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THE SAR/GALILEO OPERATIONS: EVOLVING TOWARDS NEW SERVICES ASSISTING EMERGENCY MANAGEMENT FROM SPACE.

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Abstract

Since the declaration of its Initial Service in December 2016, Galileo has been providing uninterrupted Search and Rescue (SAR) Service globally which account for more than 2,000 lives saved per year. The SAR/Galileo Service, Europe's contribution to the international COSPAS-SARSAT MEOSAR System, plays a crucial role in world-wide SAR efforts thanks to the large space and ground segment components, emergency signals transmitted by distress beacons are timely and accurately located and its resulting data swiftly expedited to relevant authorities. Since 2020, the SAR/Galileo Return Link Service (RLS), a unique Galileo feature, provides users in distress with prompt confirmation that their distress alert has been well received by the relevant authorities and SAR responders.

The French Space Agency (CNES) embodies the SAR/Galileo Data Service Provider (SGDSP) for the European Union Agency for the Space Programme (EUSPA). The SGDSP is entrusted to operate the SAR/Galileo Ground Segment (SGS) and ensure the continuous provision of the SAR Galileo Services in accordance with the minimum performance levels defined in the SAR/Galileo Service Definition Document.

The Galileo System has been designed with high levels of redundancy and, to continue to provide world-class Services, is in continuous improvement to strengthen its operational, performance and functional capabilities. The Galileo System evolution is also driven by new innovative on-demand Services that further contribute the global emergency space operations, namely :

- Two-Way Communication (TWC): Provides bi-directional communication, through exchange of codes, between emergency beacons and SAR responders for a more adequate and efficient emergency response.
- The Remote Beacon Activation (RBA) on-demand RLS-based Service under definition that would enable the remote command of an emergency beacon, complementing other means of activation in response to ICAO's recommendation for Autonomous Distress Tracking.

In addition, leveraging the data broadcasting capabilities offered by the Return Link channel, Galileo is adding a new service for sending alerts to population directly on their standard PNT equipment:

- Emergency Warning Satellite Service (EWSS): Enabling National civil protection authorities with a satellite broadcasting capability to disseminate on-demand authenticated Alerts to a precise target area and its population directly to any device capable of processing Galileo signals without dependency on cell service.

As the above new Galileo Services progressively come online, they will enter in scope of SGDSP operations requiring adaptations in both the current operations and supporting infrastructure. This paper will present a high-level overview of the new SGDSP's CONOPS and the staggered steps that are being taken to address a safe rollout of the new Services within an operational environment.

Nomenclature

C/S, CS	=	Cospas/Sarsat	MEO Orbit	=	Medium-altitude Earth
CALBE	=	Calibration Beacon	MEOLUT	=	MEO Local User Terminal
CNES	=	French Space Agency			

CONOPS	=	Operational Concepts	MEOSAR	=	MEO Search And Rescue
DASS	=	Distress Alerting Satellite System	MTCF	=	MEOLUT Tracking Coordination Facility
ICD	=	Interface Control Document	PNT	=	Positioning, Navigation and Timing
EC	=	European Commission	RBA	=	Remote Beacon Activation
ECA	=	European Coverage Area	RCC	=	Rescue Coordination Centre
ERAS	=	Emergency Alerting System	REFBE	=	Reference Beacon
EUSPA	=	European Union Agency for the Space Program	RL/RLS	=	SAR Return Link/SAR Return Link Service
EWS/EWSS	=	Emergency Warning Service / Emergency Warning Satellite Service	RLM	=	Return Link Message
EWM	=	Emergency Warning Message	RLMR	=	Return Link Message Request
FL/FLS	=	SAR Forward Link / SAR Forward Link Service	RLSP	=	Return Link Service Provider
FLAM	=	Forward Link Alert Message	SAR	=	Search and Rescue
FMCC	=	French Mission Control Center	SARN	=	SAR Network
GMS	=	Ground Mission Segment	SDH	=	SAR Data Hub
GNSS	=	Global Navigation Satellite System	SGB	=	Second Generation Beacon
GSC	=	GNSS Service Center	SGS	=	SAR/Galileo Ground Segment
GSOp	=	Galileo Service Operator	SGSC	=	SAR/Galileo Service Centre
ICAO	=	The International Civil Aviation Organization	SGDSP	=	SAR/Galileo Data Service Provider
IOCA	=	Indian Ocean Coverage Area	SLA	=	Service Level Agreement
KCP	=	Key performance indicators Collection Platform	SPMCC	=	Spanish Mission Control Center
KPI	=	Key Performance Indicator			
MCC	=	Mission Control Centre			

Acronyms/Abbreviations

1. Introduction

The SAR/GALILEO Service is a contribution to the International Cospas-Sarsat System that is a global and free of charge satellite-based program allowing the detection and localization of distress beacons worldwide. Canada, France, USA and USSR founded the Programme in 1988. Today 45 countries or organizations contribute to the Programme either on the ground or in space segment. In 2023, the Cospas-Sarsat System provided assistance in rescuing 3,109 persons in 951 SAR events, which represents an average of more than eight people per day.

Since the Initial Services Declaration in December 2016, SGDSP is responsible for operating the SAR/Galileo Ground Segment (SGS) ensuring the continuous provision of the SAR Forward Link (FL) and Return Link (RL)

Services. It is also responsible for the continuous service monitoring and performance reporting in accordance to the minimum performance levels targets defined in the SAR/Galileo Service Definition Document [2].

Figure 1 below presents the SAR/Galileo Ground segment supporting the Forward Link and Return Link services (light green SGDSP blocks). It also provides an overview of its inclusion within the Cospas-Sarsat and Galileo systems. The description of these two systems is not part of the present paper, the focus is kept on the SAR/Galileo ground segment under SGDSP responsibility.

