GADSS in depth

Airbus views on Global Aeronautical Distress Safety System
ICAO Regional Preparatory Group / WRC-19 Workshop

Claude PICHAVANT

February 2018, Mexico

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SECOND HIGH-LEVEL SAFETY CONFERENCE 2015 (HLSC 2015)

"ICAO should encourage States and the International Telecommunication Union (ITU) to discuss allocation requirements at the World Radio Communication Conference in 2015 (WRC 15) to provide the necessary spectrum allocations for global air traffic services surveillance as a matter of urgency; "

WORLD RADIO CONFERENCE 2015

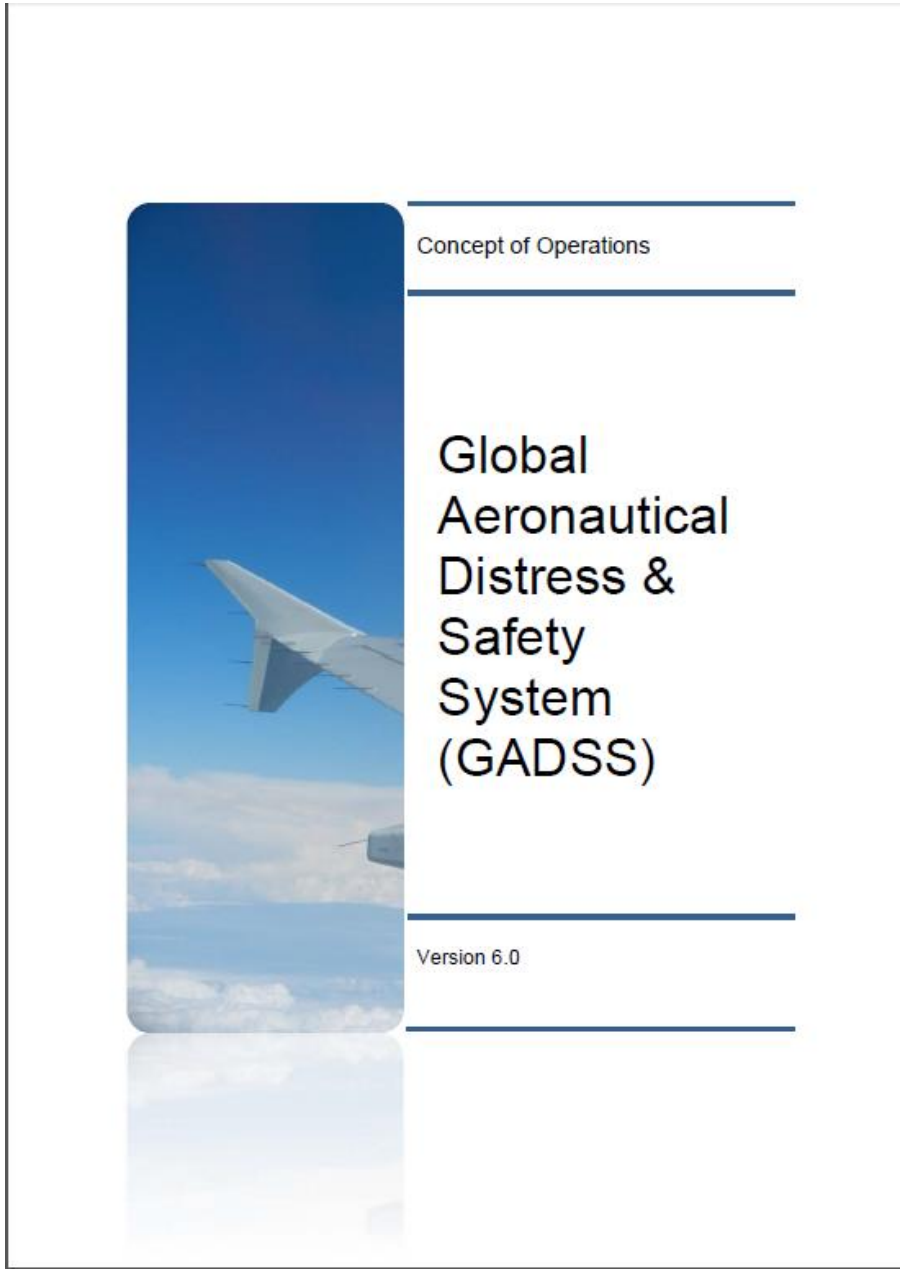
Resolution 425 (WRC-15)

"Use of the frequency band 1 087.7-1 092.3 MHz by the Aeronautical Mobile-Satellite (R) Service (Earth-to-space) to facilitate global flight tracking for civil aviation."

