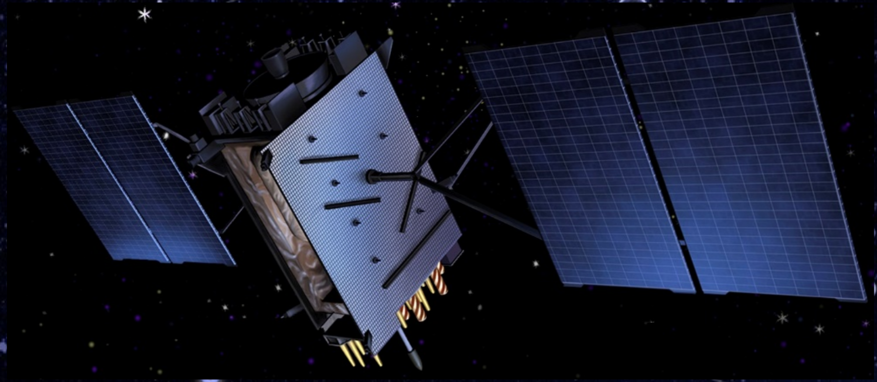
Beacon Manufacturers Workshop

Palm Beach Gardens, USA
Sept 28th 2018



Cospas-Sarsat updates and ELT-DT Development

Dany St-Pierre
Cospas-Sarsat Secretariat

Cospas-Sarsat Programme

Cospas-Sarsat Programme Status

- Overall Mission and Participants
- System segments status: Space segment, Ground Segment, Beacon population
- Assisted Saves distribution and evolution

ELT-DT development

- Concept Evolution and demonstration
- Development Status
- Characteristics
- Key Points

LEO,GEO and C/S constellations comparison

- Visibility to satellites
- Examples: aircraft in distress

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Cospas-Sarsat Mission

Mission Statement

The International Cospas-Sarsat Programme provides accurate, timely and reliable distress alert and location data to help search and rescue authorities assist persons in distress.

Objective

The objective of the Cospas-Sarsat system is to reduce, as far as possible, delays in the provision of distress alerts to SAR services, and the time required to locate a distress and provide assistance, which have a direct impact on the probability of survival of the person in distress at sea or on land.

Strategy

Cospas-Sarsat Participants implement, maintain, co-ordinate and operate a satellite system capable of detecting distress alert transmission from radiobeacons and of determining their position anywhere on the globe. The distress alert and location data is provided by Cospas-Sarsat Participants to the responsible SAR services.

Services are provided world-wide and free of charge for the user in distress.

Cospas-Sarsat Participants

Cospas-Sarsat Participants (44)

>75% of World Population
>85% of World Wealth

Algeria
Argentina
Australia
Brazil
Canada
Chile
China (P.R.)
Cyprus
Denmark
Finland
France
Germany
Greece
Hong Kong
India
Indonesia
Italy
ITDC
Japan
Korea (R. of)
Malaysia
Netherlands
New Zealand
Nigeria
Norway
Pakistan
Peru
Poland
Qatar
Russia
Saudi Arabia
Serbia
Singapore
South Africa
Spain
Sweden
Switzerland
Thailand
Tunisia
Turkey
UAE
UK
USA
Vietnam

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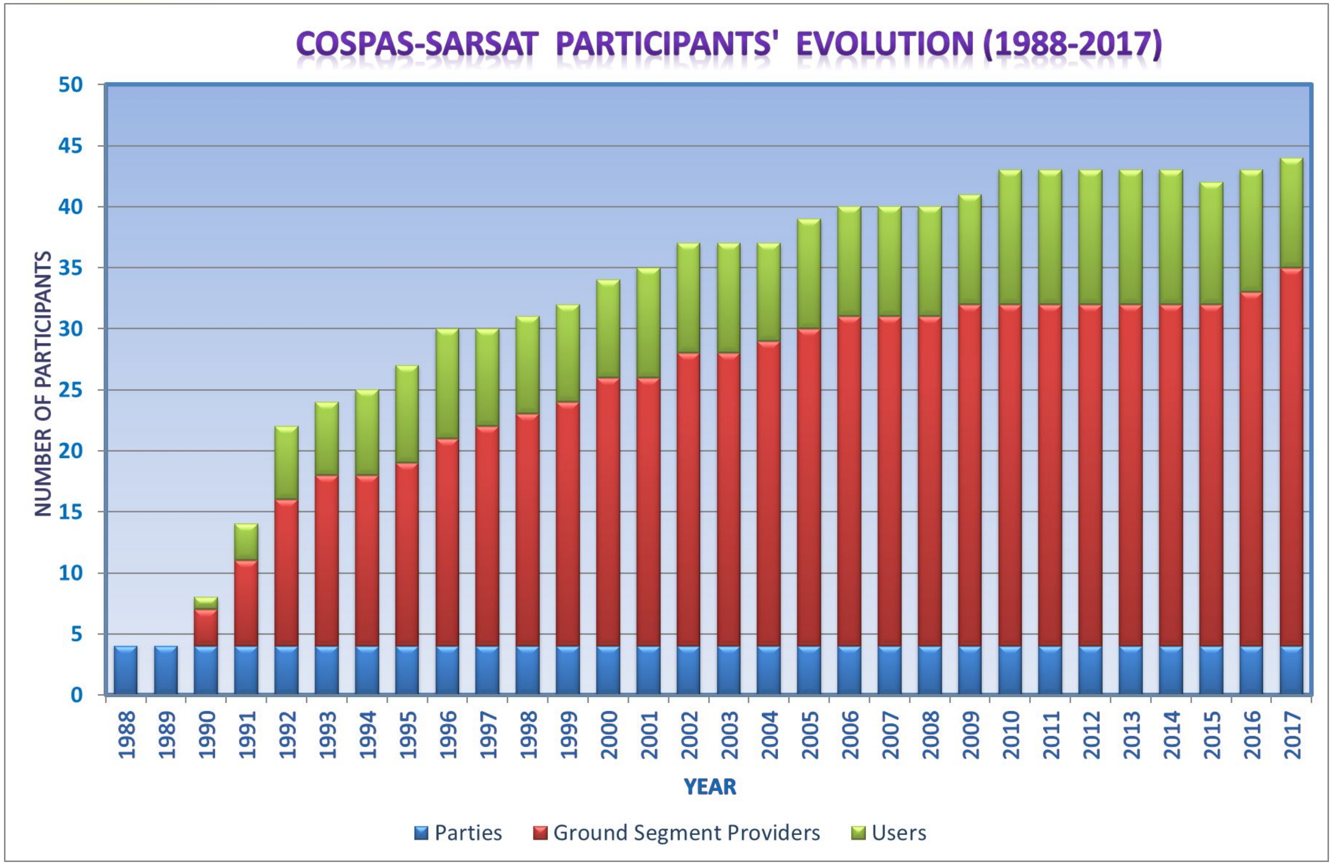
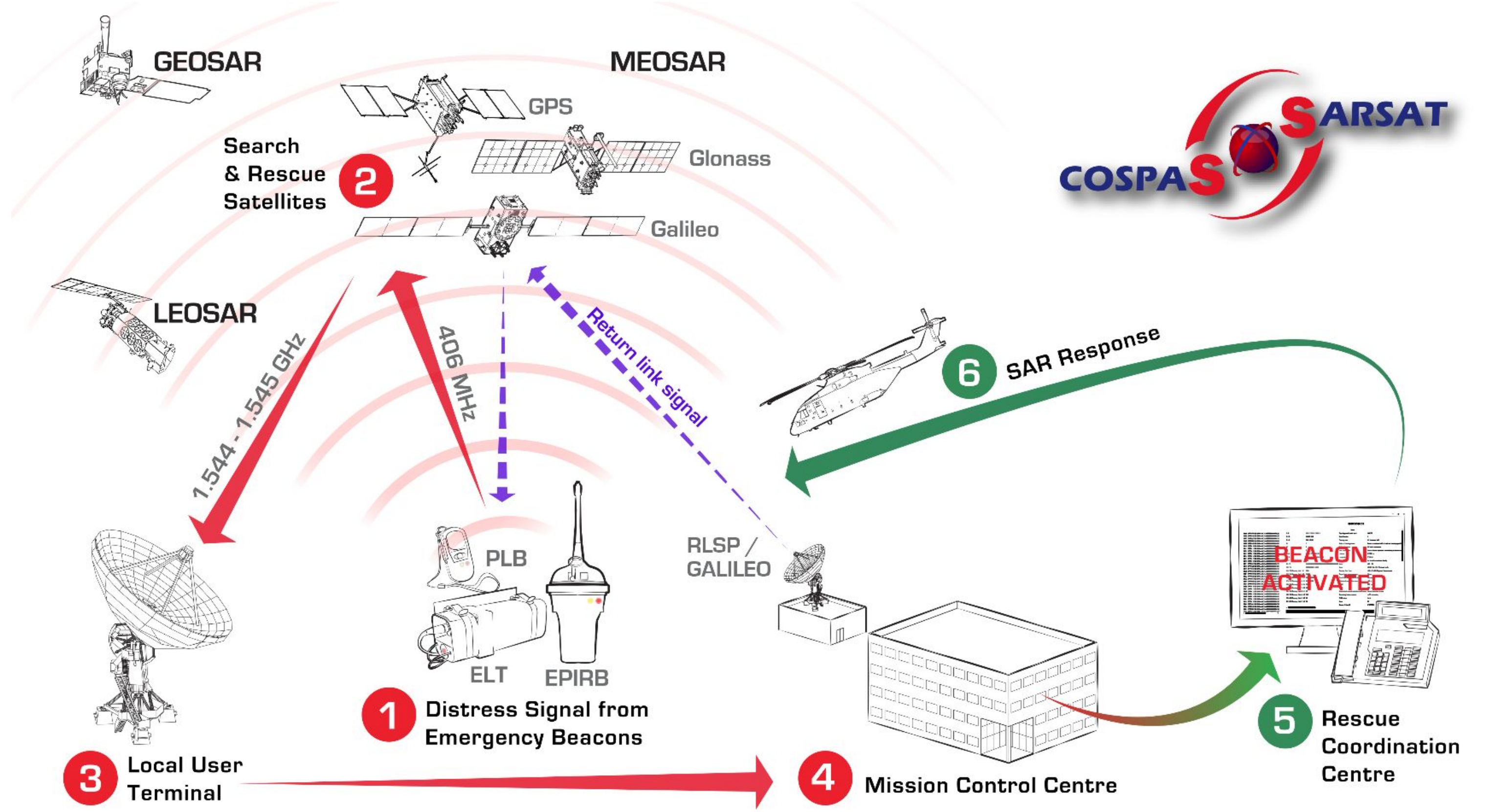
Cospas-Sarsat Participants' Evolution



