SAR / Galileo

SAR/Galileo Early Service Demonstration & the MEOLUT Terminal

Galileo Application Days

INDRA ESPACIO

Brussels / 3-5 March 2010

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SAR/Galileo Overview

Forward Link Service

MEOSAR transponders will relay distress signals from the Cospas-SarSat dedicated beacons to specialised ground facilities (European MEOLUTs)

European MEOLUT

- ✓Recovering the message and locating the emergency beacons
- ✓Providing the relevant SAR distress data to the associated Cospas-Sarsat Mission Control Centre (MCC), connected to Rescue Coordination Centre (RCC) and the Return Link Service Provider (RLSP)

Return Link Service

Provide the capability to relay Return Link Messages (RLMs) to specific beacons and sends the user in distress with a confirmation that the alert has been received and processed correctly. Ground infrastructure of Galileo distributes the SAR feedback information to the Galileo Up-Link Stations

RLSP

- ✓Will manage the generation and delivery of RLMs, as well as the exchange of status information between the C/S and Galileo Ground Segments

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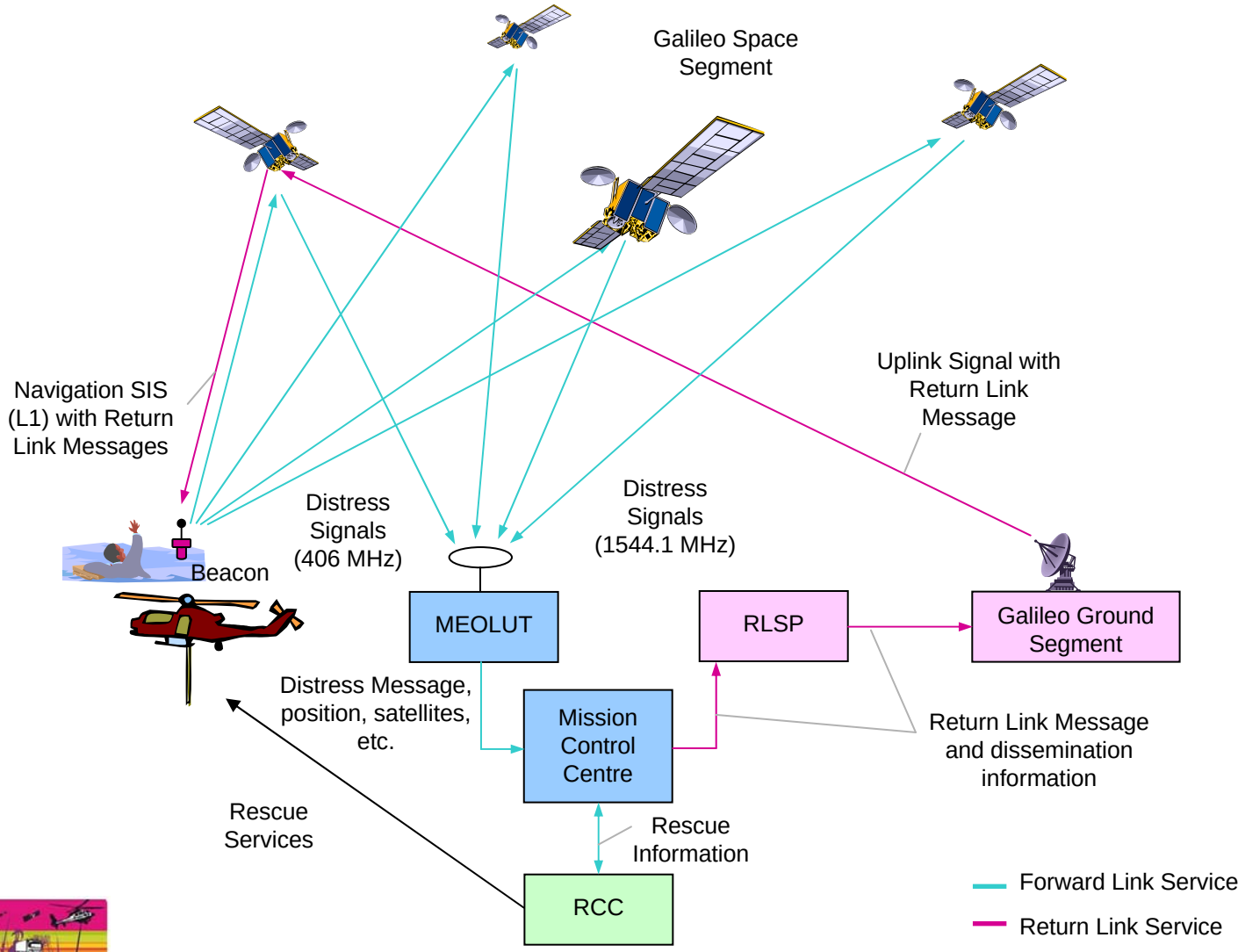
SAR/Galileo System Architecture



