ICAR CONGRESS 2024

THESSALONIKI - GREECE

15-20 OCTOBER 2024

GALILEO, CHALLENGES AND FUTURE IN PLBs

RESCUE INTERNATIONAL

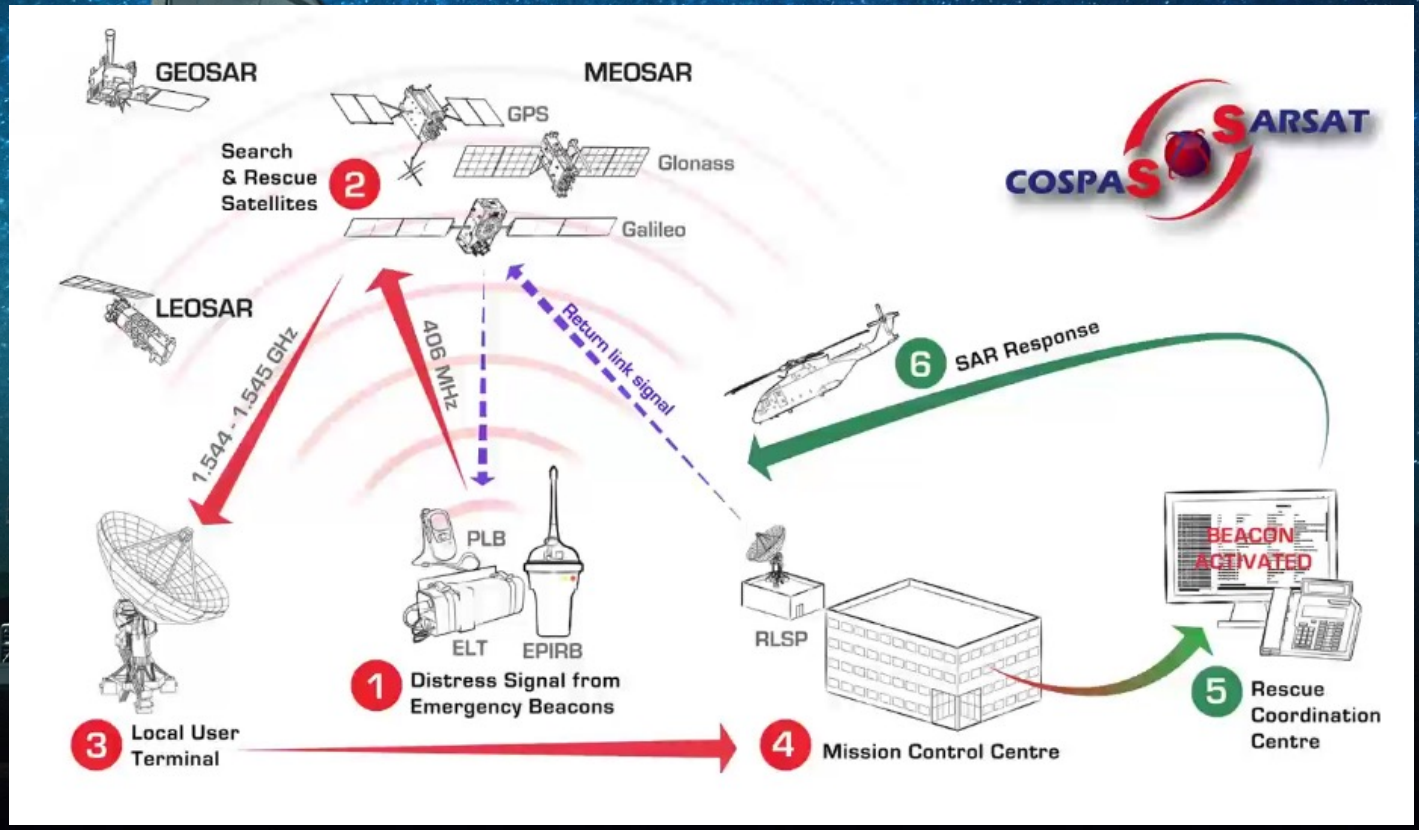
HUMBERTO HINESTROSA
RESCUE INTERNATIONAL
THE NETHERLANDS

SARSAT-COSPAS CURRENT STATE

RESCUE INTERNATIONAL

406 Beacons	Satellite constellations	Local User Terminals –LUT	Mission Coordination Centers –**MCC**s	Rescue Coordination Centers –**RCC**s	Emergency Services
• ELT • EPIRB • **PLB**	• **Galileo (EU)** • **METEOSAT (EU)** • SARSAT (US-CA-FR) • GPS (US) • DASS (US) • Glonass (RU) • Cospas (RU) • Electro-L (RU) • Louch (RU) • INSAT (IN) • BeiDou (CN)	• LEOLUTs • MEOLUTs • GEOLUTs	• FMCC (FR) • USMCC (US) • SPMCC (ES) • CMC (RU) • JAMCC (JP) • AUMCC (AU)	• Your country RCC	• Your organization Here (maybe) • Aeronautical Authority • Police • Firemen • Coastguard • Mountain Rescue • Etc.

SARSAT-COSPAS CURRENT STATE



BEACON TYPES

ELT

(Emergency Locator Transmitter)

Source: Rescue International

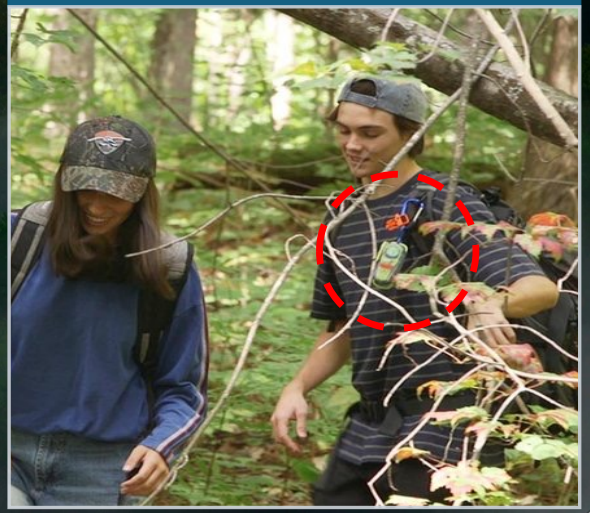
EPIRB

(Emergency Position Indicating Radio Beacon)

Source: NOAA

PLB

(Personal Locator Beacon)



Source: NOAA

BEACON TYPES

ELT

(Emergency Locator Transmitter)

Source: Acrartex

EPIRB

(Emergency Position Indicating Radio Beacon)

Source: Ocean Signal

PLB

(Personal Locator Beacon)

Source: Ocean Signal

PERSONAL LOCATOR BEACONS -PLB

RESCUE INTERNATIONAL

Not to be confused with satellite tracking and messaging devices such as:

SPOT (Globalstar)
InReach (Iridium)
Bullit
iPhone
Etc...

PERSONAL LOCATOR BEACONS -PLB

	406 Beacons	Commercial Messengers
Legal	ICAO/IMODoc.9731 IAMSAR	Depends on local laws and local SAR
Functions	Distress signal and return link only	SOS function, messenger, tracking
SOS transmission (1)	Continuous until switched off or until battery dead	Until message burst ends, in SOS goes tracking
SOS transmission (2)	RF continuous transmission and/or GNSS	Needs GNSS position first, then transmits that position
Homing frequency	Yes, AM121.5MHz (analog)	No
Battery	Average 7yrs.	Needs to be charged/Batt is used while performing other functions
Service	Free and unlimited	Paid and limited to subscriptions
Message	Received by RCC	Received by operator and family/friend

PERSONAL LOCATOR BEACONS -PLB

Beacons may be subject to legal obligations in 193 countries: A State must have the domestic legal framework in place to implement a national SAR system **to meet its international SAR commitments (Doc 9731-1 6.4.2)**

ICAO's Annex 12 and the International Convention on Maritime Search and Rescue requires availability and response times to beacon distress signals

- **Doc 9731-1, 6.5.2:** All SAR incident aspects must be **sensitive to timeliness**, i.e. alerting, planning transit, location and rescue. Information derived from survival data and incidents involving fatalities indicates that two (2) hours is generally the average critical time within which persons in distress must be rescued in order to survive. **Initial action should begin within FIVE MINUTES of initial notification of a distress incident.**
- **Doc 9731-1, 6.5.6: Transit time must be minimized**. SRUs **should get under way** and arrive at the distress location, or in the search area if the actual location is not known, **WITHOUT DELAY**.

PERSONAL LOCATOR BEACONS -PLB

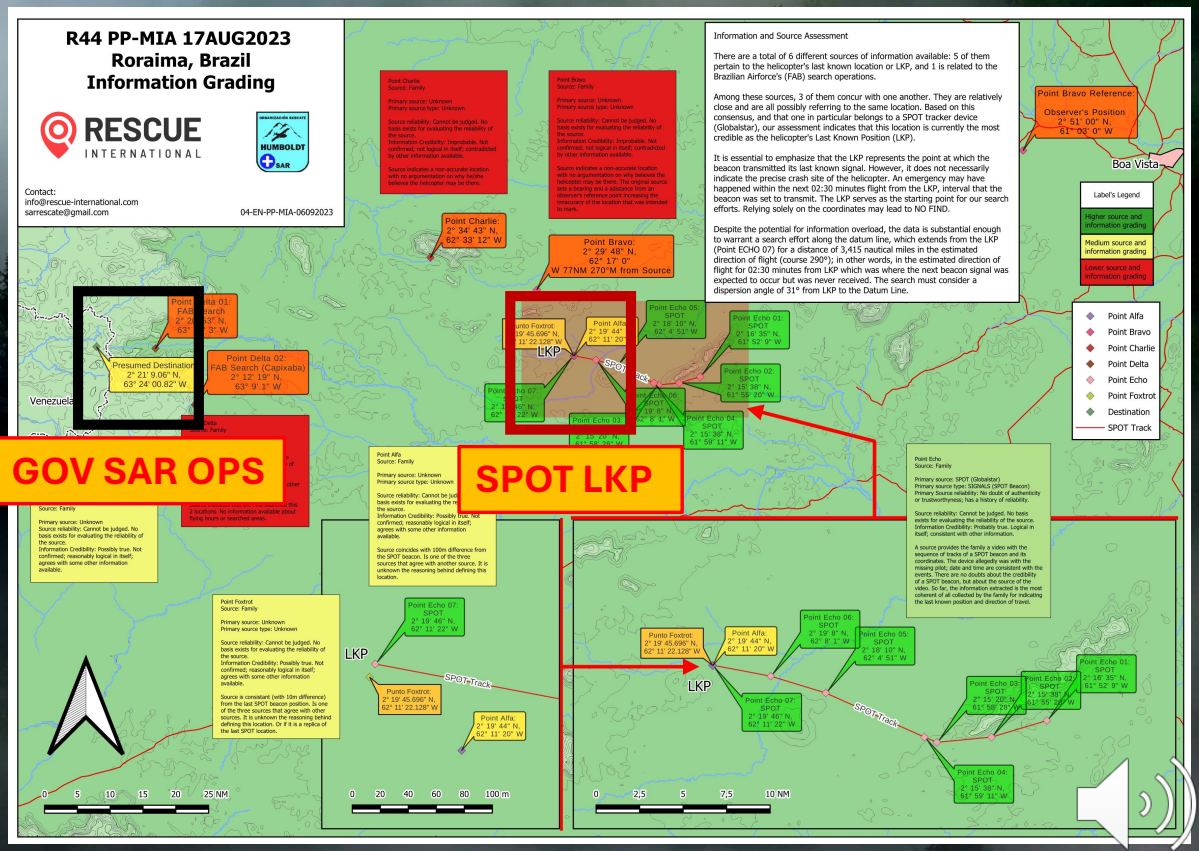
Brazil 2023 –Helicopter Missing

Authorities **dismissed tracking signal** coming from a commercial satellite messenger **SPOT**

Authorities locked in an area **~75NM far from LKP**

Aircraft was **never found**

Unfortunately, this is not the only case where commercial beacons are disregarded



PERSONAL LOCATOR BEACONS -PLB

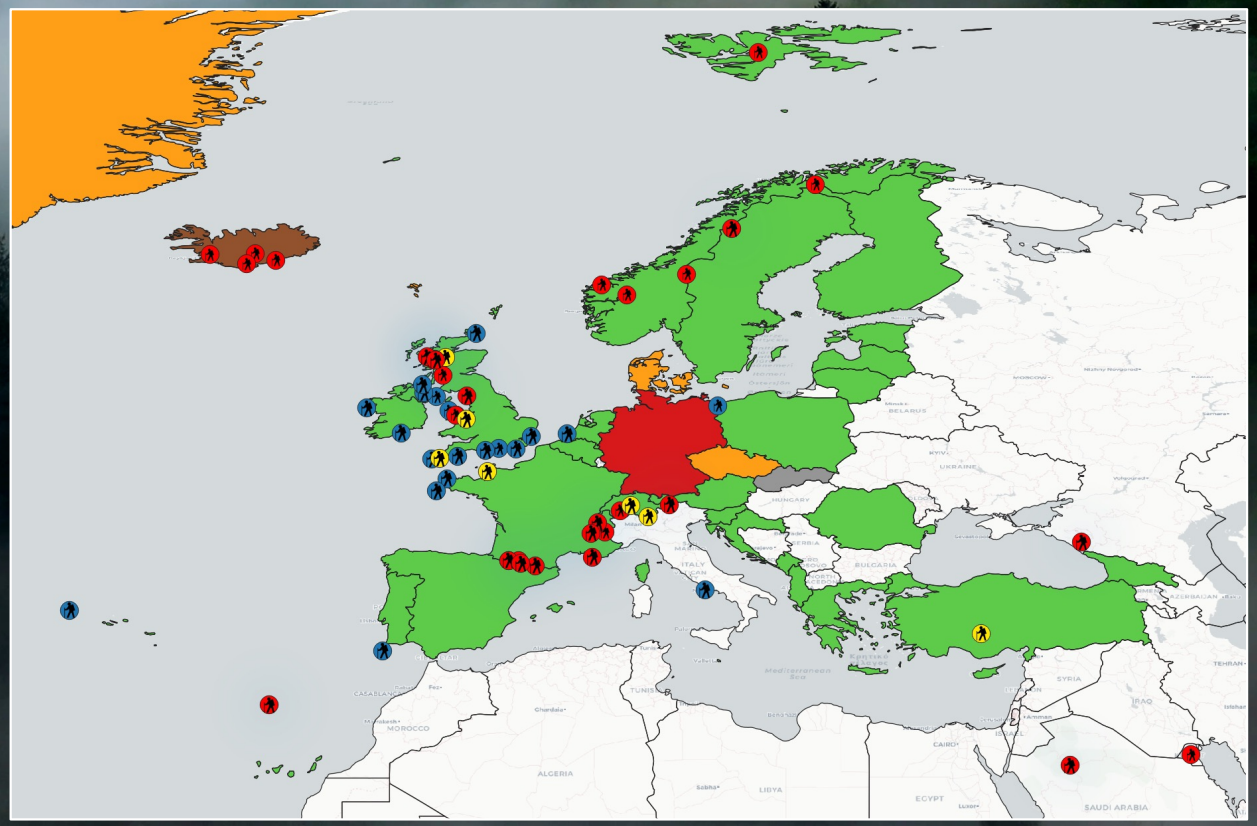
RESCUE INTERNATIONAL

PLB-Land Use | PLB-Aeronautical Use | PLB-Maritime Use

Legality of PLBs in CEPT* States

Country Colors:

- Yes all is good!
- Only possession and NOT usage
- Yes/No some conditions apply
- Pending legislation
- Nope



*European Conference of Postal and Telecommunications Administrations

Source: European Conference of Postal and Telecommunications Administrations
Site: https://cept.org/ecc/topics/maritime/personal-locator-beacons-plbs-usage-in-cept

PERSONAL LOCATOR BEACONS -PLB

RESCUE INTERNATIONAL

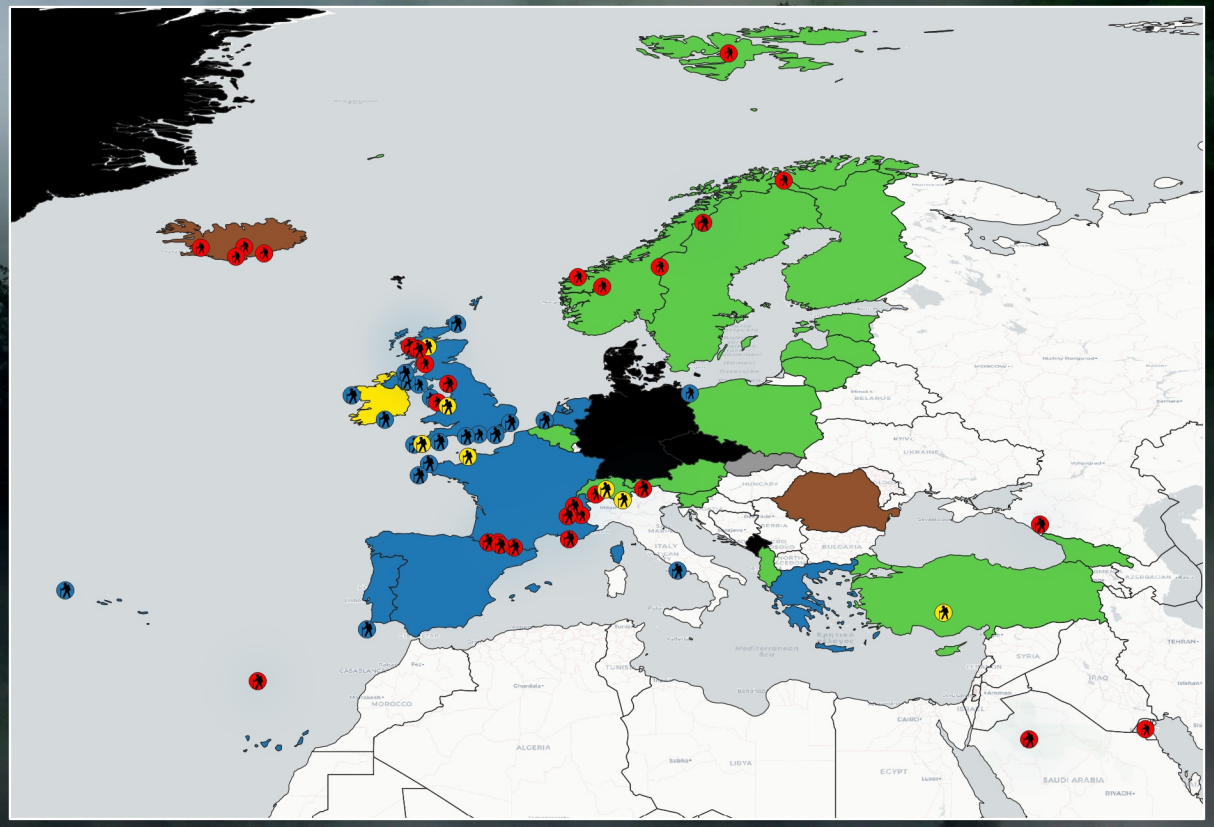
PLB-Land Use | PLB-Aeronautical Use | PLB-Maritime Use

PLB Authorized Context of Use in CEPT* States

Country Colors:

- **Anywhere**
- **Only use on land**
- **Only use at sea (Spain some conditions apply)**
- **Only national use**
- **Pending legislation**
- **N/A (Mainly because is forbidden so there is no law about its use)**