42 States and 2 Organisations:

- **4** Parties: Canada, France, Russia, USA
- **31** Ground Segment Providers
- **9** User States

Cospas-Sarsat System



Cospas-Sarsat Satellite Systems

3 Types of Satellite Systems

- Low Earth Orbiting Search And Rescue (LEOSAR): first payload deployed in 1982. Main operational system since the beginning of Cospas-Sarsat
- Geostationary Orbiting Search And Rescue (GEOSAR): first payloads deployed in the mid-late 90s to provide early alerts and complement the LEOSAR system
- Medium Earth Orbiting Search And Rescue (MEOSAR): first payloads deployed in the early 2000s, first operational payload deployed in 2012 (Galileo), declared at Early Operational Capability in 2016

Cospas-Sarsat LEO-GEO Components

Space Segment: - 5 LEO payloads in operation (2 more planned to be deployed by the end of 2019)

- 7 GEO payloads in operation+ 5 additional satellites under in-orbit tests (3 more planned to be deployed between 2021 and 2024)

Ground Segment: - 56 Operational LEOLUTs (+3 new at JC-32) and 26 Operational GEOLUTs (+1 new at JC-32)

- 30 Operational Mission Control Centres including 3 commissioned at LGM (Leosar, Geosar, Meosar),

MEOSAR payloads status

- Galileo: 18 SAR repeater satellites are operational. Four additional payloads recently launched will be tested in the coming months. 12 additional payloads are to be launched starting in December 2020.

  The EC has recently launched the procurement of new satellites that will make the transition between the Galileo First Generation and Second Generation. These satellites will embark a new generation of SAR payloads which will be optimized for reaching the performances expected from the SGBs. These transition satellites are planned to be launched from 2025.
- SAR/Glonass: Two experimental L-band SAR/Glonass payloads are available to support current the MEOSAR D&E and EOC activities. Six additional Glonass payloads expected to be launched between 2018 and 2020

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MEOSAR payloads status

- DASS/GPS II: 19 DASS payloads used operationally. Eight additional DASS payloads planned to be deployed on GPS-III satellites starting in 2018. First L-band payloads to be deployed starting in 2026 on GPS-III
- Chinese BEIDOU: 2 SAR/Beidou payloads launched in September 2018, currently under tests. 4 more satellites planned to be deployed with a SAR payload prior to 2020. Future payloads are TBD
- By 2021 more than 50 MEOSAR payloads are expected to be made available for SAR operations and more than 70 MEOSAR payloads are expected to be available by 2030

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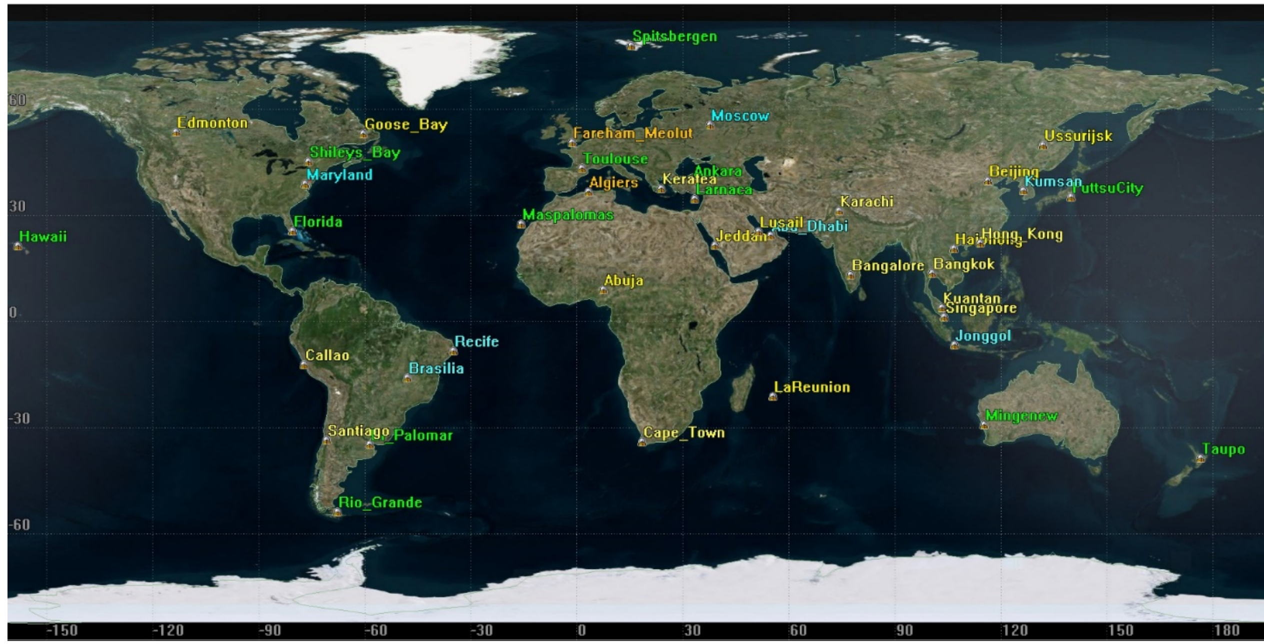
MEOSAR Ground Segment updates

- 12 commissioned MEOLUTs (+4 new at JC-32)
- 3 commissioned LGM MCCs.



30 more MEOLUTs planned to be commissioned by 2020 along with 31 more LGM MCC's. The MEOSAR system is expected to become the Cospas-Sarsat main operating system once it is declared at FOC.