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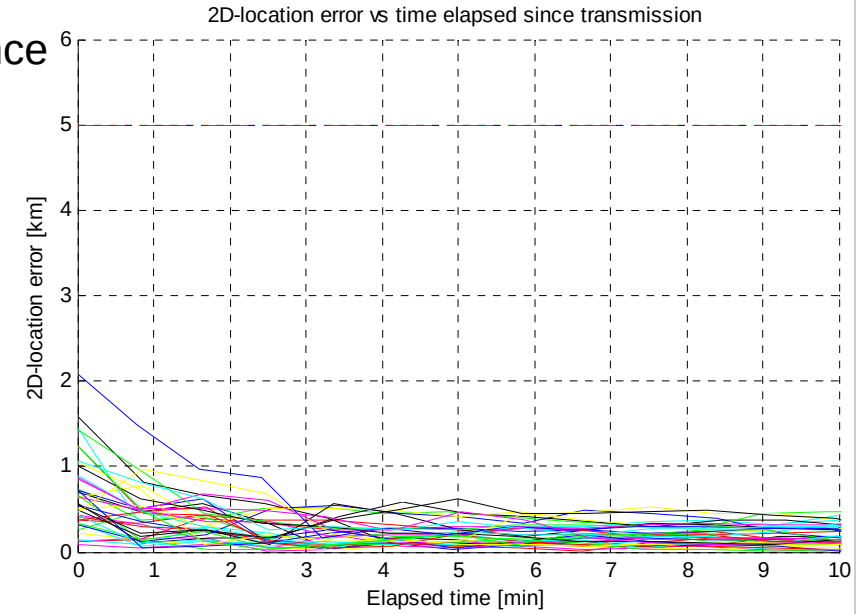
SAR/Galileo System Performance

Forward Link Service

- ✓Reception of message (error-free) in 5 min
- ✓Localisation error (beacons without GNSS): < 500 m in 10 min
- ✓Global coverage (European MEOLUT: 5000 km)
- ✓Availability: > 99.5%
- ✓Capacity: > 450 beacons
- ✓In IOV, somewhat lower performance (limit. Constel.)

Return Link Service

- ✓Innovative service, useful for rescue operations
- ✓Flexible Return Link Messages



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GISAR OVERVIEW
Objectives and Consortium Partners

- Main goal: development of the SAR Ground Segment Prototype:
  - European MEOLUT Prototype: station in charge of receiving distress alerts, recovering the beacon message and locating the person in distress
  - RLSP Prototype: station in charge of managing Return Link Messages (transmitted via Galileo to the person in distress)
- Analysis of the required evolution from the Ground Segment Prototype to the Operational GS
- A high degree of coordination with Cospas-Sarsat and GalileoSat will need to be ensured
- Partners: CNES, ASP, RMR, CapGemini, TAS, MSI, INTA, Edisoft and ISS

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GISAR OVERVIEW
European MEOLUT features

- ✓ Satellite tracking, up to 4 satellites
- ✓ Signal In Space acquisition in SAR/Galileo downlink band (1544.05 – 1544.15 MHz) and DASS POC band (2226.42 – 2226.52 MHz)
- ✓ Beacon message demodulation
- ✓ TOA/FOA measurement with high accuracy
- ✓ SAR beacon localisation
- ✓ Interface with MCC