>>> "Space ADS-B "

New Agenda Item 1.10

"To consider spectrum needs and regulatory provisions for the introduction and use of the Global Aeronautical Distress and Safety System (GADSS), in accordance with Resolution 426 (WRC15)."



Version 6 released and distributed June 2017

This Concept of Operations document specifies the high-level requirements and objectives for the GADSS.

Responding to the requirements and objectives, the ConOps specifies the high-level functions needed, with a description of users and usages of **aircraft position information**, **in all airspaces, during all phases of flight, both normal and distress flight conditions including the timely and accurate location of an aircraft accident site and recovery of flight data.**

Global Aeronautical Distress Safety System

AT

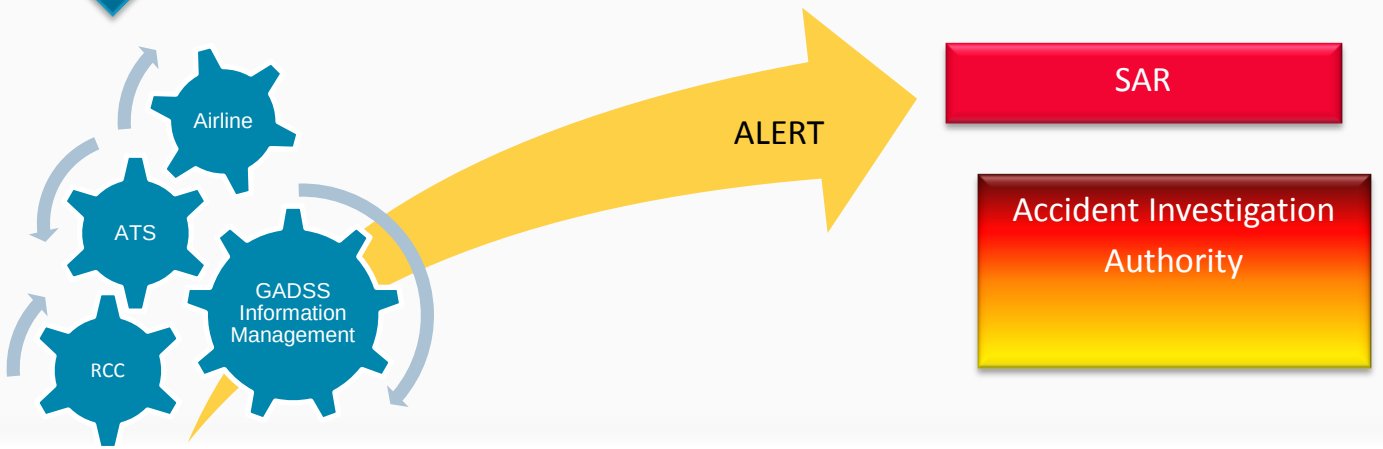
- Aircraft Tracking

ADT

- Autonomous Distress Tracking

PFLR

- Post Flight Localization & Recovery



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ICAO Recommendations

- 90 days ULB “Underwater Locator Beacons” (37,5Khz) attached to recorders CVR and DFDR (replacement of 30 days ULB)

  >>>>> **January 2018 Forward fit & Retrofit.**

- 90 days Low Frequency ULD “Underwater Locating Devices” (8,8Khz) attached to the aircraft for long-range over-water flights

  >>>>> **2019 Forward fit & Retrofit**

  (ICAO: Not later than 1 January 2018 ; EASA: By 1 January 2019)