*European Conference of Postal and Telecommunications Administrations



Source: European Conference of Postal and Telecommunications Administrations
Site: https://cept.org/ecc/topics/maritime/personal-locator-beacons-plbs-usage-in-cept

PERSONAL LOCATOR BEACONS -PLB

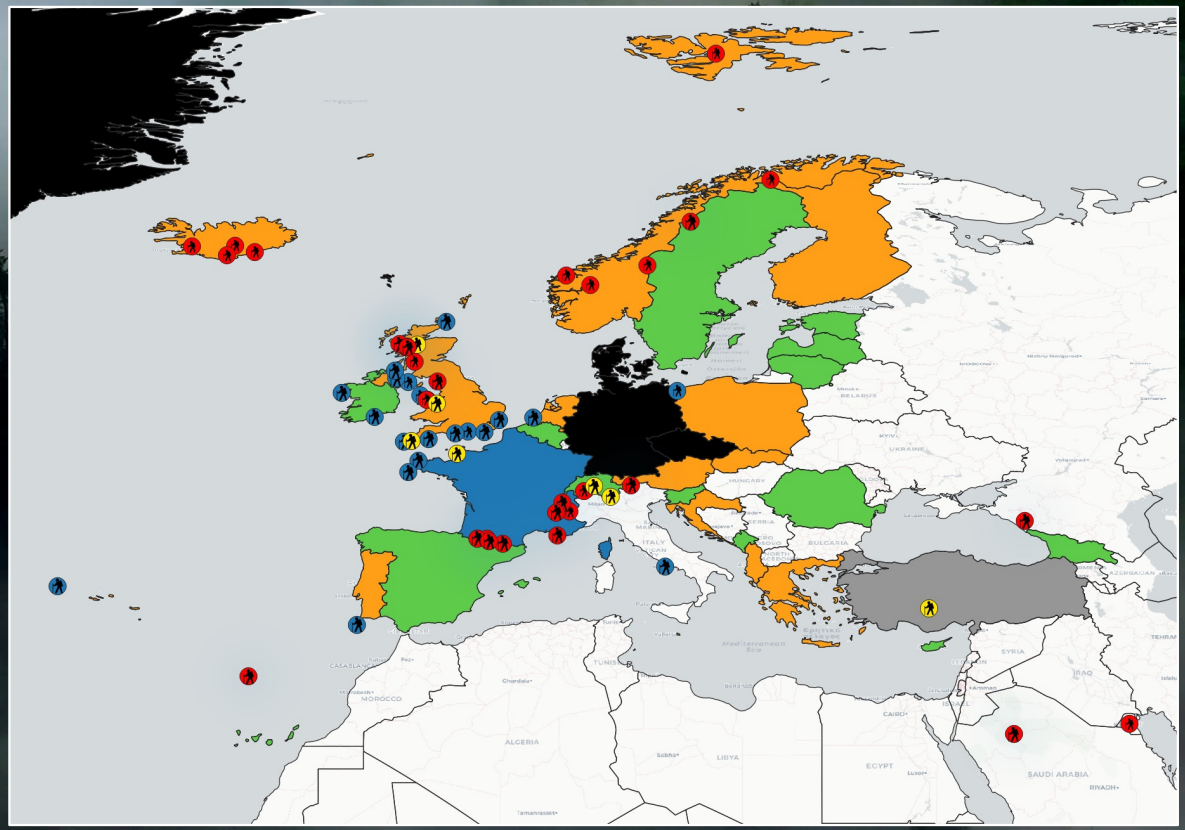
RESCUE INTERNATIONAL

PLB-Land Use | PLB-Aeronautical Use | PLB-Maritime Use

PLB License Needed in CEPT* States

Country Colors:

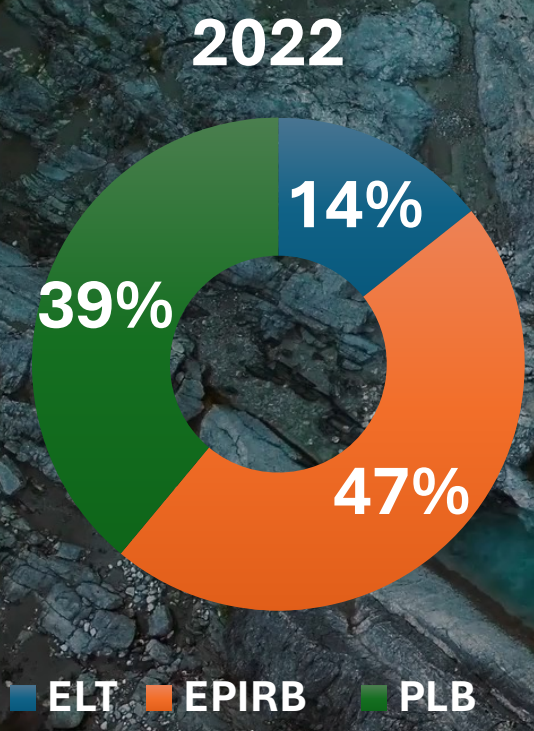
- **Not required**
- **Required**
- **Only MMSI (Maritime Mobile Service Identity)**
- **Pending**
- **N/A (Mainly because it's forbidden so there is no law about its use, thus not license possible)**



*European Conference of Postal and Telecommunications Administrations

Source: European Conference of Postal and Telecommunications Administrations
Site: https://cept.org/ecc/topics/maritime/personal-locator-beacons-plbs-usage-in-cept

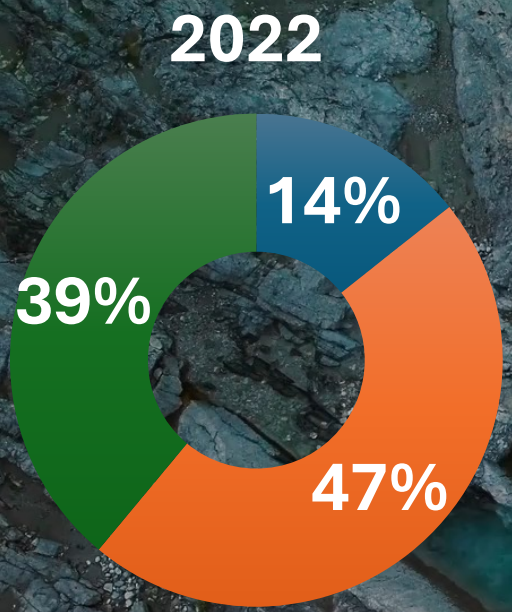
BEACON POPULATION



- We observed a constant growth of beacon population (expected)
- In 8 years, an average of 0,42% PLBs were activated, and 0,041% were actual SAR events (Globally)
- Registration average for all beacons is 73,43%
- In 8 yrs of the PLB that generated an alert call, an average of 73,4% (per year) were registered
- PLBs are 16% of all confirmed alerts
- In 2022 39% of all SAR cases were Land SAR events

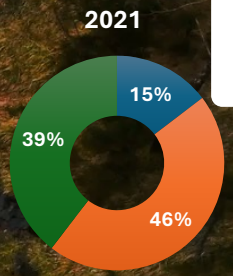
Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

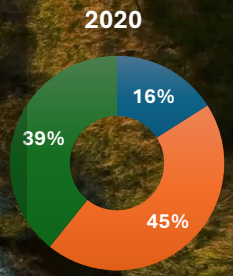
BEACON POPULATION

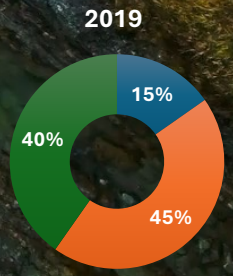


In 2022 there was an estimated of 3.100.908 beacons

Of all, 1.225.032 were PLBs







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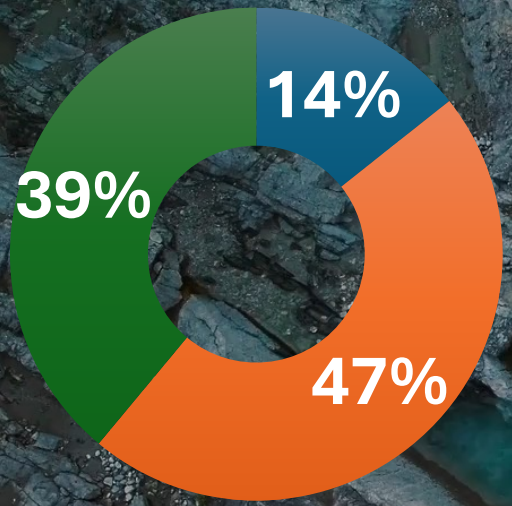
Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

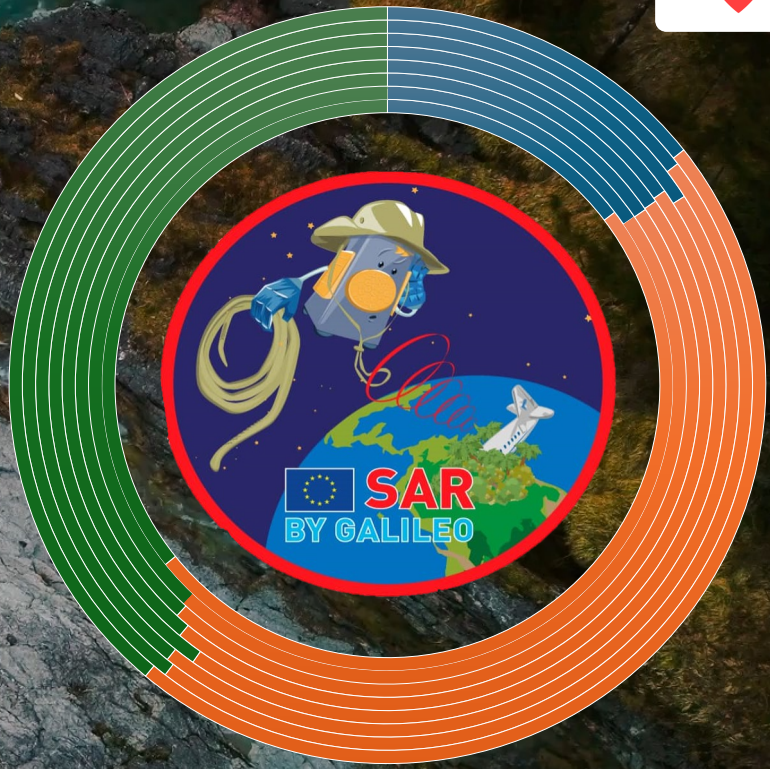
BEACON POPULATION

2022



ELT EPIRB PLB

2015 - 2022

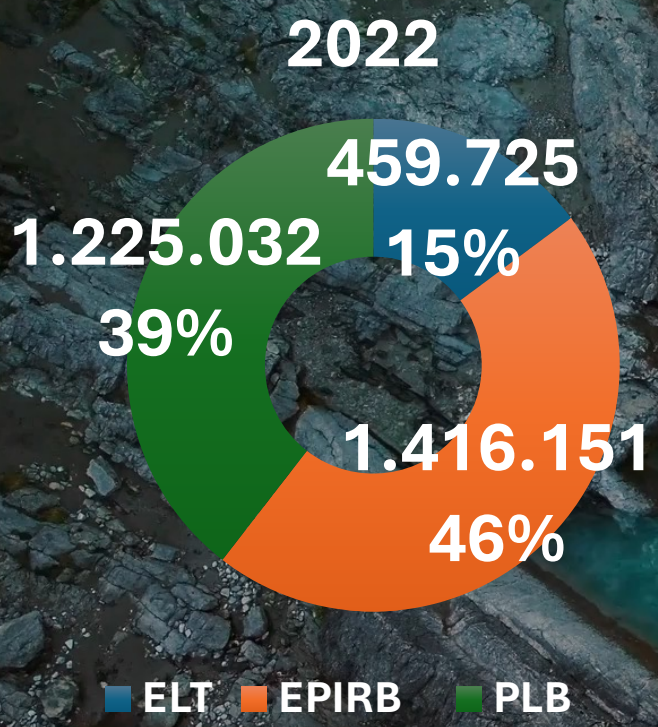


ELT EPIRB PLB

RESCUE INTERNATIONAL

Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

BEACON (Est)POPULATION



406-MHz total Estimated Beacon Population as Reported by Administrations

Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

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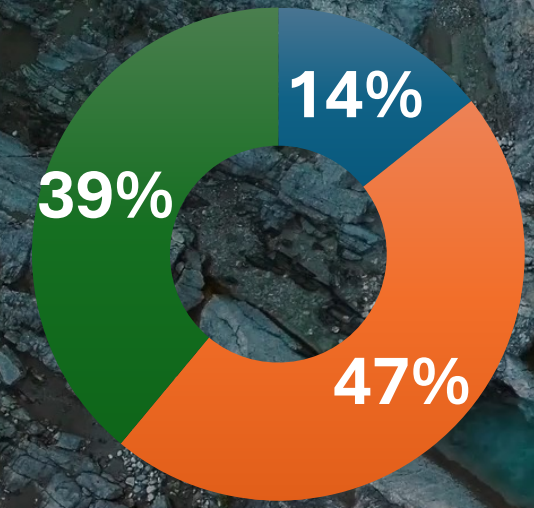
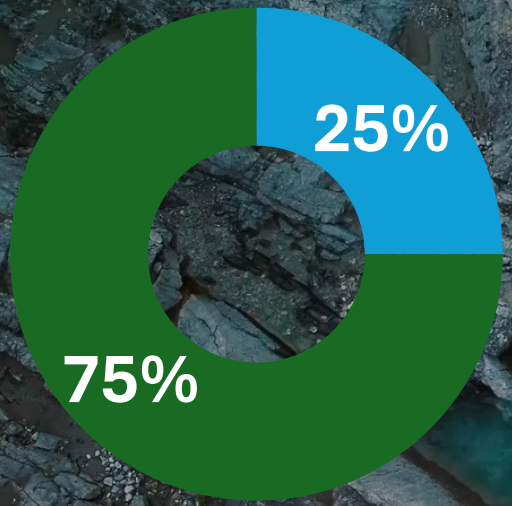
BEACON REGISTRATION



406-MHz Registered Beacon Population as Reported by Administrations

Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

BEACON REGISTRATION



Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

BEACON POPULATION

RESCUE INTERNATIONAL

BEACON ALERT

WHEN THE C/S SYSTEM DETECTS A BEACON EMITING A DISTRESS SIGNAL

IT DOES NOT INCLUDE THE FALSE POSITIVE ALERTS WHICH CONSTITUTE (est.) 95% OF THE SIGNALS WHICH IS FILTRATED BY THE SYSTEM

SAR EVENT

THE ACTIVATION IS CONFIRMED AS AN EMERGENCY SITUATION AN REQUIRES A SAR RESPONSE

DATA IS AS REPORTED BY ADMINISTRATOR

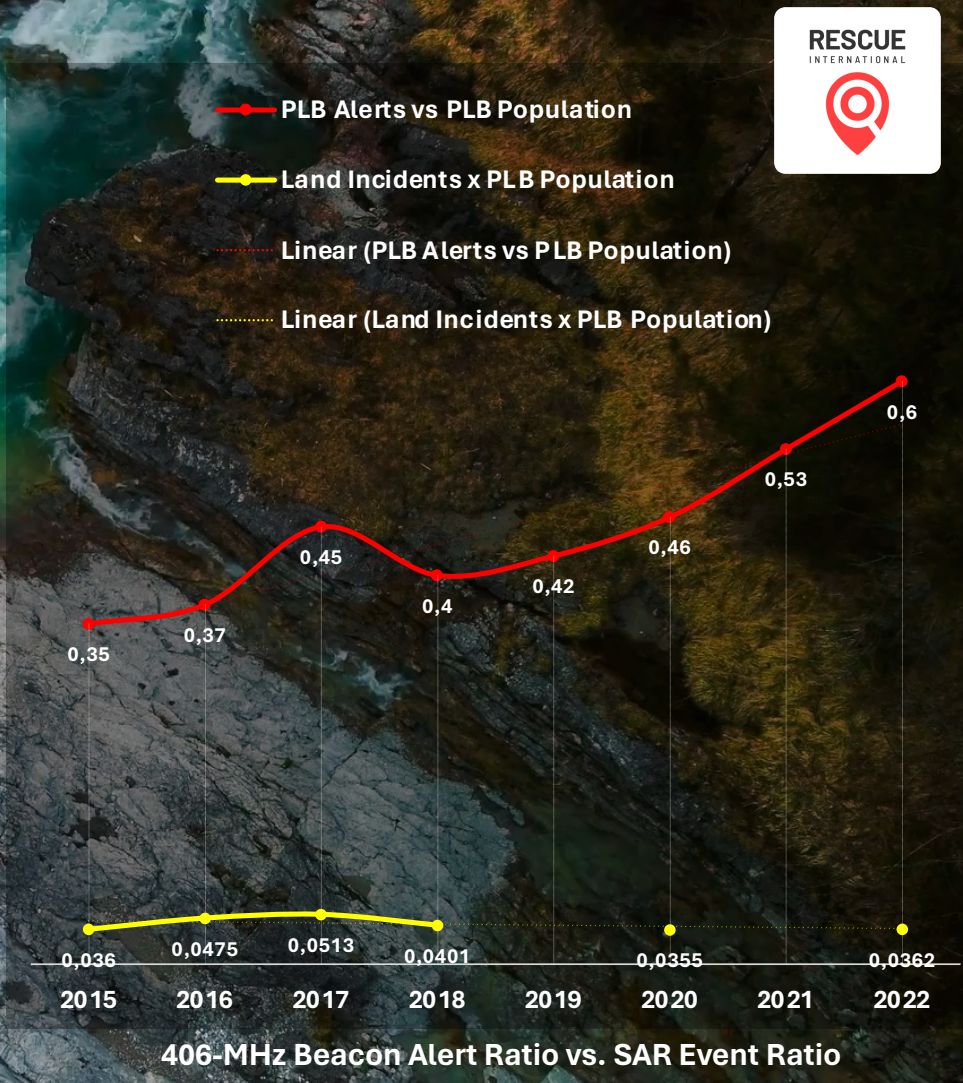
BEACON ALERTS

Percentage of SAR Events in relation to all PLBs (Globally) in 2022 was 0,0362%

For SAR Responders YELLOW trend

SAR Administrators RED trend

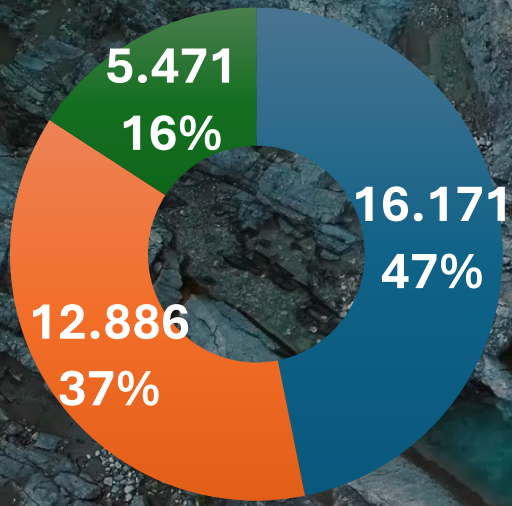
False Alerts not included – S/C system filters all signals of which ~95% are false alerts



406-MHz Beacon Alert Ratio vs. SAR Event Ratio

Data source: SARSAT-COSPAS "Report on System Status and Operations No.39"
Analysis: Rescue International