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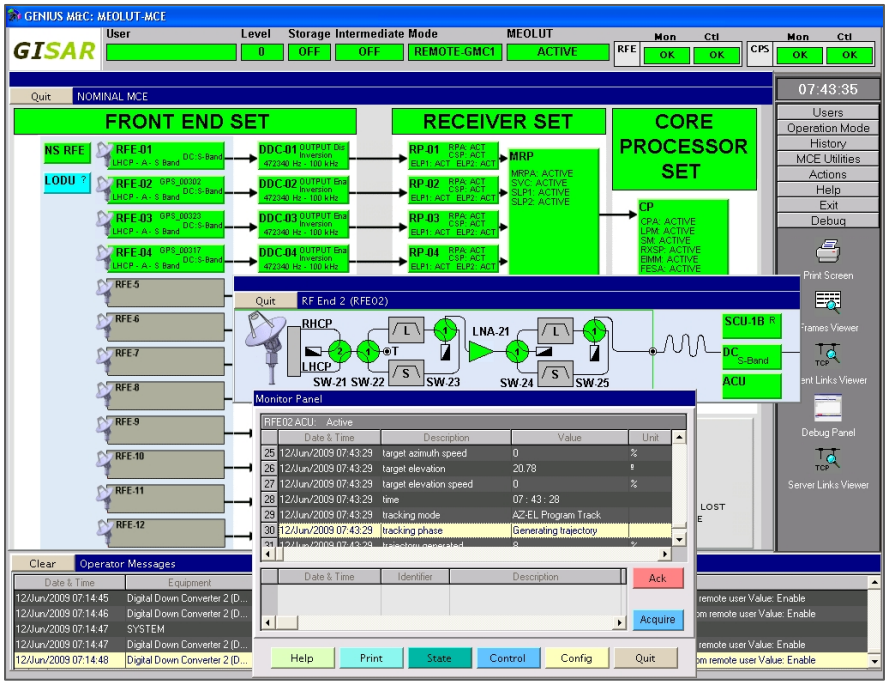
GISAR OVERVIEW
European MEOLUT description

MEOLUT Front-End Set Dish Antennas, Toulouse



MEOLUT Monitoring and Control Equipment (MCE)

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GISAR OVERVIEW
European MEOLUT description

European MEOLUT Front-end-set, CPS and RXS,Toulouse

European MEOLUT ACUs and MCE PCs, Toulouse

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GISAR OVERVIEW

European MEOLUT key results: On-site Experimentation with DASS-PoC

- **Detection Probability**

✓Successful detection and extraction message in almost 100% of the cases, testing 3 and 4 satellites configurations with beacons emitting as low as 29 dBm

✓ Stable detection probability discovered in sub-band 406.020 – 406.075 MHz within SAR-band

- **Localisation Accuracy**

✓With 37 dBm emission power and 3 channel configuration, accuracy of 4.60km (4.61 km) was achieved for 2D (3D) localisation

✓Similar results obtained with 33 dBm emission power and 4 channels configuration tend to demonstrate the importance of the 4 channels configuration

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GISAR OVERVIEW

European MEOLUT key results: On-site Experimentation with DASS-PoC

- **System Capacity: processing beacons simultaneously**

✓A sequence based on the SAR-BS reference sequence with 3 beacons emitting at 37 dBm simultaneously was designed for this test

✓Results achieved show that any decrease in performance is no due to beacon capacity since no losses of message occurred for beacons transmitting simultaneously

