COSPAS-SARSAT & Aviation Safety

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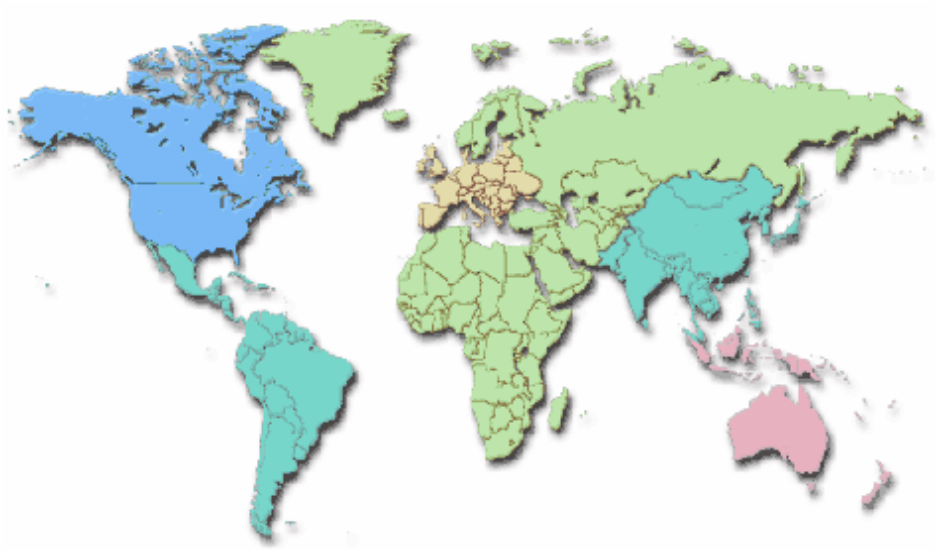
Source: CNES – D. Ducros

- 1. Introduction to Cospas-Sarsat Programme
- 2. Advancements in CS Programme
- 3. ELT(DT)s, GADSS, LADR
- 4. AF447
- 5. Boeing 737 NG and MAX Models

Cospas-Sarsat History International Cooperation

- 1978: Canada, France and the USA agree to co-operate on the development of the SARSAT low-altitude polar orbiting satellite system to:
  - Locate existing 121.5 MHz beacons
  - Develop new 406 MHz technology for improved performance



- Russia declares its interest in co-operating with the objective of ensuring inter-operability of their COSPAS system with SARSAT

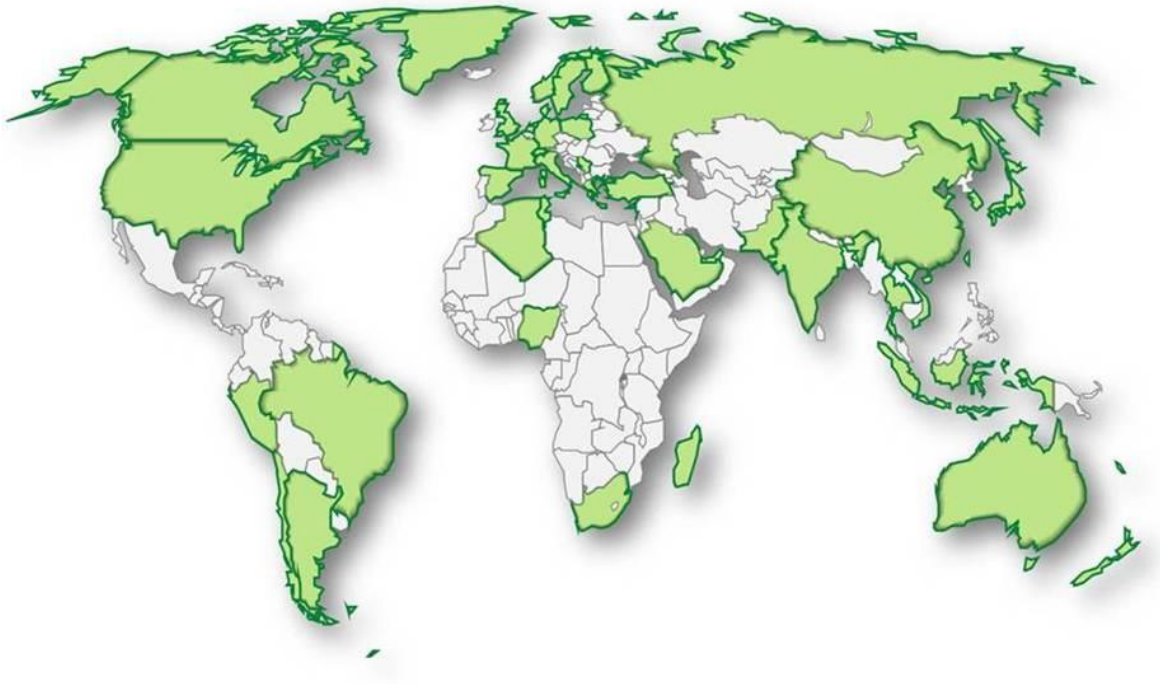
International Cospas-Sarsat Programme

C/S provides distress alert and location information to Rescue Coordination Centres (RCCs) for aviation, maritime and land users in distress

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

Alerts are provided using satellite systems to relay and process the transmissions of distress radio-beacons operating on 406 MHz (Satellite detection of 121.5 MHz alert ended in Feb 2009)https://www.youtube.com/watch?v=_IissmeIxgE

Cospas-Sarsat
Participating Countries in 2024



4 Founders: Canada, France, Russia and the USA
26 Ground Segment Providers
13 User States
2 Organisations
45 PARTICIPANTS

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)
Madagascar
Netherlands
New Zealand
Nigeria
Norway
Pakistan
Peru
Poland
Russia
Saudi Arabia
Serbia
Singapore
South Africa
Spain
Sweden
Switzerland
Thailand
Tunisia
Turkey
UAE
UK
USA
Vietnam

Cospas-Sarsat Organization

Cospas-Sarsat Council

Programme Management

Cospas-Sarsat Secretariat

Administrative Body

Joint Committee

System Operation

Operations Working Group

Technical Working Group

Principles of Participation

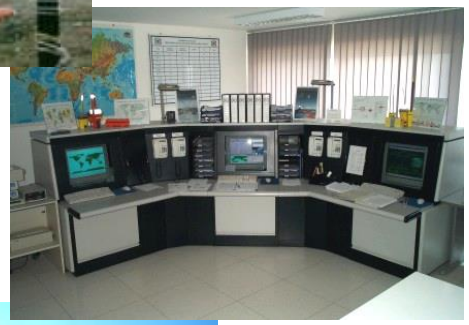
All States, including States not formally associated with Cospas-Sarsat should:

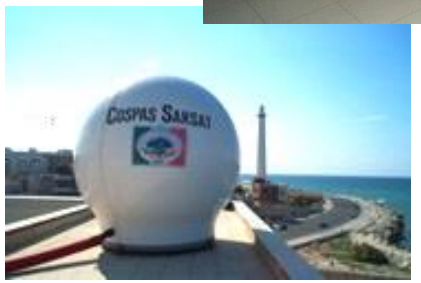
– Designate a SAR Point of Contact (SPOC) to receive alerts from Cospas-Sarsat MCC

– Decide on 406 MHz beacon coding, national beacon approval requirements

– Ensure that 406 MHz beacons authorised for use have received a Cospas-Sarsat type-approval certificate

– Establish a 406 MHz beacon register as required by ICAO and IMO or opt to use the international registry (IBRD)

