European Commission

Navigation solutions powered by Europe

SAR/Galileo Service Status

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ICG, Sochi, November 2016

Article 4 (e) of GNSS Regulation 1285/2013

"*4. The specific objectives of the Galileo programme shall be to ensure that the signals emitted by the system established under that programme can be used to fulfil the following functions:*

……

(e) to contribute to the search and rescue support service (SAR) of the COSPAS-SARSAT system by detecting distress signals transmitted by beacons and relaying messages to them"

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

- **SAR/Galileo Service Definition**
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- **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/localisation 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

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SAR/Galileo Forward Link Service - 1

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
- 5 Galileo MEOSAR Ref Beacons
- SAR Server (GSA)

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

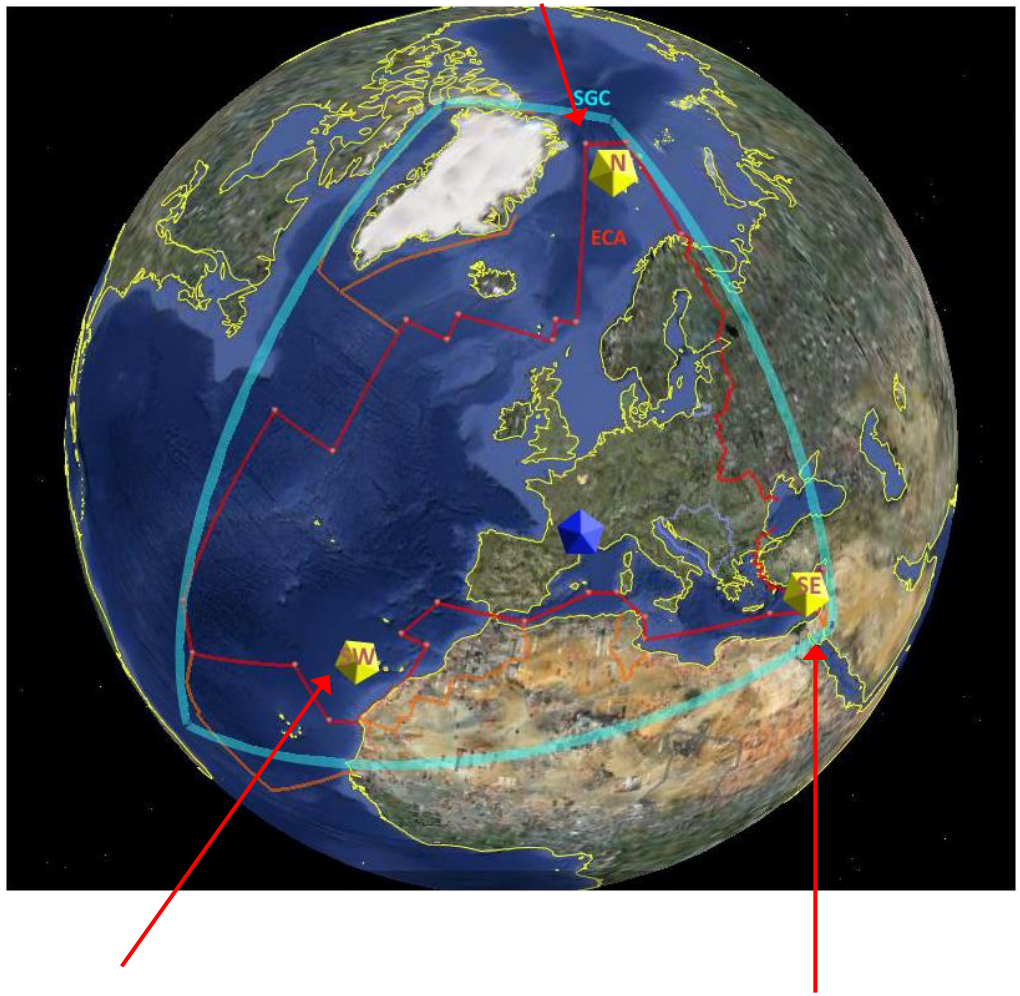
- 2 IOV SARR (No SARR on IOV FM1/FM2)
- 22 FOC SARR (in deployment)