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GISAR OVERVIEW

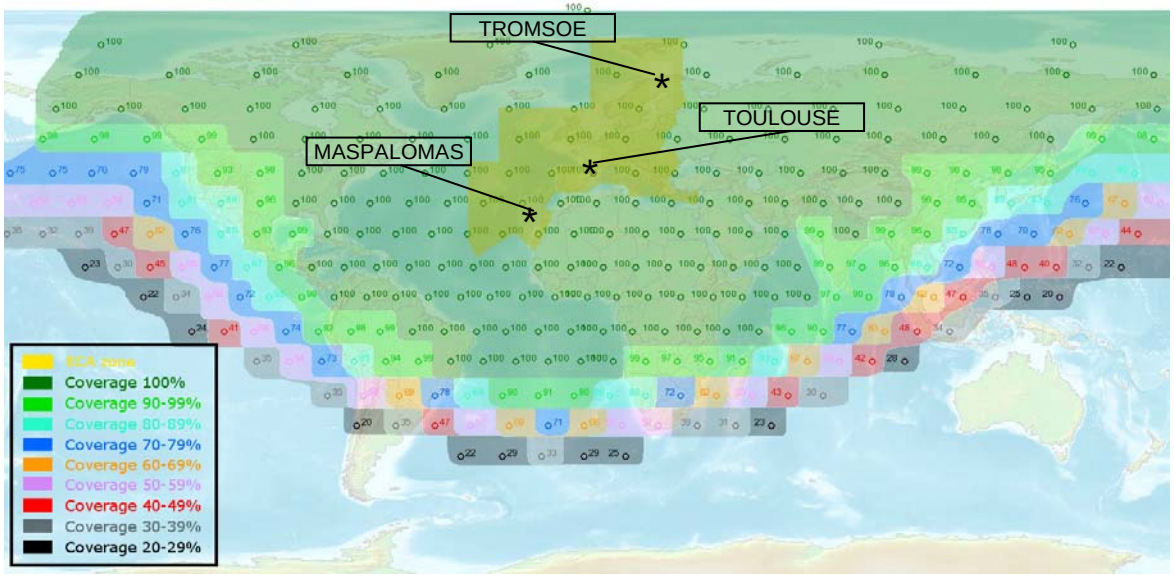
European MEOLUT coverage simulation

Scenario

Coordinated Network of 3 European MEOLUTs located in Toulouse (France), Tromsoe (Norway) and Maspalomas (Spain)

Results

The Network of European MEOLUTs entirely coordinated guarantees total coverage of ECA as shown in the image below with the percentage time that at least four satellites are in common view with assessed area and the Network of European MEOLUTs



SAR Service Availability Map

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GISAR OVERVIEW

European MEOLUT key results: FOA Interoperability Test Campaign

- **FOA Performance Analysis**

✓FOA measurements done by the EC/ESA MEOLUT contain systematic errors, satellite and pass dependent, thus they can be removed by fitting and optimum polynomial to the FOA measurements

✓Comparing the available data between the Toulouse Orbitography Beacon and the USA Beacon, the FOA error pattern is approximately equal. Therefore, the FOA systematic errors could be calibrated in real time by the European MEOLUT

✓Moreover, it can be observed that in the case of the calibrated EC/ESA FOA measurements, the residual FOA errors are slightly below, in most cases, than the FOA errors for the other MEOLUTs

✓Results show that the standard deviation requirement of 0.1 Hz is not reached. The standard deviations obtained are approximately 0.3 Hz

GISAR OVERVIEW

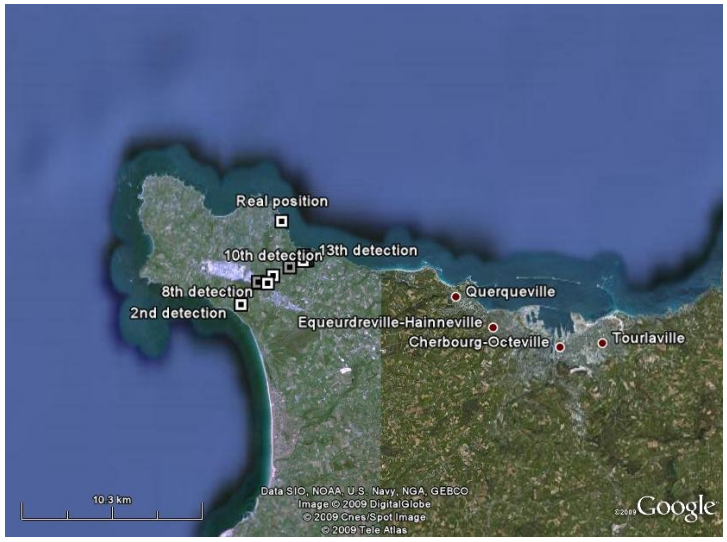
European MEOLUT key results: On-site Experimentation with DASS-PoC

- **Localisation Accuracy**

✓Additional localisation tests performed to demonstrate localisation capacity of a commercial beacon

✓Localisation tests consisted in the displacement of a SAR standard beacon with a priori unknown position through Normandy and Brittany (France)

STB locations computed by EC/ESA European MEOLUT



European MEOLUT computed localisations for STB emissions

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GISAR OVERVIEW
European MEOLUT key results

✓Achievements obtained allow us to guarantee that the European MEOLUT performance will enhance European SAR/Galileo service reliability by offering:

- ✓SAR distress event detection and message processing
- ✓SAR standard beacon high accuracy localisation
- ✓High availability and broad coverage
- ✓Better throughput results for MEOSAR system than for GEOSAR system

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GSARSED OVERVIEW
Project Objectives and Consortium Partners