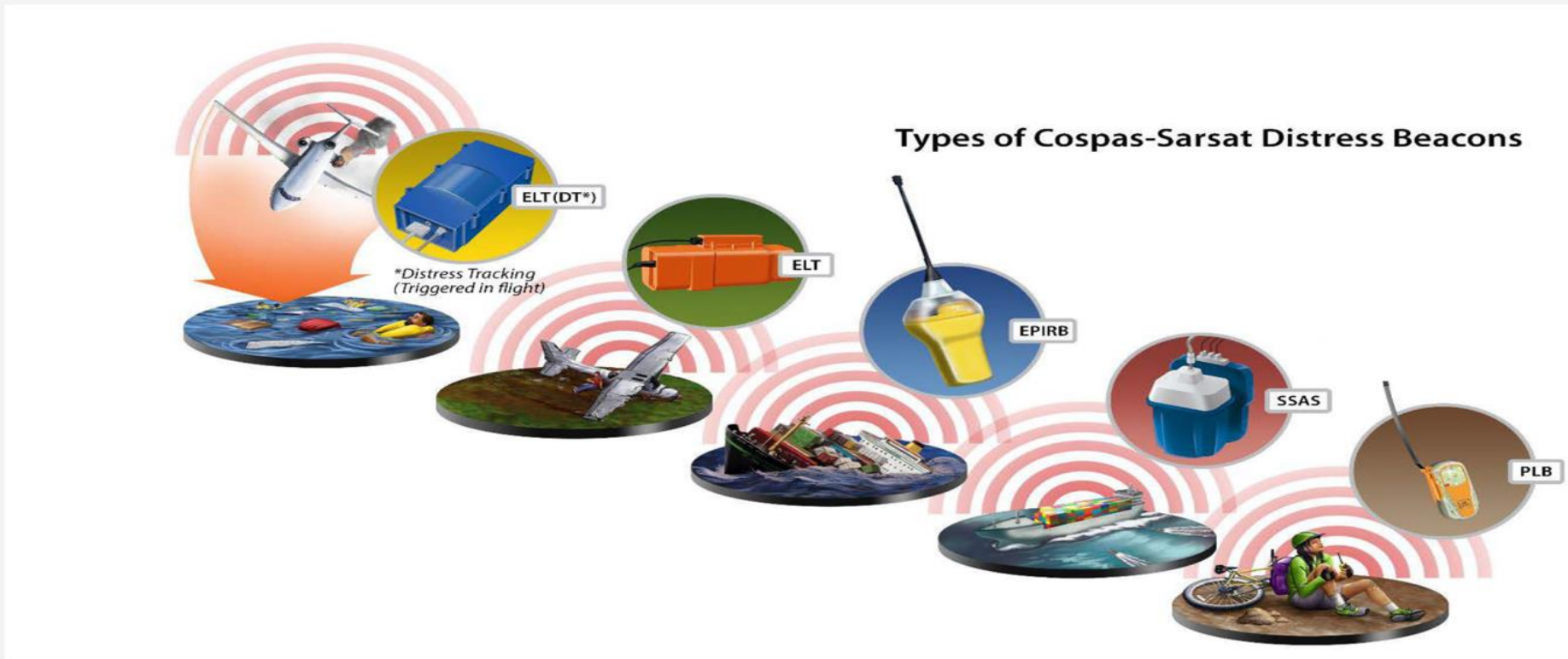




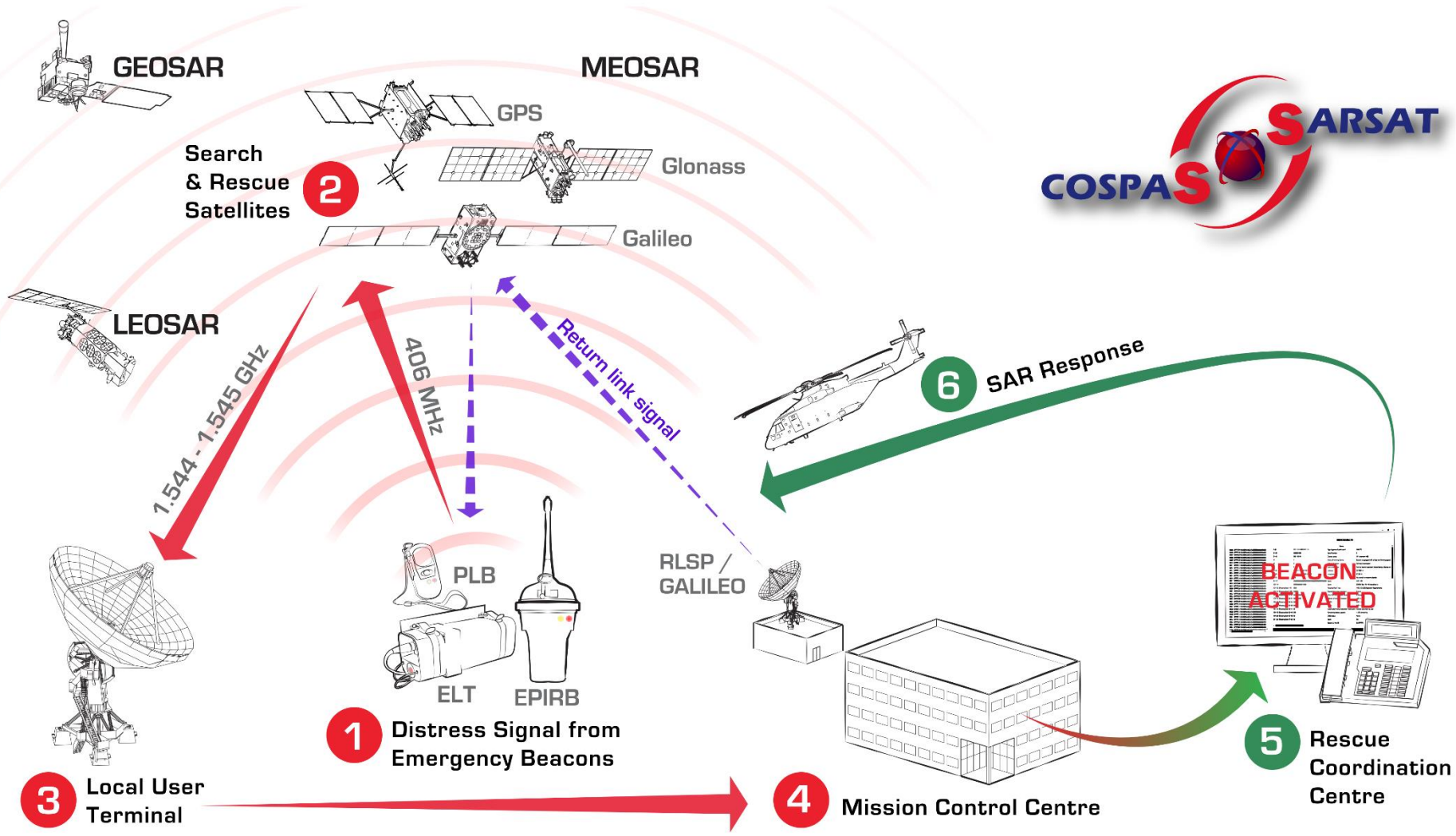
COSPAS-SARSAT SYSTEM

COSPAS-SARSAT Distress Beacons

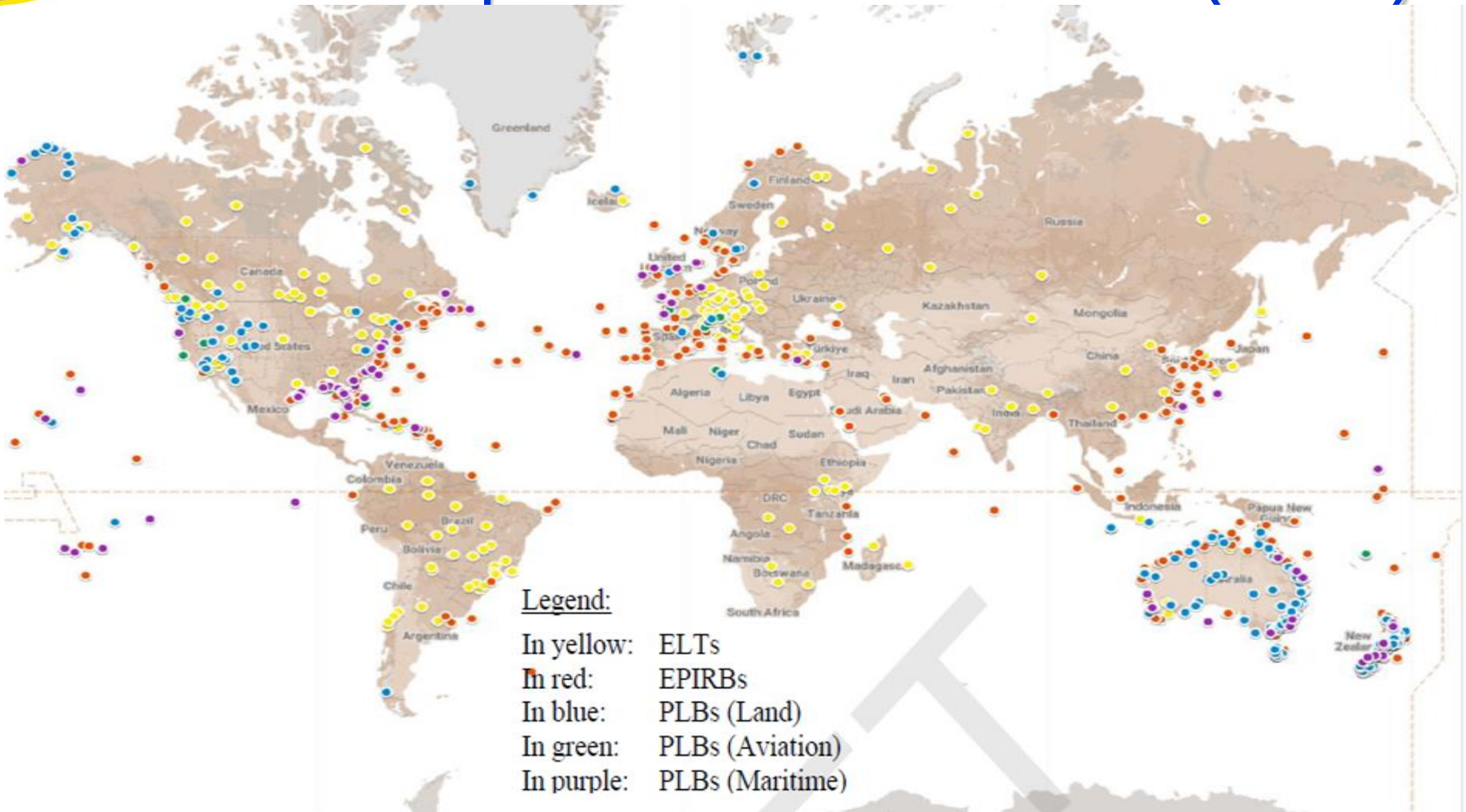
Cont'd



Over-3 millions emergency/distress beacons are currently in use worldwide


GEOSAR
MEOSAR
GPS
Glonass
Galileo
Search
& Rescue
Satellites
2
LEOSAR
1.544 - 1.545 GHz
406 MHz
Return link signal
6
SAR Response
PLB
ELT
EPIRB
RLSP /
GALILEO
BEACON