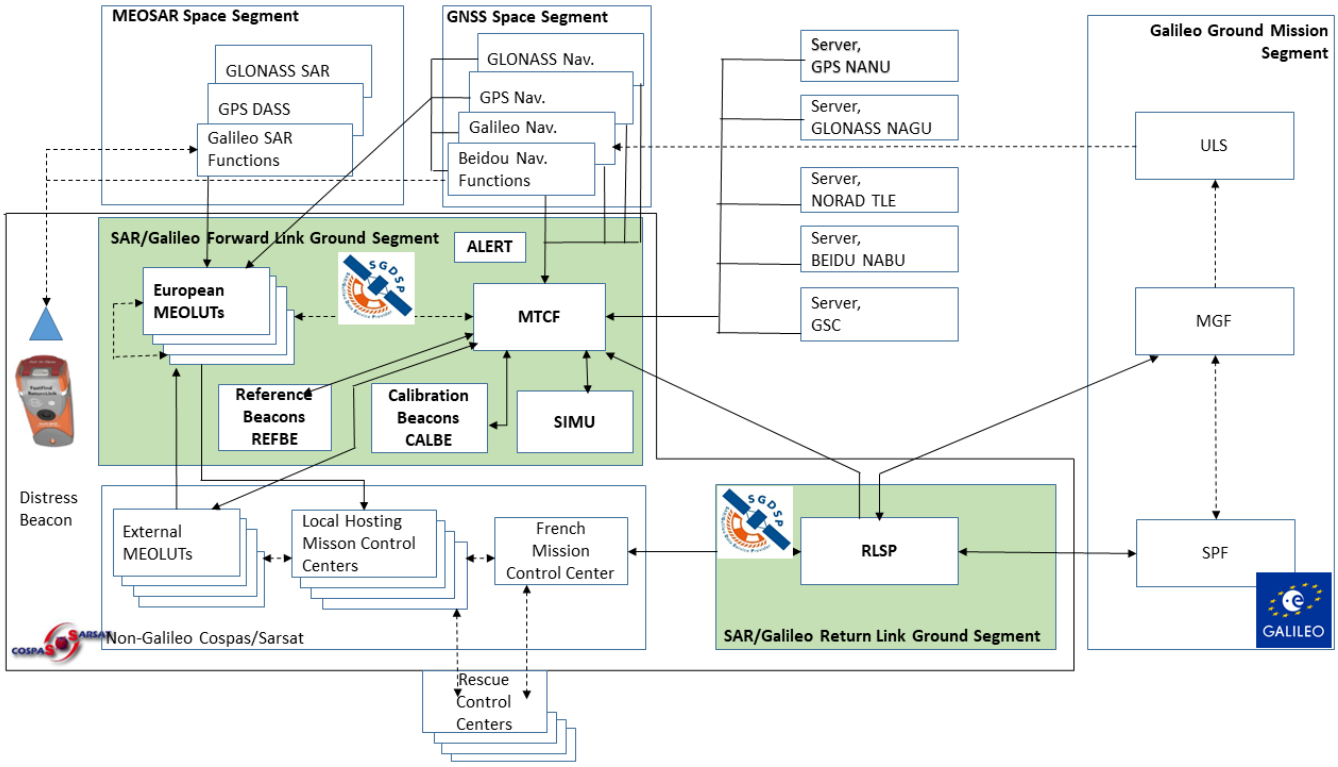

Figure 1- SAR/Galileo Ground Segment

The SAR/Galileo Ground Segment (SGS) is composed by:

- 4 European MEOLUTs located in Maspalomas (Gran Canaria, Spain), Spitsbergen (Svalbard), Larnaca (Cyprus) and La Reunion (France),
- 1 MEOLUT Tracking Coordination Facility located (MTCF) in Toulouse including the KPI Collection Platform functionality (KCP) (OPE and VAL chains),
- 6 SAR/Galileo Reference Beacons located in Maspalomas, Spitsbergen, Larnaca, Santa Maria, Toulouse, and Greenland to cover the European Coverage Area (ECA),
- 2 SAR/Galileo Reference Beacon in La Reunion and Kerguelen (in the French Southern and Antarctic Lands) to cover the Indian Ocean Coverage Area (IOCA)
- 1 SAR/Galileo Reference Platform for simulation and validation purpose (made of the VAL chains),
- 1 IOT-MEOLUT
- 1 SAR Network (SARN) connecting all these entities together as well as the 4 MEOLUTs with their local MCC,
- 5 Calibration beacons located in Maspalomas, Spitsbergen, Larnaca and La Reunion (x2),
- 1 Return Link Service Provider segment (RLSP) in Toulouse (OPE and VAL chains),
- 1 automatic notification system ALERT in Toulouse.

1 SAR/Galileo Ground Segment actors

The SAR/Galileo actors involved in the service provision are described in Figure 2 and Table 1 below :

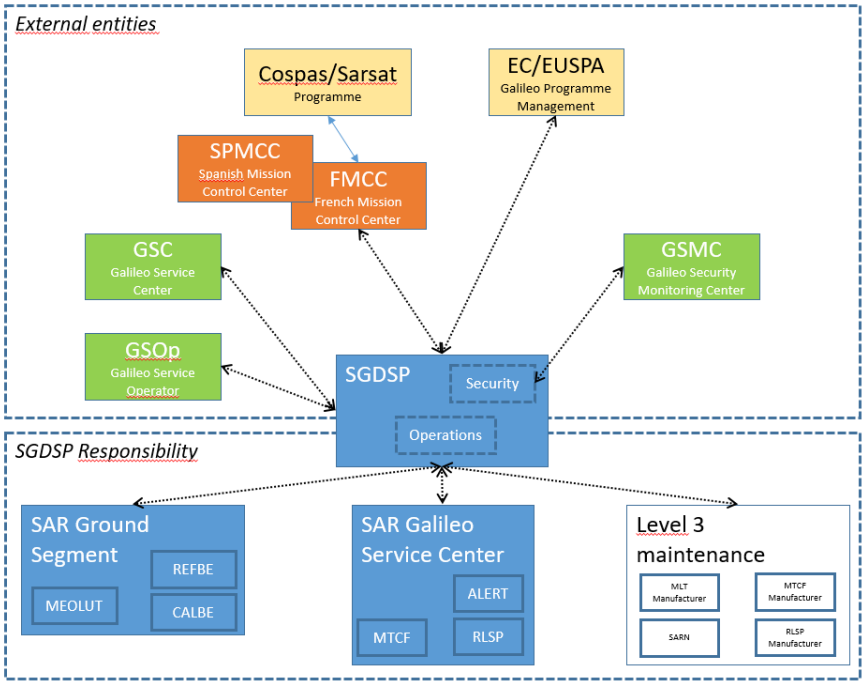

Figure 2- SAR/Galileo actors

The following table provides details for each of the entity depicted above (from top to down). The description provided is "operations" oriented to help understand the interfaces set up to manage the SGDSP operations.