- ✓ Early Demonstration of the Forward and Return Link Service functionalities proposing a set of suitable scenarios. After this demonstration, the SAR/Galileo Service will become the first operative service of Galileo
- ✓ Interoperability has to be demonstrated with Intergovernmental SAR Satellite Systems (such as GPS/DASS or SAR/Glonass)
- ✓ Contribution to the Cospas-Sarsat MEOSAR Proof of Concept Phase implementing a complete demonstration collection of the service and to prepare the C/S D&E phase
- ✓ Integration of SAR/Galileo infrastructure in the Cospas-Sarsat MEOSAR Service. SAR/Galileo will offer considerable benefits to the global SAR service provided by the current Cospas-Sarsat system
- ✓ Wide dissemination activity that implies the demonstration of service contributing to a gradual inclusion of navigation services and rescue operations based on Galileo infrastructure
- ✓ Partners: INDRA, Thales Alenia, INTA, KANNAD, Ursa Minor and Capgemini

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GSARSED OVERVIEW
State of the Art

- ✓ The MEOSAR system is devoted to provide benefits to the Global SAR service, where LEOSAR and GEOSAR systems are currently fully operational
- ✓ Prior to distributing distress alert data from MEOSAR system, a D&E phase has to evaluate the operational effectiveness and the benefits to SAR services
- ✓ GSARSED will test the performances of the algorithms; this will be the environment to prove extensively some of the components of SAR/Galileo (like TOA/FOA exchange) and to check its improved capabilities (i.e. faster localization algorithms)
- ✓ The MEOSAR system will provide considerable benefits to the Global SAR Service enhancing the capabilities from both previous C/S systems. Some of these benefits are: true global and continuous coverage, capability for locating all beacon population and Return Link Service

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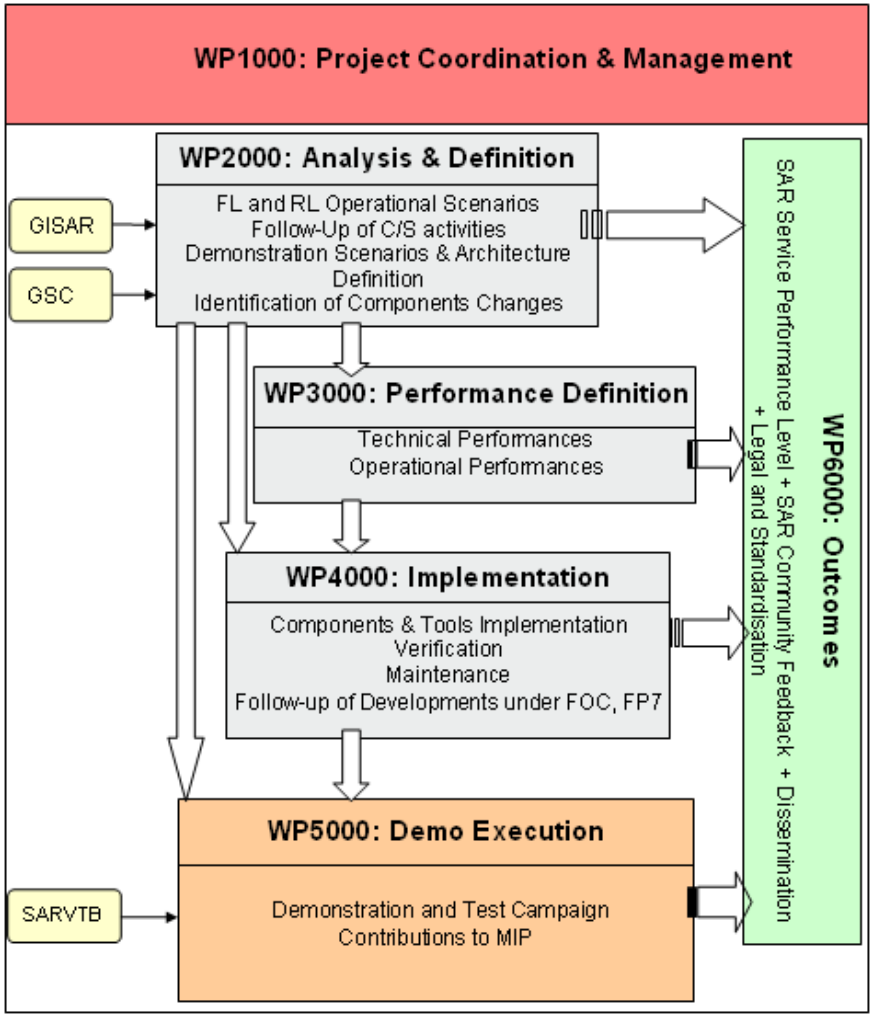
GSARSED OVERVIEW