ACTIVATED
1
Distress Signal from
Emergency Beacons
3
Local User
Terminal
4
Mission Control Centre
5
Rescue
Coordination
Centre

Geographical distribution of SAR events with Cospas-Sarsat data used (2023)



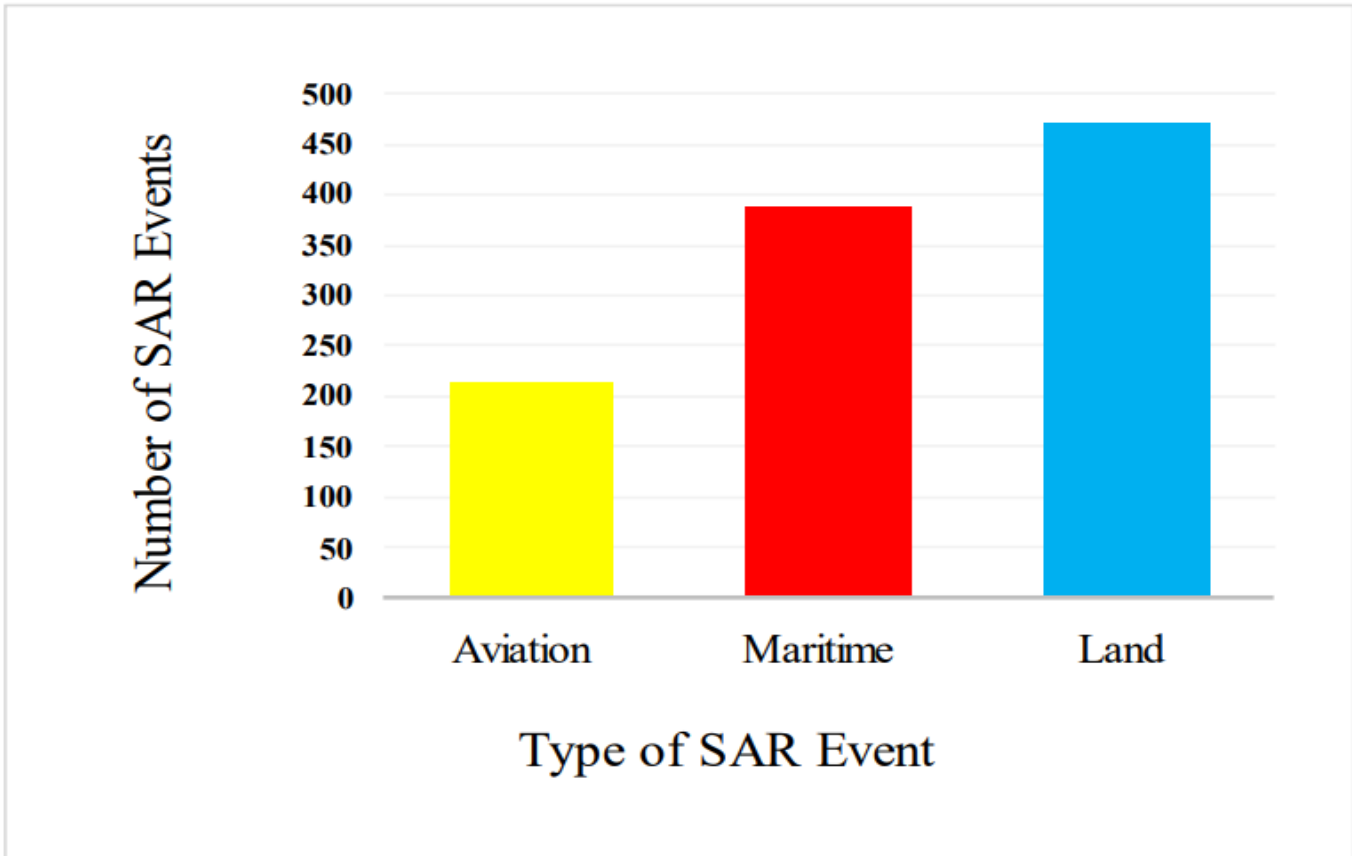


Figure B.1: Number of '406-MHz' SAR Events Assisted by Cospas-Sarsat (2023)

Cospas-Sarsat helps save lives…

… on average ten lives per day

in at least one SAR incident per day!