BEACON ALERTS



406-MHz Beacon Alert per beacon type

Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

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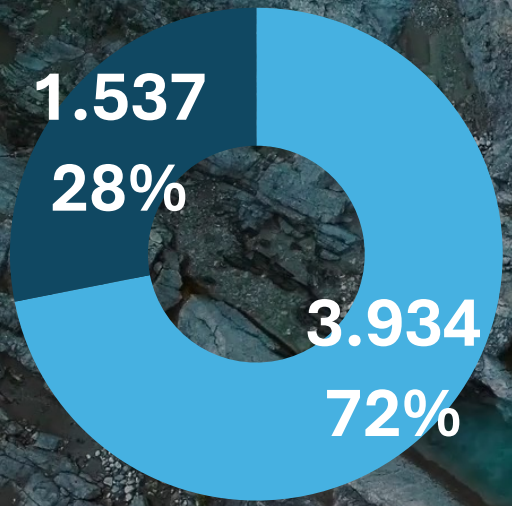
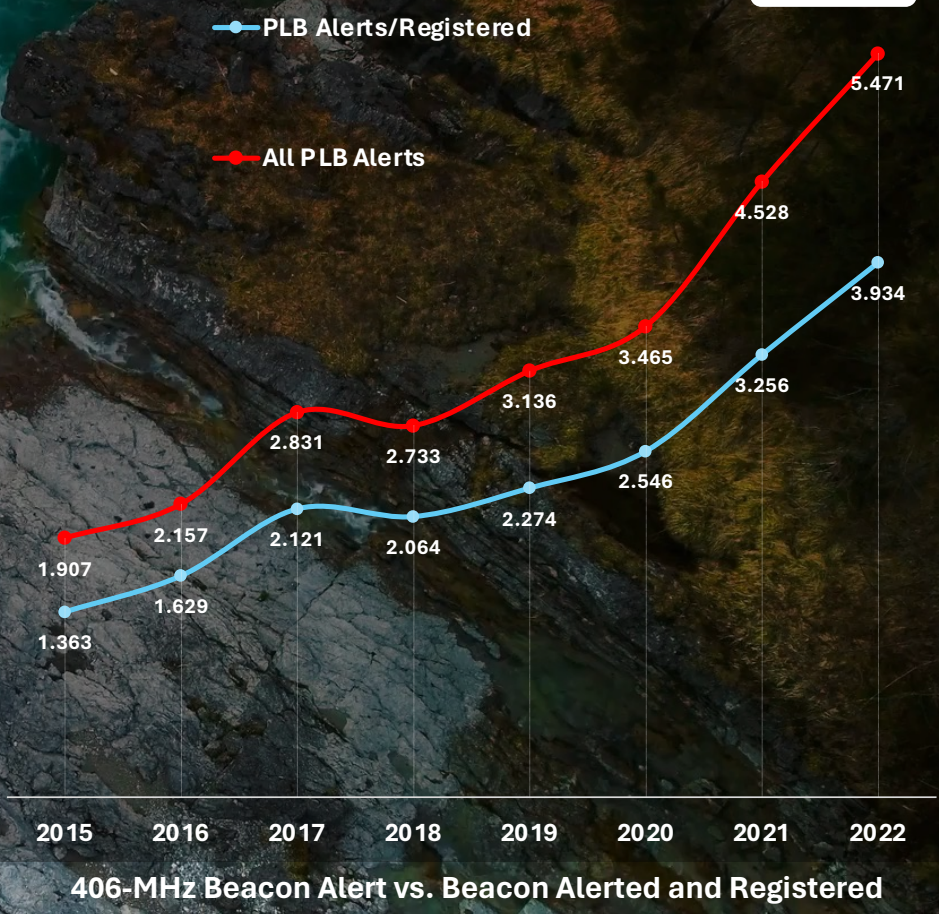
BEACON ALERTS

PLB Alerts-2022



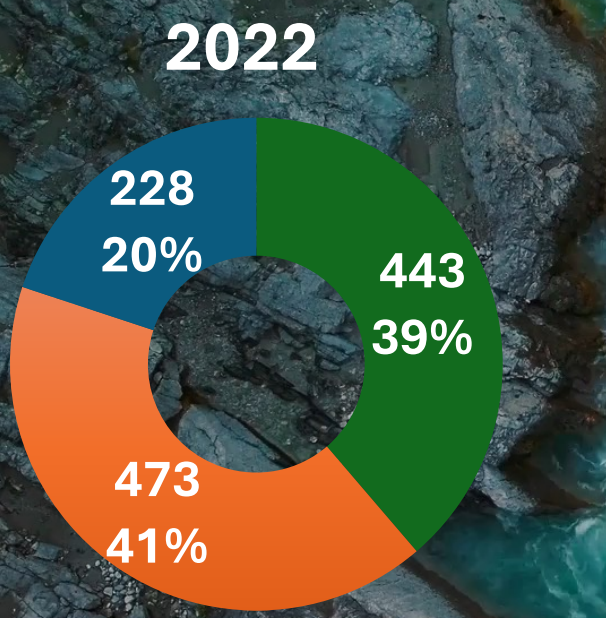
Registered Unregistered

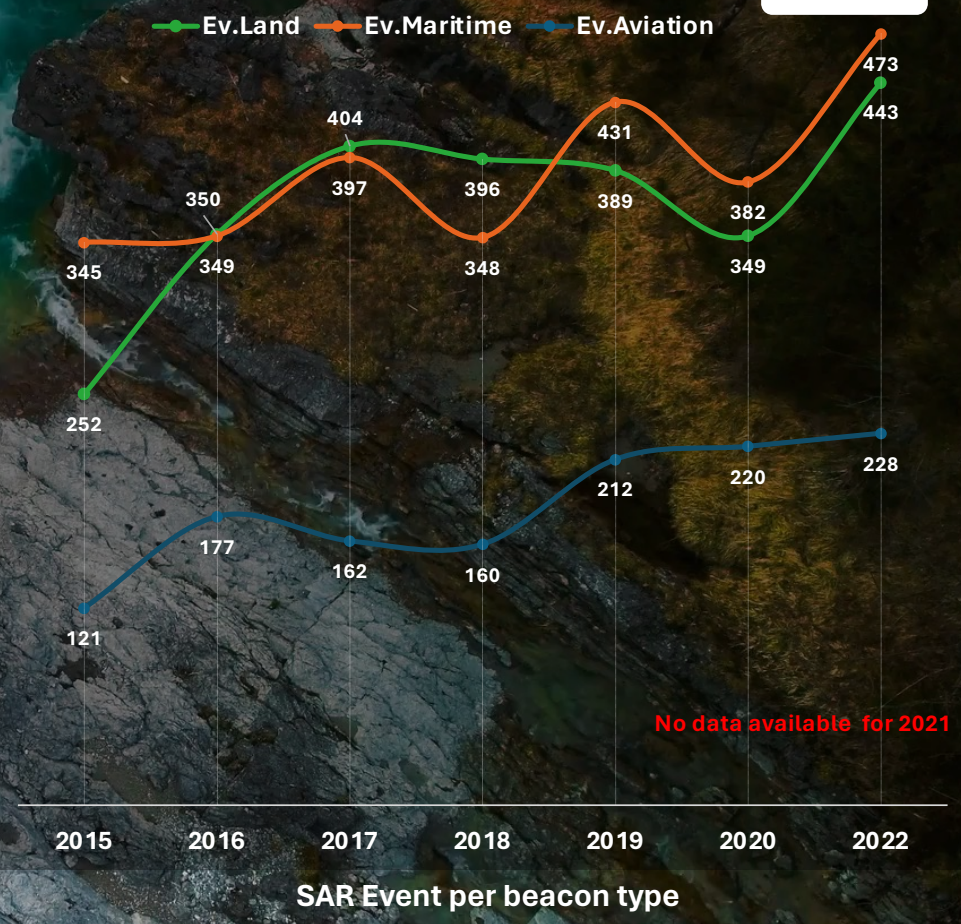


406-MHz Beacon Alert vs. Beacon Alerted and Registered

Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

BEACON SAR EVENTS

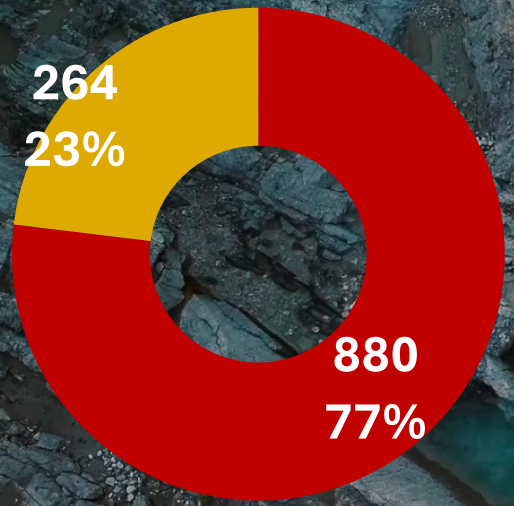




Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

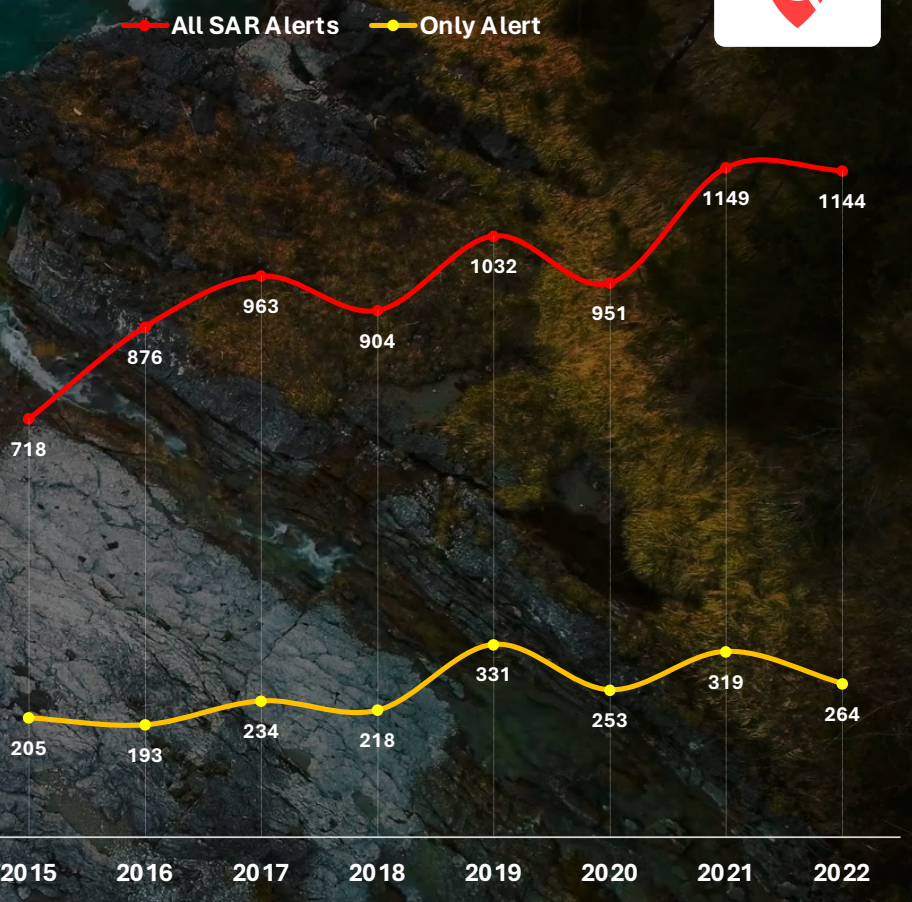
BEACON SAR EVENTS

Beacon-only Event 2022*



All Alerts Only Alert

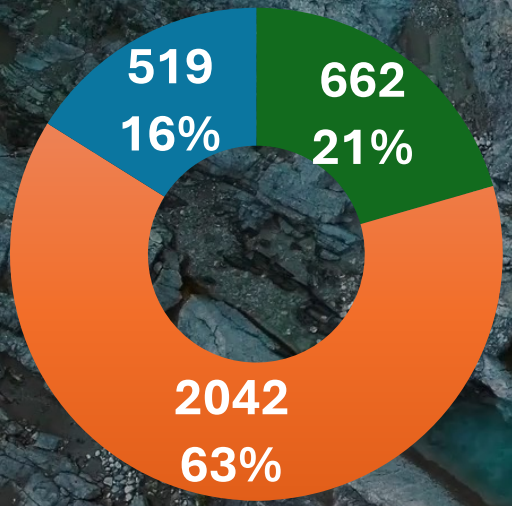
*all beacons



SAR Beacon as ONLY mean of alert vs All SAR Events

Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

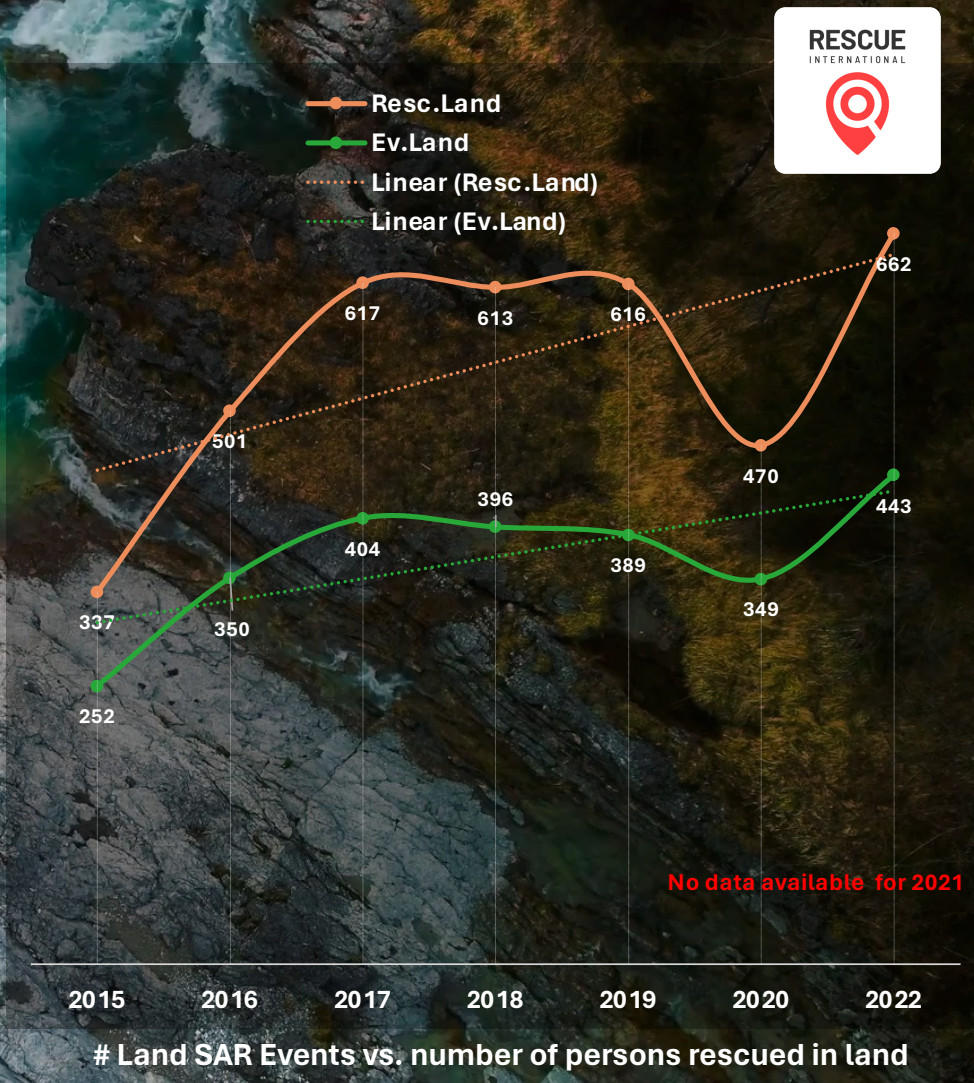
BEACON
PERSONS RESCUED



Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

BEACON PERSONS RESCUED

Avg. 1,5 persons rescued per event (LAND)



Land SAR Events vs. number of persons rescued in land

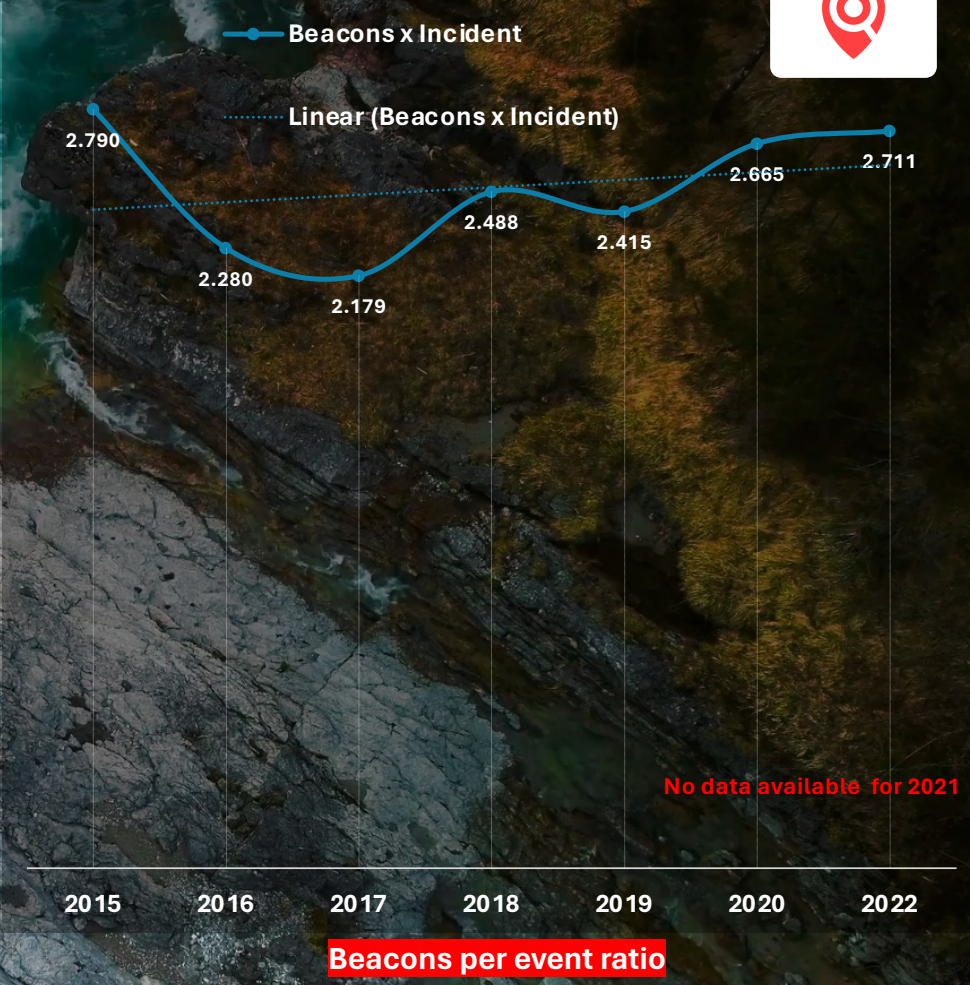
Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

BEACON INDICATORS

All beacons-all events:

Avg. in 7 years (excl.2021) is one SAR Incident every 2.500 beacons

1:2.500



Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

BEACON INDICATORS

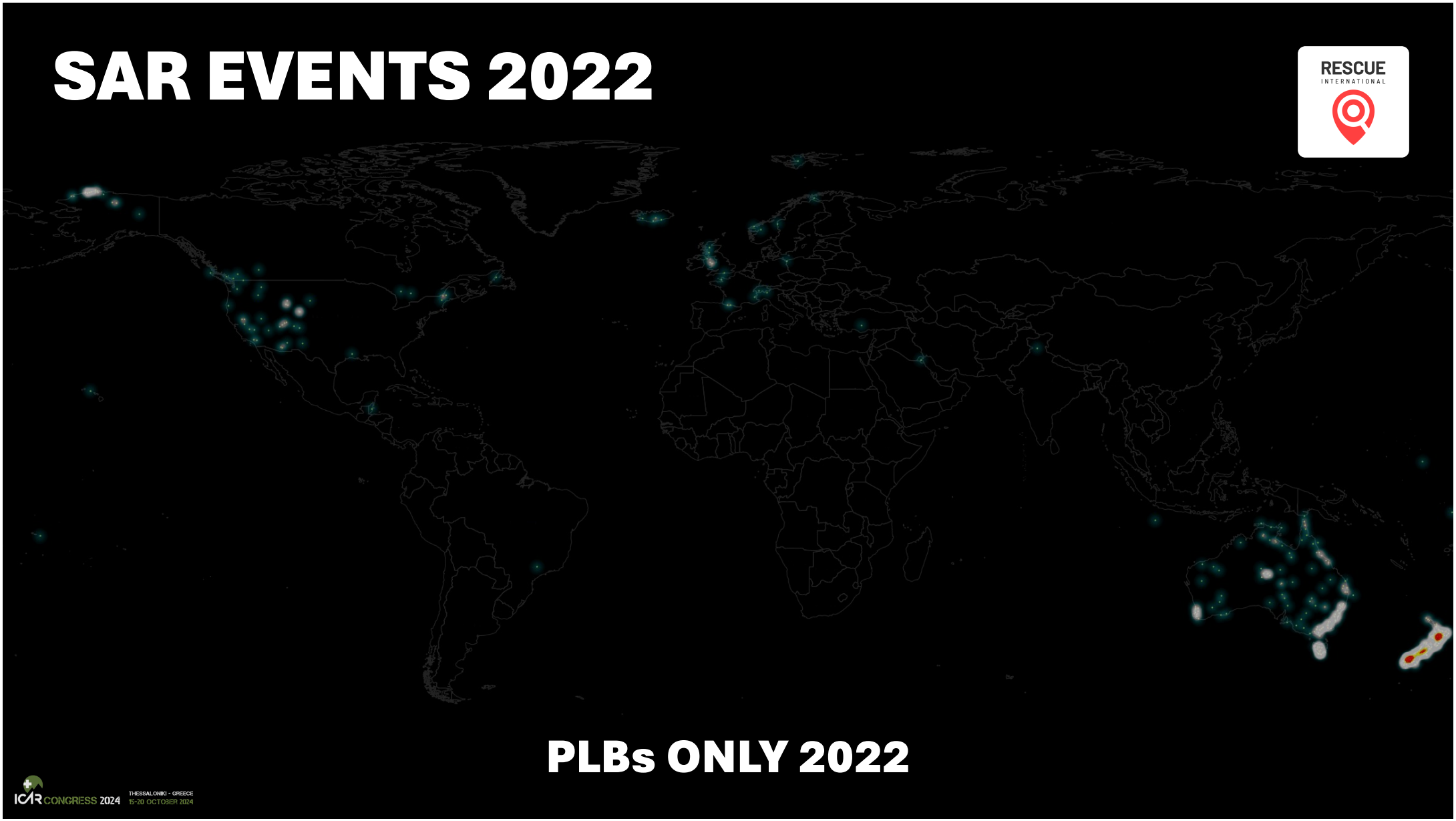
All PLBs and all Land SAR events:

Avg. in 6 years (excl.2019 and 2021) is one SAR Incident every 2.479 beacons

1:2.479

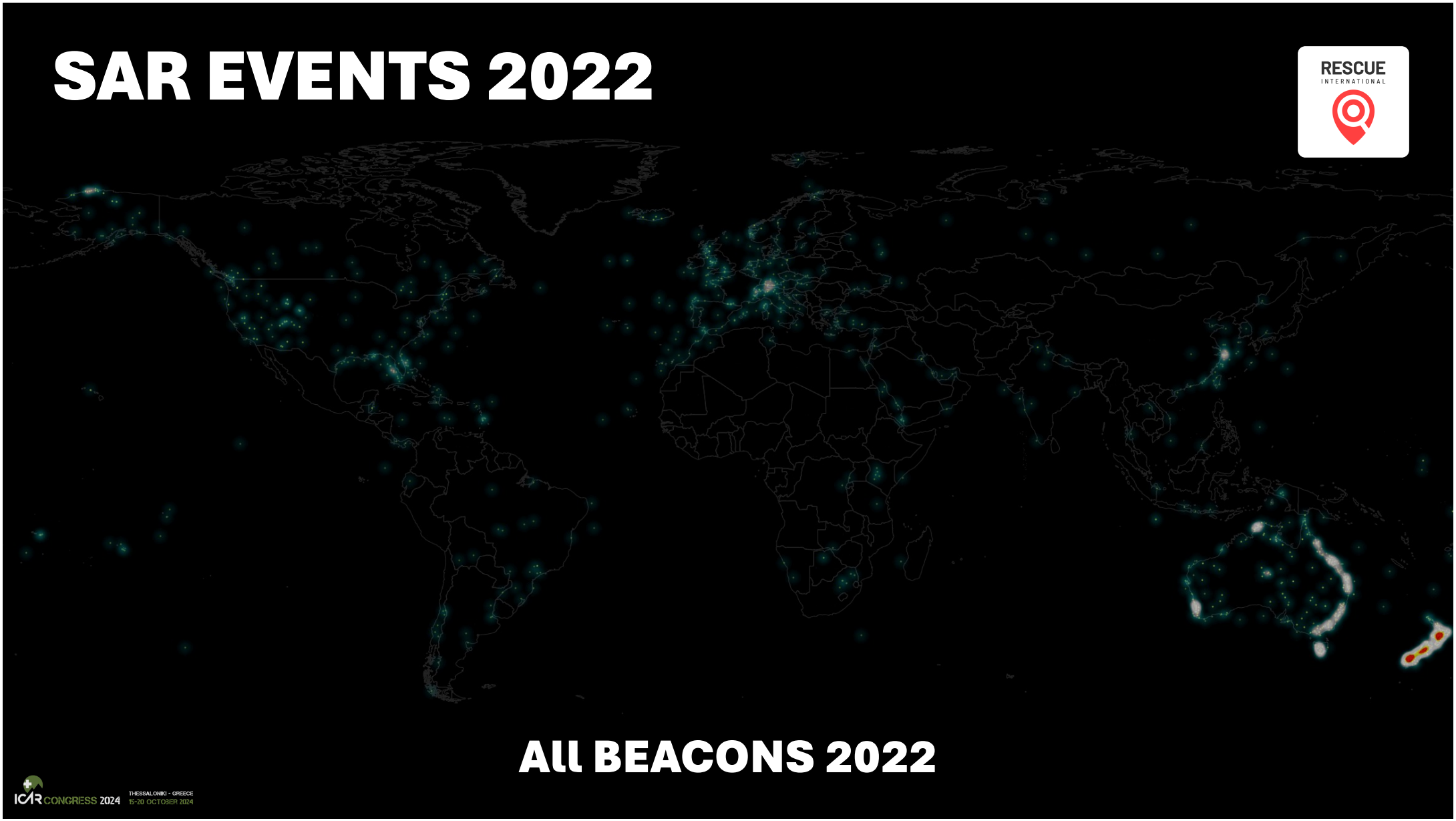
Source: SARSAT-COSPAS "Report on System Status and Operations No.39"

SAR EVENTS 2022



PLBs ONLY 2022

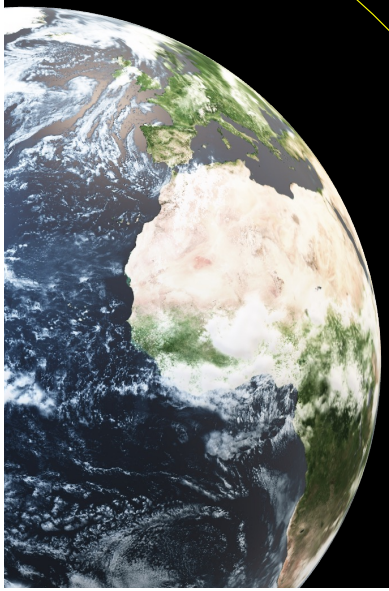
SAR EVENTS 2022



All BEACONS 2022

CONSTELLATION PROPERTIES

RESCUE INTERNATIONAL



Geosynchronous –GEO (~35.000km)

- Need stronger signal signals
- Can't compute
- location
- More coverage
- Less LUTs

Medium Earth Orbit –MEO (~20.000km)

- Need stronger signal
- Higher accuracy
- Minutes to process (almost real-rime)
- More coverage
- Less LUTs

Low Earth Orbit –LEO (~800km)

- Better for weaker signals
- Lower accuracy
- Wait times significant
- Less coverage
- More LUTs

CONSTELLATION PROPERTIES

RESCUE INTERNATIONAL

LEOLUTs

Table 5: LEOSAR Ground Segment Status (LEOLUTs) (31 December 2023)

Code	Location	Provider	Status	Associated MCC	Dual	Comments
2241	Maspalomas	Spain	FOC	SPMCC	No	
2271-2	Toulouse	France	FOC	FMCC	Yes	
2324	Lee-on-Solent	UK	FOC	UKMCC	No	
2401	Penteli	Greece	FOC	GRMCC	No	
2471	Bari	Italy	FOC	ITMCC	No	
2573	Spitsbergen	Norway	FOC	NMCC	No	
2711-2	Ankara	Türkiye	FOC	TRMCC	Yes	
2733	Nakhodka	Russia	FOC	CMC	No	
3037-8	Alaska	USA	FOC	USMCC	Yes	Combined LEO-MEO antenna.
3161	Goose Bay	Canada	FOC	CMCC	No	
3162	Churchill	Canada	FOC	CMCC	No	
3163	Edmonton	Canada	FOC	CMCC	No	
3168	Ottawa (LOW)	Canada	FOC	CMCC	No	Testing and back-up, used operationally as needed.
3381-2	Guam	USA	IOC	USMCC	Yes	Combined LEO-MEO antenna.
3387-8	Hawaii	USA	FOC	USMCC	Yes	Combined LEO-MEO antenna.
3667-8	Florida	USA	FOC	USMCC	Yes	Combined LEO-MEO antenna.
3678	Maryland (LME)	USA	FOC	USMCC	No	LEO-MEO support Equipment. Combined
4031-2	Jeddah	Saudi Arabia	FOC	SAMCC	Yes	
4121-2	Beijing	China (P.R. of)	FOC	CNMCC	Yes	
4164-5	Dapingding	ITDC	IOC	TAMCC	Yes	
4191	Bangalore	India	FOC	INMCC	No	
4192	Lucknow	India	FOC	INMCC	No	
4311	Futtsu	Japan	FOC	JAMCC	No	
4403	Incheon	Korea (Rep. of)	FOC	KOMCC	No	
4631	Karachi	Pakistan	FOC	PAMCC	No	
4661	Doha	Qatar	FOC	QAMCC	No	
4701	Abu Dhabi	UAE	FOC	AEMCC	No	
4771-2	Hong Kong	Hong Kong China	FOC	HKMCC	Yes	
5254	Jakarta	Indonesia	FOC	IDMCC	No	
5331-2	Kuntan	Malaysia	UD	MYMCC*	Yes	Pending MCC commissioning.
5632	Singapore	Singapore	FOC	SIMCC	No	
5671-2	Bangkok	Thailand	FOC	THMCC	Yes	
5741	Haiphong	Viet Nam	FOC	VNMCC	No	
6011	Cape Town	South Africa	FOC	ASMCC	No	
6051	Ouargla	Algeria	FOC	ALMCC	No	
6052	Algiers	Algeria	FOC	ALMCC	No	
6571	Abuja	Nigeria	CNO	NIMCC	No	MCC configured as a SPOC of the Spanish MCC.
7012	Rio Grande	Argentina	FOC	ARMCC	No	
7014	El Palomar	Argentina	FOC	ARMCC	No	
7101	Brasilia	Brazil	FOC	BRMCC	No	
7102	Recife	Brazil	FOC	BRMCC	No	
7251	Santiago	Chile	FOC	CHMCC	No	
7252	Punta Arenas	Chile	FOC	CHMCC	No	
7254	Easter Island	Chile	FOC	CHMCC	No	
7601	Callao	Peru	FOC	PEMCC	No	

MEOLUTs

Table 7: MEOSAR Ground Segment Status (MEOLUTs) (31 December 2023)

Code	Location	Provider	Channels	Comments	Additional Capabilities (b)
6054	Algiers	Algeria	4		
5035	Mingenew	Australia	6	Networked with NZ MEOLUT 5125	1, 2, 4, 5, 7, 8
4123	Beijing	China (P.R. of)	6		7f
2091	Larnaca / EU	Cyprus	4	Part of European 12-channel MEOLUT. MEOSAR IOC/FOC standard.	4, 5f, 7f
2275	Toulouse	France	20	Phased-array L-band antenna. MEOSAR IOC/FOC standard.	4, 5f, 7f
6601	Saint-Denis-La Réunion / EU	France	30	Phased-Array L-Band antenna. Connected to the FR MEOLUT network.[1]	4, 5f, 7f
2405	Keratea	Greece	6		5f
4163	Dapingding	ITDC	8		7f
4314	Futtsu	Japan	6		
5125	Taupo	NZ	6	Networked with UMCC Hawaii MEOLUT	1, 2, 4, 5, 7, 8
2574	Spitsbergen / EU	Norway	4	Part of European 12-channel MEOLUT. MEOSAR IOC/FOC standard.	4, 5f, 7f
4034	Jeddah	Saudi Arabia	6		
5635	Changi	Singapore	6	One additional LEO/MEO channel with Changi LEOLUT (5632).	7f
2244	Maspalomas / EU	Spain	4	Part of European 12-channel MEOLUT. MEOSAR IOC/FOC standard.	4, 5f, 7f
2714	Ankara	Türkiye	6		
4706	Abu Dhabi	UAE	6		
2325	Lee-On-Solent	UK	7	One combined MEO/LEO antenna. Two additional antennas installed at Kinloss (UK) for D&E if needed.	
3385	Hawaii	USA	12	6 MEO, and 6 LEO/MEO channels - 2 in HI, - 2 in AK - 2 in GU	4, 5, 7, 8
3669	Florida	USA	9	MEOSAR IOC/FOC standard.	4, 5, 7, 8
3683	NSOF	USA	8	MEOSAR IOC/FOC standard. Backup of 3669.	4, 5, 7, 8

GEOLUTs

Table 6: GEOSAR Ground Segment Status (GEOLUTs) (31 December 2023)

Code	Location	Provider	Status	Associated GEOSAR	Comments
2242	Maspalomas	Spain	FOC	GOES-East	
2243	Maspalomas	Spain	FOC	MTG-I1	
2273	Toulouse	France	FOC	MTG-I1	
2323	Lee-on-Solent	UK	FOC	MSG-4	
2402	Penteli	Greece	FOC	MSG-3	
2472	Bari	Italy	FOC	MSG-3	
2713	Ankara	Turkey	FOC	MSG-4	
2735	Moscow	Russia	FOC	Electro-L No.3	
2736	Moscow	Russia	FOC	Electro-L No.2	
2738	Khabarovsk	Russia	FOC	GOES-West / Electro-L No.3	
3166	Edmonton	Canada	FOC	GOES-West	
3167	Ottawa	Canada	FOC	GOES-East or GOES-West	Testing and back-up facility.
3169	Ottawa	Canada	FOC	GOES-East or GOES-West	
3674	Maryland	USA	FOC	GOES-East	
3675	Maryland GSE	USA	FOC	GOES-East or GOES-West	Test facility used operationally as needed.
3676	Maryland	USA	FOC	GOES-West	
4194	Bangalore	India	FOC	INSAT-3D	
4194bis	Bangalore	India	FOC	INSAT-3DR	
4662	Doha	Qatar	FOC	MSG-3	
4702	Abu Dhabi	UAE	FOC	MSG-3	
4707	Abu Dhabi	UAE	FOC	MSG-2	
5123	Goudies Road	New Zealand	FOC	GOES-West	
5124	Goudies Road	New Zealand	FOC	Louch-5A	Active-tracking capable antenna.
6053	Algiers	Algeria	FOC	MSG-4	
7011	El Palomar	Argentina	FOC	GOES-East	
7104	Brasilia	Brazil	FOC	GOES-East	
7105	Recife	Brazil	FOC	MSG-3	
7253	Santiago	Chile	FOC	GOES-East	
7602	Callao	Peru	FOC	GOES-West	

Geosynchronous –GEO (~35,000km)

- Minutes to process (almost real-rime)

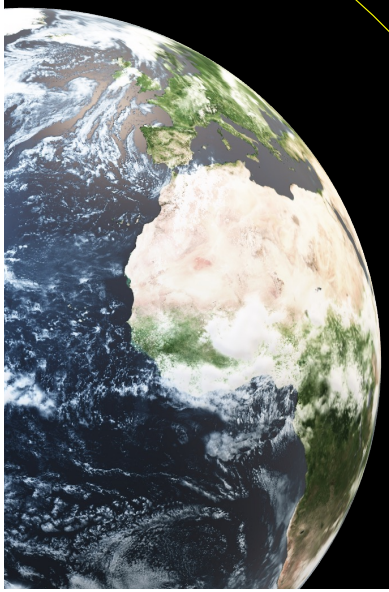
Low Earth Orbit –LEO (~800km)

- Better for weaker signals
- Lower accuracy
- Wait times significant

- Less coverage
- More LUTs

CONSTELLATION ACCURACY

RESCUE INTERNATIONAL



Geosynchronous –GEO (~35.000km)

- No computed location
- Reports only with encoded location
- Accuracy of the beacon's GNSS chip or external device

Medium Earth Orbit –MEO (~20.000km)

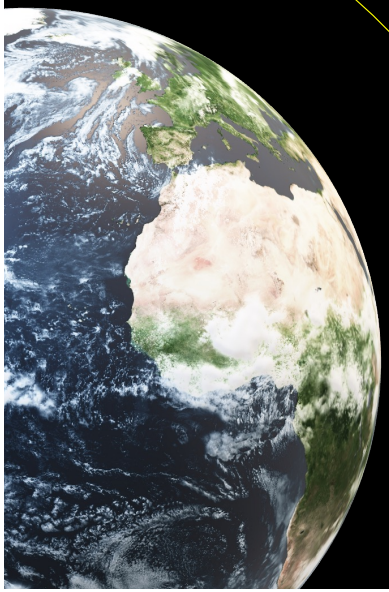
- Reports computed and encoded location
- S/C refers to 2km error

Low Earth Orbit –LEO (~800km)

- Reports computed and encoded
- Up-to 10nm

CONSTELLATION ACCURACY

RESCUE INTERNATIONAL



Geosynchronous –GEO (~35.000km)

- Electro-L (RU)
- GOES (US)
- GSAT (IN)
- INSAT (IN)
- Louch (RU)
- **MSG (EUMETSAT) (EU)**
- **MTG (EUMETSAT) (EU)**

Medium Earth Orbit –MEO (~20.000km)

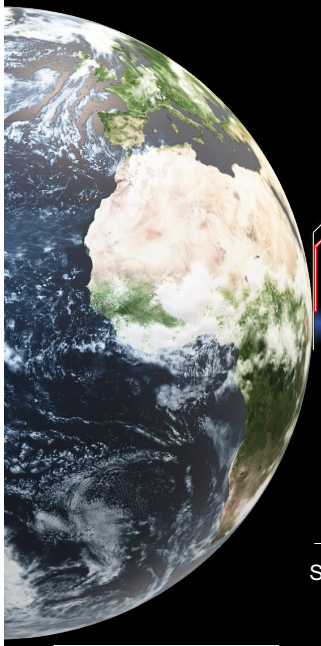
- GPS (GPSII, GPSIII) (US)
- **GSAT (Galileo) (EU)**
- DASS (US)
- Glonass (RU)

Low Earth Orbit –LEO (~800km)

- Cospas (Meteor) (RU)
- Sarsat (NOAA) (US)

ORBITAL ALTITUDES

RESCUE INTERNATIONAL



0 km / mi – Sea level

37.6 km / 23.4 mi – Self-propelled jet aircraft flight ceiling (Record set in 1977)

215 km / 133.6 mi – Sputnik-1, the first artificial satellite of Earth

340 km / 211.3 mi – International Space Station

390 km / 242.3 mi – Former Russian space station Mir

595 km / 369.7 mi – Hubble Space Telescope

[700–1700 km] – Polar-orbiting satellites
[435–1056 mi]

LEO zone (Low Earth orbit)

MEO zone (Medium Earth orbit)

2000 km / 1243.7 mi

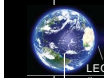
600–800 km / 372.8–497.1 mi – Sun-synchronous satellites
These satellites orbit the Earth in nearly exact polar orbits north to south.
They cross the equator multiple times per day, and each time they are at the same angle with respect to the Sun. Satellites on these types of orbits are particularly useful for capturing images of the Earth's surface or images of the Sun.