The entities blue in the following table are the ones in the SGDSP responsibility perimeter and for which the processes described later in the document are applicable. The entities out of this perimeter are supposed to have their own operational management plan (when relevant).

Entity	Role / Responsibility	Type of OPS interface with SGDSP
EC (European Commission)	The European Commission is the Galileo Programme manager.	None
EUSPA	EUSPA is the Contracting Authority for SGDSP. It is the Galileo Programme Service Provider	Reporting, Problem management, Configuration Management, Planning.
COSPAS/SARSAT	The Cospas-Sarsat Programme is responsible for the provision worldwide of the SAR service through implementation and operations of the MEOSAR.programme. The European Commission provides a contribution to this programme through the SAR/Galileo Service.	Reporting (inc. availability of SAR Transponders)
FMCC (French Mission Control Center) – SPMCC (Spanish Mission Control Center)	The French MCC is in charge of coordinating the C/S service provided by France to C/S. From SGDSP perspective, the FMCC is interfacing with SGDSP to spread general status messages (SIT 605) to C/S community (MCCs) and to act as an interface between the Cospas-Sarsat network and the RLSP. The SPMCC acts as the backup of the FMCC for the Cospas-Sarsat/RLSP interface.	Routine operations, Planning, RLSP monitoring

Entity	Role / Responsibility	Type of OPS interface with SGDSP
GSC (Galileo Service Center)	The Galileo Service Center is the EUSPA entity in charge of interfacing with the user community. Through its website it broadcasts the Programme reference documents (SDD, ICD, etc..).	EUSPA SAR server, NAGUs, NASUs, Notifications
GSMC (Galileo Security Monitoring Center)	The Galileo Security Monitoring Center is the EUSPA entity in charge of the security monitoring of the system operations.	Security Incident management, Reporting (Cyber)
Galileo Core Infrastructure	The Galileo Core infrastructure is operated by the Galileo Service Operator (GSOp). Its role is to provide the Galileo Signal in Space with a committed quality. From SGDSP point of view, the GSOp is responsible for the SAR payload on-board the space segment and the upload of return link messages (RLMs).	Reporting, Routine OPS interfaces (planning, anomalies), Incident management, SSEG status
SGDSP (SAR Galileo Data Service Provider)	The SAR/Galileo Data Service Provider (SGDSP) is responsible for the management of the operations and maintenance (L2) of the SAR/Galileo service ground infrastructure and the monitoring of the performances of the SAR/Galileo service.	N/A
EU hosting sites (EUMLT + REFBE)	The hosting sites providers are the entities responsible for the hosting, on-site operations and 1st line maintenance of the SAR/Galileo facilities (MEOLUTs, Reference Beacons). They are located in Maspalomas, Spitsbergen, Larnaca, and La Réunion for the MEOLUT/REFBE and in Santa Maria for one REFBE	Routine operations, Planning, Problem management (anomalies and incidents), Reporting, Maintenance
SGSC (SAR Galileo Service Center)	The SAR Galileo Service Center is responsible for the hosting, on-site operations and 1st line maintenance of the facilities hosted in CNES (MTCF, RLSP, Toulouse REFBE).	Routine operations, Planning, Problem management (anomalies and incidents), Reporting, Maintenance,
L3 manufacturers	The SAR Ground Segment Manufacturers are responsible for the 3rd line and evolution maintenance of the SAR/Galileo facilities.	Maintenance (corrective and evolutive), Problem management
SARN Provider	The SAR network is managed by a CNES IT entity that is responsible of the 1st and 3rd line maintenance of the system.	Routine operations, Maintenance

Table 1 - SAR/Galileo actors and responsibilities

2 The Return Link Service

The SAR/GALILEO introduced in January 2020 a new key SAR function called Return Link Function, which provides through the dedicated facility RLSP (**R**eturn **L**ink **S**ervice **P**rovider) an automatic acknowledgment to the distress beacon. The RLS allows the users in distress to be promptly informed that their distress alert has been well received on ground, such reassurance delivers a valuable psychological lift to victims and boosts survival rates by reducing panic and improving confidence in the rescue system.

Through the Acknowledgement RLS provision, the SAR/GALILEO plays a very important role in the Cospas-Sarsat system, providing by first time the possibility to provide feedback from the SAR System to the beacons in

distress. It is important to note that Galileo, through the RLSP, is the only GNSS system committed to enable the Return Link service.

Evolutions on Return Link were presented in [1].

As well as the Acknowledgement Service being a great improvement from the current Cospas-Sarsat operations, additional services are also under study by European institutions. In that way, the EC has started various projects to demonstrate: reliable, standardized, low latency, Galileo-based services that will enhance global safety and security.

2.1 *How does it work*

Figure 3 below presents the Cospas-Sarsat MEOSAR system.