Work logic



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GSARSED OVERVIEW
Work logic

Analysis and Definition of the Operational Scenarios: This phase first analyses which are the needed capabilities to be demonstrated by GSARSED. After that, it also defines a series of scenarios and the performances (technical and operational) to be assessed during the demonstration phase

Implementation phase: From the scenarios defined in the previous phase changes are needed to be implemented in the GSARSED components and tools that are going to be used during the demonstration campaign

Demonstration Execution phase: each scenario demonstration is launched. The outcomes from the different scenarios are gathered and analysed in order to confirm that the expected technical and operational performances have been assessed

Dissemination Phase: the outcomes from the demonstrations are presented in different formats to the SAR experts and also to the general public in order to reach the maximum population as possible. Here are also included tasks supporting for standardisation and legal aspects of GSARSED topics

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GSARSED OVERVIEW
Demonstration Scenarios Descriptions

- ✓ GSARSED plans to perform a collection of demonstrations for exposing the SAR/Galileo service capabilities in order to integrate it into the C/S SAR System and contributing to MEOSAR PoC phase

- ✓ The proposed demonstrations are to be performed sequentially

  - ✓ Demo-1: SAR/Galileo Ground Interfaces (partial RLS demo)
  - ✓ Demo-2: MEOSAR Interoperability and Ground Segment Interfaces (IOV RLS)
  - ✓ Demo-3: SAR/Galileo End-to-End
  - ✓ Demo-4: SAR/Galileo enhancements

GSARSED OVERVIEW
Demonstration Scenarios Descriptions

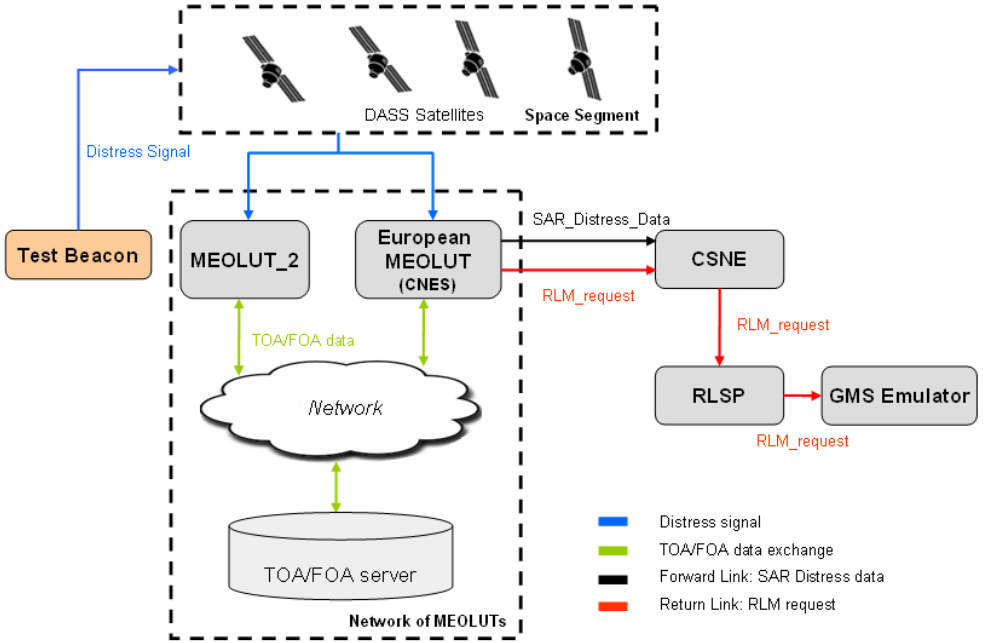
Demo-1 : SAR/Galileo Ground Interfaces (partial RLS demo)

✓Evaluation of the interfaces used in the Beacon-SiS-European MEOLUT-MCC-RLSP-GMS chain

✓Two levels: FL including the TOA/FOA exchange functionality at service level and the first partial RLS demonstration

Expected results:

- ✓ Localization accuracy requirement
- ✓ RLM emission request with a response time required
- ✓ Common FOA correlation definition in order to standardise the FOA measurement
- ✓ Location of the test beacons used in the scenario
- ✓ Corresponding RLM requests containing a correct satellite dissemination list



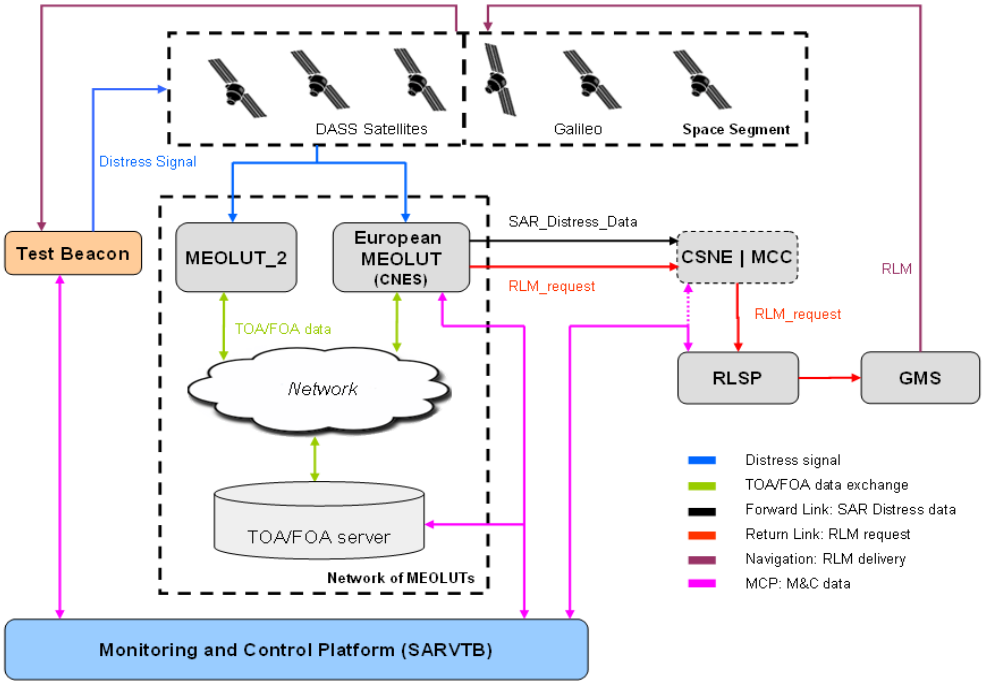
GSARSED OVERVIEW
Demonstration Scenarios Descriptions

Demo-2 : MEOSAR Interoperability and Ground Segment Interfaces

- ✓ Demonstration of the FLS interoperability of the European MEOLUT evaluated at ground and space levels
- ✓ First RLS demonstration without involving C/S components

Expected results:

- ✓ Localization accuracy within the requirements
- ✓ Emission of the RLM request with a response time within RLSP requirements
- ✓ Location of the test beacons used in the scenario
- ✓ Corresponding RLM requests containing a correct satellite dissemination list
- ✓ Reception by the test beacon of the acknowledgement of detection
- ✓ Feedback of the SAR community



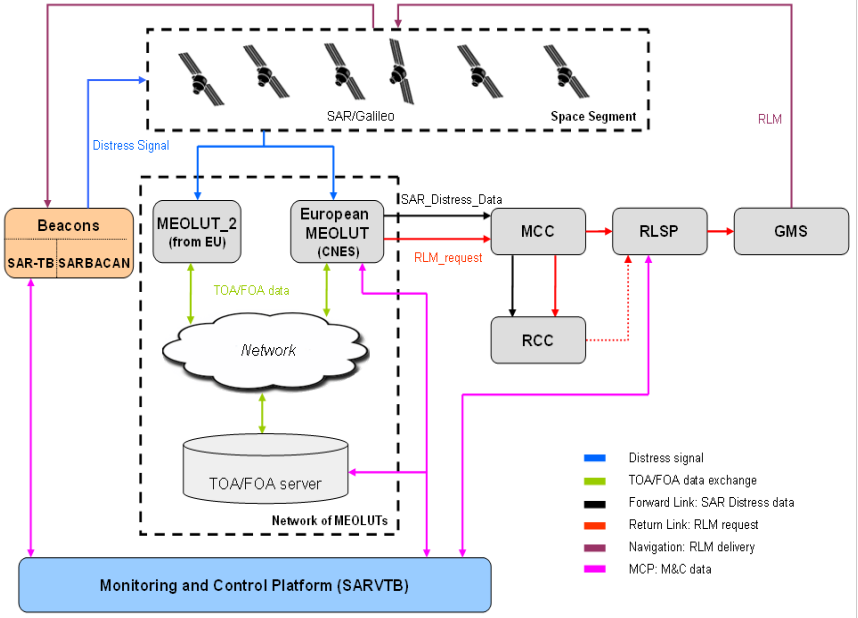
GSARSED OVERVIEW
Demonstration Scenarios Descriptions