MEOSAR: Transition to FOC

MOVING BEACONS

- To overcome today's systems limitations:
  - LEOSAR has "time delays" as satellites orbit the earth
  - GEOSAR:
    - no coverage in polar regions;
    - no independent location of distress beacon signals (unless location is encoded in message)
    - signal path to fixed satellites could be blocked

- MEOSAR provides:
  1. Faster detection & independent location of beacons
  2. Continuous, global coverage
  3. Single alert location (no mirror image like LEOSAR has)
  3. But signals are weaker than LEOSAR and have less Doppler shift, since MEO satellites are farther away

- MEOSAR basic principle: *"Every MEO satellite must be tracked during its entire orbit, so no distress signals get missed"* (more MEOLUTs tracking it improve reliability and redundancy)

MEOSAR BENEFITS

- continuous, global coverage
- more reliable reception, multiple signal paths
- beacons located quickly (in seconds)
- Return link service possible
- moving beacons can be tracked
- more effective use of SAR resources
- better SAR service, more lives saved

Second Generation Beacons

Second Generation Beacon Goals

- Improve system performance to meet new, more demanding requirements
  - including detection probability, location accuracy and system capacity
- Optimize beacon signal to take advantage of the MEOSAR system
- Work with beacon manufacturers to obtain the most competitive end product that is attractive to customers
- Specs in C/S T.019

ACCIDENTS OVER OCEANIC AREA

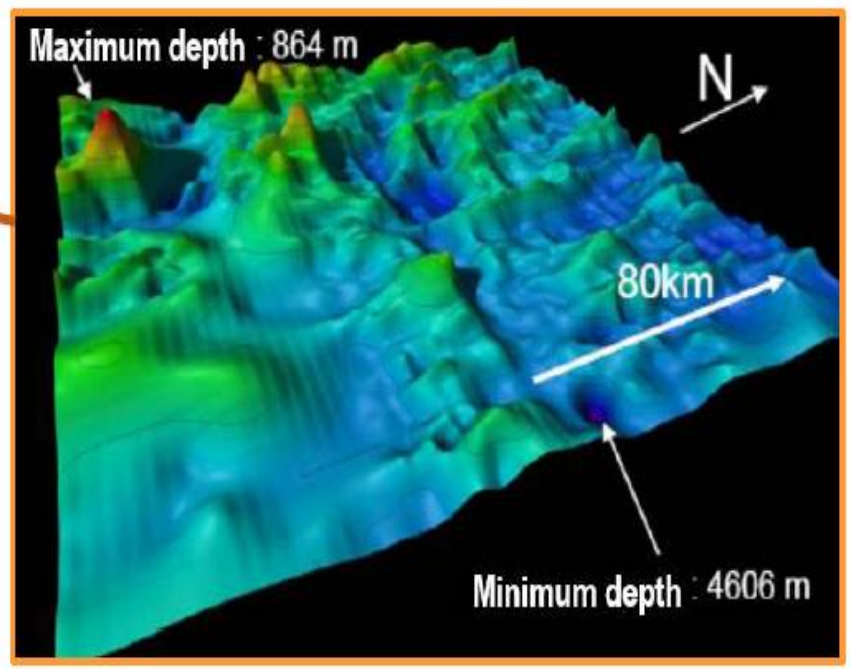
Accident to AF447 on 1st June 2009

- On Monday 1st June 2009 at around 7:45 UTC, the BEA was alerted by the Air France Operations Coordination Centre, which had received no updates from flight AF447 between Rio de Janeiro Galeão (Brazil) and Paris Charles de Gaulle

- After having established that the Airbus A-330 had undoubtedly disappeared in international waters and in accordance with Annex 13 to the Convention on International Civil Aviation the BEA launched an investigation

Accident to AF447 on 1st June 2009

- First floating parts found 6 days after the accident
- Wreckage localized on 4th April, 2011 (22 months after the accident) after 4 phases of sea search operations



- Unfavorable area: Atlantic ocean ridge
- Little known area: currents and seabed terrain

Flight Recorder Data Recovery

- Recovery of flight recorders and aircraft parts is always a challenge

Cruise

AP off
T_i – 262 s

Climb

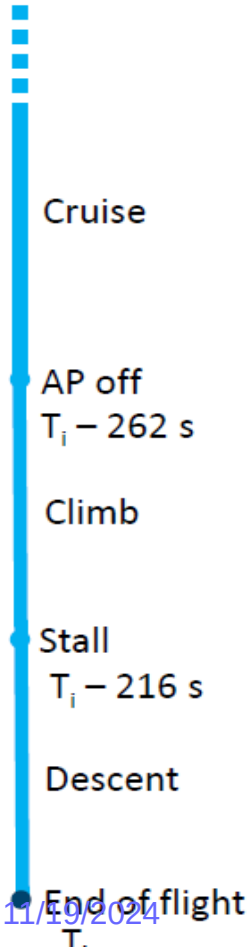
Stall
T_i – 216 s

Descent

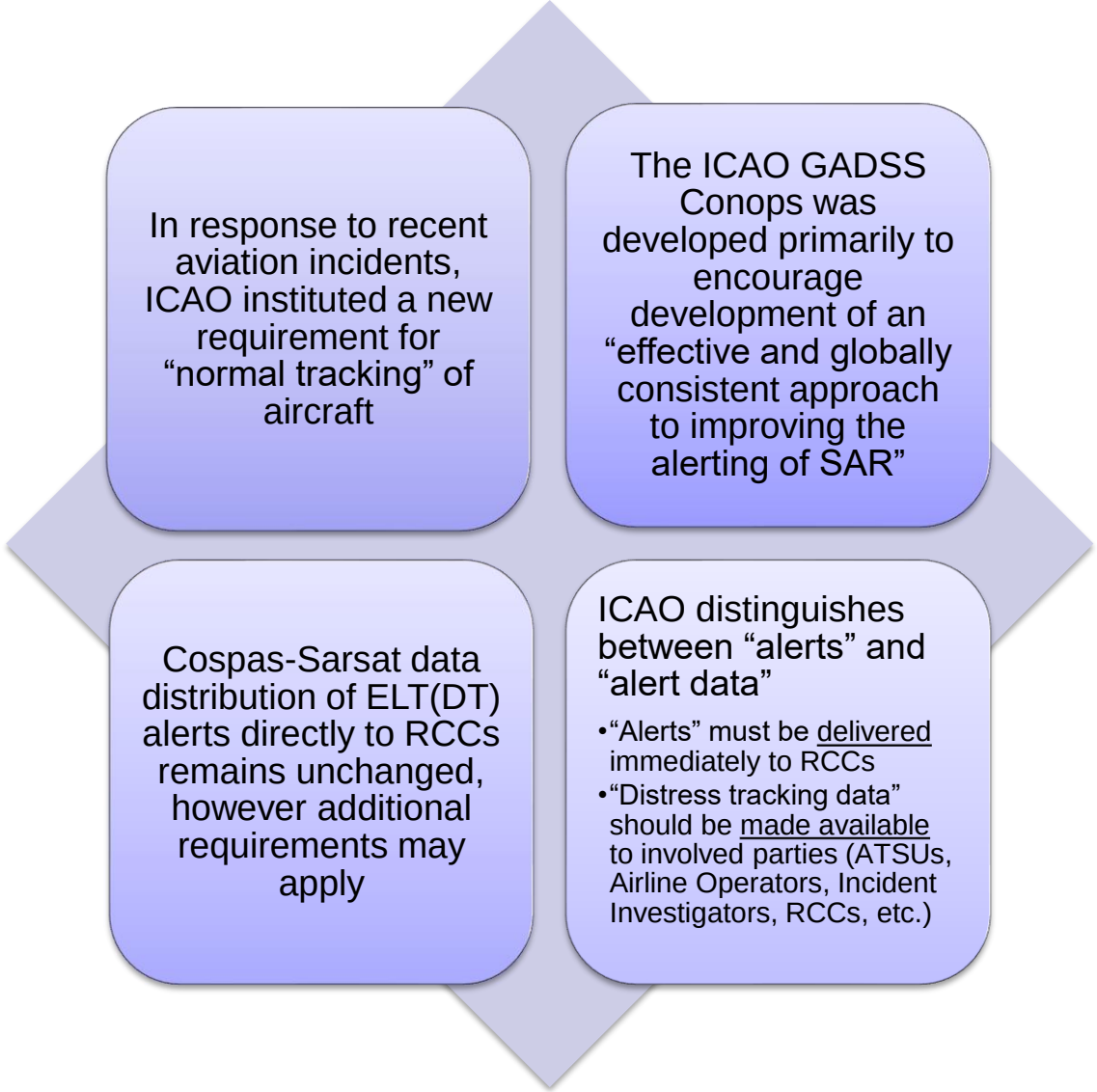
End of flight
T_i

Flight Recorder Data Recovery

- Wreckage located on 4 April, 2011 (22 months after the accident) and flight recorders recovered 25 days later
- 6 M€ were spent just on this recovery phase (32 M€ in total by all parties)
- The recovery of an ADFR in a timely manner after the accident would have permitted us, in particular, to not need to recover the fixed recorder or to better determine the parts to recover from the bottom of the sea (4000 m)