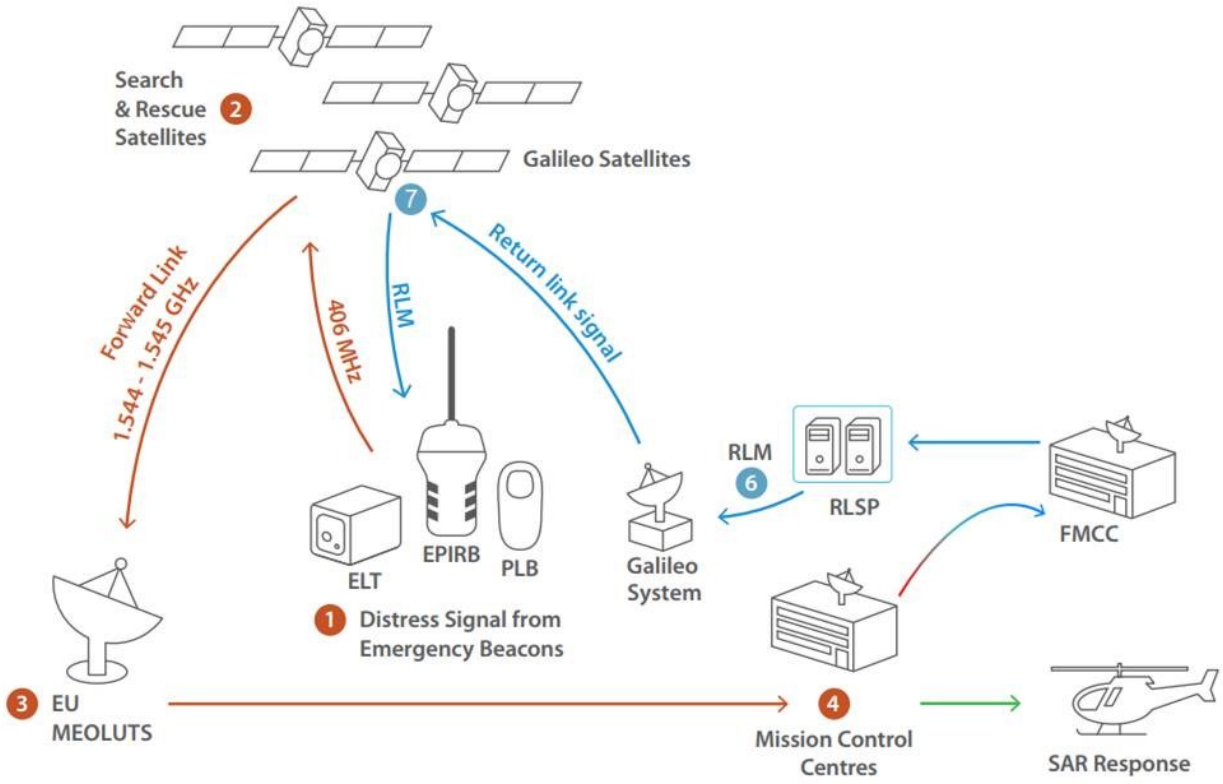

Figure 3 - The Cospas-Sarsat MEOSAR system

Galileo supports the **Search And Rescue service** by equipping its satellites with a SAR Payload that pick-up 406 MHz beacon distress signals**(1)**.

Relayed signals from the different satellites are received by one or several Medium altitude Earth Orbit Local User Terminals (EU MEOLUTs) **(2).**

The EU MEOLUT is in charge of determining the location of the beacon, either by demodulating the beacon message or by processing the times of arrival (TOA) and Doppler shifts of the received signals (FOA). **(3)**

The EU MEOLUT then sends the estimated beacon position and other relevant data to a Mission Control Centre (MCC) **(4)**

This MCC communicates with the Rescue Coordination Centre (RCC) and the Return Link Service Provider (RLSP) through the French MCC. The FMCC sends a Return Link Message Request to RLSP.

The RCC is in charge of launching a rescue operation.

RLSP sends the RLMR to GMS **(6)**

GMS inserts the RLM data in the C band mission uplink **(7)**

The Return Link Message is downlinked to the beacon in the I/NAV signal in E1B **(7)**.

The RLS capable Emergency Beacon will receive these RLMs. Upon reception, the acknowledgement will be visible to user, thus indicating that rescue teams are on their way.

2.2 *Performances*

In order to fulfil the SAR/Galileo Services commitments declared in the Service Definition Document, SGDSP is continuously collecting and computing Service metrics and performance indicators. Since its entry into service, the RLS has achieved a measured availability greater than 99.9% and an average latency for the delivery of the Return Link signal (RL) within few minutes.

The KPI are computed using a network of stations spread over the world, as showed in Figure 4:

Figure 4 - REFBE and REGINA Stations Geographical Position

In term of availability, the Return Link facilities reach very high level of expectations and have proven their robustness since their commissioning as shown in Table 2:

	RLSP Availability (Target=99%)	
	Operational	**Not Operational**
December 2024	**100.0%**	**0.0 %**
Last 12 months	**99.96 %**	**0.04 %**

Table 2 - RLSP Availability over a year

Even in term of latency, the figures calculated over 12 months (period from January 2024 to December 2024) are excellent, as shown in Table 3 :

Return Link Message Latency			
Coverage	*Percentage of RLM received under 5 min*	*Percentage of RLM received under 15 min* ***(Target: 99%)***	*Mean latency (seconds)*
	Last 12 months	Last 12 months	Last 12 months
ALL Beacon	**98.98 %**	**99.18 %**	**30 seconds**

Table 3 - Return Link Message Latency over a year

More in detail, the performance of the Return Link in terms of latency for the delivery of the RLM messages was within 5 minutes 98.98% of the time and the mean latency computed over 12 months was of about 30seconds.

These excellent performance targets have paved the way to develop additional Galileo Services.

3 Future Galileo RLM-Based Services

The broadcasting capabilities provided by RLS (i.e. return communication link) offers the capability to reach any end user worldwide, enabling key differentiators in the field of the Search and Rescue and Emergency Management to be developed.

The SAR/Galileo has the ability to send Return Link Messages (RLM) and with this unique way of reaching the beacons several possibilities are now available. Several new services are currently being developed, at different stages.