- ★ **3 MEOLUTs to cover SAR areas over 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



- ★ **Search and Rescue Repeaters on-board each Galileo satellite***
- ★ **<u>Main Characteristics</u>:**
  - ★ **Reception: uplink @ 406.05 MHz, G/T ~ -13 dB/K, RHCP**
  - ★ **Transmission: downlink @ 1544.1 MHz, EIRP ~17dBW, LHCP**
  - ★ **Several operating modes**
    - ★ **Narrow Band (50kHz) / Wideband (90kHz)**
    - ★ **Automatic Level Control (ALC) / Fixed Gain Mode (FGM)**
    - ★ **Default Mode: ALC 90kHz**
- ★ **SAR Repeaters are commissioned to Cospas-Sarsat Standard**
  - ★ **Full description provided in Cospas-Sarsat T.16 Document**
- ★ **12 Operational SAR Repeaters by December 2016**

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

- **Test Campaign performed by ESA in October 2015**
- **Localisation probability as a function of number of bursts**

	Bcn ch	Tx ant	1	2	3	4	5	6	7	8	9	10	11	12
LNC	1	EPIRB	84,24	99,04	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	**99,8**
	2	REB λ/4	82,72	99,36	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	**99,8**
	3	λ/2	82,8	99,2	99,92	99,92	99,92	99,92	99,92	99,92	99,92	99,92	99,92	**99,9**
	4	λ/2	82,48	99,28	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	**99,8**
	5	λ/2	81,44	99,28	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	**99,8**
	Acceptance		93	100	100	100	100	100	100	100	100	100	100	**100,0**
SBG	1	EPIRB	83,92	99,52	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	**99,8**
	2	REB λ/4	83,12	99,2	99,52	99,52	99,52	99,52	99,52	99,52	99,52	99,52	99,52	**99,5**
	3	λ/2	82	99,12	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	99,84	**99,8**
	4	λ/2	79,28	99,12	100	100	100	100	100	100	100	100	100	**100,0**
	5	λ/2	80,96	98,4	98,8	98,8	98,8	98,8	98,8	98,8	98,8	98,8	98,8	**98,8**
	Acceptance		91	100	100	100	100	100	100	100	100	100	100	**100,0**
MSP	1	EPIRB	87,12	99,52	99,92	99,92	99,92	99,92	99,92	99,92	99,92	99,92	99,92	**99,9**
	2	REB λ/4	89,84	99,44	99,92	99,92	99,92	99,92	99,92	99,92	99,92	99,92	99,92	**99,9**
	3	λ/2	87,52	99,52	99,92	99,92	99,92	99,92	99,92	99,92	99,92	99,92	99,92	**99,9**
	4	λ/2	87,04	99,52	100	100	100	100	100	100	100	100	100	**100,0**
	5	λ/2	86,32	98,8	99,2	99,2	99,2	99,2	99,2	99,2	99,2	99,2	99,2	**99,2**
	Acceptance		93	100	100	100	100	100	100	100	100	100	100	**100,0**

Outline

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- ★ Unique Galileo feature; provides return channel to distress beacons
- ★ Currently being deployed to provide an acknowledgment service to beacons via a Return Link Message (RLM)
- ★ Possible future uses include: distress acknowledgment, beacon activation, beacon control, etc
- ★ Developed in coordination with Cospas-Sarsat for full integration into the Cospas-Sarsat MEOSAR system
- ★ Uses Galileo's L1 Navigation Message to broadcast acknowledgment messages

- **During development, two acknowledgment types are considered for the Return Link Service:**

  - **<u>Acknowledgment Type 1 (also called system acknowledgment):</u>**

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

  - **<u>Acknowledgment Type 2 (also called RCC acknowledgment):</u>**

  The Galileo system sends the RLM to the emitting beacon once it has received the authorisation of the RCC. This acknowledgment informs the user that the distress has been received by the RCC.