- 25 hours CVR

  >>>>> **Jan 2021 -Forward fit**

ICAO Recommendations

- Aircraft Tracking Normal (& Abnormal) Conditions

  >>>>> **Nov or Dec 2018 Forward fit & Retrofit**

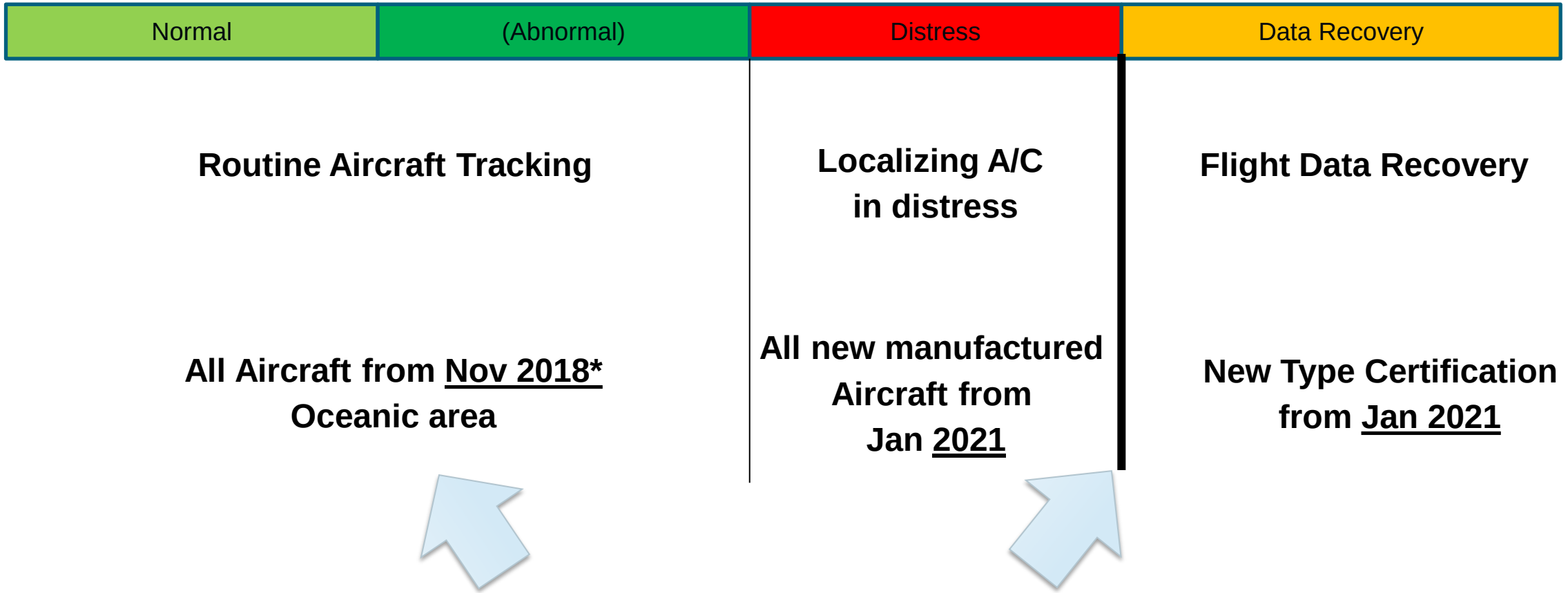
- Location and tracking of an Airplane in Distress

  >>>>> **Jan 2021 - Forward-fit**

- Flight Data Recovery , two alternative means:
  - Data streaming (CVR and FDR data content)
  - or ADFR “Automatic Deployable Flight Recorders” (with integrated ELT).

  >>>>> **Jan 2021 - new Type Certificate**

Current ICAO Recommended Practices



Recommendations into ICAO SARPS
Refer to Annex 6, 10, 11, 12

*: *implementation date can be different according to regional or national regulations*