20 350 km
GPS (Global Positioning System) satellites
These satellites are on a semi-synchronous orbit (SSO), meaning that they orbit the Earth in exactly 12 hours (twice per day).

35 786 km
Geosynchronous (GEO) and geostationary (GSO) satellites.
Geosynchronous satellites orbit the Earth at the same rate that the Earth rotates. Thus they remain stationary over a single line of longitude. A geostationary satellite remains in a fixed location as observed from the surface of the Earth, allowing a satellite dish to be alligned to it. This particular altitude marks the border between the MEO and HEO zones.

HEO zone (High Earth orbit)

Scale: 2000 km / 1243.7 mi



MEO zone (Medium Earth orbit)

HEO zone (High Earth orbit)

LEO zone (Low Earth orbit)

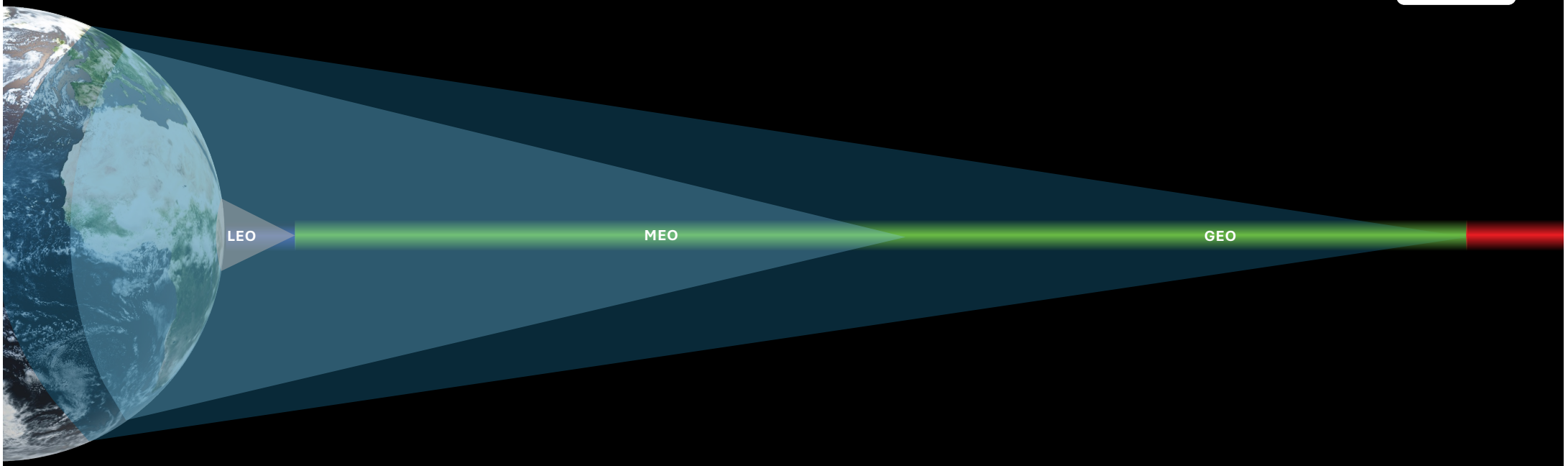
384 000 km
The Moon

You're Here

MOON

ICR CONGRESS 2024
THESSALONIKI - GREECE
15-20 OCTOBER 2024

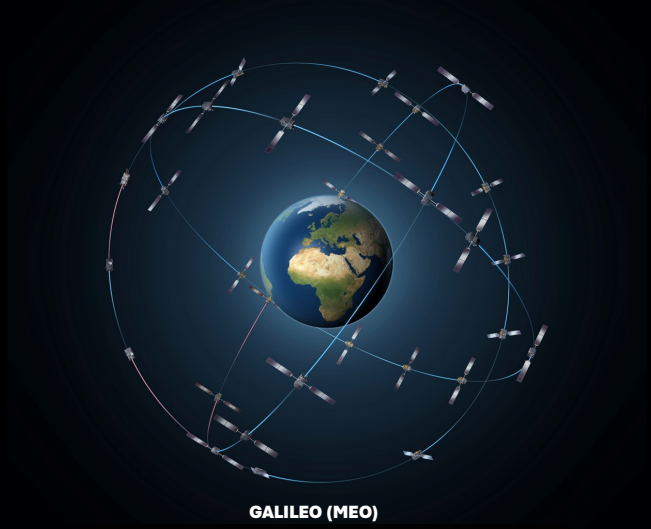
ORBITAL ALTITUDES



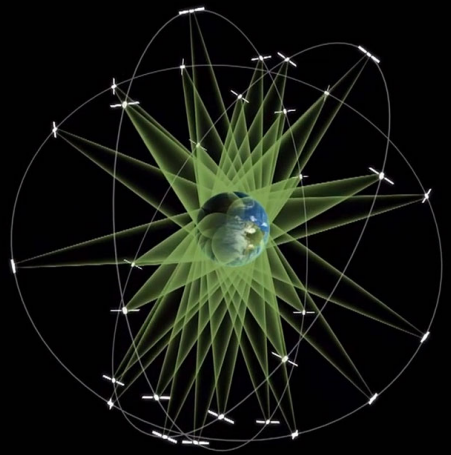
You're Here

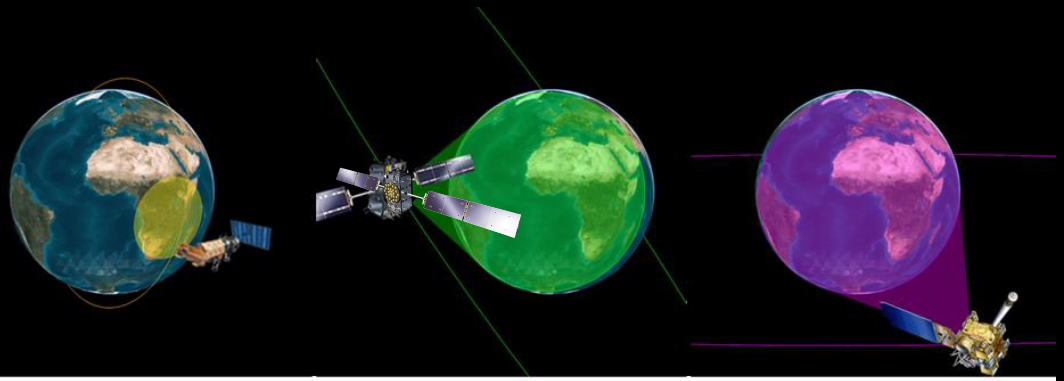
MOON

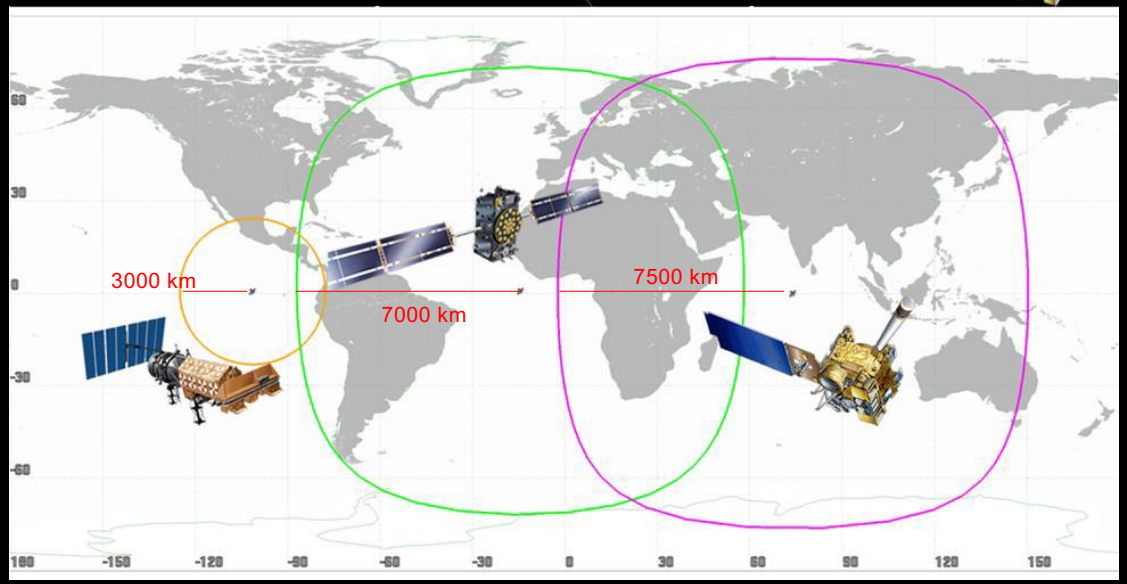
ORBITAL ALTITUDES



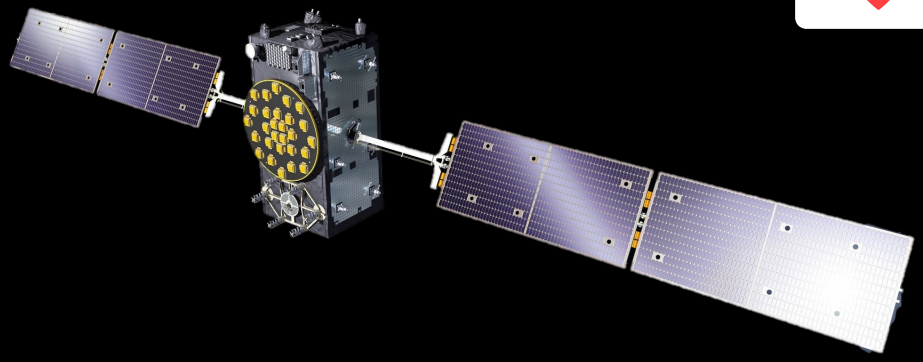
GALILEO (MEO)







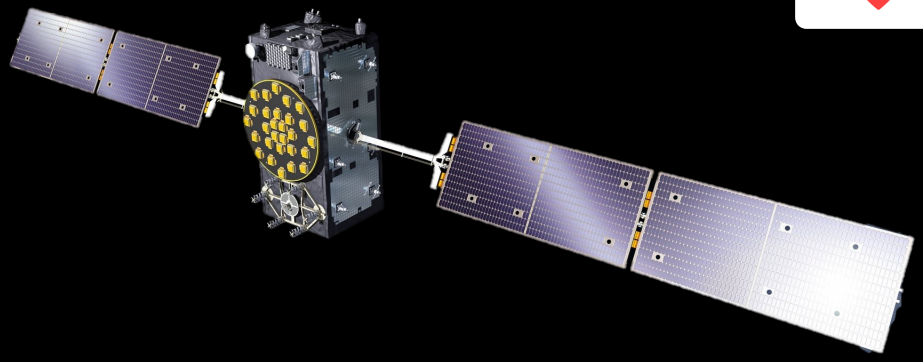
GALILEO EVOLUTION OF SAR



SARSAT-COSPAS

- First established in 1979 by Canada, France, the USA, and the former Soviet Union
- MEOSAR upgrade to current infrastructure complement the LEO and GEO satellites

GALILEO
EVOLUTION OF SAR



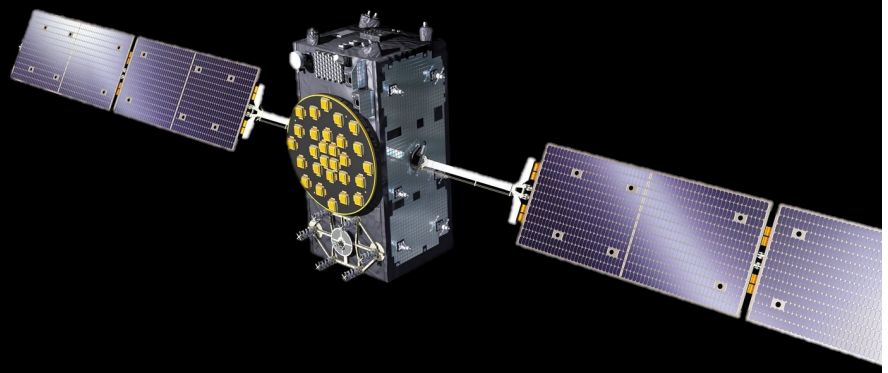
SARSAT-COSPAS

- First established in 1979 by Canada, France, the USA, and the former Soviet Union
- MEOSAR upgrade to current infrastructure complement the LEO and GEO satellites

GALILEO

- Operational since 2016
- Under civilian control
- Integrated in COSPAS-SARSAT
- Constellation of 24 + 6 satellites at 23,200 kms (MEO)
- 3 orbital plans

GALILEO
EVOLUTION OF SAR



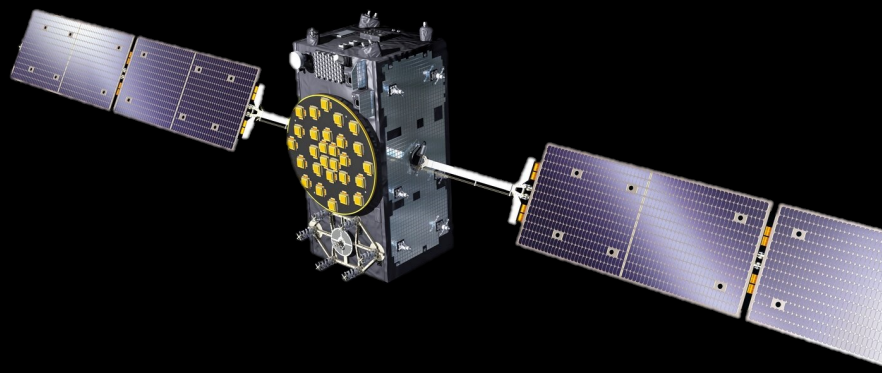
Enables nearly real-time detection and localization of distress signals

Unprecedented speed and accuracy, meaning a reduced alert time and a smaller search zone

Features the unique Return Link Service-RLS

GALILEO
EVOLUTION OF SAR

RESCUE
INTERNATIONAL



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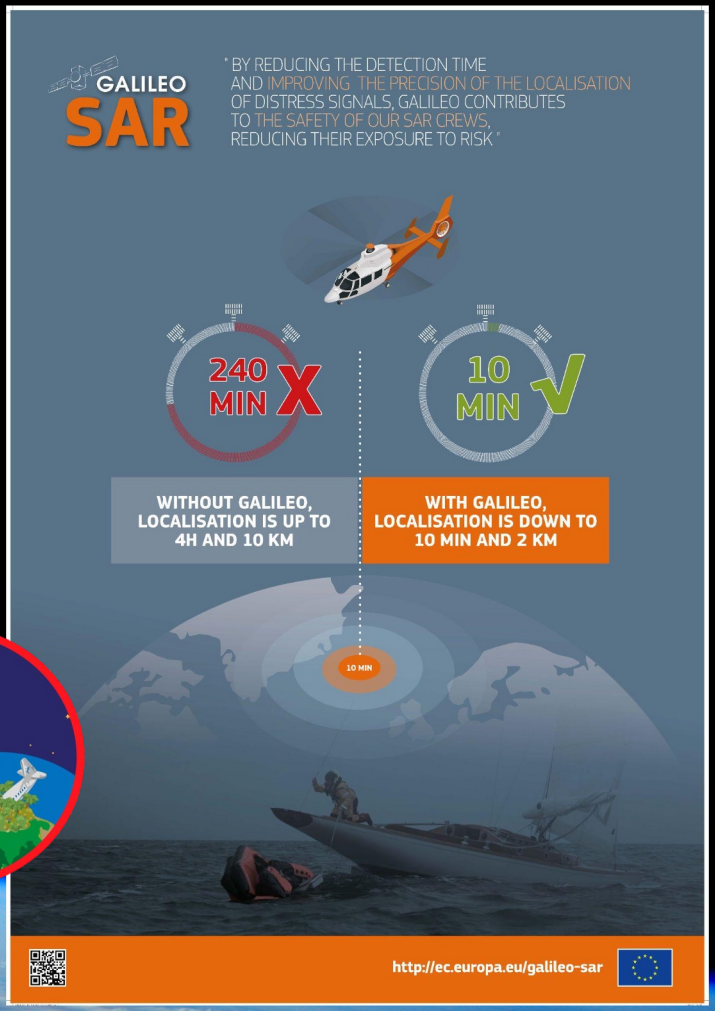

GALILEO
EVOLUTION OF SAR

RESCUE INTERNATIONAL

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In real cases distress are computed under 10 minutes

On 8th October 2021, in Svalbard at 78° Latitude the position was confirmed after 1m 20s after activation with an initial accuracy of 730m

On 26 September 2019, in Belgium the position was calculated in 3m 32s after activation with an initial accuracy of 100m

GALILEO
EVOLUTION OF SAR

RESCUE INTERNATIONAL

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Minimum Probability Requirements

Location probability after:

1 burst	**>90%**
12 bursts	**>98%**
1 burst within 5k	**>90%**
12 bursts within 5k	**>95%**
12 bursts within 2k	**>90%**

This is according to the Galileo Service Definition Document (SDD)
Performance in real life is above these specifications!