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

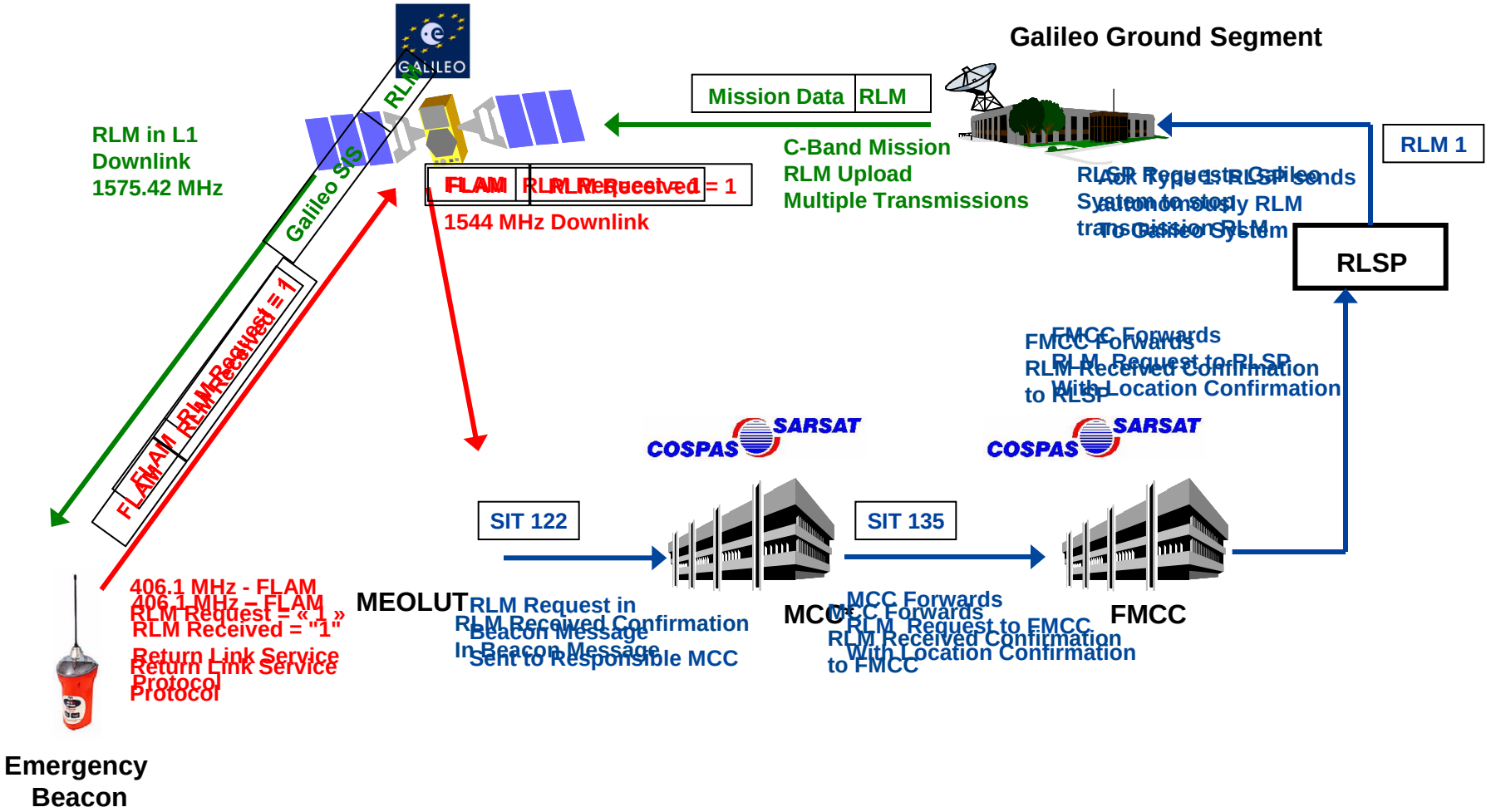
6.22 The Sub-Committee endorsed:

…

.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 Ground Segment: Return Link Service Provider (RLSP)