ELT(DT)s, GADSS, and GMDSS



GADSS
Global Aviation Distress and Safety System

- The new SARPs are applicable to new aeroplanes with take-off mass greater than 27,000 kg from **1January 2025** (and Recommended for >5,700 kg)
- This implies a deadline for ELT(DT) readiness for deployment by **1 January 2025**, to support timely installation by Airline Operators

ELT(DT) and GADSS Data Distribution

Implementation Timeline

Implementation Challenge

Annex 6 Part I

6.18.3 The operator shall make position information of a flight in distress **available** to the appropriate organizations, as established by the State of the Operator.

…

Appendix 9

2.3 … These shall include as a minimum:

a) air traffic unit(s); and

b) SAR rescue coordination centre(s) and sub-centre(s).

RESCUE COORDINATION CENTRE

DISTRESS TRACKING

→ Automatic
→ Manual

AUTONOMOUS

6 NM

Aircraft behavior event that, if left uncorrected, can result in an accident.

Squawk at one minute intervals

Adopted SARP

Airline role

- Check relevant regulation with NAA
- Make sure that all concerned A/C are fitted with the right technologies
- Manage the Alerts generated by the tracking system
- Establish the procedures supporting GADSS

Reminder:
ADT is placed under Airlines / Operators responsibility

ICAO

Refer to ICAO ANNEX 6.

Use for guidance the ICAO Doc 10054: Manual on Location of Aircraft in Distress and Flight Recorder Data Recovery.*

* ICAO Doc 10054 “Manual on Location of Aircraft in Distress and Flight Recorder Data Recovery” dated 2019, will be replaced soon by a new Manual Doc 10165 “Manual on Global Aeronautical Distress and Safety System (GADSS)”

** Doc 10150 is the Manual on the Functional Specifications for the Location of an Aircraft in Distress Repository (LADR)

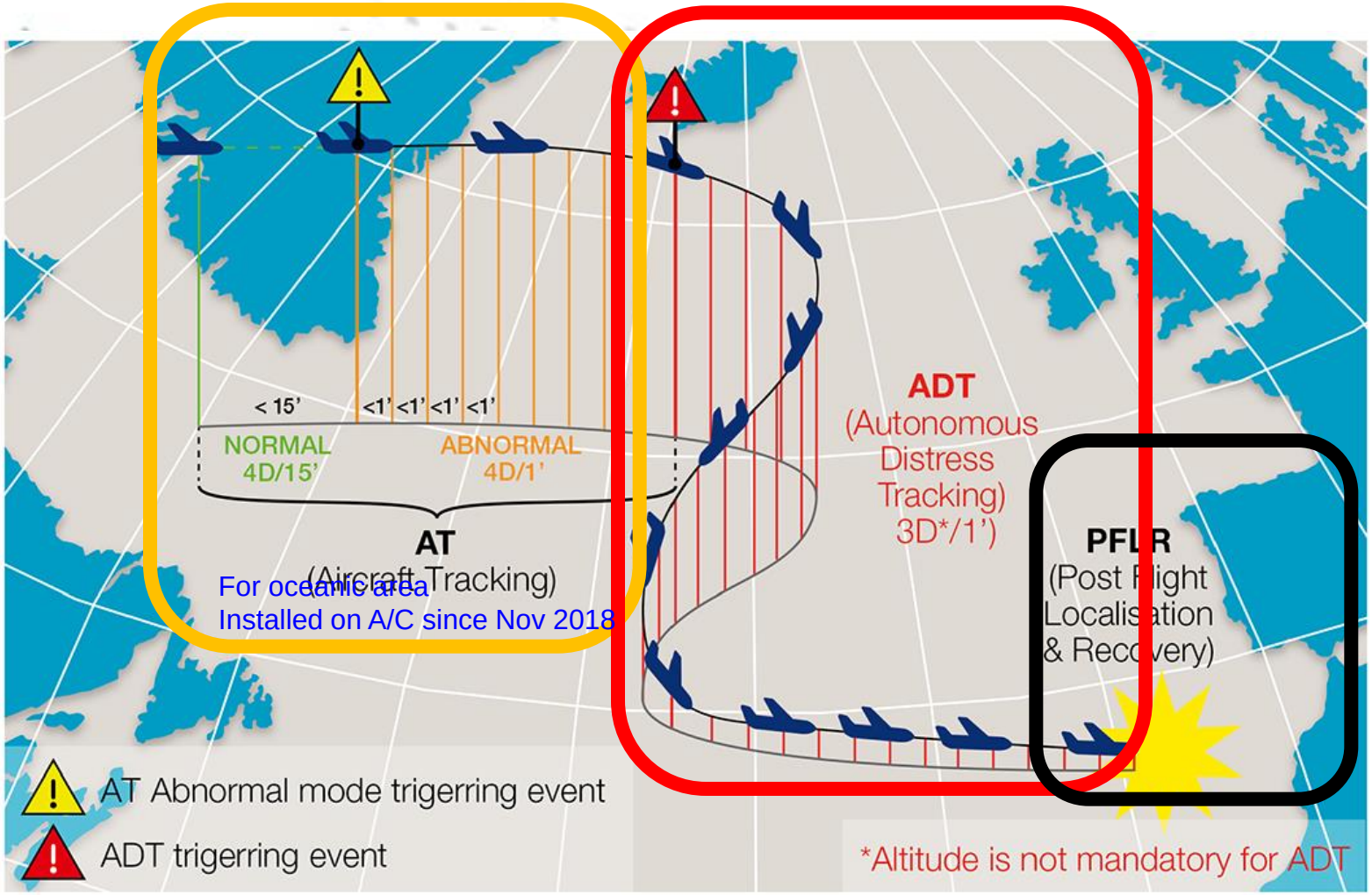
Autonomous Distress Tracking

Capability to detect a distress and transmit information allowing to determine the position of an aircraft at least once every minute:

- Provides 3D Position
- Activates within 5 seconds upon detection of a confirmed distress condition
- Gives accident site determination with a 6NM radius
- Uses protected distress spectrum
- Is resilient to faults of A/C power, communication and navigation
- Sends signal to Search and Rescue