GALILEO
EVOLUTION OF SAR

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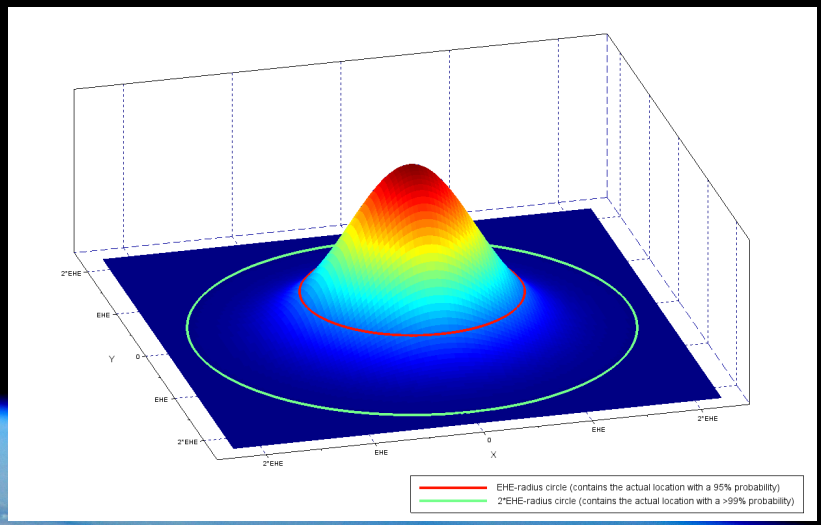
Performance Reported in 2024

Average location probability with reference beacons:

1 burst	**+99,9%**
12 bursts	**100%**
1 burst within 5k	**98,9%-99,9%**
12 bursts within 5k	**99,9%-100%**



GALILEO
EVOLUTION OF SAR

Enables nearly real-time detection and localization of distress signals

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The Beacon will receive confirmation (RLM) from the MCC that his message have been read and help is underway

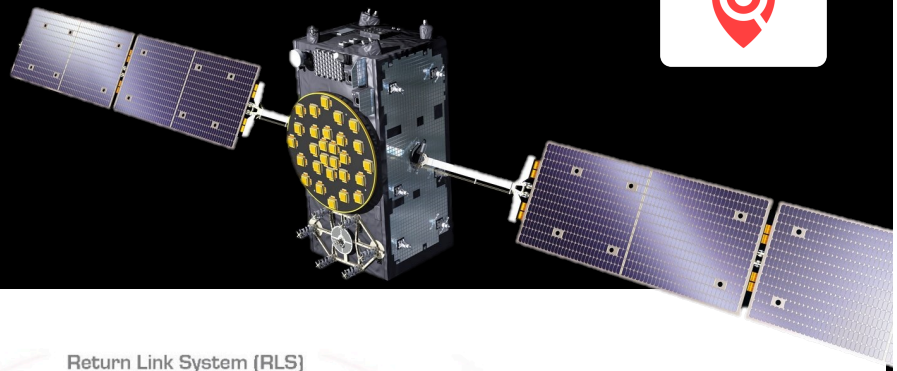
This helps morale and improve the chances for staying put (in LandSAR) and with the beacon

Delivery latency within 15m is avg. 99,73%
Average delivery time in real cases it's 37 seconds according to EUSPA

Operational (FOC) since 26 March 2021

Galileo is the only RLSP

GALILEO
EVOLUTION OF SAR



Enables nearly real-time detection and localization of distress signals

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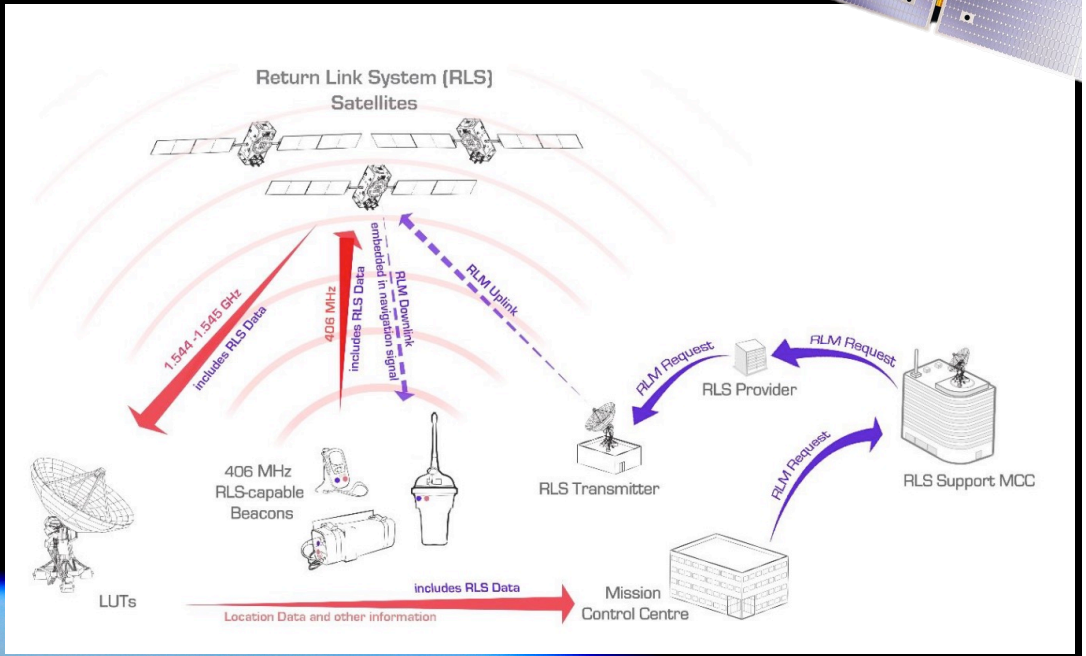

GALILEO
OTHER FACTS

All this time you have been navigating with Galileo

Galileo has brought increased accuracy since entering service in 2016

With the **High Accuracy Service (HAS)** you can reach up-to 20cm accuracy

Galileo is upgradeable by design reducing the need for additional (expensive) space missions

Expansion to LEO in sight for future Telecom capabilities and many other applications

SPACE GRAFFITI

GALILEO
OTHER FACTS

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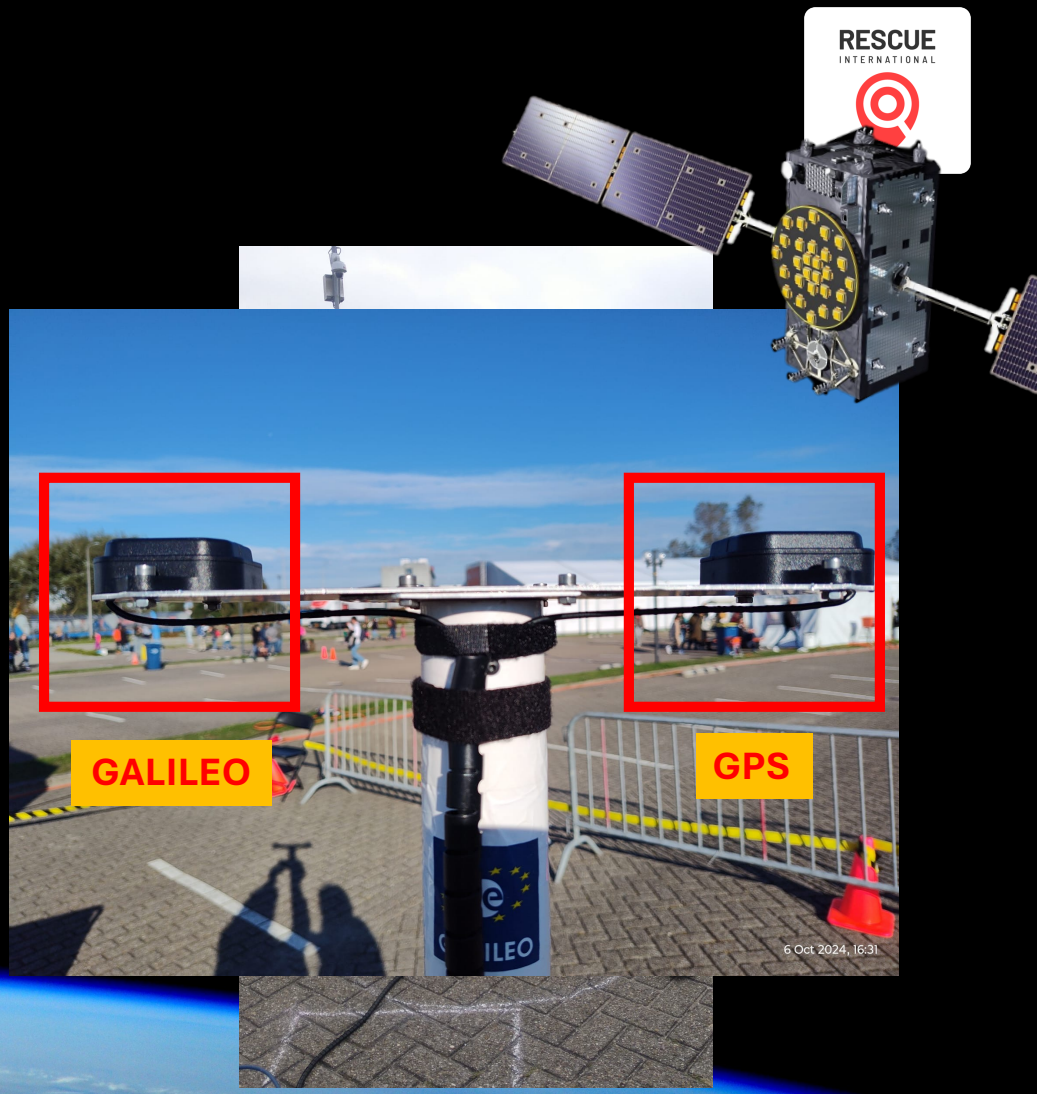
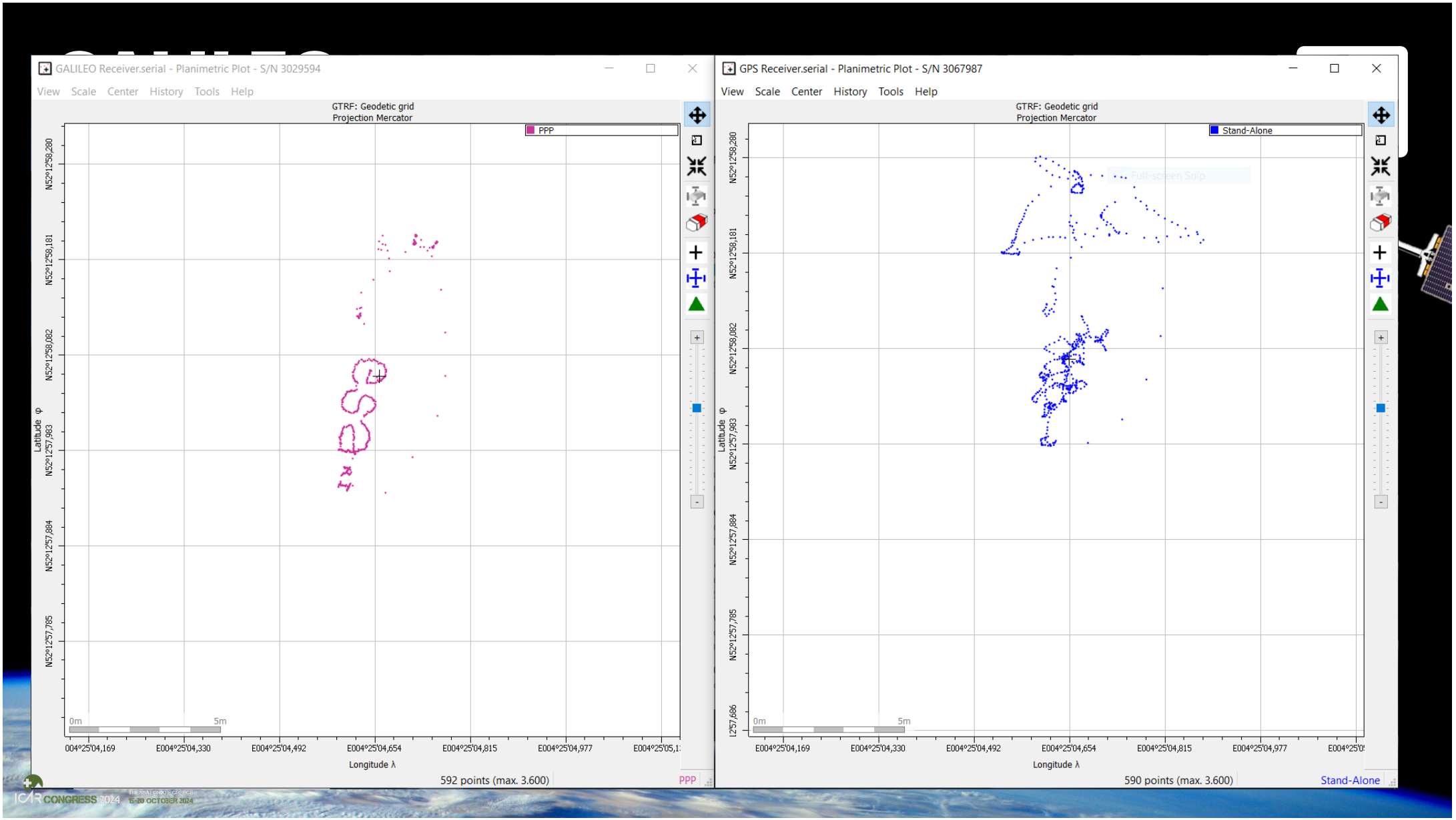
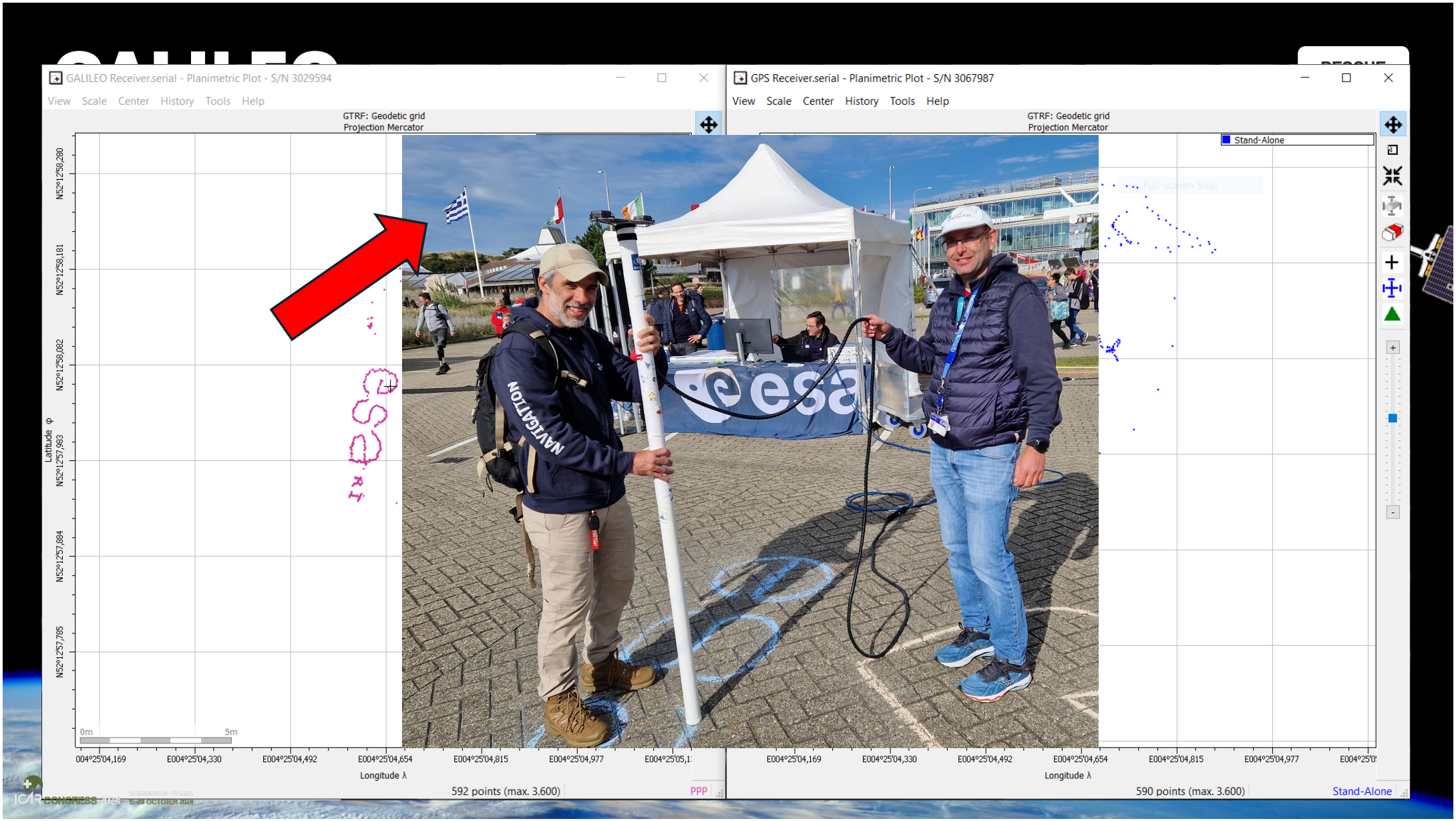



GALILEO Receiver.serial - Planimetric Plot - S/N 3029594
View Scale Center History Tools Help
GTRF: Geodetic grid
Projection Mercator
PPP
Latitude φ
N52°12'58,280
N52°12'58,181
N52°12'58,082
N52°12'57,983
N52°12'57,884
N52°12'57,785
0m
5m
E004°25'04,169
E004°25'04,330
E004°25'04,492
E004°25'04,654
E004°25'04,815
E004°25'04,977
Longitude λ
592 points (max. 3.600)
PPP
GPS Receiver.serial - Planimetric Plot - S/N 3067987
View Scale Center History Tools Help
GTRF: Geodetic grid
Projection Mercator
Stand-Alone
Latitude φ
N52°12'58,280
N52°12'58,181
N52°12'58,082
N52°12'57,983
N52°12'57,884
N52°12'57,785
N52°12'57,686
0m
5m
E004°25'04,169
E004°25'04,330
E004°25'04,492
E004°25'04,654
E004°25'04,815
E004°25'04,977
Longitude λ
590 points (max. 3.600)
Stand-Alone