- **RLSP: Galileo Service Facility that generates Return Link Messages**
- **Interfaces with Galileo Ground Segment to uplink Return Link Messages**
- **Interface with Cospas-Sarsat system (through FMCC) to receive RLM requests (information about activated distress beacons with RLM capability)**
- **RLSP facility located at the SAR/Galileo Service Centre, Toulouse, France**
- **Operated by the SAR/Galileo Data Service Provider (CNES)**
- **RLSP deployment foreseen, end-2017**

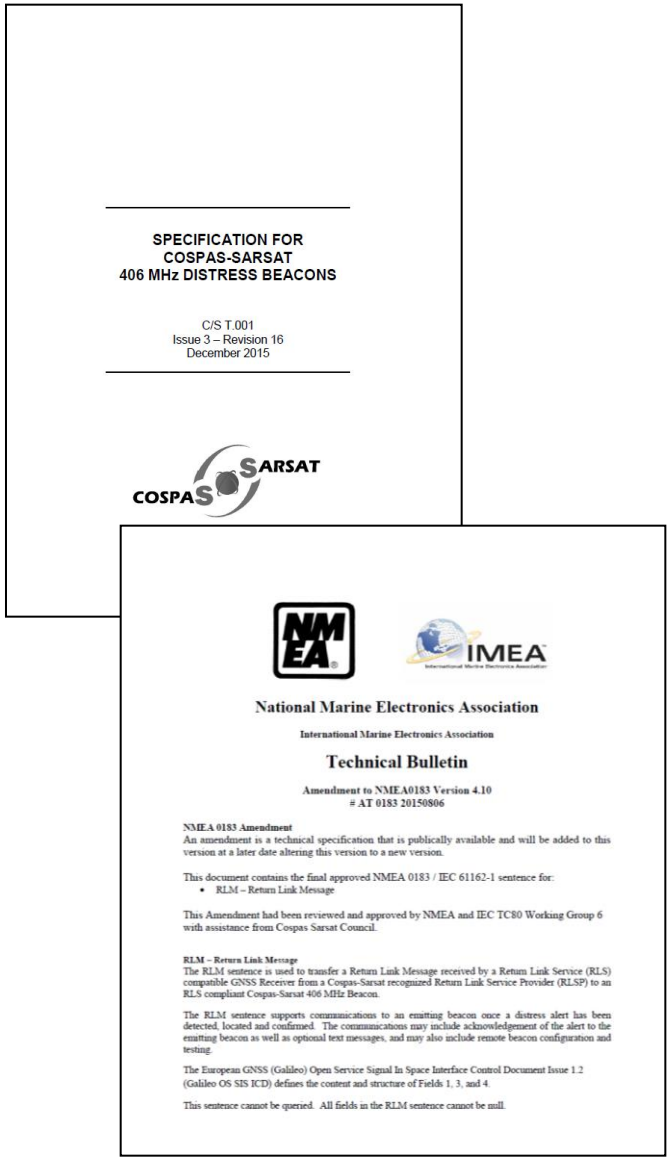
- **RLM reception at the distress beacon**
  - The GNSS receiver must be switched on after beacon activation to allow RLM reception
  - RLM messages sent through two satellites in view of the beacon. Satellite choice made by RLSP, based on beacon location information and perceived link quality
  - Beacon does not know which satellites will be used for RLM transmission
    → needs to track all Galileo satellite in view
  - Beacon's GNSS receiver must remain ON during certain periods to ensure RLM reception (activation sequence described in Cospas-Sarsat documentation)
  - Upon reception of the Return Link Message, the Beacon will modify its forward link alert message to indicate to the system that the RLM has been received (triggers end of RLM transmission by Galileo)

★ Standardisation Activities in Cospas-Sarsat

- ★ Complete Cospas-Sarsat Beacon Standard T.001 for inclusion of all requirements specific to the RLM function implementation:
- ★ Complete Cospas-Sarsat Beacon Testing Standard T.007 to allow verification of the RLS functionality as part of the RLS enabled beacon Type Approval process

★ Standardisation in IEC

- ★ Interface between the GNSS receiver and distress beacon is standardised:



SPECIFICATION FOR
COSPAS-SARSAT
406 MHz DISTRESS BEACONS

C/S T.001
Issue 3 – Revision 16
December 2015

COSPAS SARSAT

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.

