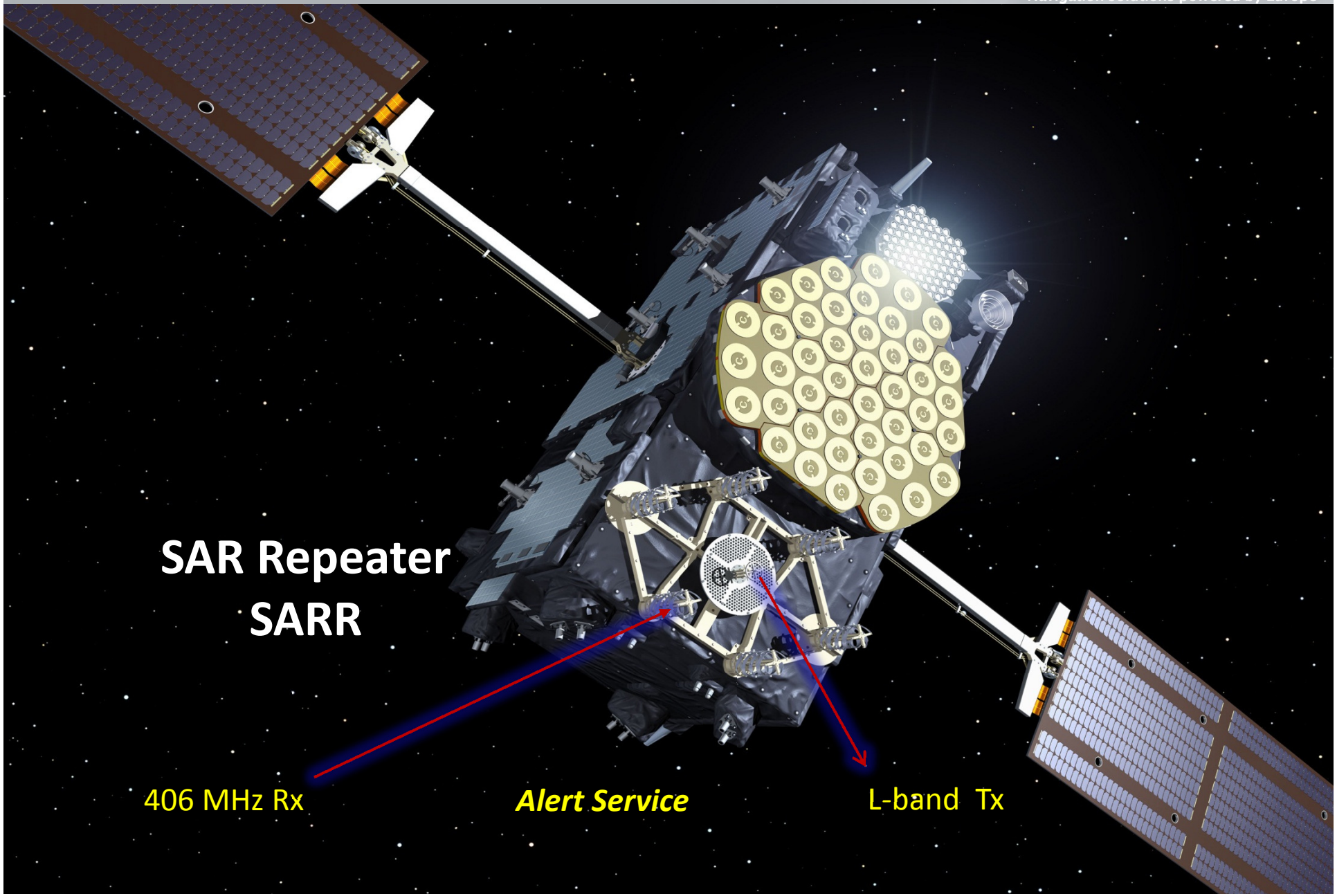

SAR/Galileo Service Space Segment Deployment

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Cospas-Sarsat Satellite ID	GALILEO Satellite Name	Orbital Slot	Launch ID	Launch Date	Availability Date for SAR	CS Commissioning Report
411	GSAT 0101	**B5**	L1	21 October 2011	2012	No SARR; only RLS
412	GSAT 0102	**B6**		21 October 2011	2012	; only RLS
419	GSAT 0103	**C4**	L2	12 October 2012		June 2013
420	GSAT 0104	**C5**		12 October 201	2016	June 2013
414	GSAT 0202	**Ecc**	L3		Jan 2016 - April 2016	*JC-September 2016*
418	GSAT 0201	**Ecc**		August 2014	Jan 2016 - April 2016	*JC-September 2016*
426	GSAT 0203		L4	27 March 2015	January 2016	*JC-September 2016*
422	G			27 March 2015	January 2016	*JC-September 2016*
424	0205	A5	L5	10 September 2015	*December 2015*	*JC-September 2016*
	GSAT 0206	A8		10 September 2015	*December 2015*	*JC-September 2016*
409	GSAT 0209	*C2*	L6	17 December 2015	*April 2016*	*JC-September 2016*
408	GSAT 0208	*C7*		17 December 2015	*April 2016*	*JC-September 2016*
410	GSAT0210	A2	L7	24 May 2016	September 2016	Council December 2016
411	GSAT0211	A6		24 May 2016	September 2016	Council December 2016

12 Operational SAR Repeaters by September 2016 !

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- **Unique feature of Galileo to provide return channel to the distress beacon for multiple purposes (distress acknowledgment, beacon activation, beacon control…)**
  - ★Currently under deployment for providing an acknowledgment service to the beacon through a Return Link Message (RLM)
  - ★Development in coordination with Cospas-Sarsat for full integration into the Cospas-Sarsat MEOSAR system
- **Use the Galileo L1 Navigation Message to broadcast the acknowledgment messages**

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★ **During the development process two types of acknowledgments are considered in the Return Link Service:**

★ **Acknowledgment Type 1 (also called system acknowledgment):**

The Galileo system is the solely responsible for the automatic transmission of a Return Link Message (RLM) to the emitting beacon once the alert has been detected and located

★ **Acknowledgment Type 2 (also called RCC acknowledgment):**

The Galileo system sends the RLM to the emitting beacon once it has received the authorization of the RCC (Rescue Coordination Center). This acknowledgment would inform the user that the distress has been received by the RCC.

Coordination with IMO on the use of Return Link Service

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- **In March 2012, the European Commission participated to the COMSAR 16 (IMO) and presented a paper on the Return Link Service**
  - **Outcome of COMSAR 16:**