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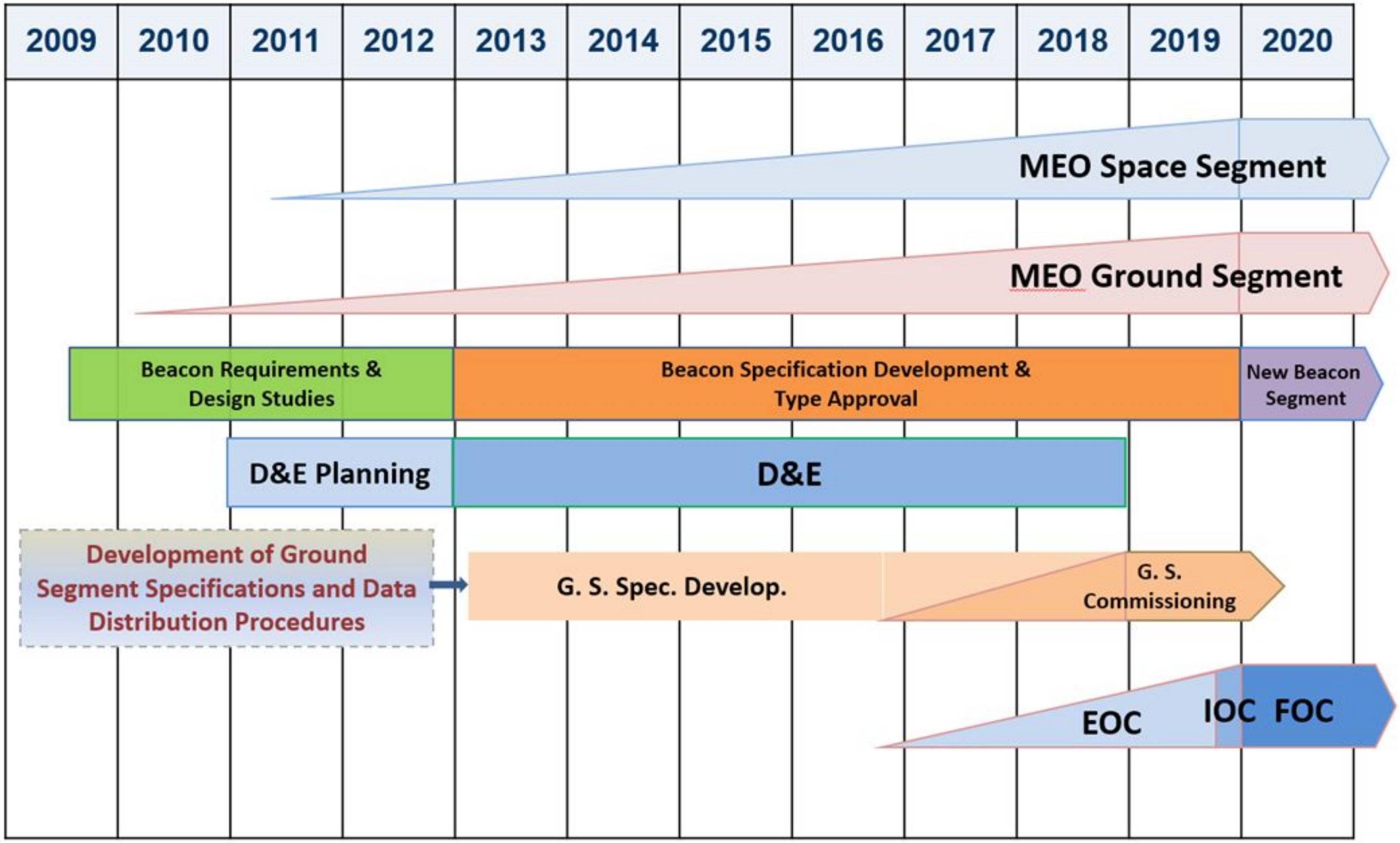
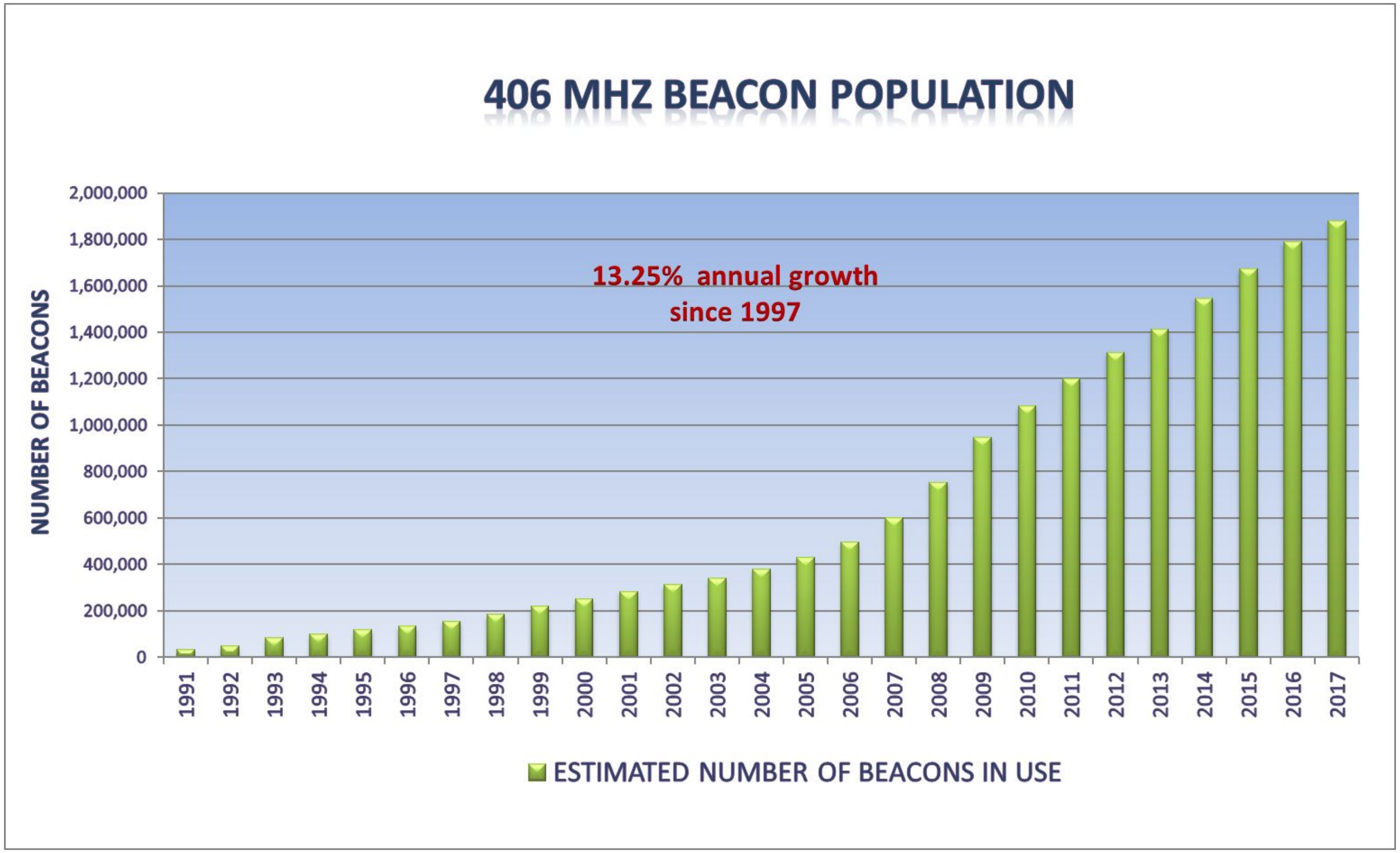
Cospas-Sarsat MEOSAR Implementation Timelime (to be confirmed at JC-32)



Beacon Population Evolution



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SAR Events and Assisted Saves

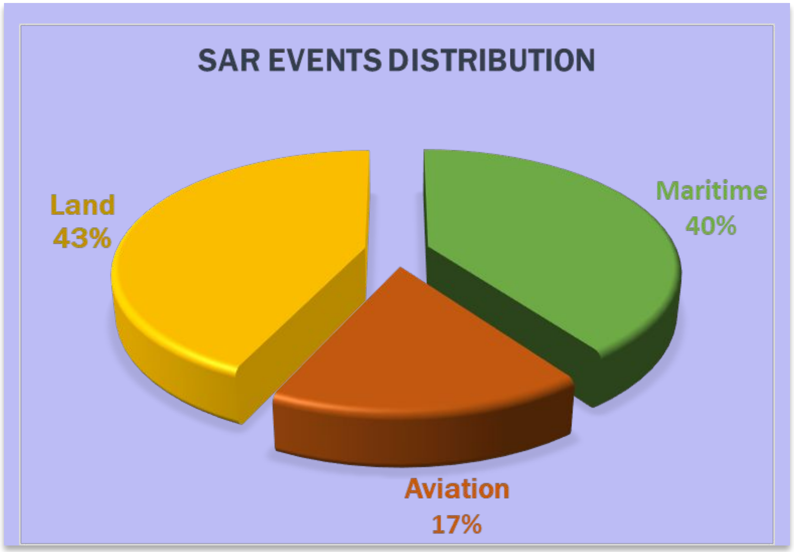
Worldwide Results

2017(*)