GALILEO Receiver.serial - Planimetric Plot - S/N 3029594
View Scale Center History Tools Help
GTRF: Geodetic grid
Projection Mercator
Latitude φ
N52°12'58,280
N52°12'58,181
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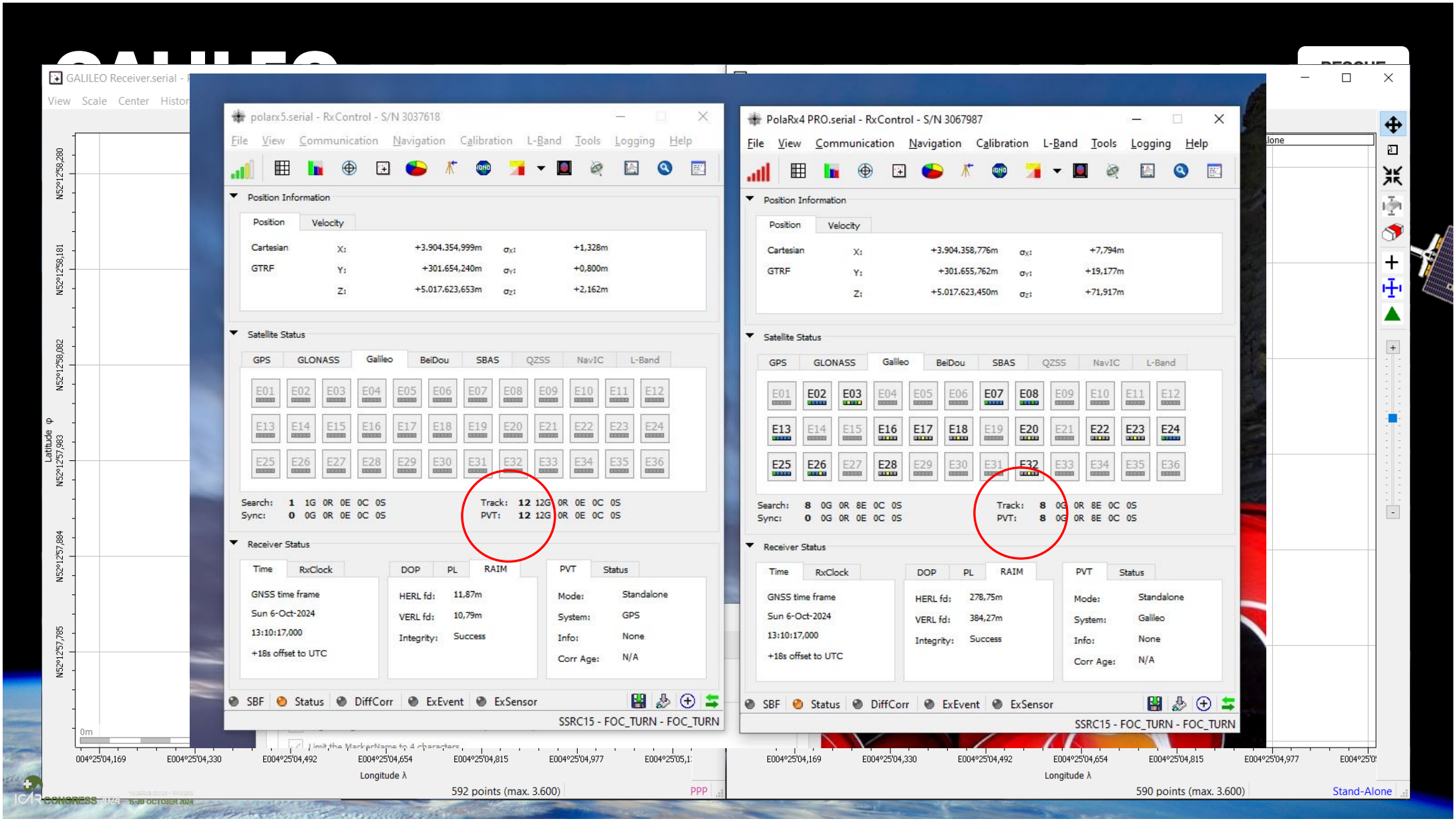
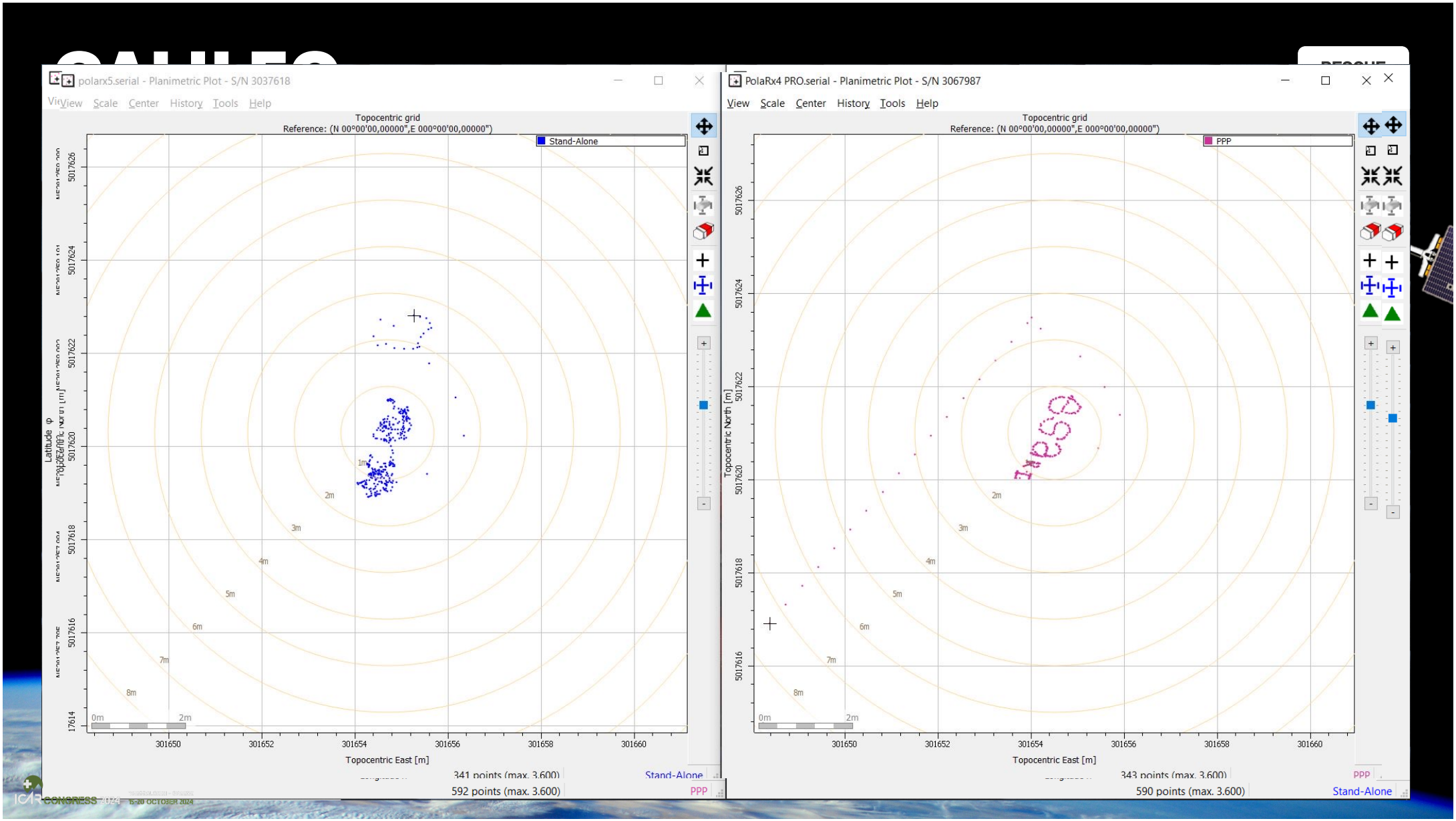
E004°25'04,654
E004°25'04,815
E004°25'04,977
Longitude λ
592 points (max. 3.600)
PPP
GPS Receiver.serial - Planimetric Plot - S/N 3067987
View Scale Center History Tools Help
GTRF: Geodetic grid
Projection Mercator
Stand-Alone
Full-screen Snip
E004°25'04,169
E004°25'04,330
E004°25'04,492
E004°25'04,654
E004°25'04,815
E004°25'04,977
Longitude λ
590 points (max. 3.600)
Stand-Alone
NAVIGATION
esa


GALILEO Receiver.serial - RxControl - S/N 3037618
File View Communication Navigation Calibration L-Band Tools Logging Help
Position Information
Position Velocity
Cartesian X: +3.904.354,999m σX: +1,328m
GTRF Y: +301.654,240m σY: +0,800m
Z: +5.017.623,653m σZ: +2,162m
Satellite Status
GPS GLONASS Galileo BeiDou SBAS QZSS NavIC L-Band
E01 E02 E03 E04 E05 E06 E07 E08 E09 E10 E11 E12
E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23 E24
E25 E26 E27 E28 E29 E30 E31 E32 E33 E34 E35 E36
Search: 1 1G 0R 0E 0C 0S
Sync: 0 0G 0R 0E 0C 0S
Track: 12 12G 0R 0E 0C 0S
PVT: 12 12G 0R 0E 0C 0S
Receiver Status
Time RxClock DOP PL RAIM PVT Status
GNSS time frame
Sun 6-Oct-2024
13:10:17,000
+18s offset to UTC
HERL fd: 11,87m
VERL fd: 10,79m
Integrity: Success
Mode: Standalone
System: GPS
Info: None
Corr Age: N/A
SBF Status DiffCorr ExEvent ExSensor
SSRC15 - FOC_TURN - FOC_TURN
PolaRx4 PRO.serial - RxControl - S/N 3067987
File View Communication Navigation Calibration L-Band Tools Logging Help
Position Information
Position Velocity
Cartesian X: +3.904.358,776m σX: +7,794m
GTRF Y: +301.655,762m σY: +19,177m
Z: +5.017.623,450m σZ: +71,917m
Satellite Status
GPS GLONASS Galileo BeiDou SBAS QZSS NavIC L-Band
E01 E02 E03 E04 E05 E06 E07 E08 E09 E10 E11 E12
E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23 E24
E25 E26 E27 E28 E29 E30 E31 E32 E33 E34 E35 E36
Search: 8 0G 0R 8E 0C 0S
Sync: 0 0G 0R 8E 0C 0S
Track: 8 0G 0R 8E 0C 0S
PVT: 8 0G 0R 8E 0C 0S
Receiver Status
Time RxClock DOP PL RAIM PVT Status
GNSS time frame
Sun 6-Oct-2024
13:10:17,000
+18s offset to UTC
HERL fd: 278,75m
VERL fd: 384,27m
Integrity: Success
Mode: Standalone
System: Galileo
Info: None
Corr Age: N/A
SBF Status DiffCorr ExEvent ExSensor
SSRC15 - FOC_TURN - FOC_TURN
Latitude φ
Longitude λ
592 points (max. 3.600)
590 points (max. 3.600)
PPP
Stand-Alone


polarx5.serial - Planimetric Plot - S/N 3037618
View Scale Center History Tools Help
Topocentric grid
Reference: (N 00°00'00,00000",E 000°00'00,00000")
Stand-Alone
Topocentric East [m]
341 points (max. 3.600)
592 points (max. 3.600)
PolaRx4 PRO.serial - Planimetric Plot - S/N 3067987
View Scale Center History Tools Help
Topocentric grid
Reference: (N 00°00'00,00000",E 000°00'00,00000")
PPP
Topocentric North [m]
Topocentric East [m]
343 points (max. 3.600)
590 points (max. 3.600)
Stand-Alone

FUTURE OF GALILEO RLS APPLICATIONS

RESCUE INTERNATIONAL

SAR Remote Beacon Activation -RBA

For airspace users in specific confirmed distress situations when aircraft are no longer tracked by Air Traffic Service Units (ATSUs) and no contact can be established.

Two Way Communication - TWC

Enables communication between distress beacons and the RCC in charge, through predefined questions and answers. Aims at helping rescue teams deploying adequate resources, improving SAR operations.

Distress Position Sharing

Enables RCCs to share the position of a Beacon User in distress with other nearby beacons

Emergency Warning Satellite Service -EWSS

Galileo satellites will be disseminating alert messages directly to smartphones and navigation devices in areas threatened by a looming natural or manmade disaster

IN PROGRESS

Source: EUSPA / Telespazio
https://www.euspa.europa.eu/newsroom-events/news/galileo-emergency-warning-satellite-service-ewss
https://defence-industry-space.ec.europa.eu/galileo-emergency-warning-satellite-service-underway-2024-01-24_en
https://www.telespazio.fr/en/press-release-detail/-/detail/serenity-project-april21

DISTRESS MESSAGE

Messages come in SIT 185 format

Every beacon has a Unique Identification Number –UIN, also known as the Hex ID

Already indicates homing options

Key information and accuracy aspects for POA may be easily missed for untrained eye

Message wording may refer to very specific technical and accuracy parameters

PARAGRAPH#	TITLE	
1.	MESSAGE TYPE	M
2.	CURRENT MESSAGE NUMBER	M
	MCC BEACON REFERENCE	M
3.	BEACON MESSAGE INFORMATION	M
	TYPE OF BEACON	O
	IDENTIFICATION	O
	BEACON HEX ID	M
	COUNTRY OF BEACON REGISTRATION	O
	BEACON NUMBER	O
	HOMING SIGNAL	O
	ACTIVATION TYPE	O
	SOURCE OF GNSS POSITION DATA	O
	EMERGENCY CODE	O
4.	ALERT POSITION INFORMATION	M
	DETECTION TIME & SPACECRAFT	M
	GNSS POSITION, TIME OF UPDATE AND ALTITUDE	O
	MCC REFERENCE POSITION	O
	DOA POSITION AND ALTITUDE	O
	A POSITION & PROBABILITY	O
	B POSITION & PROBABILITY	O
5.	OTHER INFORMATION	M
	DETECTION FREQUENCY	M
	OTHER ENCODED INFORMATION	O
6.	REMARKS	M
END OF MESSAGE		M

DISTRESS MESSAGE

```
080401Z JAN 2017
FROM AUMCC
TO RCC WELLINGTON
BT
1.  DISTRESS COSPAS-SARSAT INITIAL LOCATED ALERT
2.  MSG NO 12590  AUMCC REF C00F429578002C1
3.  BEACON MESSAGE INFORMATION
    BEACON TYPE SERIAL USER - PLB
    SERIAL NO 0042334
    HEX ID C00F429578002C1
    COUNTRY OF BEACON REGISTRATION 512/NEWZEALAND
    BEACON NUMBER ON AIRCRAFT OR VESSEL NIL
    HOMING SIGNAL 121.5
    ACTIVATION TYPE MANUAL
    GNSS POSITION PROVIDED BY NIL
    EMERGENCY CODE NIL
4.  ALERT POSITION INFORMATION
      DETECTED AT 08 JAN 17 0354 UTC BY SARSAT 10
      GNSS - NIL
      MCC REFERENCE - NIL
      DOA - NIL
      DOPPLER A - 41 14 S  172 31 E  PROB 79 PERCENT
      DOPPLER B - 48 20 S  135 51 E  PROB 21 PERCENT
5.  OTHER INFORMATION
    DETECTION FREQUENCY 406.0282 MHZ
    TAC NO 0176
    BEACON MODEL - STANDARD COMMS, AUSTRALIA MT410, MT410G
6.  REMARKS NIL
END OF MESSAGE
```

Sample Distress Message

PARAGRAPH#	TITLE	
1.	MESSAGE TYPE	M
2.	CURRENT MESSAGE NUMBER	M
	MCC BEACON REFERENCE	M
3.	BEACON MESSAGE INFORMATION	M
	TYPE OF BEACON	O
	IDENTIFICATION	O
	BEACON HEX ID	M
	COUNTRY OF BEACON REGISTRATION	O
	BEACON NUMBER	O
	HOMING SIGNAL	O
	ACTIVATION TYPE	O
	SOURCE OF GNSS POSITION DATA	O
	EMERGENCY CODE	O
4.	ALERT POSITION INFORMATION	M
	DETECTION TIME & SPACECRAFT	M
	GNSS POSITION, TIME OF UPDATE AND ALTITUDE	O
	MCC REFERENCE POSITION	O
	DOA POSITION AND ALTITUDE	O
	A POSITION & PROBABILITY	O
	B POSITION & PROBABILITY	O
5.	OTHER INFORMATION	M
	DETECTION FREQUENCY	M
	OTHER ENCODED INFORMATION	O
6.	REMARKS	M
END OF MESSAGE		M

Data Fields

DISTRESS MESSAGE

```
1.  DISTRESS COSPAS-SARSAT INITIAL LOCATED ALERT
2.  MSG NO 12307  AUMCC REF BEEE43FCF8001AD
3.  BEACON MESSAGE INFORMATION
    BEACON TYPE SERIAL USER LOCATION - EPIRB (NON FLOAT FREE)
    SERIAL NO 0065342
    HEX ID BEEE43FCF8001AD
    COUNTRY OF BEACON REGISTRATION 503/AUSTRALIA
    BEACON NUMBER ON AIRCRAFT OR VESSEL NIL
    HOMING SIGNAL 121.5
    ACTIVATION TYPE MANUAL
    GNSS POSITION PROVIDED BY NIL
    EMERGENCY CODE NIL
4.  ALERT POSITION INFORMATION
      DETECTED AT 27 APR 13 1653 UTC BY LEOSAR SARSAT 12
      GNSS - NIL
      MCC REFERENCE - NIL
      DOA - NIL
      DOPPLER A - 43 04.04 S  147 15.75 E  PROB 83 PERCENT
      DOPPLER B - 51 45.19 S  167 48.58 W  PROB 17 PERCENT
5.  OTHER INFORMATION
    THE B POSITION IS LIKELY TO BE AN IMAGE POSITION
    DETECTION FREQUENCY 406.0277 MHZ
    TAC 0107
    BEACON MODEL - ACR, USA RLB-32
    LUT ID 6011
6. REMARKS NIL
END OF MESSAGE
```

Sample Initial Location

```
1.  DISTRESS COSPAS-SARSAT INITIAL ALERT (UNLOCATED)
2.  MSG NO 12301  AUMCC REF BEEE43FCF8001AD
3.  BEACON MESSAGE INFORMATION
    BEACON TYPE SERIAL USER - EPIRB (NON FLOAT FREE)
    SERIAL NO 0065342
    HEX ID BEEE43FCF8001AD
    COUNTRY OF BEACON REGISTRATION 503/AUSTRALIA
    BEACON NUMBER ON AIRCRAFT OR VESSEL NIL
    HOMING SIGNAL 121.5
    ACTIVATION TYPE MANUAL
    GNSS POSITION PROVIDED BY NIL
    EMERGENCY CODE NIL
4.  ALERT POSITION INFORMATION
      DETECTED AT 27 APR 13 1557 UTC BY GEOSAR INSAT 3A
      GNSS - NIL
      MCC REFERENCE - NIL
      DOA - NIL
      DOPPLER A - NIL
      DOPPLER B - NIL
5.  OTHER INFORMATION
    LUT ID 4191 BANGALORE GEOLUT, INDIA
    DETECTION FREQUENCY 406.0286 MHZ
    TAC 0107
    BEACON MODEL - ACR, USA RLB-32
6.  REMARKS NIL
END OF MESSAGE
```

Sample GEOSAR Unlocated Alert

DISTRESS MESSAGE

```
1.  DISTRESS COSPAS-SARSAT POSITION UPDATE ALERT
2.  MSG NO 00191  AUMCC REF BEEE4634B00028D
3.  BEACON MESSAGE INFORMATION
    BEACON TYPE  SERIAL USER - EPIRB (NON FLOAT-FREE)
    SERIAL NO 101676
    HEX ID BEEE4634B00028D
    COUNTRY OF BEACON REGISTRATION 503/AUSTRALIA
    HOMING SIGNAL 121.5
    ACTIVATION TYPE MANUAL
4.  ALERT POSITION INFORMATION
      DETECTED AT 15 MAR 16 1248 UTC BY MEOSAR
      ALERT LAST DETECTED AT 15 MAR 16 1248 UTC
      MCC REFERENCE - 17 47.5 S  146 06.2 E
      DOA - 17 47.6 S  146 07.4 E  ESTIMATED ERROR 005 NMS
5.  OTHER INFORMATION
    DETECTION FREQUENCY 406.0280 MHZ
6.  REMARKS NIL
END OF MESSAGE
```

Position Confirmed Alert

```
1.  DISTRESS COSPAS-SARSAT POSITION UPDATE ALERT
2.  MSG NO 00194  AUMCC REF BEEE4634B00028D
3.  BEACON MESSAGE INFORMATION
    BEACON TYPE SERIAL USER - EPIRB (NON FLOAT-FREE)
    SERIAL NO 101676
    HEX ID BEEE4634B00028D
    COUNTRY OF BEACON REGISTRATION 503/AUSTRALIA
    HOMING SIGNAL 121.5
    ACTIVATION TYPE MANUAL
4.  ALERT POSITION INFORMATION
      DETECTED AT 15 MAR 16 1301 UTC BY MEOSAR
      ALERT LAST DETECTED AT 15 MAR 16 1301 UTC
      MCC REFERENCE - 17 47.6 S  146 05.3 E
      DOA - 17 47.9 S  146 04.5 E  ESTIMATED ERROR 002 NMS
5.  OTHER INFORMATION
    DETECTION FREQUENCY 406.0280 MHZ
6.  REMARKS NIL
END OF MESSAGE
```