- *Remote Beacon Activation (RBA)* : The Remote beacon activation is one of the extra features that are under study by the Galileo Programme. This capability will allow the Rescue Coordination Centres (RCC) or Aircraft companies for instance to trigger a SAR beacon on board of a vessel or an aircraft, as an additional (and optional) means of activation. Once activated, the beacon will start transmitting distress alert messages which are detected by Galileo SAR payloads and the position of the beacon will be confirmed to the Authorised User allowing its tracking, which will facilitate search and rescue operations
- *Two-Way-Communication (TWC)* : The two-way-communication (TWC) is a capability, enabling to retrieve additional information directly from the people in danger. It will allow the user in distress to send short pre-defined messages in response to SAR Forces and Rescue Coordination Centres questions, this will greatly improve facilitate the rescue operations. Often in a distress situation, mobile phone communications are not available, so the use of a satellite link is very useful. In such a case, the Rescue Control Centres (RCC) will be able to activate and send, via the RLS channel, Questions or Messages on an activate beacon, in order to retrieve information about the distress situation or give instructions.
- *Emergency Warning Satellite Service (EWSS)* : The goal of the future EWSS service is, in case of disaster, to provide the ability to reach the population on a large scale and in a timely manner, including in cases where traditional ground-based warning systems cannot operate at full capacity or have collapsed. The advantages of the Galileo EWSS service are that it will be complementary to existing means, free of charge, resilient, independent of terrestrial infrastructure, versatile, fast and geo-targeted

This paper will focus on the operational implementation of the EWSS and TWC for which the design phases are more advanced.

3.1 *Two-way Communication*

The two-way communication (TWC) service is a SAR/Galileo service which uses both the Forward Link (for SGB only) and the Return Link channels to exchange messages between the RCC and the user for an active 406 MHz distress beacon. The TWC service is designed for beacon with an identified and reachable user, i.e. beacons with

manual activation capability and portable beacons. This service is applicable to Second Generation Beacons (SGB) only and makes use of the flexibility provided by the rotating field in the forward link message. The TWC will have the following features:

- Capability for the beacon user to provide pre-defined answers to a set of pre-defined questions available at beacon level. These answers are sent to the RCC (through the FLAM) to provide more details on the distress situation and improve the rescue operations preparation,
- Capability for the RCC to request additional answers to the beacon user (through the RLM),
- Capability for the RCC to send information to the beacon user related to the particular distress situation,
- Capability of the system to have confirmations from both sides that the data has been received (acknowledgments).

3.1.1 TWC Actors

Table 4 captures the main TWC Actors (Organisations and/or Entities) and associated roles and responsibilities across the end-to-end Service Provision.

Entity	Role	Main Responsibilities
EC (European Commission)	Galileo TWC Service Provider for C/S.	EC is responsible of the Galileo TWC service provision
EUSPA	TWC Service Provider	EUSPA is accountable to EC for TWC exploitation & service provision on behalf of EC.
SGDSP/SGSC	TWC Service Operator	The Galileo TWC Service Operator operates the TWC Service within the Galileo System. SGSC hosts and maintains the TWC infrastructure and its configuration control. SGDSP ensures that all the TWC L1 and L2 operations are executed in a safe, secure and orderly manner that provides the continuity of service provision. It monitors and reports the TWC infrastructure key elements and related Service performance values.
GSOp	Galileo Core Infrastructure Operator	Galileo Core Infrastructure GMS inserts the RLM data in the C-band mission uplink (Return link signal), the Return Link Message is downlinked to the beacon in the I/NAV signal.
ESA	Galileo Design Authority	ESA is responsible for design and evolutions of the Galileo Core Infrastructure
Cospas-Sarsat Program	Cospas-Sarsat Authority	C/S ensures the compatibility of the Cospas-Sarsat distress alerting services with the needs, the standards and the applicable recommendations of the international community. C/S is responsible for the definition of the service.

Entity	Role	Main Responsibilities
SAR Forces	Rescue coordination	The SAR forces provides the rescue means as SPOC and RCCs
Industry	Beacon Manufacturer	Development and sales of distress beacons
Individual	Beacon User	Owns & activate alert on distress beacons

Table 4 - TWC Actors

3.1.2 Operational Concept

The two-way communication service system is composed of :

- The Galileo Core infrastructure, including the Galileo Mission Segment (GMS) and the Galileo Space Segment (SSEG);
- The Cospas-Sarsat distribution network, including the MCCs;
- RLSP/TWC Service Providers : provides the TWC Interface, (web interface to enable the communication between the beacon and the RCC) and the RLSP element;
- The Rescue Coordination Centers (RCC);

The SAR/Galileo Two Way Communication (TWC) is a new capability for Second Generation Beacons (SGB) allowing to establish an effective communication channel between SAR Forces and the Beacon User through a web interface and RLS (see Figure 5):.

(1) Activated beacon sends distress Alert messages

(2) Messages are detected and the beacon is located.

(3) An initial set of automatic questions prompted to the user allowing SAR forces to increase the SAR operation success.

(4) Communication is performed through codes defined in shared Libraries (i.e. 101010 equal Fire)

(5) SAR Services can establish a communication channel through a Web interface enabling them to submit follow-on questions.

This new service intends to increase the SAR Ops preparation & awareness during SAR operation. It shall also allow an early False Alert identification. As a reminder, 97.32% in 2024 for the FMCC service areas were false alarms.