SAR Events: 934

P. Rescued: 2554

* Based on preliminary data



- SAR Events (1982 / 2017) : ≃ 13,600
  P. Rescued (1982 / 2017) : ≃ 46,400

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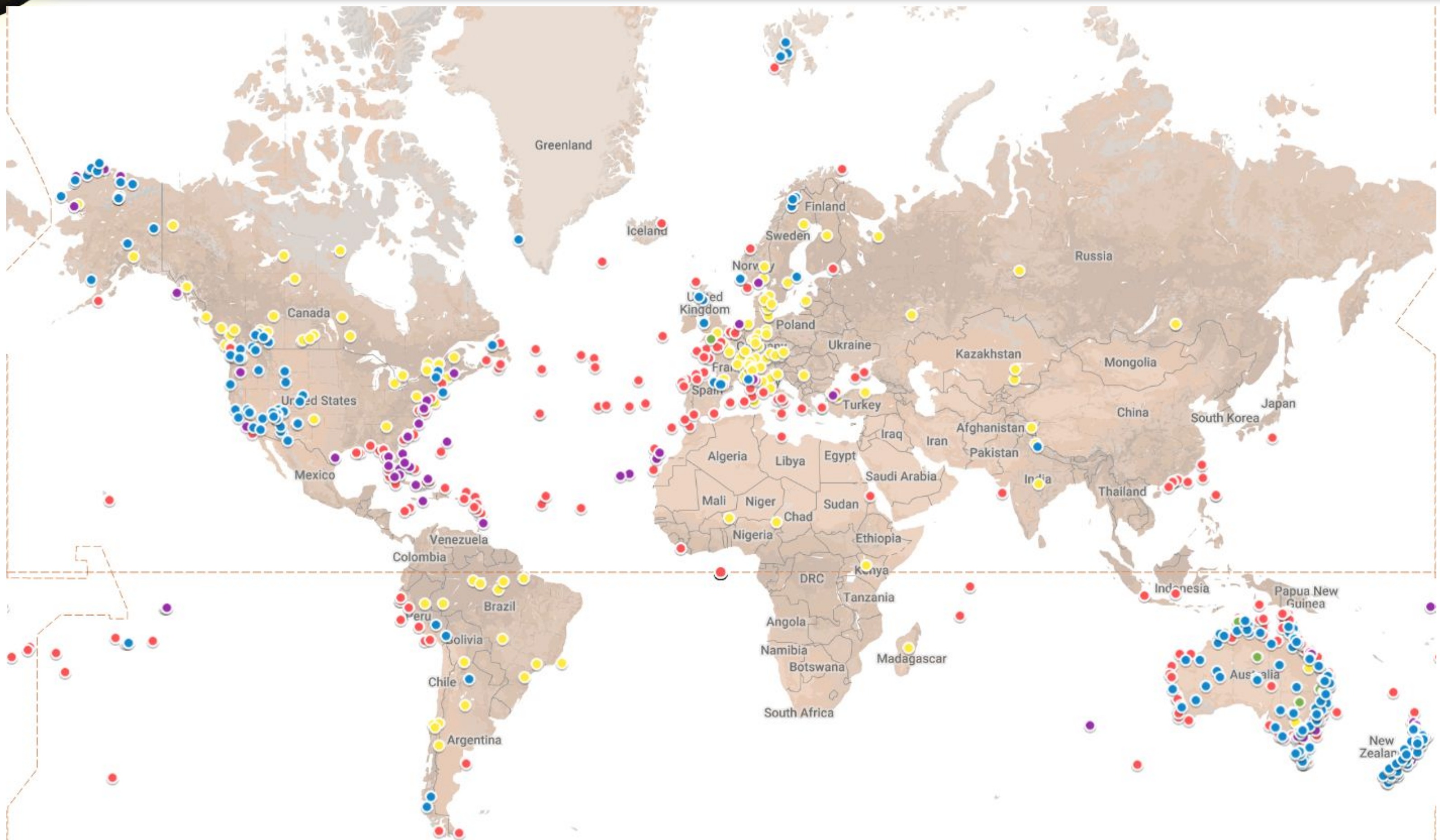
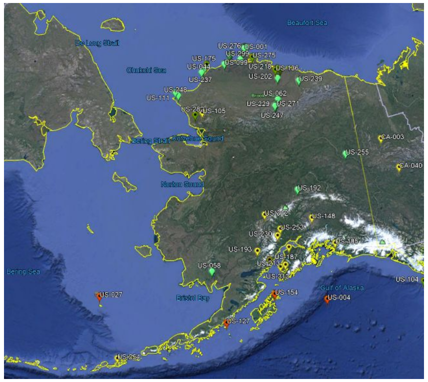
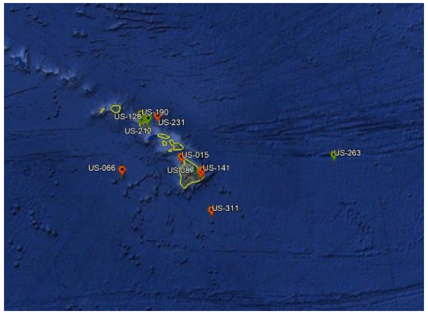
2017 Worldwide Alert Locations



2017 USA Alert Locations





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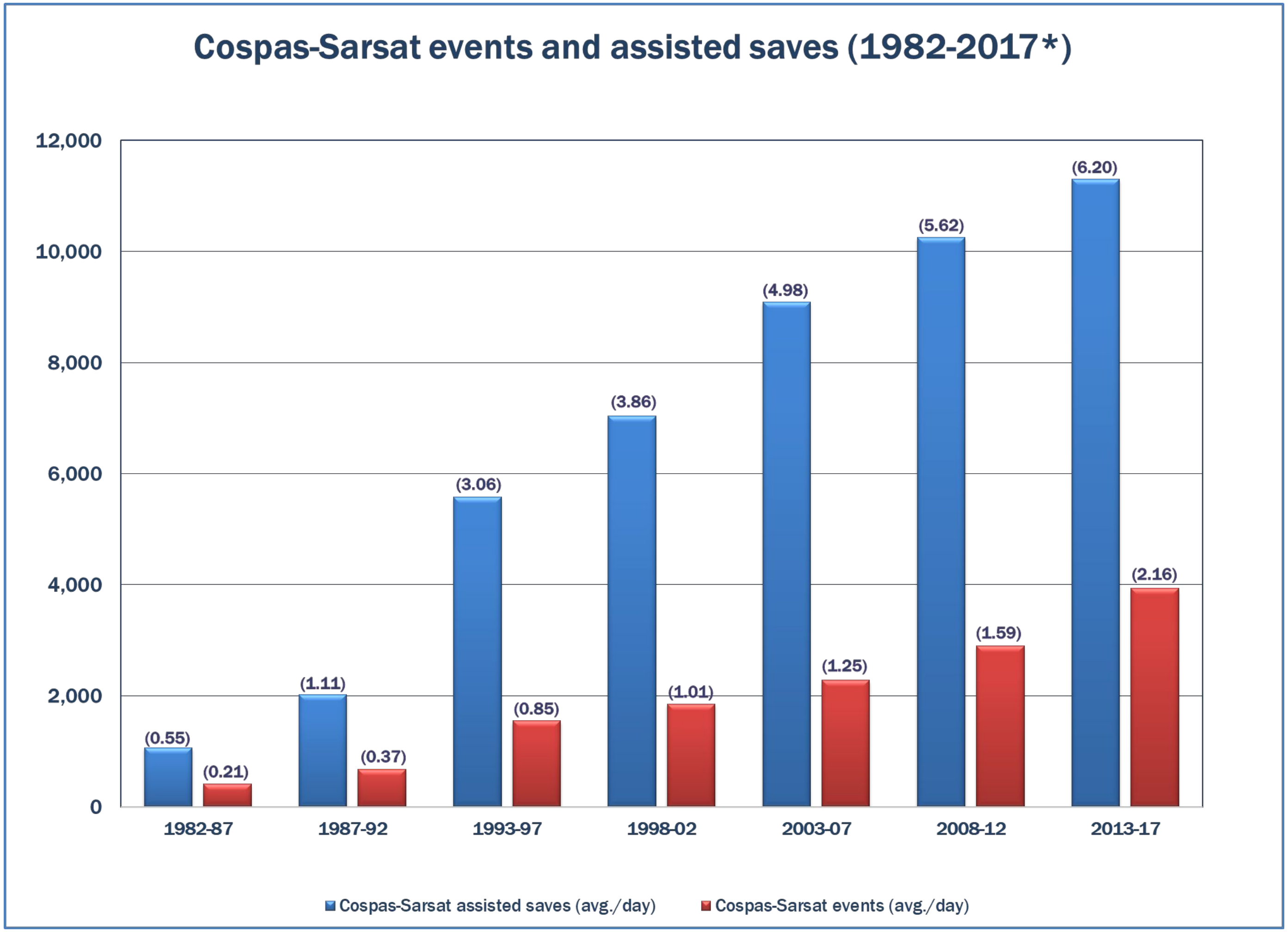
Cospas-Sarsat events and assisted saves evolution