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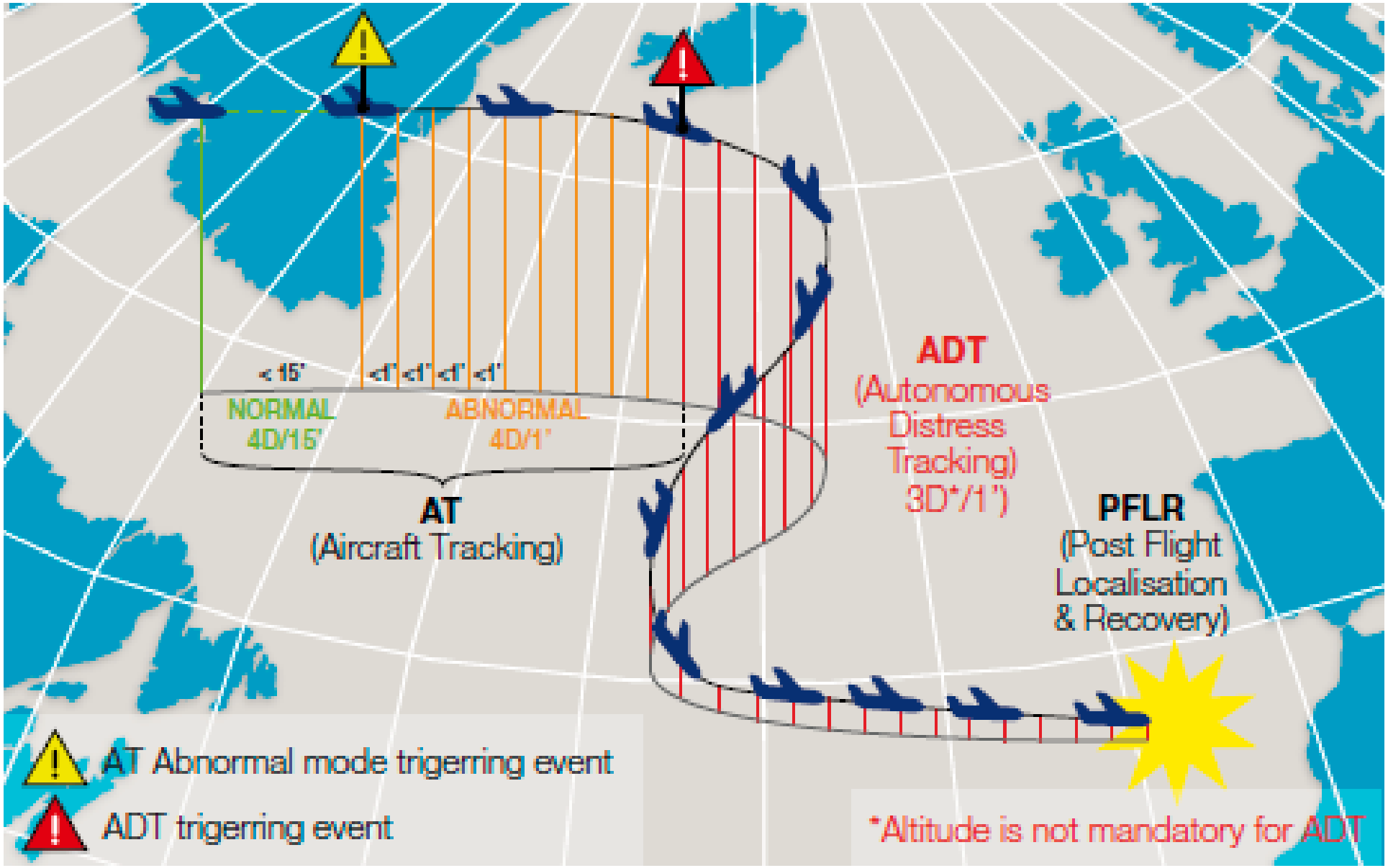
< 15'
<1'
<1'
<1'
<1'
NORMAL
4D/15'
ABNORMAL
4D/1'
AT
(Aircraft Tracking)
ADT
(Autonomous
Distress
Tracking)
3D*/1')
PFLR
(Post Flight
Localisation
& Recovery)
AT Abnormal mode trigerring event
ADT trigerring event
*Altitude is not mandatory for ADT

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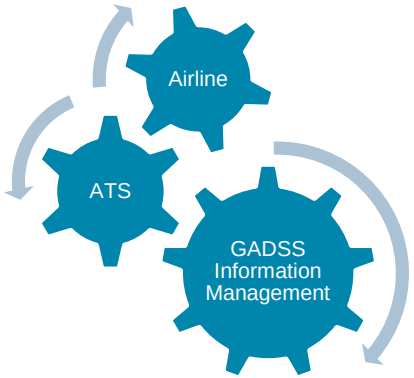
Global Aeronautical Distress Safety System

AT

• Aircraft Tracking

- **Provides automatic A/C position at least once every 15 minutes**
- **ATS Surveillance may be utilized**
- **Can be isolated by Flight crew**
- **Multiple solutions**
- **May have airline defined triggers for abnormal operations with higher reporting rate**



Use of any type of spectrum properly allocated, on a primary basis

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Regulatory FrameWork – NAA status

States regulations

National Aviation Authorities (NAA) are defining their regulations according to ICAO recommendations.