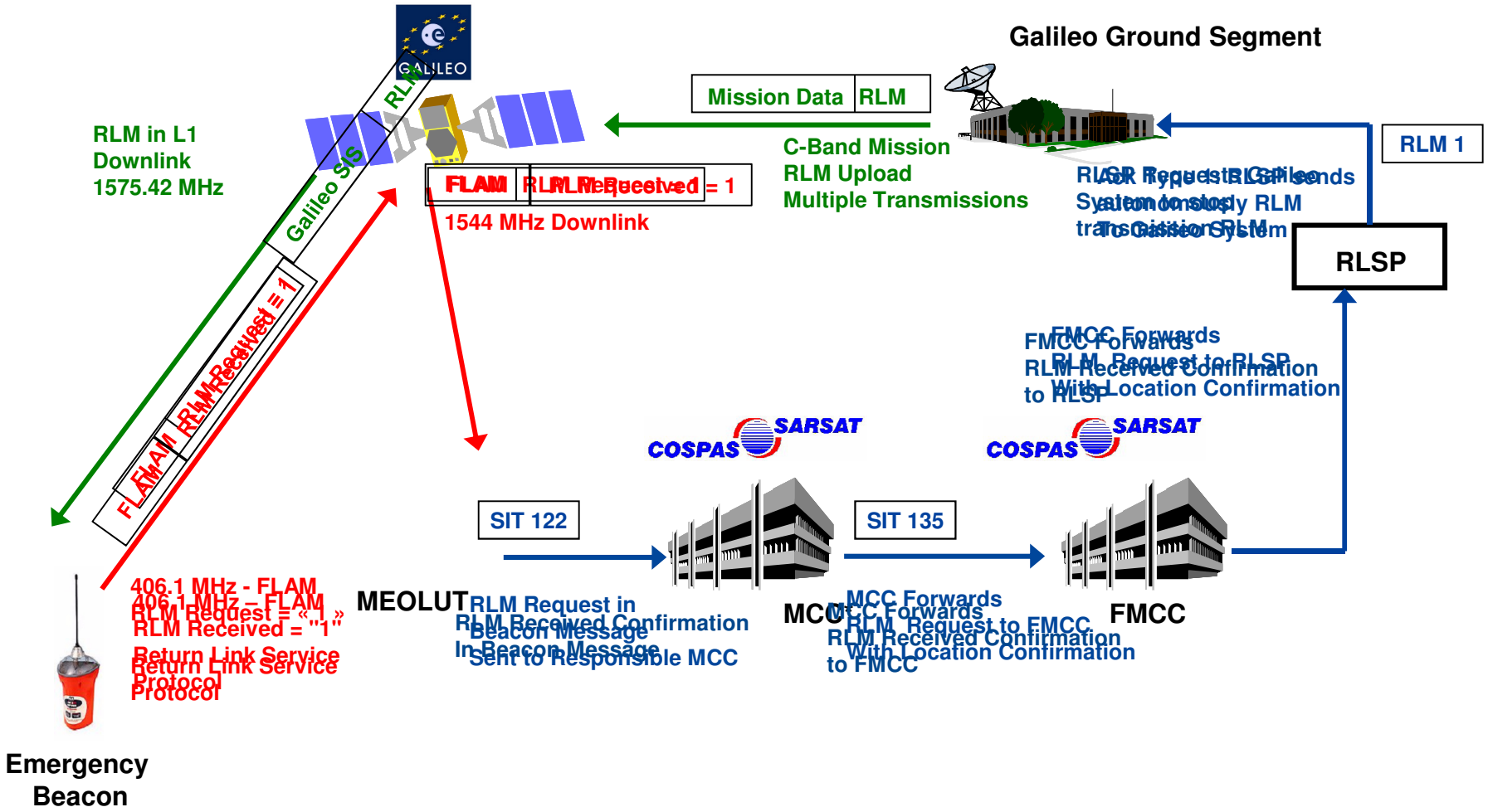
6.22 The Sub-Committee endorsed:

...

.4 the acceptability of the Return Link Message (RLM) Type-1 including the optional inclusion of this particular functionality within distress beacons; and

.5 the further consideration of the complex matter of RLM Type-2 messages by the ICAO/IMO Joint Working Group.

Return Link Acknowledgment Service End-to-End Loop (RLM Type-1)