AN AVERAGE OF 6.2 ASSISTED SAVES PER DAY IN THE LAST 5 YEARS



ELT (DT)s concept evolution

- Despite many Cospas-Sarsat-assisted saves resulting from 406 mHz ELT activation, the reliability of ELT transmissions after an impact with the ground has always been problematic, especially for large aircraft which are usually impacting the ground at high velocities
- In 2010, Cospas-Sarsat Participants began investigating the development a new capability, namely the capability to detect and locate an ELTs signal activated prior to an impact using the upcoming MEOSAR system
- In 2013, triggered in-flight beacon requirements were included as part of C/S G.008 “406 MHz Second Generation Beacons Operational requirements”

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ELT (DT)s concept evolution (2)

- In 2015 ICAO introduced ADT requirements for Distress Tracking along with expected implementation dates (January 2021) and accuracy expectations for locating an aircraft accident site (6 nm accuracy) (Annex 6, chapter 6.18).
- In 2016 Cospas-Sarsat Participants reviewed how to best address ICAO requirements. Two paths were developed, one based on the use of modified T.001 compliant beacons and one based on the use of Second-Generation beacons. Participants are developing both approaches with an aim to make ELT(DT)s available in early 2019. Both approaches were based on the provision of an encoded location as part of the beacon message (primary means of locating) with independent location capability to be further developed as a complementary measn of location (secondary and complementary means).

ELT (DT)s concept demonstration

- Since 2013, several tests have been undertaken by Cospas-Sarsat Participants using fast moving beacons or ELTs triggered-in-flight (ELT-DT concept). These tests supported the technical feasibility of Cospas-Sarsat ELT(DT)s
- Additional tests are planned to be undertaken in the upcoming years to better assess what performance levels could be achieved by the Cospas-SARSAT system when ELTs are activated in flight, especially with regards to MEOSAR independent location determination accuracies
- The capability of the Cospas-Sarsat systems to detect and locate ELTs triggered-in-flight was further demonstrated in recent distress aircraft incidents (MH17 and MS804)

ELT(DT)s Characteristics(1)

Compared with existing 406 MHz beacons, Cospas-Sarsat ELT-DTs specifications have been tailored to Autonomous Distress Tracking needs and will:

- Use the transmission of GNSS locations as a primary means for beacon location determination with GNSS position latency of less than 2 seconds, but independent location capability will also be provided as a back-up if no GNSS position is available
- Use transmission schedule "tailored" to the expected duration of an aircraft in distress (transmission every 5 sec for the first two minutes, 10 seconds up to 5 min and every 30 seconds thereafter)
- Could likely operate over a wider temperature range (lower minimum temperature in particular). A new temperature class 0 (-55 to +70C), has been created for these beacons
- Would provide 3-D location data or information about the aircraft altitude

ELT(DT)s Characteristics (2)

- Would be expected to operate for the shorter duration (up to 370 mins) than the typical minimum 24 hours
- Could be optionally powered by aircraft power if required or desireable
- Would not be required to provide a homing capability while transmitting distress signals in flight
- Would be triggered by a new automatic activation means (based on aircraft avionic status or its equivalent)
- Would need to be capable of ceasing transmission of distress signals following deactivation commands provided by the same means as the one used for activation (manual or automatic)
- Would require that a cancellation message be sent in case of voluntary deactivation
- Would be expected to start transmission shortly after beacon activation (less than 5 sec)

ELT(DT)s Characteristics (3)

From an operational perspective, compared with existing 406 MHz, Cospas-Sarsat ELT-DTs:

- May required a different data distribution scheme. In addition to the data being forwarded to RCCs (as per the current data distribution), data would also likely need to be provided to Aircraft Operators and/or ATSU's and/or a central data repository facility if required by ICAO
- Require a more frequent position (and additional information) update to be provided to RCC's

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ELT(DT)s Development (1)

- Cospas-Sarsat Specifications for ELT-DTs:
  - First generation beacons: Completed
  - Second generation beacons: Completed but minor adjustment needed, to be finalized by early 2019
- Cospas-Sarsat Type approval for ELT-DTs:
  - First Generation beacons: Completed
  - Second Generation beacon: In progress
- Modifications to National specification to allow the use of ELT-DTs:
  - RTCA: DO-204B under final review, approval expected before the end of 2018 along with FAA TSO to revised DO-204B at the end of 2018 or January 2019
  - EUROCAE ED-62B under final review, approval expected before the end of 2018. EASA ETSO expected around April-May 2019.

ELT(DT)s Development (2)

- Cospas-Sarsat Ground Segment documentation to adequately process ELT-DT message protocol and distribution of data:
  - First generation beacons: Completed
  - Second generation beacons: Completed
- Modifications to Ground Segment software to adequately process ELT-DT message protocol and distribution of data:
  - First Generation beacon: in progress, status report on the implementation expected at JC-32
  - Second generation beacons: to be completed as part of the modifications needed for SGB implementation

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ELT-(DT)s key points (1)

- "Intelligent" transmission schedule allowing for expected location accuracy to be typically around 1.0 NM, more than 6 times better than the ICAO expectations
- 4D position information to be provided for FGB and SGB ELT(DT)s
- Inherently designed to operate without external power for a minimum duration of operation without aircraft power: 370 min (longest expected duration of flight) but could also optionally be fed by aircraft power if needed
- Two means of providing aircraft location: using GNSS position (primary) and independent location determination (redundant)
- Automatic activation (ED-237 compliant) with manual activation from the pilot. Possibility to add a remote activation via a return link if needed/required

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ELT-(DT)s key points (2)

- Choice of temperature range: Class 0 (-55 to +70C), Class 1 (-40 to +55C) and Class 2 (-20 to +55C) allowing OEM a wide range of possible locations on their aircraft
- Designed to withstand and operate in the adverse conditions expected while an aircraft in distress is flying (shock, vibration, flame as specified in ED-62B and DO-204B)
- Two possible technologies (FGB based on current ELT signal modulation) and SGB (newer signal modulation) with the likely possibility, to be offered by several ELT manufacturers, to migrate from one technology to another during regular maintenance verification or simply by software upgrade
- Benefit from a significant industrial base (18 active ELT manufacturers), likely to allow OEM a large choice of suppliers and stimulating innovation
- Possibility to be combined with other ELT types, ELT(DT) surviving crash, ELT(DT)/(AF), ELT(DT)/(AD)