EUROPEAN COMMISSION

Amendment to AIR-OPERATIONS (EU 965/2012) with new requirement CAT.GEN.MPA.205

Aircraft tracking from December 2018. Abnormal mode detection required, but no modification of transmission rate requested (i.e: abnormal detection from ground based on 15 min reporting rate)

No regulation on Aircraft tracking

CAAS Civil Aviation Authority of Singapore

Amendment to "Aircraft Operator Certificate Requirements" with issue 3 revision 30

Aircraft tracking effective since July 2016 (with automated solution by November 2018).

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What is 4D (4 dimensions) ?

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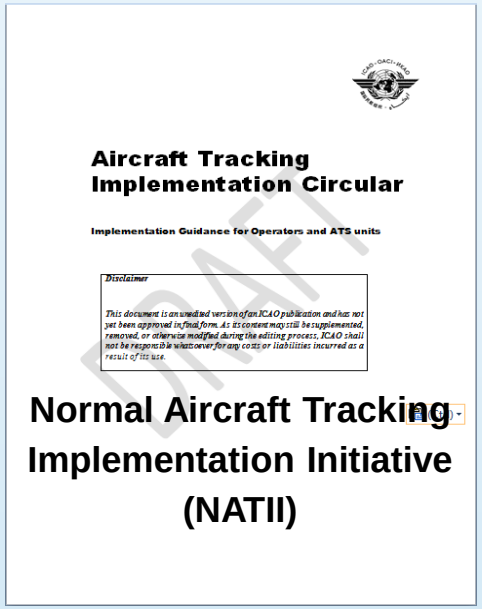
Aircraft tracking supported by existing technologies

Applicability November 2018 (Recommended in all areas of operations and mandatory over Oceanic areas)



Normal Aircraft Tracking Implementation Initiative (NATII)

Aircraft Tracking Normal Operations	**Aircraft Tracking** Abnormal Operations
 **4D (Lat, Long, Alt, Time) position + A/C Ident**	**Same content** as Normal Tracking (4D) Higher transmission rate triggered on abnormal event
 **≤15 mins**	 **1 min**

AIRCRAFT TRACKING IS PLACED UNDER OPERATORS RESPONSIBILITY

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Datalink communication means on Airbus Aircraft

Communication systems *Geographical Coverage*			
VHF Datalink *Continental areas*	Basic	Basic	Basic
SATCOM Inmarsat *Worldwide except polar area*	Option	Basic	Basic
SATCOM Iridium *Worldwide*	Option	Option	Not yet available
HF Datalink *Worldwide*	Option	Basic	Basic
ADS-B *Continental areas and soon Worldwide*	Basic	Basic	Basic

<u>Note</u>: Operators will need to make sure that the A/C are equipped with the proper Datalink communication means (VDL / Satcom / HFDL) with regards to their operated routes and that coverage is ensured for these routes.