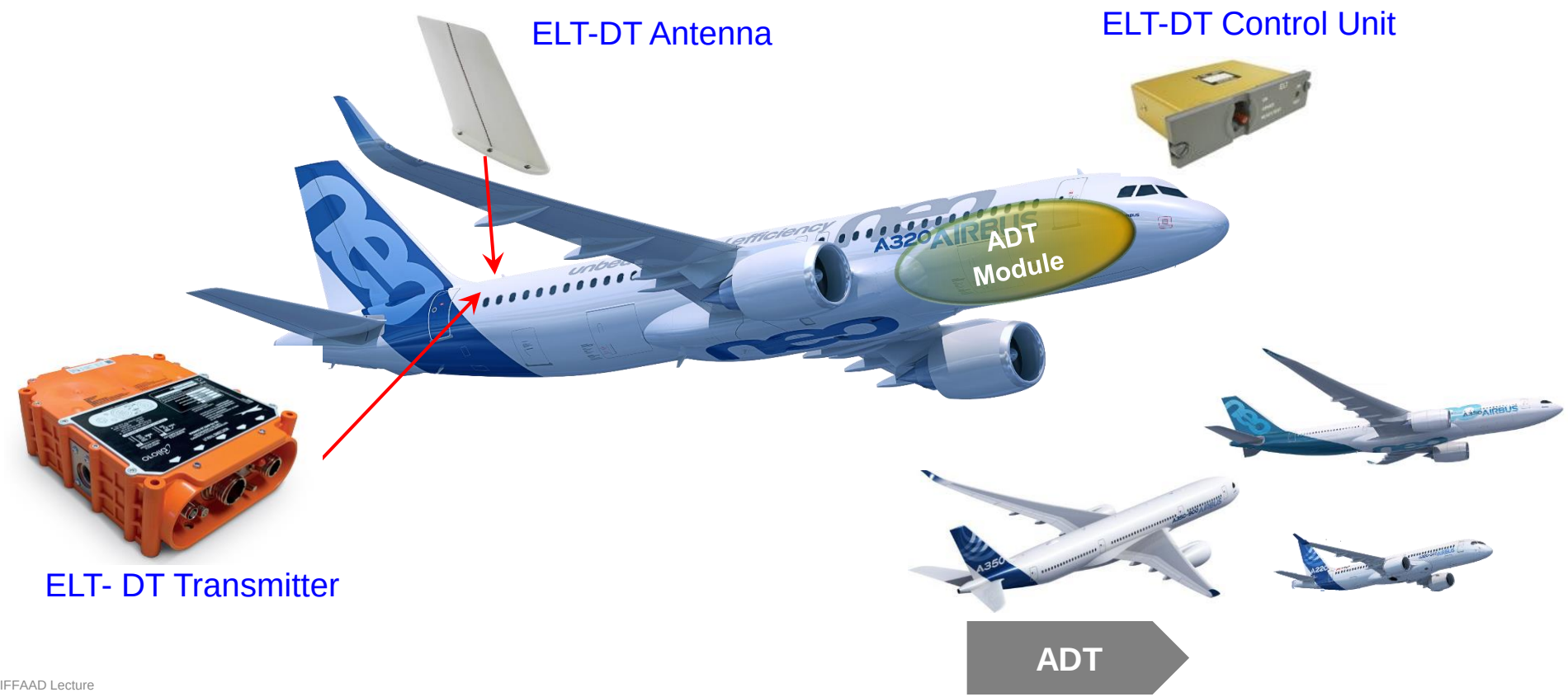
Note: "Distress is a situation which, if left uncorrected, is likely to result in an accident".

ADT


< 15'
<1' <1' <1' <1'
NORMAL
4D/15'
ABNORMAL
4D/1'
AT
(Aircraft Tracking)
For oceanic area
Installed on A/C since Nov 2018
ADT
(Autonomous
Distress
Tracking)
3D*/1')
PFLR
(Post Flight
Localisation
& Recovery)
AT Abnormal mode trigerring event
ADT trigerring event
*Altitude is not mandatory for ADT

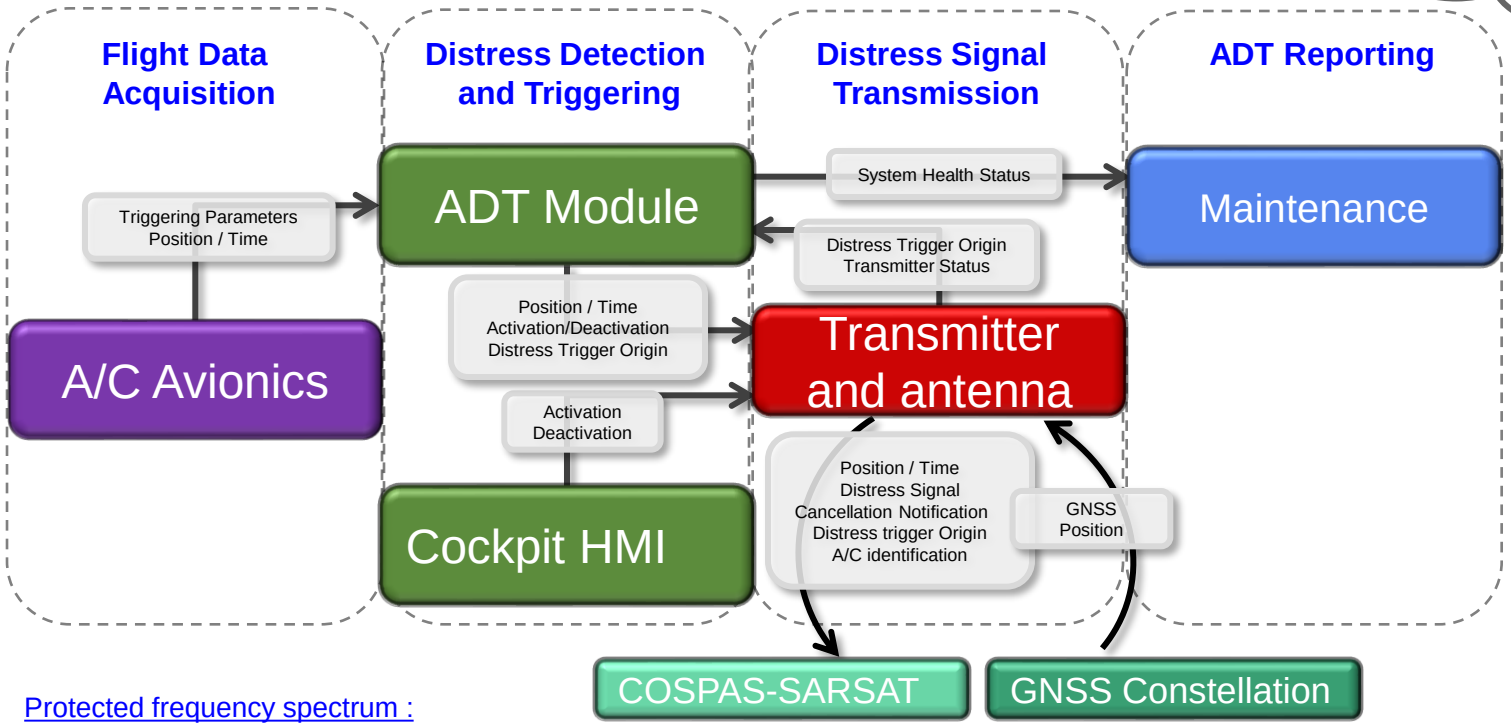
Autonomous Distress Tracking

Airbus solution - Equipment overview on A320 / A330 / A350 and A220 families



Autonomous Distress Tracking Principle

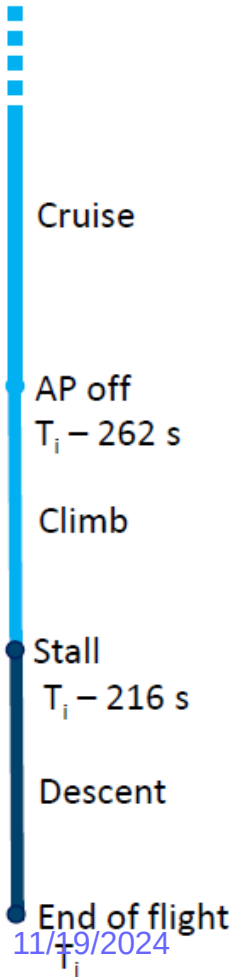
Nuisance alerts to SAR should not exceed more than 2 per 100 000 Flight Hours



Protected frequency spectrum :