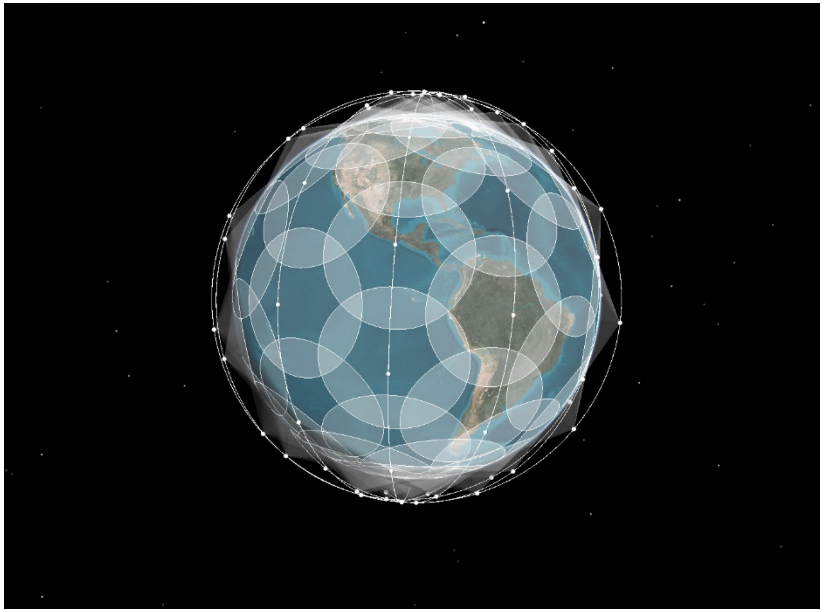
ELT-(DT)s key points (3)

- Use of a very robust system (large space and ground redundancy for communication paths), likely to provide more than 15 communication paths at any time anywhere on Earth and likely to relay via satellites distress transmissions in highly unusual aircraft attitudes
- Benefit from assets (infrastructure and distribution network) mostly used for the transmissions of other types of distress alerts and planned to be still in place in the decades to come
- Supporting assets (space and ground segment, distribution network) planned to be available prior to the ICAO needed implementation date for ADT (Jan 2021)
- Provision of a cancellation message, allowing operator, ATSU and RCC's to know when an activation has been intentionally cancelled

ELT-(DT)s key points (4)

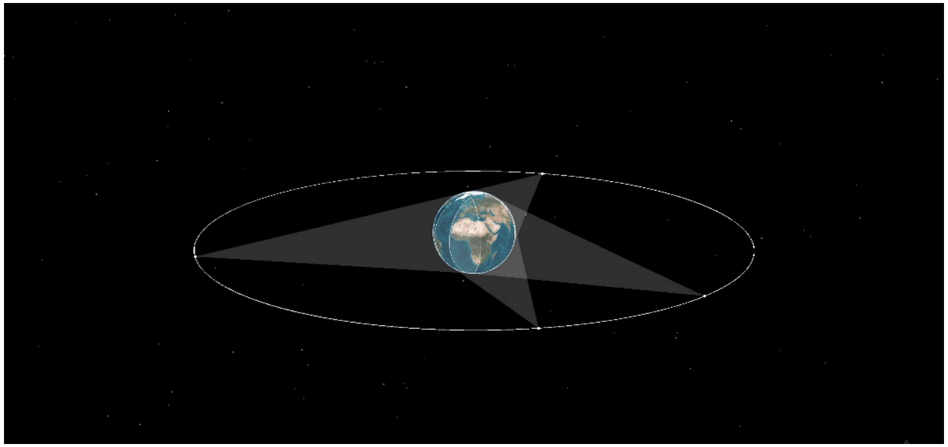
- Distress situation immediately identified as part of the receipt of a message (positive identification)
- Use of frequency bands dedicated for distress transmission (uplink and downlink communications)
- Existing and recognized Certification programme demonstrating system compatibility (Cospas-Sarsat Type approval) and environmental compliance (RTCA, Eurocae etc.)
- Services provided by an International Organisation which has operated satellites systems which successfully provided worldwide distress alert and locations to responsible authorities for over 35 year
- Services provided free of charge to the users

LEO and GEO satellite coverage



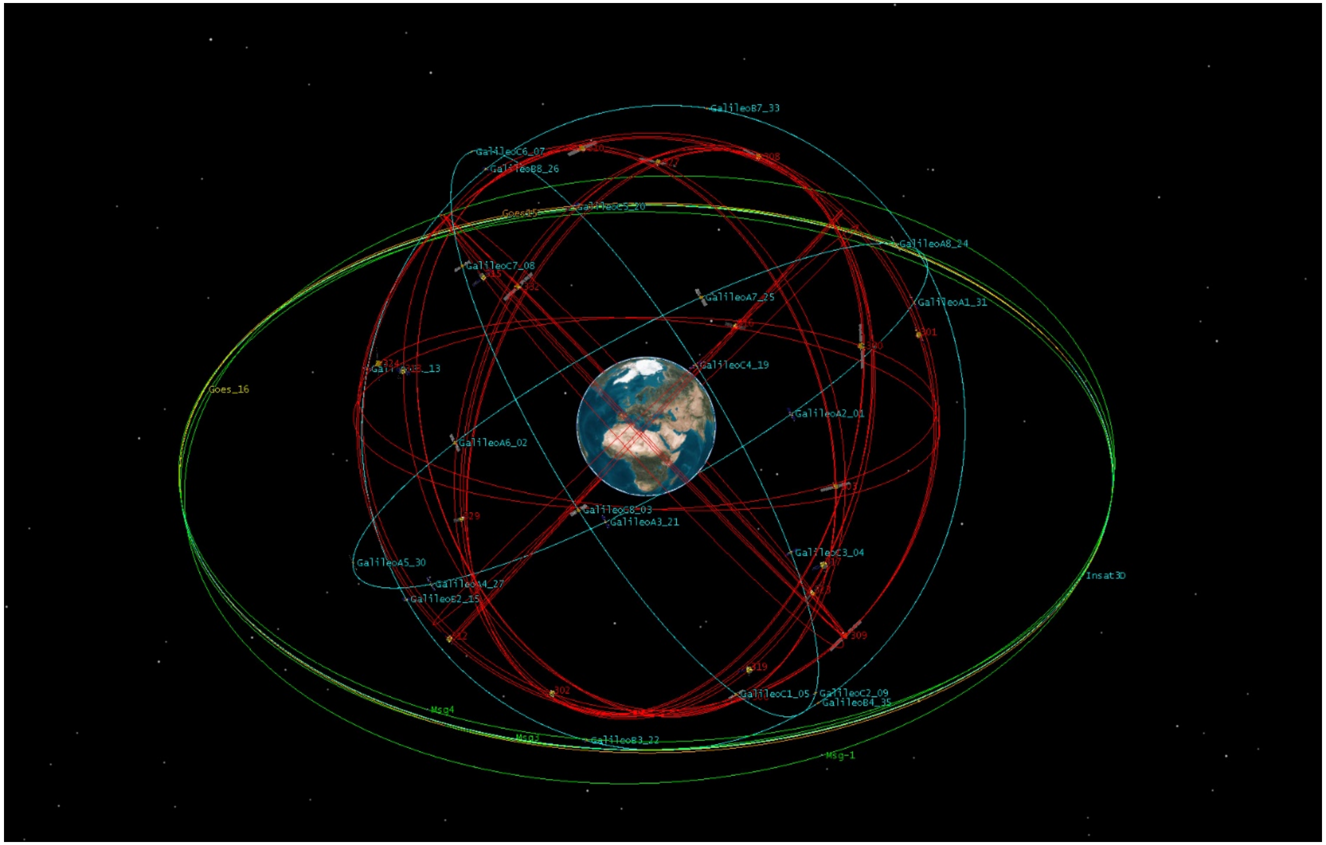
Leo constellation coverage
(66 satellites)

Geo constellation coverage
(4 satellites)