Position Confirmed Updated Alert

DISTRESS MESSAGE

Not only location can be provided:

If beacon was registered, registration information may be available to the RCC

SAR agencies may use this information to know more about the subject and the event

```
/71472 00000/3660/20 100 0657
/925/5030
/3EF4957FBF81FE0
/
BEACON ID: 2DC4000000FFBFF

**** BEACON REGISTRATION DATABASE INFORMATION ****

OWNER: ANONYMOUS OWNER
 1234 LOCAL DRIVE       TEL 1: HOME 0123456789
 HOME CITY          CA   TEL 2: WORK 1234567890
 98765   USA            TEL 3:
 EMAIL:
CONTACTS: JOHN DOE          JANE DOE
 TEL 1: HOME 0123456789     TEL 1: HOME 0123456789
 TEL 2:                       TEL 2: WORK 1234567890

VESSEL NAME: SUNKEN
TYPE: SAIL 1 Masts             LENGTH OVERALL (FT):  36
COLOR: BLUE/WHITE           CAPACITY:   8
RADIO CALL SIGN:             REGISTRATION NO: CF12345P
RADIO EQP: VHF               INMARSAT NUMBER:
CELLULAR NUMBER: 2345678901
NUMBER OF LIFE BOATS:   0      NUMBER OF LIFE RAFTS:   0
HOME PORT PRIMARY SRR: PACAREA    SECONDARY SRR:
HOME PORT: MARINA NAME           SAN FRANCISCO        CA

MANUFACTURER: XXX           MODEL NUMBER: ABC-12
ACTIVATION TYPE: CAT2 (MANUAL)
BEACON CONTAINS SVDR: NO
DATE FIRST REGISTERED: 02 JUN 1999  DATE REG EXPIRES: 02 JUN 2001
DATE LAST UPDATED: 02 MAY 2001

REMARKS:
SPECIAL STATUS:          SPECIAL STATUS DATE:
SPECIAL STATUS INFO:

QQQQ
/LASSIT
/ENDMSG
```

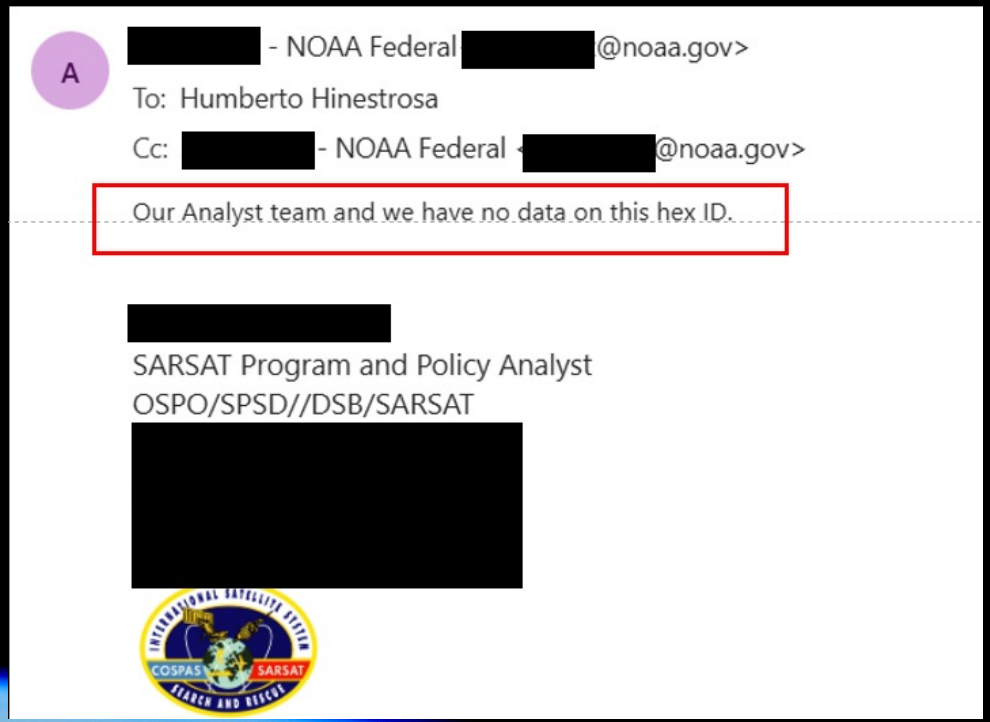
Sample Message to Report Beacon Registration Data

DISTRESS MESSAGE REAL CASES

Multiple variables that are beyond our [and subject's] control may affect the reception of the beacon signal

Ionospheric disturbances
Humidity
Tree Canopy
Position of the beacon
Damage of the beacon
Weather
...and more

The alert system message sometimes may seem incomplete

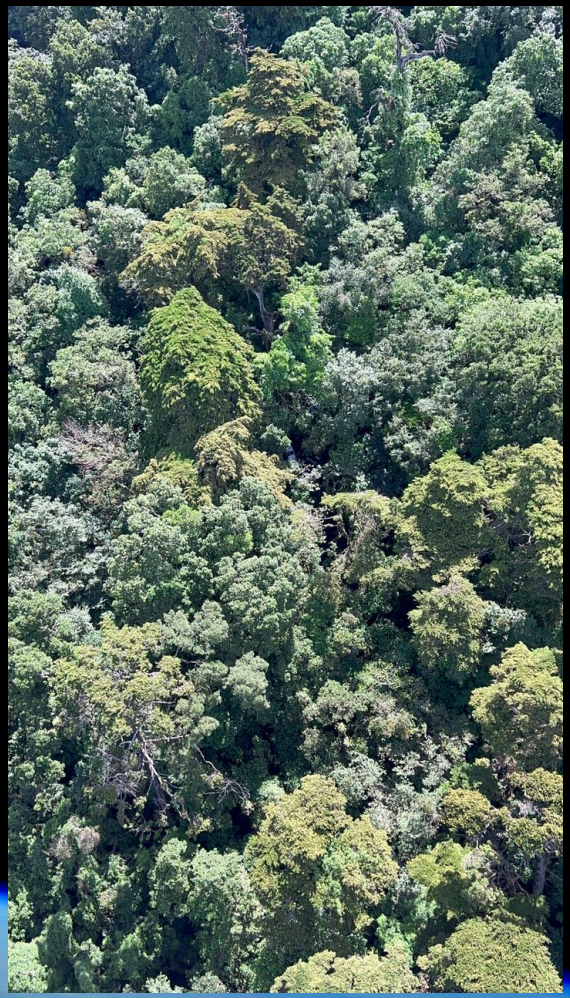


DISTRESS MESSAGE REAL CASES

Multiple variables that are beyond our [and subject's] control may affect the reception of the beacon signal

Ionospheric disturbances
Humidity
Tree Canopy
Position of the beacon
Damage of the beacon
Weather
...and more

The alert system message sometimes may seem incomplete



DISTRESS MESSAGE REAL CASES

Multiple variables that are beyond our [and subject's] control may affect the reception of the beacon signal

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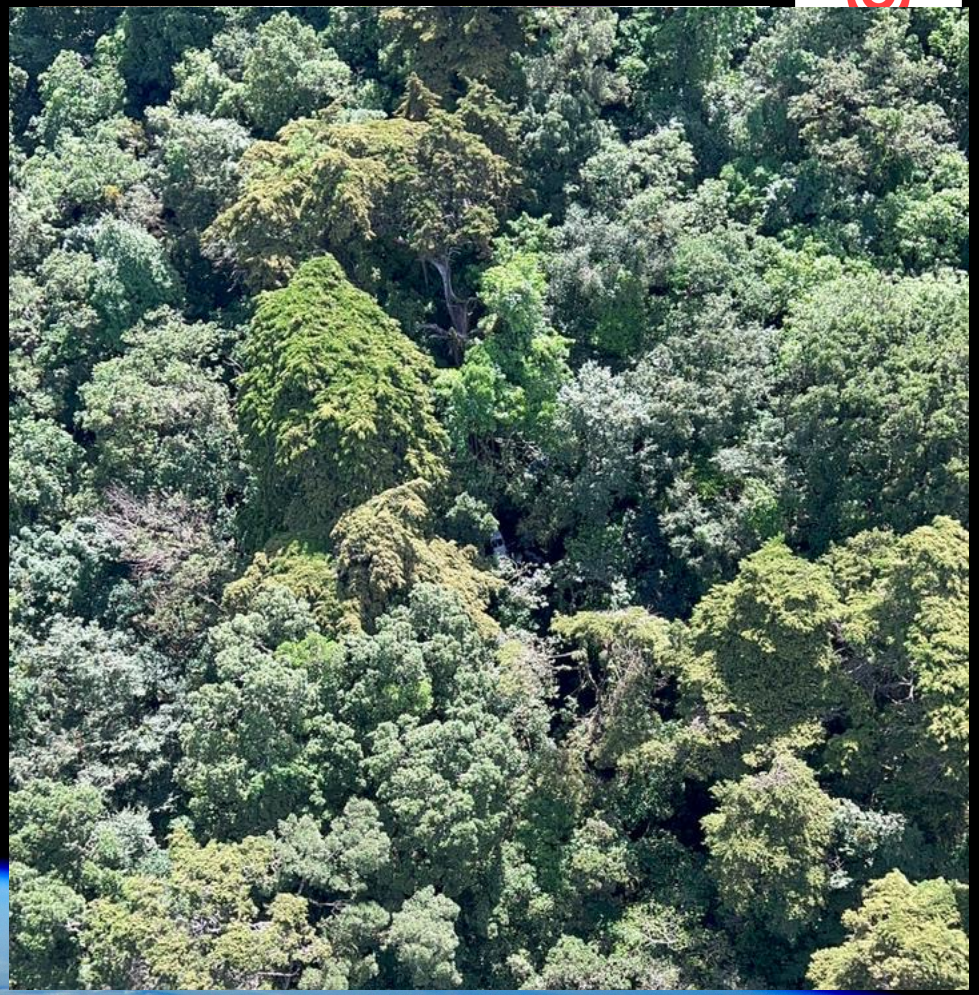
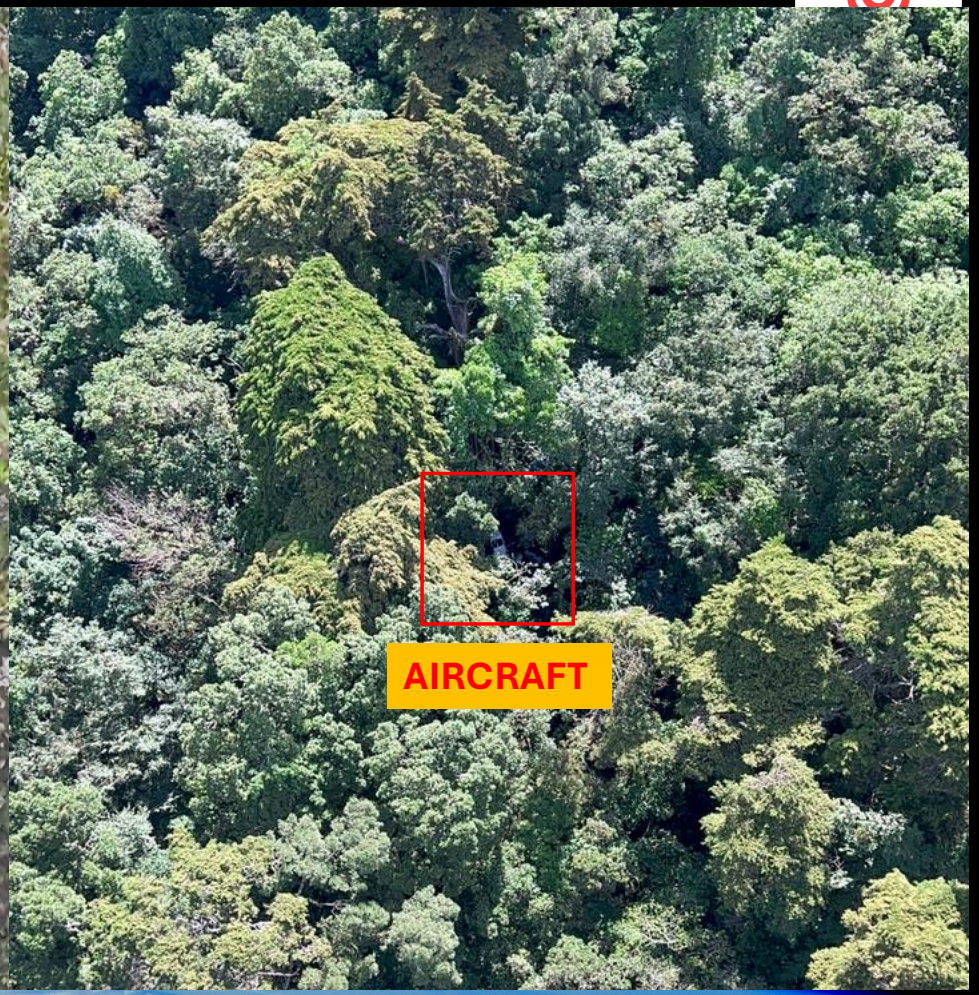


DISTRESS MESSAGE



DISTRESS MESSAGE REAL CASES

Multiple variables that are beyond our [and subject's] control may affect the reception of the beacon signal

Ionospheric disturbances
Humidity
Tree Canopy
Position of the beacon
Damage of the beacon
Weather
...and more

The alert system message sometimes may seem incomplete

Mensaje SAR SIT-185

/85452 00000/3660/24 247 1602
/185/CNAM
/
1. DISTRESS COSPAS-SARSAT POSITION UPDATE ALERT

2. MSG NO. 85452 USMCC REF 39367

3. BEACON MESSAGE INFORMATION
BEACON TYPE ELT SERIAL AVIATION ID
SERIAL NO 5945
HEX ID A98C405CE4002F1
COUNTRY OF BEACON REGISTRATION 332/GUATEMALA
HOMING SIGNAL 121.5

4. ALERT POSITION INFORMATION
DETECTED AT 03 SEP 24 1559 UTC BY MEOSAR
MEOSAR ALERT LAST DETECTED AT 03 SEP 24 1601
MCC REFERENCE - 14 34.2N 090 32.0W
DOA - 14 34.4N 090 32.9W ESTIMATED ERROR UNKNOWN

5. OTHER INFORMATION
BEACON MANUFACTURER / MODEL: TAC 188
LUT: 3385/HI-MEO

REGISTRATION AT C/S INTERNATIONAL BEACON REGISTRATION DATABASE
AFTN: KZDCZSZA
PHONE: 1 301-817-4576
WEB: WWW.406REGISTRATION.COM
DETECTION FREQUENCY 406.0277 MHZ

6. REMARKS
NIL

END OF MESSAGE
QQQQ
/LASSIT
/ENDMSG

Position Confirmed Alert

DISTRESS MESSAGE REAL CASES

RESCUE INTERNATIONAL

It’s up to us [when possible] to fill those gaps

DISTRESS MESSAGE REAL CASES

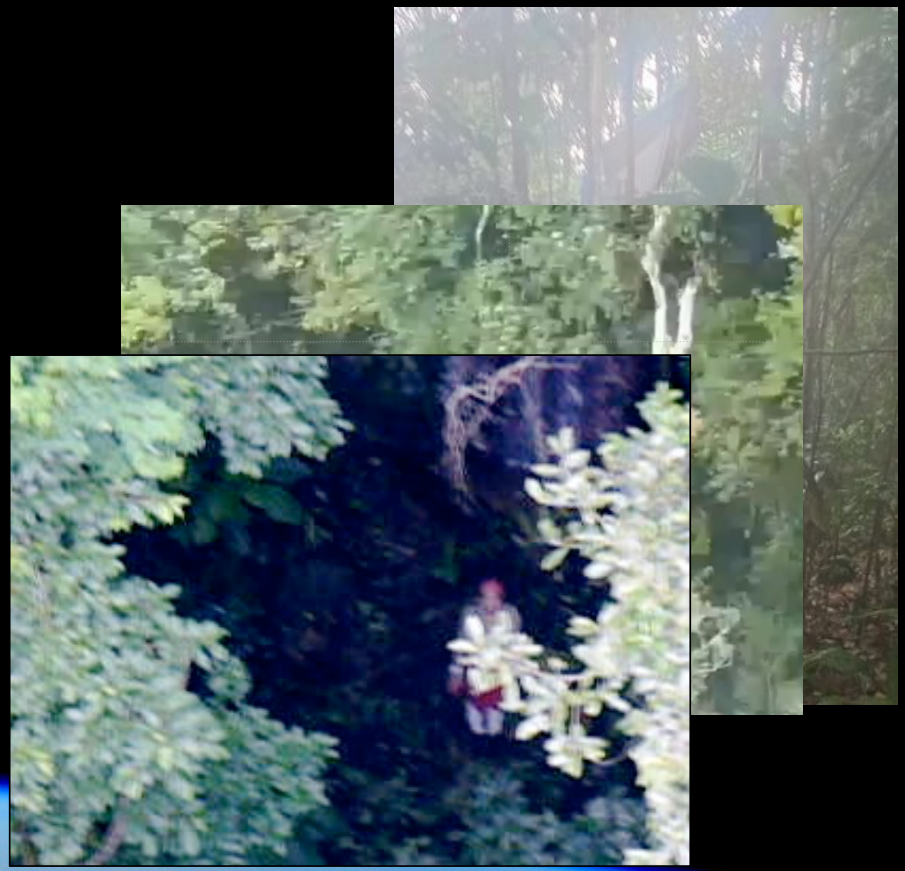
RESCUE INTERNATIONAL

It’s up to us [when possible] to fill those gaps

DISTRESS MESSAGE REAL CASES

RESCUE INTERNATIONAL

It’s up to us [when possible] to fill those gaps

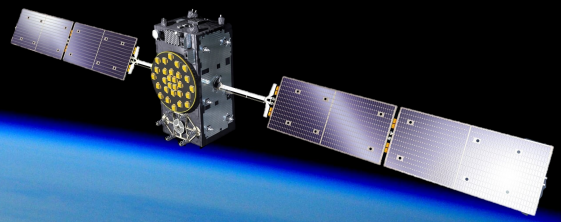


OUTCOMES

- Compared to the other 406 beacons, in the near future **PLBs are likely to become the leader in incident activation**, and the most numerous of the 406 beacons
- It is possible to increase the value of the SIT185 messages. Many times, the **distress message is not enough** and requires input from SAR Managers
- **SIT185 interpretation becomes a great advantage in calculating our POAs and Theoretical Search area**
- **Education on S/C** is necessary in GroundSAR. It may be the difference for our subject, allowing SAR Managers to know what to ask

OUTCOMES

- ~75% of the beacons may provide additional context to our case
- Analysis of statistics can have significant impact in increasing knowledge in SAR: PLEASE SHARE YOUR STATISTICS!
- Close collaboration with the RCC will be necessary
- Homing [and training on how to do it] is expected to increase as 406 beacons alerts increase
- Every rescue activated by a PLB, is a multi-day search we don't have to do!



THANKS FOR YOUR ATTENTION!

ICAR CONGRESS 2024

THESSALONIKI - GREECE

15-20 OCTOBER 2024

...and many thanks to those directly contributing to this work:

GALILEO

esa

INTERNATIONAL SATELLITE SYSTEM COSPAS SARSAT SEARCH AND RESCUE

SAR BY GALILEO

ORGANIZACIÓN RESCATE HUMBOLDT SAR

RESCUE INTERNATIONAL

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