SAR/Galileo RLS Space Segment Component

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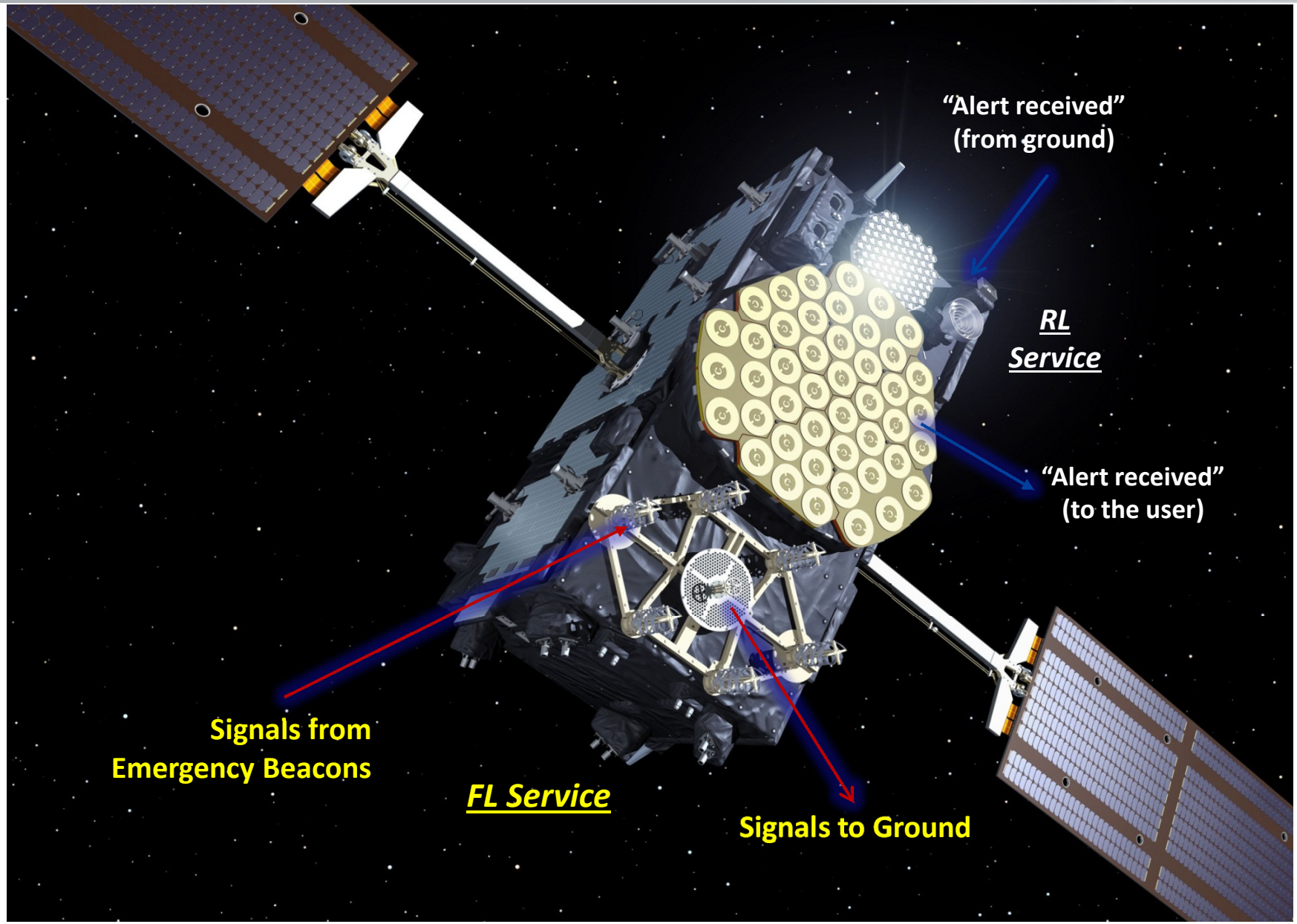

SAR/Galileo RLS Ground Segment: Return Link Service Provider (RLSP)

- ★ The RLSP is the Galileo Service Facility in charge of the generation of the Return Link Messages (RLM)
- ★ Interface with the Galileo Ground Segment for uplinking of RLM
- ★ Interface with the Cospas-Sarsat system (through French MCC) for receiving RLM requests (information of activated distress beacons with RLM capability)
- ★ The facility is located in the SAR/Galileo Service Centre, Toulouse France
- ★ Operated by the SAR/Galileo Data Service Provider (CNES)
- ★ Procurement of the RLSP facility is launched; deployment foreseen at the end of 2017

★ Return Link Message Request (RLM Request)

- ★ **Message sent by the distress beacon (specific RLS protocol on the 406 MHz uplink signal) to the Return Link Service Provider (RLSP) to indicate that it has a Return Link capability**
- ★ **The protocol is defined for the current generation (T.001) of beacons and is being adapted for the next generation of Cospas-Sarsat beacons**
  - ★ Protocol Applicable as from January 2017
- ★ **The RLM request is received at the RLSP through the Cospas-Sarsat network**
  - ★ Is included as part of the SIT message (SIT135)
  - ★ Follows a specific routing through the FMCC which interfaces with RLSP

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★ Return Link Message (RLM)