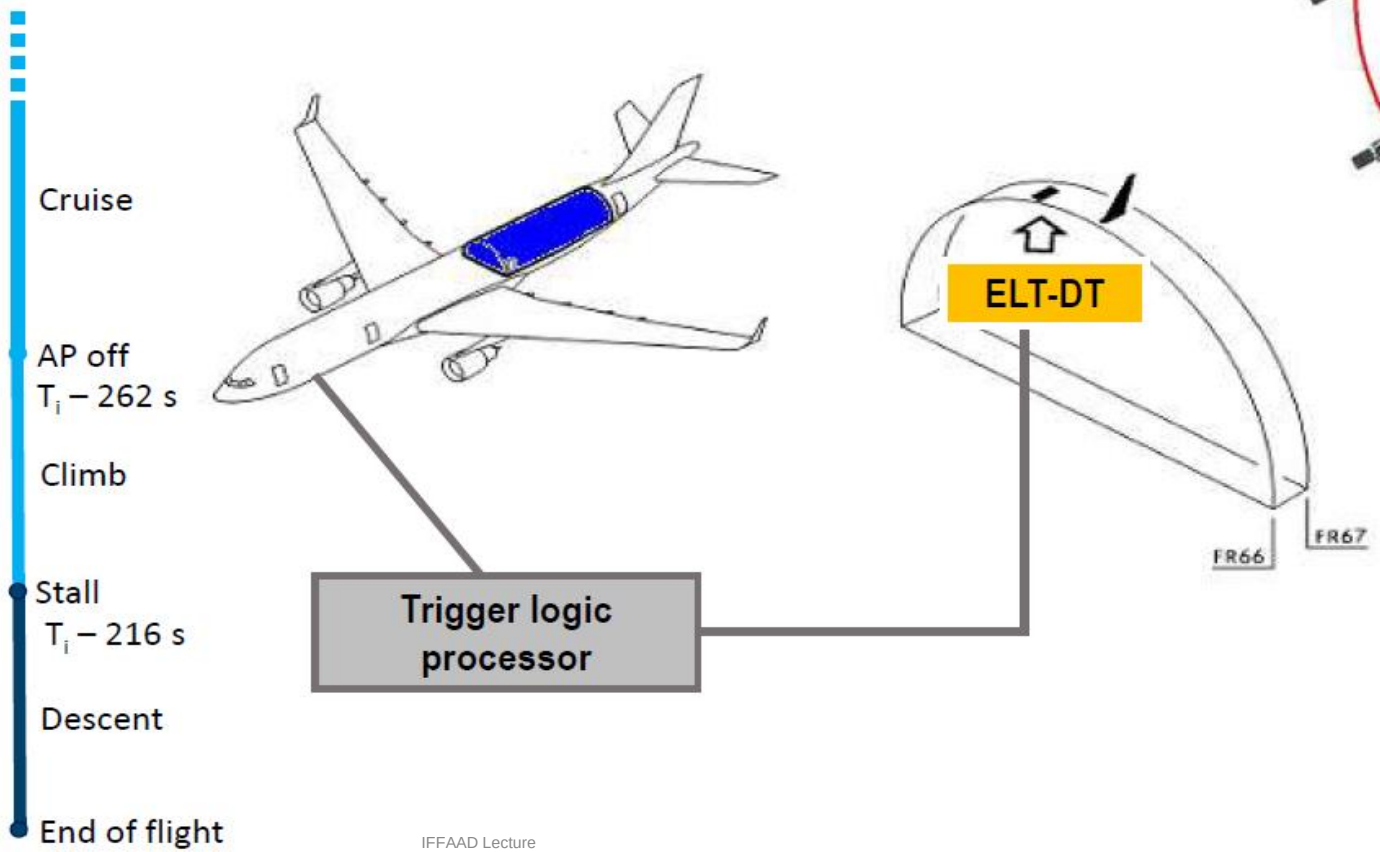
- ✓ 406 MHz for SAR & 121.5 MHz for Homing Signal
- ✓ GNSS reception for position

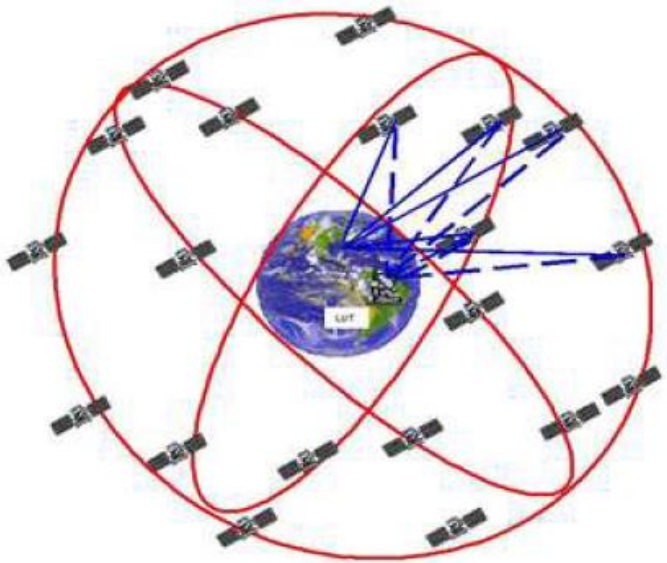
Distress Situation



- Activation of ADT following triggers associated with conditions which, if left uncorrected, are likely to result in an accident
- EUROCAE ED-237 Criterias: Unusual attitude, Unusual speed, Collision with terrain, Total loss of thrust/propulsion on all engines
- One triggering criteria or a combination of criteria
- Altitude 37,500 ft, Mach 0.68 and angle of attack 5° => triggering criteria of the distress condition and stall warning
- 216 seconds between the time of the triggering criteria of the distress condition and the time of impact

ELT-DT System





- 406 MHz transmission to Cospas-Sarsat workload on MEO (GPS, GALILEO, GLONASS) satellites will provide position from the first burst