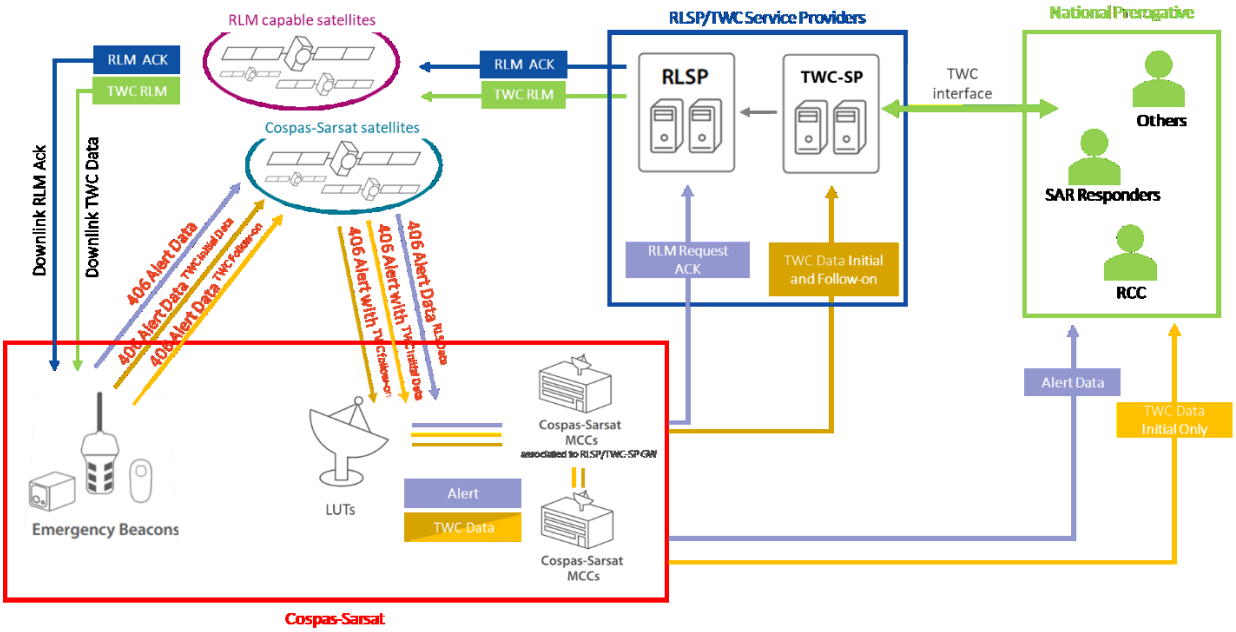

Figure 5 -.TWC Operational Concept

A conversation is engaged between RCC and the beacon's owner with the help of pre-determined questions.

The communication is performed through codes defined in shared Libraries in both the Beacon and the TWC provider and RCCs (i.e. 101010= Fire on board). TWC Questions, Answers and Messages are exchanged as codes.

Initial Automatic Questions (IAQs) have been defined in close cooperation with active SAR and RCC operators, resulting in a no-nonsense approach, like:

- « how many people do need help? » (1, 2-4, 5-8, etc …)
- « do you need medical assistance? »
- « What is the nature of distress? » (Water/Maritime, Land, Air, Lost, etc …)

Responses trigger supplementary questions to further detail the distress scenario.

Follow-on Questions are divided in two main categories:

- Question common to all cases (medical condition, equipment & supplies available, etc..) Ex: geographical surroundings (In water (river/sea/lake), Down a cliff/ravine, In a hole/rift, In a plain, In desert, In a tree, In forest/jungle, In snow, In mountain, In high mountains) , …)
- Questions specific to the nature of distress (Water/Maritime, Land, Air, Lost, etc …), 1. Ex: « Are there Life Rafts available? » (Yes, Yes and donned, No or don't know)

3.1.3 From demonstration to Service Provision

The Two-way communication concept has been proofed during various demonstration through the Serenity project held by the EC in 2022.

In the next steps, Cospas-Sarsat will release specification documents [3] [4] & [5] providing the Question/Answer/Instruction dataset beta release (English version).

By the end of 2025, the European Commission and EUSPA will launch a TWC Pilot Capability bringing the essential features of TWC (e.g. RCC web-interface) into operation allowing RCCs and final Users early-access and preparation

prior the service provision phase. This phase will generate valuable user-feedback that will be injected into the final operational infrastructure. The pilot capability will be offered in a controlled 'testing mode' only for beacon manufacturers and SAR operators prior enrolment.

In order to implement the pilot capability, some evolutions are necessary on system elements before service can become operational :

- MCCs shall adapt to be able to process the message added of TWC information
- The TWC Interface shall be procured
- The RLSP shall adapt to interface with TWC user Interface
- The development of SGBs beacons with TWC capability is required

In parallel of the pilot phase, the operational infrastructure will be procured and deployed by EUSPA, the following elements are foreseen: :

- TWC-PC Front-End: in charge of providing the TWC Interface as well as a helpdesk functionality.
- TWC-PC Back-End: responsible for all the TWC processing of the alerts, validation and interfacing with the RLSP component for further final uplink to the Galileo satellites.
- TWC-PC MCSA: A monitoring and control platform allowing the SGDSP to perform its operational duties as well as to generate the needed performance metrics. .

The performance target for TWC are being specified at time of writing this article and are preliminary as follow:

- The latency time from the RCC request to RLM dissemination shall be less than 3 minutes with a 99% probability (TBC).
- The TWC shall be provided with a monthly availability of at least 95% (TBC).

3.2 *Emergency Warning Satellite Service*

National Civil Protection Authorities' most important tools for saving lives, reducing risk for emergency service personnel, and cutting costs is **warning citizens of emergencies**. Indeed, natural disasters can cause major losses in terms of human life and financial damage. As a result, there is a growing need for the implementation of early warning systems that address the need for the protection of civil population and physical installations.

In 2015, the United Nations adopted a new framework for Disaster risk reduction, the Sendai Framework. The 5th target within this framework recommends nations to "substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030". EWSS is the EU contribution to this target.

In its regulation (EU) 2021/696 establishing the Union Space Programme, the European Union introduces EWSS as a new service in the Galileo portfolio of services aimed at broadcasting a warning message to population facing an upcoming threat (natural- or man-made-hazard): the Emergency Warning Satellite Service (EWSS). As established in article 45§e of this regulation, "the services provided by Galileo shall comprise […] an emergency service, broadcasting, through emitting signals, warnings regarding natural disasters or other emergencies in particular areas".

EWSS is designed as an early warning system that would supplement those currently in place in EU Member States. Galileo offers, thanks to its special features, a possibility to reach out population on a large scale, including in the cases where the conventional terrestrial alerting systems cannot operate at full capacity or even collapse. Member States and their administration and services will still be competent in deciding to initiate an advisory, a warning, or an alert over their jurisdiction. The following are the primary capabilities provided by the Galileo infrastructure that can be used in the context of EWSS:

- Single point of access to Galileo infrastructure for national alert services,
- Worldwide access via the Galileo Signal in Space, independently of terrestrial mobile or internet access,
- Dissemination of an advisory/warning/alert message, including associated instructions to react,
- Authentication of the message by using the OSNMA capability,
- Geo-location information encoded in the message used to target only the relevant population.

Galileo Second Generation will deliver EWSS as one of its new services, however the European Commission (EC) believes that benefits could be gained if the service were to be launched now, at least in an initial capability mode.