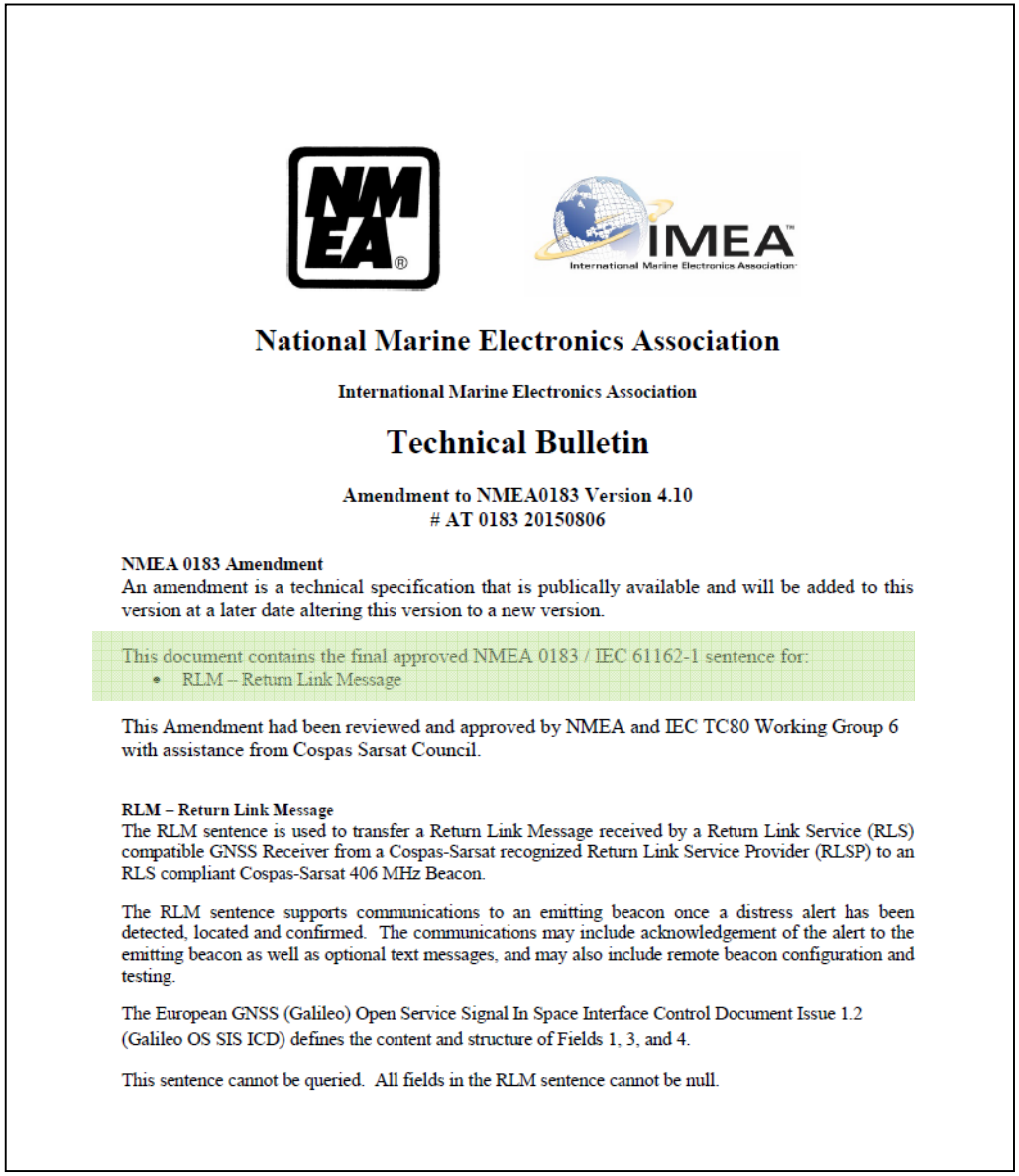
- ★ Message sent by the Galileo system to the beacon through the Galileo L1 signal (1575.42 MHz)
- ★ Defined in Galileo Signal in Space ICD, version 1.2 (May 2014)
- ★ Two types of RLMs: short RLM (80 bits) and long RLM (160 bits)

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

★ RLM reception at the distress beacon

- ★ The RLMs message will be sent through 2 satellites in visibility of the beacon. The choice of the satellite is made by the RLSP based on the beacon location information and perceived link quality
- ★ The beacon cannot detect which satellites will be used for RLM transmission → needs to track all Galileo satellites in view
- ★ The GNSS receiver in the beacon must be maintained ON during certain periods to ensure the reception of the RLM (activation sequence is described in Cospas-Sarsat Documentation)
- ★ Upon Reception of the Return Link Message, the Beacon will modify its forward link alert message (FLAM) to indicate to the system that the RLM has been well received (to trigger the end of the RLM transmission by Galileo)

- **Standardization Activities in IEC**
  - Interface between the GNSS receiver and distress beacon is standardized: IEC has developed a new IEC 61162-1 NMEA sentence for the RLS message



National Marine Electronics Association

International Marine Electronics Association

Technical Bulletin

Amendment to NMEA0183 Version 4.10
 # AT 0183 20150806

NMEA 0183 Amendment
An amendment is a technical specification that is publically available and will be added to this version at a later date altering this version to a new version.