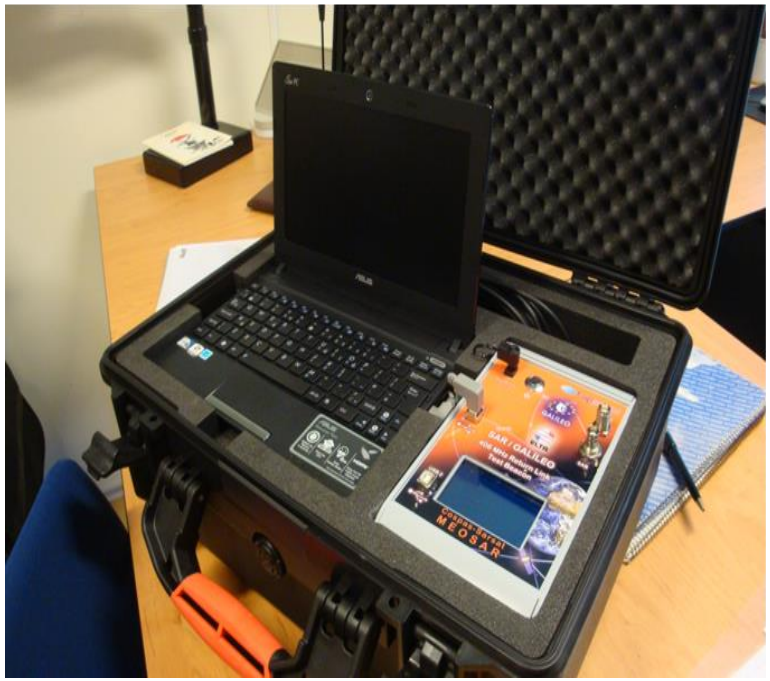
RLM – Return Link Message
The RLM sentence is used to transfer a Return Link Message received by a Return Link Service (RLS) compatible GNSS Receiver from a Cospas-Sarsat recognized Return Link Service Provider (RLSP) to an RLS compliant Cospas-Sarsat 406 MHz Beacon.

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.

- **IOV Test Campaign executed from October 2013 to March 2014**
  - RLS Capacity (GMS + Satellites)
  - RLM delivery time by the GALILEO System and Global coverage
  - End-to-end (Forward + Return Link) Loop
  - Proved concept
- **Cospas-Sarsat MEOSAR Test Campaign – Operational Test #5**
  - Large, global test campaign involving several Cospas-Sarsat MCCs
  - Q4 2016



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Galileo Initial Service Declaration in end-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: 12 SART and 3 MEOLUTs**
- **Service Operations managed by CNES (acting as SAR/Galileo Data Service Provider)**

SAR/Galileo Initial Service Main Key Performances Indicators

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KPI	Description
KPI #1	**Detection Service Availability: 99%**
KPI #2	**Quality of the Localisation Service** • **98% of localisation in 5 km** • **80% of localisation in 2 km** Assessed in single burst and after 10 minutes
KPI #3	**Per MEOLUT Availability** • **97.6% in Nominal mode** • **99.9% in Nominal or Degraded Mode**

Return Link Service Roadmap

- ★ **Q3 2016: Kick-Off Operational RLSP Development**
- ★ **2017: Pre-Operational RLSP available for Cospas-Sarsat Test Campaign on RLS**
- ★ **Late-2017: Deployment of operational RLSP in SAR/Galileo Service Center (CNES, Toulouse)**
- ★ **End-2017: Connection of operational RLSP to Galileo Operational Chain for system validation and qualification**
- ★ **Beginning-2018: Operational RLSP available for testing purposes (RLS Test Protocol)**
- ★ **Mid-2018: Start of Initial Return Link Service**

Further evolutions of SAR/Galileo Service

- **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

- ★ **Substantial infrastructure and operations procured by the Galileo Programme to support the Search and Rescue applications; particularly supporting the Cospas-Sarsat MEOSAR Programme (close to 100M€ over 10 years)**
- ★ **A significant step will be achieved at Initial Service Declaration end-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**