Expected Benefits of GADSS Functions

Cruise

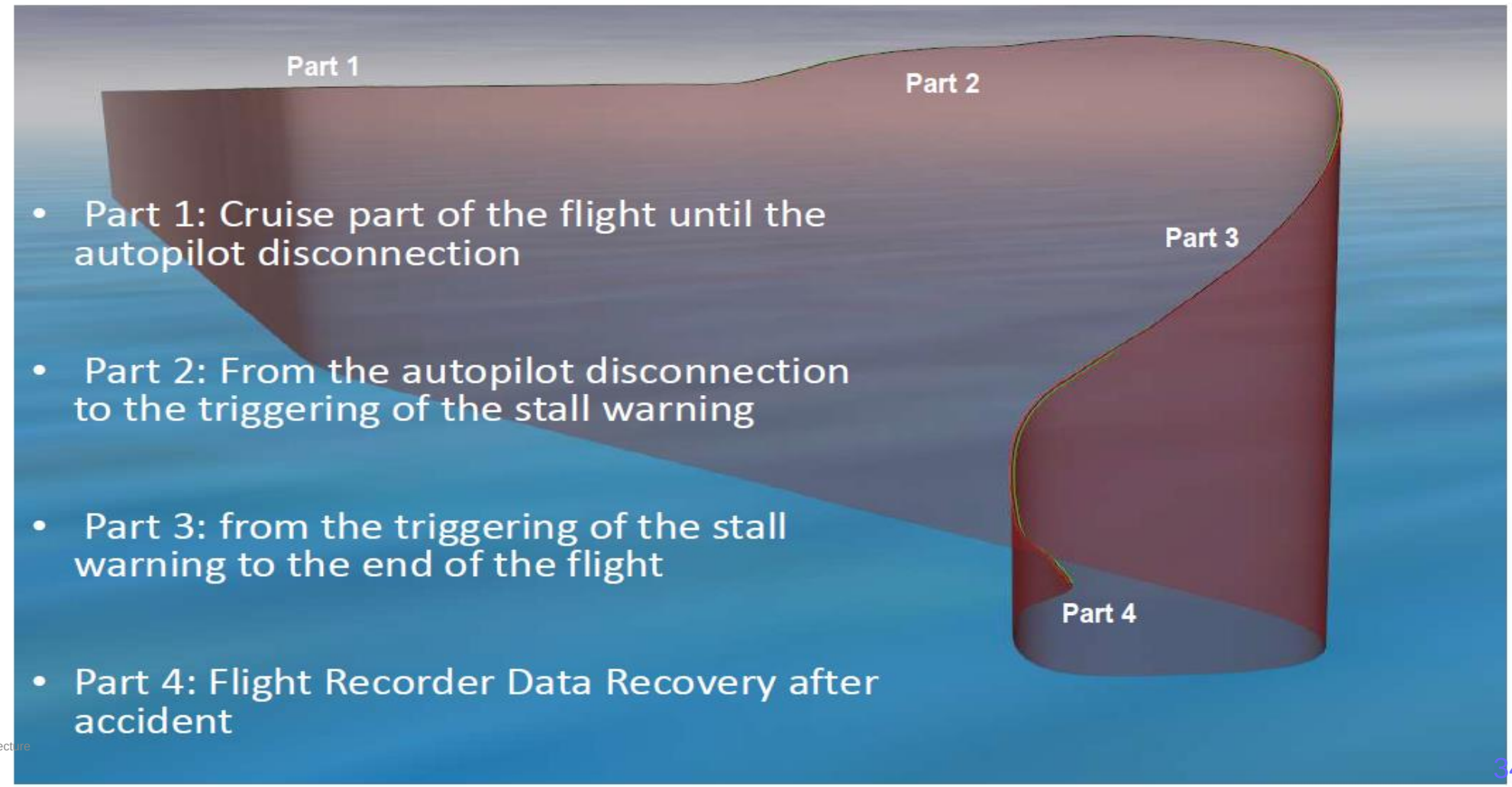
AP off
T_i – 262 s

Climb

Stall
T_i – 216 s

Descent

End of flight
T_i



Role of COSPAS-SARSAT IN GADSS

ELT(DT)

As of 1 January 2023, **Cospas-Sarsat** declared readiness to operationally process and distribute data from a new beacon type, the ELT(DT).

ELT for Distress Tracking (DT) was specifically developed to support new ICAO Standards as part of its GADSS initiative. (ELT(DT)s) are compliant with ICAO GADSS requirements for Autonomous Distress Tracking (ADT) to transmit accurate position information at least every minute, which should allow an aircraft crash site to be located within six nautical miles (6 NM).

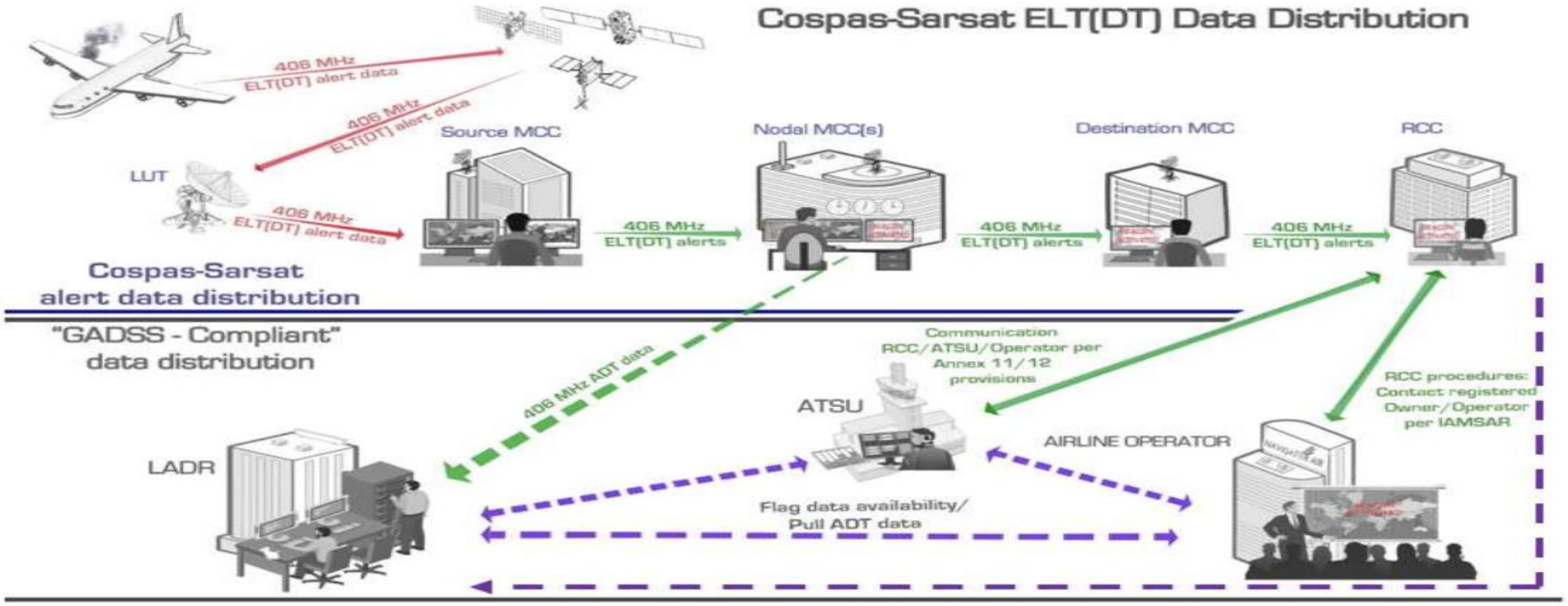
ELT (DT) has been selected by major aircraft manufacturers.

ELT(DT)s are designed to be activated, either automatically or manually, while the aircraft is still in flight.

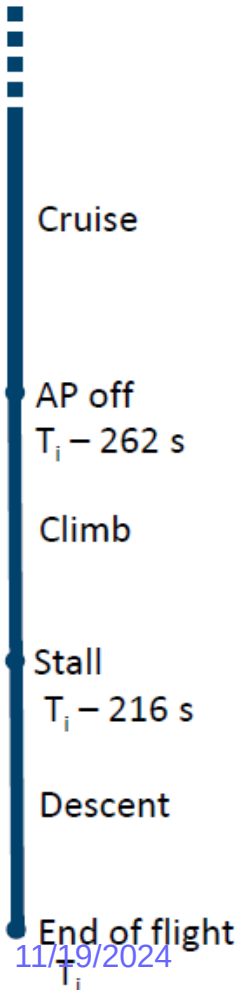
ELT(DT) messages: As with all Cospas-Sarsat alerts, ELT(DT) messages shall be distributed directly to SAR authorities by MCCs in accordance with document C/S A.001 section 3.2.3.2.2.

ELT (DT) alert: An ELT (DT) alert is triggered when an aircraft in-flight enters a state which, if no corrections are made to return that aircraft to a safe flight state, an accident is likely to occur.

Cospas-Sarsat - ELT(DT) Data Distribution LADR



Conclusion



- It would have been almost impossible to recover the aircraft without the aircraft tracking at the time of the accident
- Nevertheless, it took two years to find the wreckage
- Autonomous Distress Tracking GADSS function such as ELT-DT is expected to provide an accident location to SAR assets over sea
- Flight Recorder Data Recovery GADSS function is expected to increase the probability of flight recorder data recovery (parameters, audio from the cockpit, etc…) in a timely manner

Boeing 737 NG and MAX Models

Rudder control system issues

- The National Transportation Safety Board (NTSB) investigated a February 2024 incident where the rudder pedals on a United Airlines Boeing 737-8 were stuck in neutral during landing. The NTSB found that the bearing was installed backward in the affected units, which allowed moisture to get into the internal mechanism and freeze in cold weather.

- The NTSB estimates that as many as 288 aircraft, most of them flying for about 40 different international airlines, still have an improperly assembled rudder actuator.