This document contains the final approved NMEA 0183 / IEC 61162-1 sentence for:
- RLM – Return Link Message

This Amendment had been reviewed and approved by NMEA and IEC TC80 Working Group 6 with assistance from Cospas Sarsat Council.

RLM – Return Link Message
The RLM sentence is used to transfer a Return Link Message received by a Return Link Service (RLS) compatible GNSS Receiver from a Cospas-Sarsat recognized Return Link Service Provider (RLSP) to an RLS compliant Cospas-Sarsat 406 MHz Beacon.

The RLM sentence supports communications to an emitting beacon once a distress alert has been detected, located and confirmed. The communications may include acknowledgement of the alert to the emitting beacon as well as optional text messages, and may also include remote beacon configuration and testing.

The European GNSS (Galileo) Open Service Signal In Space Interface Control Document Issue 1.2 (Galileo OS SIS ICD) defines the content and structure of Fields 1, 3, and 4.

This sentence cannot be queried. All fields in the RLM sentence cannot be null.

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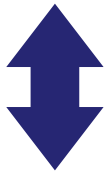
Galileo Initial Service Declaration in Sept. /Oct. 2016



Readiness of the SAR/Galileo Forward Link Service Infrastructure

- ★ **Contribution to Cospas-Sarsat MEOSAR Early Operational Capability (EOC) phase**
  - ★ **Declaration of EOC by Cospas-Sarsat Council expected in December 2016**
- ★ **Based on commissioned infrastructure: 10 SART and 3 MEOLUTs**
- ★ **Service Operations managed by the CNES (acting as SAR/Galileo Data Service Provider)**

SAR/Galileo Initial Service Main Key Performances Indicators

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KPI	Description and Target Values
KPI #1	**Detection Service Availability: 99%**
KPI #2	**Quality of the Localization Service** • **98% of localization in 5 km** • **80% of localization in 2 km** Defined for 10 minutes, assessed in single burst too.
KPI #3	**Per MEOLUT Availability** • **97.6% in Nominal mode** • **99.9% in Nominal or Degraded Mode**

SAR/Galileo Service Provisioning Milestones

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2016
Initial Service

- Initial Forward Link Detection and Localization Capability
- Infrastructure qualified under Cospas-Sarsat specifications
- Use of mix of Galileo L-Band and GPS S-Band transponders
- 10 SART

2018
Enhanced Service

- Improved Forward Link Detection and Localization Capability
- Initial Return Link Service
- Use of mix of Galileo L-Band and GPS S-Band transponders
- 20 SART
- Increased Galileo ground coverage: South Indian Ocean

2020
Full Service

- Full Forward Link Detection and Localization Capability
- Full Return Link Service
- Service can be based on Galileo L-Band transponders only
- 24 SART (+ 6 active Spares)

Further evolutions of SAR/Galileo Service

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- **Forward Link Service:**
  - **Extension of the SAR Ground Segment to further contribute to Cospas-Sarsat MEOSAR global coverage**
  - **Compatibility with Second Generation Beacons**
- **Return Link Service: additional services**
  - **RLS Type-2**
  - **Remote Beacon Activation**
  - **Two-way messaging**

Conclusions

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- ★ **A substantial infrastructure and operations have been procured by the Galileo Programme to support the Search and Rescue applications, in particular in support to Cospas-Sarsat MEOSAR Programme (close to 100M€ over 10 years)**
- ★ **A significant step will be achieved with the Initial Service Declaration in 2016**
- ★ **The Return Link Service implementation is well on its way and will provide significant added value to the SAR Service**
- ★ **Strong interaction between user community, beacon manufacturers and the Galileo Programme is required in order to develop the right features**