3.2.1 EWSS Actors

Table 5 captures the main EWSS Actors (Organisations and/or Entities) and associated roles and responsibilities across the end-to-end Service Provision.

Entity	Role	Main Responsibilities
EC (European Commission)	EWSS Service Owner.	EC is responsible of the EWS service definition and service declaration.
EUSPA	EWSS Service Provider	EUSPA is accountable to EC for EWS provision and authorises EWS-ADP, on behalf of EC. With the contribution of the EWS Service Operator, EUSPA is responsible for EWS-ADP initial training. EUSPA is responsible for developing an EWS mobile application and EWS application programming interface with EWS-PC.
SGDSP	EWSS Service Operator	The Galileo EWSS Service Operator operates the EWS Service within the Galileo System. The Operator is responsible for the execution of EWS-ADP training. SGSC hosts and maintains the EWS infrastructure and its configuration control. SGDSP ensures that all the EWS L1 and L2 operations are executed in a safe, secure and orderly manner that provides the continuity of service provision. It monitors and reports the EWS infrastructure key elements and related Service performance values.
GSOp	Galileo Core Infrastructure Operator	Galileo Core Infrastructure receives EWM from the RLSP/EWS-PC and manages their broadcast in the Galileo Signal in Space. Galileo Core includes the Ground Mission Segment (GMS), the Uplink Stations (ULS), the Ground Control Segment (GCS) and the Galileo satellites

Entity	Role	Main Responsibilities
Authorised Data Providers (MS Civil Protection Authority)	EWS Authorised Data Provider (EWS-DP)	Authorised Data Provider – are typically EU Member States' Civil Protection Authorities – needs to conclude an EWS-ADP User Agreement with EC/Galileo (via the EWS Service Provider), agreeing to the requirements for training, testing frequency, and obligations to keep information up to date. Third Countries' Civil Protection Authorities may become EWS-ADP through a similar process.

Table 5 - EWS Actors

3.2.2 Operational concept

EWS allows Authorised Data Providers (EWS-ADP), typically Member States' Civil Protection Authorities, through a dedicated interface, to submit Emergency Warning Message requests for the broadcast of Emergency Warning Messages (EWM) to a population in a target area.

Before an EMW request can be sent, initial conditions must be met:

- The EWS Authorised Data Provider (EWS-ADP) has concluded a legally binding EWS-ADP User Agreement with EC/Galileo and is thereby authorised to use the EWS;
- The EWS-ADP has registered Point(s) of Contacts and individual users of the service in the EWS-ADP User Database;
- The EWS-ADP has integrated access to EWS-ADP User Interface into their workflow;
- The EWS-ADP has successfully tested EWM requests.

The Concept of Operations consists of the following steps (see Figure 6):
(1) The EWS-ADP identifies emergency alert eligible event and authenticates itself to the EWS-PC using the assigned credentials and access rights.
(2) The EWS-ADP makes an Emergency Warning Message (EWM) request through a dedicated EWS-ADP User interface. The EWS-ADP either submits an authenticated file formatted in CAP standard [6] or manually generates an EWM request via the EWS-ADP User Interface.
(3) The EWM request is received, validated, and acknowledged by the EWS Processing Component (EWS-PC) which then generates an Emergency Warning Message (including signature) from the content of the EWM request. The EWM format allows the encoding of the type of event, its characteristics (such as severity, time of onset, expected duration, etc.), target area, guidance to react, and more. The EWS-PC transmits them to Galileo.
(4) Galileo uplinks the EWM to the selected satellites based on the target area encoded in the EWM who then broadcast it via the Signal-in-Space. The EWM (including signature) is embedded in the Galileo Open Signal, as part of the navigation data.
(5) The EWM can be received by any user equipped with an EWS-capable receiver in view of the broadcasting satellites (typically mobile phones). The receiver decodes the EWM, authenticates it, translates it using the Guidance-to-react Library and displays it according to Display Validation Rules which among others consider if the receiver is located within the target area encoded in the EWM.
Throughout this process, the EWS-PC receives acknowledgements from Galileo and provides acknowledgements and feedback to the EWS-ADP via the secure EWS-ADP User Interface.

(6) The EWS-PC acknowledgement event is published on internet.

In order to maximise reception of the EWM at User-level (step 5), each EWM will be broadcast several times (step 4) by Galileo during the event expected duration. The repetition rate, between 1 minute and 1 hour, will be selected by EWS-PC with regard to the service capacity.