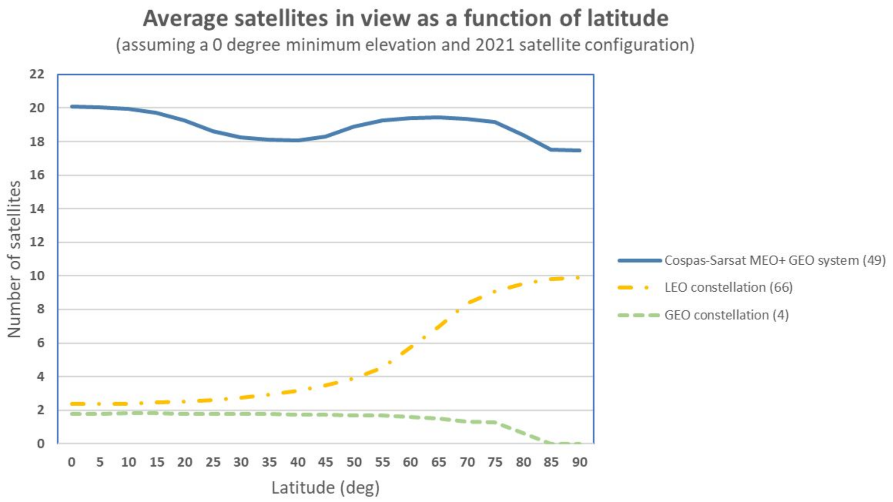


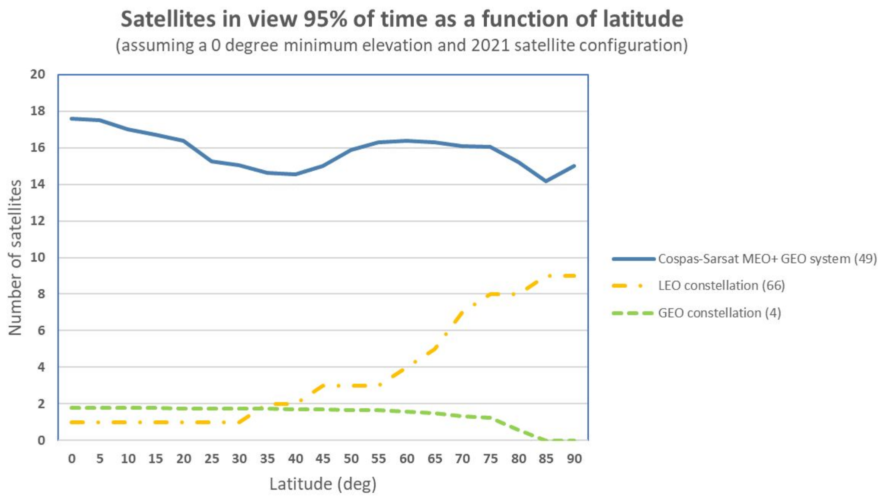
Cospas-Sarsat satellite coverage

C/S MEO (43 sat.) and GEO (6 sat.) constellations



Satellite visibility comparison as a function of latitudes for various satellites systems (1)





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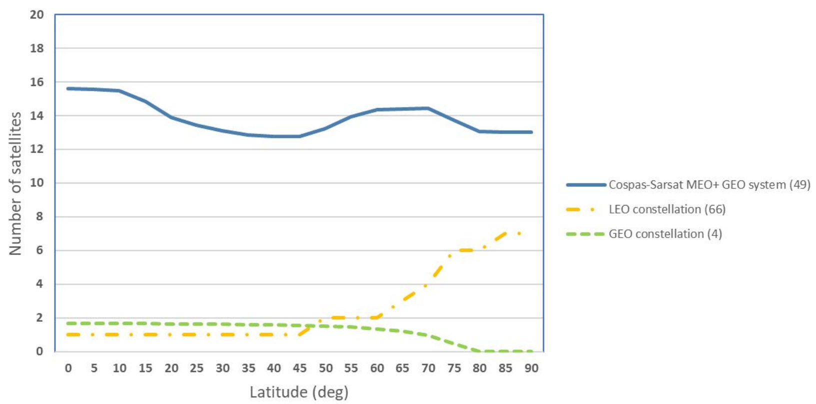
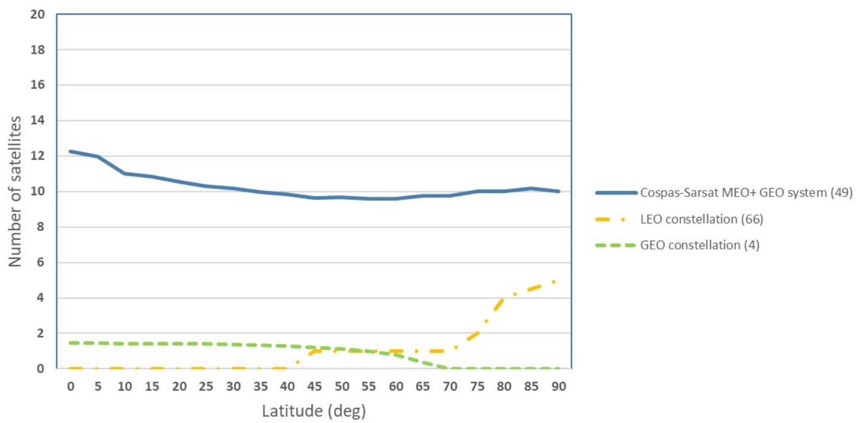
Satellite visibility comparison as a function of latitudes for various satellites systems (2)

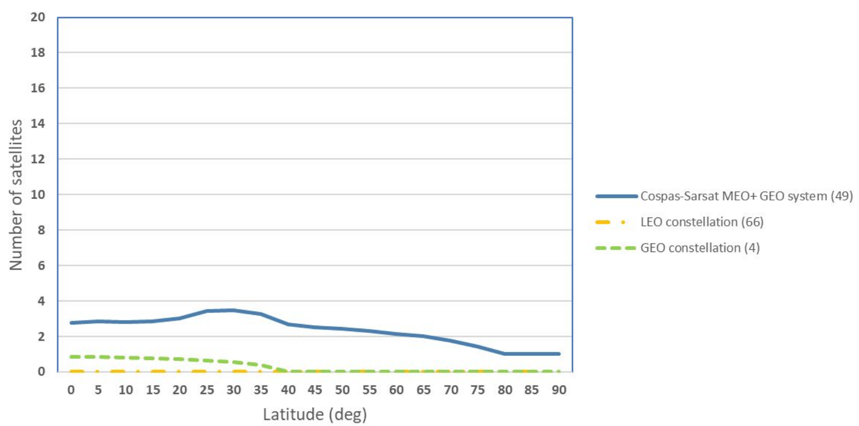
Satellites in view 95% of time as a function of latitude
(assuming a 5 degree minimum elevation and 2021 satellite configuration)



Satellites in view 95% of time as a function of latitude
(assuming a 15 degree minimum elevation and 2021 satellite configuration)



Satellites in view 95% of time as a function of latitude
(assuming a 45 degree minimum elevation and 2021 satellite configuration)