Demo-3 : SAR/Galileo End-to-End

✓To assess the technical and operational performances of the SAR/Galileo service and contribute to the C/S MEOSAR PoC phase with the end-to-end demonstration of the European MEOSAR service.

Expected results:

- ✓ Localization accuracy within the requirements
- ✓ Emission of the RLM request with a response time within RLSP requirements
- ✓ RLM first transmission sent by the GMS within its response time requirement.
- ✓ Location of the test beacons used in the scenario
- ✓ Corresponding RLM requests containing a correct satellite dissemination list
- ✓ Reception by the test beacon of the acknowledgement of detection
- ✓ Feedback of the SAR community



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GSARSED OVERVIEW
Demonstration Scenarios Descriptions

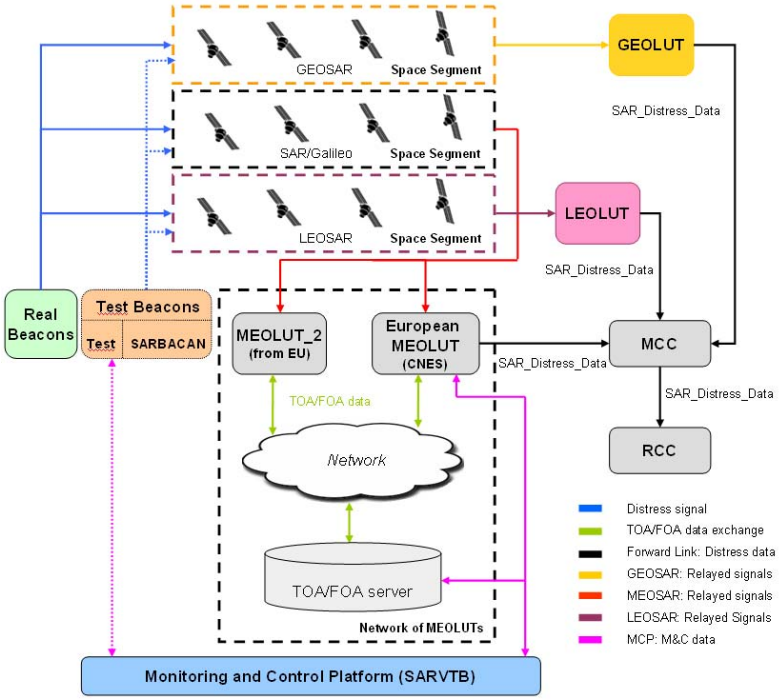
Demo-4 : SAR/Galileo enhancements

✓Inclusion of MEOSAR within the operational C/S system.

✓To localize real beacons emitting a SAR distress message in order to compare the operational results of the MEOSAR system with the provided by operational GEOSAR and LEOSAR systems

Expected results:

- ✓ Localization accuracy within the requirements
- ✓ Emission of the RLM request with a response time within RLSP requirements
- ✓ Location of the real beacons used in the scenario
- ✓ Comparison with GEOSAR and LEOSAR results
- ✓ Response time is also evaluated
- ✓ Feedback of the SAR community



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SUMMARY
Expectations

SAR/Galileo service will provide an enhanced support by:

- ✓Near real-time alert localisation and message detection
- ✓Backward compatibility with the COSPAS-SARSAT system
- ✓Higher beacon localisation accuracy for legacy beacons (below 2 Km average in less than 5 min). Much better for advanced beacons (GNSS-equipped)
- ✓High availability and global multi-satellite coverage
- ✓Return Link Service (new operational capabilities: false alert rate reduction, improve the psychological state of people in distress, etc)
- ✓Ground Segment concept will simplify operations
- ✓GSARSED demonstrations will emphasize the key features of SAR/Galileo as mentioned above

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