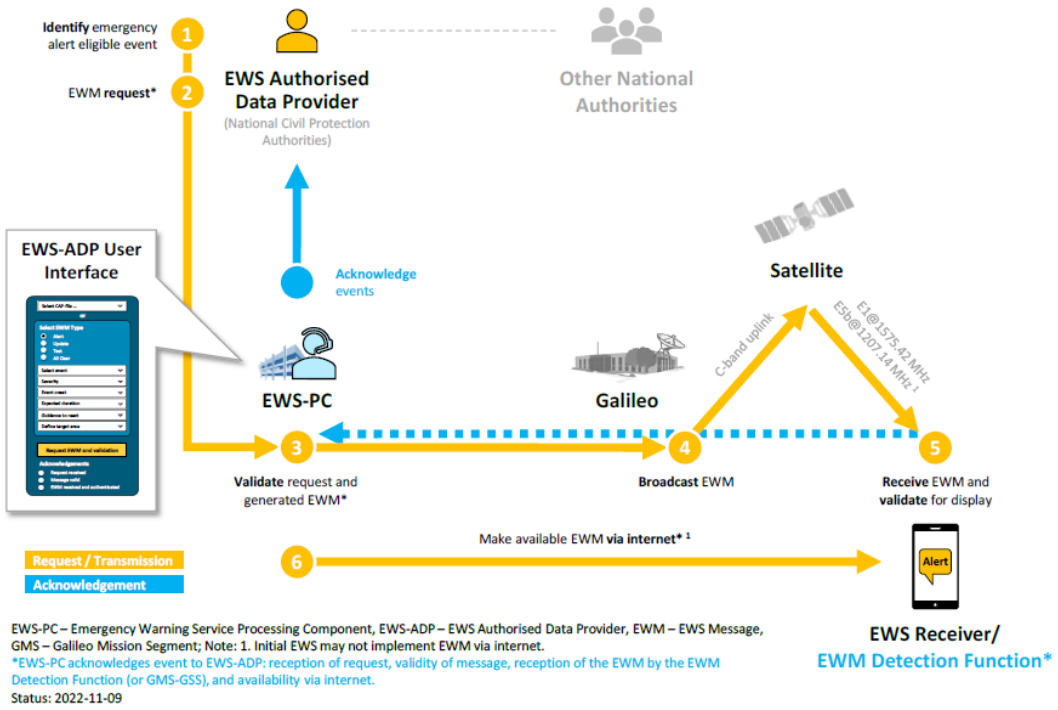

Figure 6 - EWSS Concept of Operations

3.2.3 From demonstration to Service Provision

The EWSS concept was proofed during several demonstrations in 2023, led by EC. The results were very successful and a EWSS Pilot phase was established in 2024. The first demonstration with a National Authority was held in August 2024. Since then, several countries have participated in demos and have shown interests in adopting the new Services within their national protocols.

To run the demonstration, ADPs are provided with the following materials (see Figure 7), composed of a smartphone with Android Stellar application installed (1), a Galileo NavBox (2) able to decode the EWM, a GNSS antenna (3), a power bank (4) and a set of cables (5).

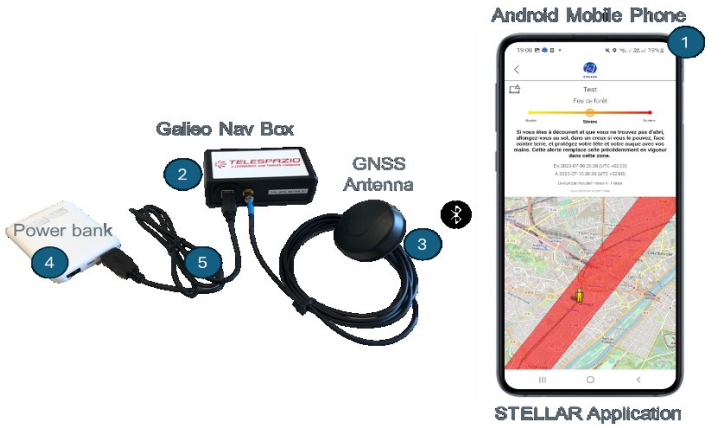

Figure 7 .EWS ADP's demonstration kit

The EWSS interface (website application), used to create ADP's alerts, is deployed on pilot infrastructure hosted within the SAR/Galileo Service Centre. The alert can be manually defined or imported through a formatted file. It contains the following parameters:

- General configuration (type of alert, severity, name of alert)
- Content of event (hazard type, guidance to react, Event date and duration)
- Danger Area definition (see Figure 8)

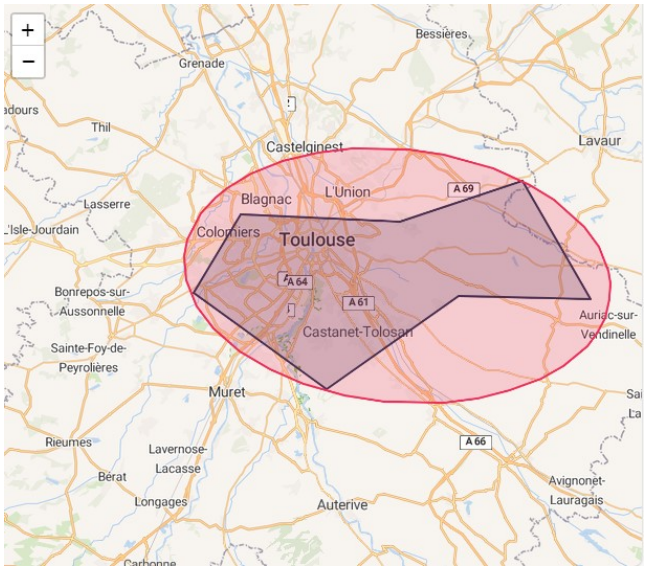

Figure 8 - Danger Area example

In parallel of the pilot phase, the Service Provision Phase is being prepared. EUSPA is procuring the operational infrastructure that will support the declaration of the Service including:

- EWS-PC Front-End: in charge of providing the EWS-ADP User Interface, used by ADPs to define the alert and the interface for the operators and the helpdesk functionality.
- EWS-PC Back-End: responsible for receiving Service Requests, validating and processing them which will generate the Return Link Message Request (EWMR). The EWMR is the consolidated message provided to the RLSP component for further processing, prior sending an RLM to GMS and/or to GSC.
- EWS-PC MCSA: allows performing the system monitoring, KPI computation & reports. It also provides the access to the EWS Service Operator to administrate the platform.

ERAS will interface with other components of the SGS :

- SDH : to exchange the navigation data
- RLSP : to exchange EWMR& ACKS
- ALERT: to raise alerts to the operational team.

SGDSP will be in charge of the qualification & service provision for the EWS segment composed of the elements ERAS, SDH, RLSP, ALERT.

The EWSS operational infrastructure is targeted to be qualified during the second half of 2025 allowing a readiness for Initial Operations early 2026. EUSPA is also currently working with mobile manufacturers to include this function natively in their devices.

A ramp-up in the service provision is foreseen in the coming years, aligned with the growing number of ADP's accounts, to reach 600-800 accounts and 24/7 service.

4 Conclusion

The TWC & EWS new services are under advanced stages of development and SGDSP is fully involved in the definition and commissioning of these new services for operations. The TWC will provide the SAR forces with information on the type distress to adapt the response to the situation. The EWSS will add a complementary system to existing alerting systems based on ground infrastructure. The pilot capabilities of both Services have proven to be a great scheme to gradually introduce new capabilities. The extension usage of the return link will bring new challenges in terms of performances, to address these new demands on space segment, Galileo Second Generation satellites (G2G) will bring significant improvements to the Return Link capability.

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