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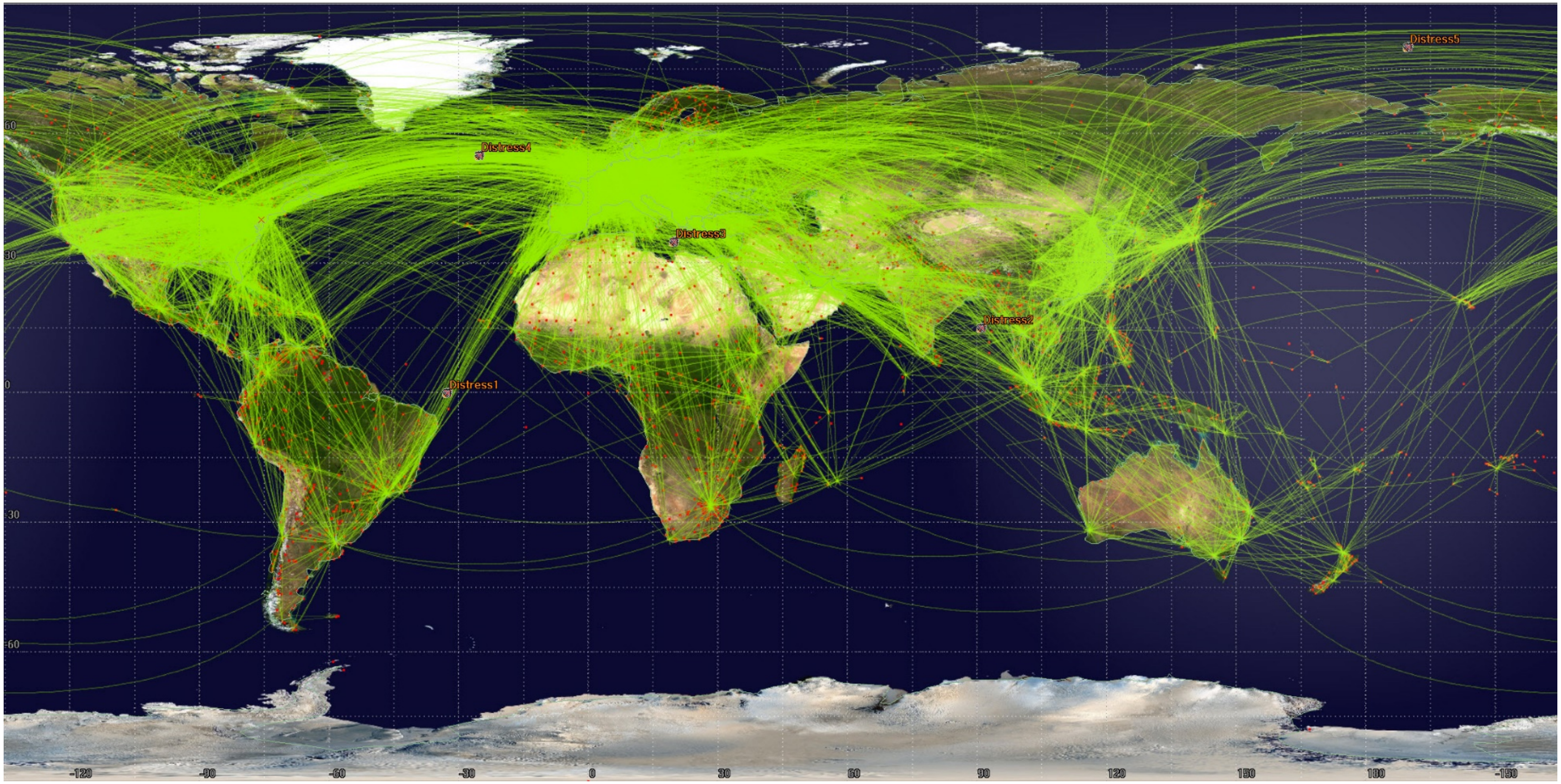
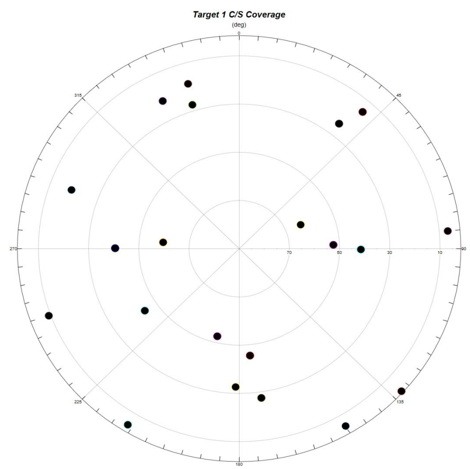
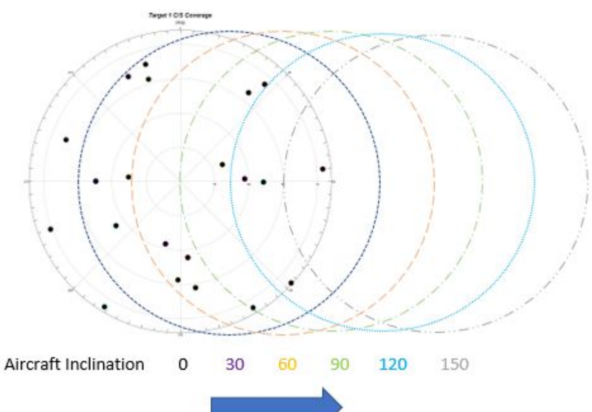
Satellite visibility comparison: Aircraft in distress examples



Impact of aircraft attitude on satellites visibility





Examples of satellite visibilities at a given time for various constellations (2021)

Lat: 0º Long: -30º

Lat: 15º Long: 90º

Lat: 35º Long: 20º

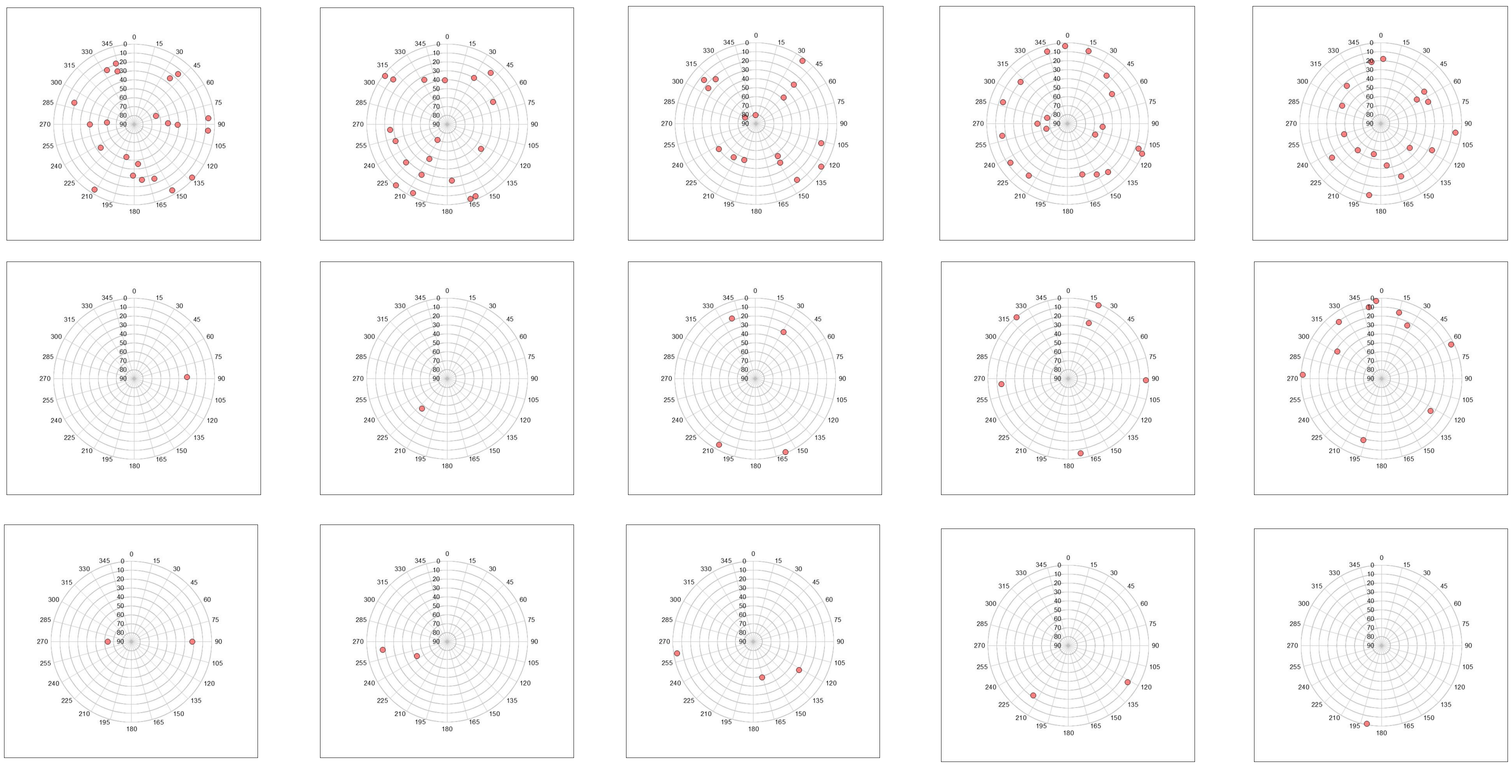
Lat: 55º Long: -25º

Lat: 80º Long: -170º

Cospas-Sarsat (43 MEO, 6 GEO)

Low orbit constellation (66 LEO)

GEO constellation (4 GEO)



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The Cospas-Sarsat satellite visibility advantage

- The Cospas-Sarsat system will allow for several redundant satellite links to be made available to beacons anywhere on Earth.
- This will allow for distress transmissions to be received in the most adverse conditions including the challenging environments likely to be encountered when an aircraft is in distress and when the position needs to be forwarded to operators and RCCs within a very short timespan available prior to an impact.
- The robustness of the communication link provided by the the Cospas-Sarsat system make it a very suitable system to forward the position of an aircraft in distress situations and to reliably comply with the new ICAO ADT requirements.

Cospas-Sarsat System as of 2021

For More Information

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