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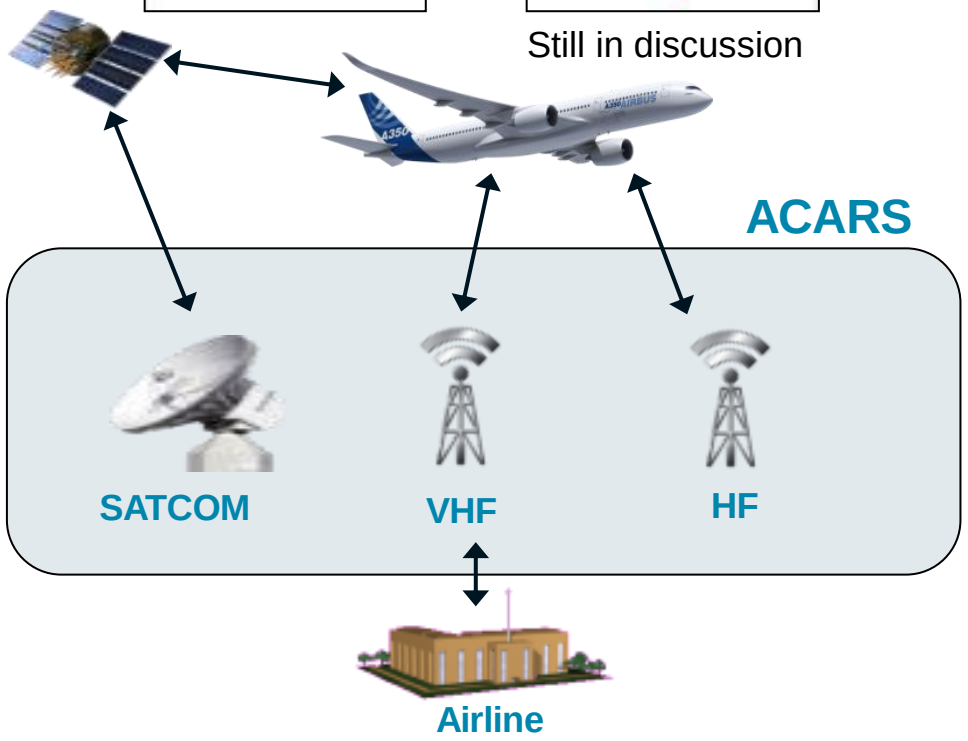
Airbus way forward for implementing Aircraft Tracking function

AOC Application
Airline Operational Control

Rockwell Collins

Honeywell

Still in discussion



- **Airbus recommendation for A320/ A330 /A350/ A380: A/C tracking solution based on existing AOC datalink applications (ACARS network) and without any additional flight crew action**
- **Partnership was established between Airbus and AOC suppliers, in order to provide generic solution for normal and abnormal tracking conditions through AOC customized database**
- **Activation/Deactivation of abnormal tracking will be done automatically through the monitoring of specific sets of A/C parameters that will trigger the emission of the A/C information at least every 1mn. Ground Airline center will also be able to activate abnormal mode upon uplink request if necessary.**

Supported by existing technologies

Fast and simple solutions available in most of Airbus fleet
Already implemented by some Airlines

Reference
ISI 23.21.00007

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Aircraft Tracking – Other solutions

Other existing technologies installed by Supplemental Type Certification (STC).

A wide variety of Standalone solutions using various Satcom constellations are available on the market.

spidertracks

SKYTRAC

Panasonic

FlightAware

Globalstar

N-TRACKING

NAVBLUE AN AIRBUS COMPANY

Aireon

Rockwell Collins

Blue Sky Network

FLYHT INSIGHT • ACTION • CONTROL

LATITUDE Optimize every flight.

inmarsat The mobile satellite company

Smart GADSS™

Thompson Aerospace

SITAONAIR

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Implementation aspects

Airbus Aircraft Tracking solution is used by a first set of customers, but we do not yet have sufficient return of experience to share.

As a first general feedback, the need for Airlines to check every 15 minutes « the good » reception of A/C routine tracking messages may highlight some communication delays .
Note: Transmission rate in normal mode can be modified to answer to some regulations or to anticipate some delays in ACARS network depending on Aircraft routes (e.g over polar zones which are only covered by HF)

Cost Aspects;
Costs of communication will depend on contracts that Airlines have negotiated with their Service Providers (Fees, Volume, Package…) .

Based on a 10 hours long range flight , the following amount of data is expected :

Routine / normal mode:	**3ko**
Abnormal mode:	**40ko**

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Global Aeronautical Distress Safety System

ADT

- Autonomous Distress Tracking

- **Provides automatic A/C position at least once every minute**
- **Must be active prior to accident event**
- **Location of an accident site within 6 NM**
- **Operates autonomously of aircraft power**
- **Results in Distress signal to appropriate SAR FIR**
- **May be manually activated**
- **Cannot be isolated**

Only protected aeronautical safety spectrum, or protected distress spectrum (e.g., 406.1 MHz), can be used

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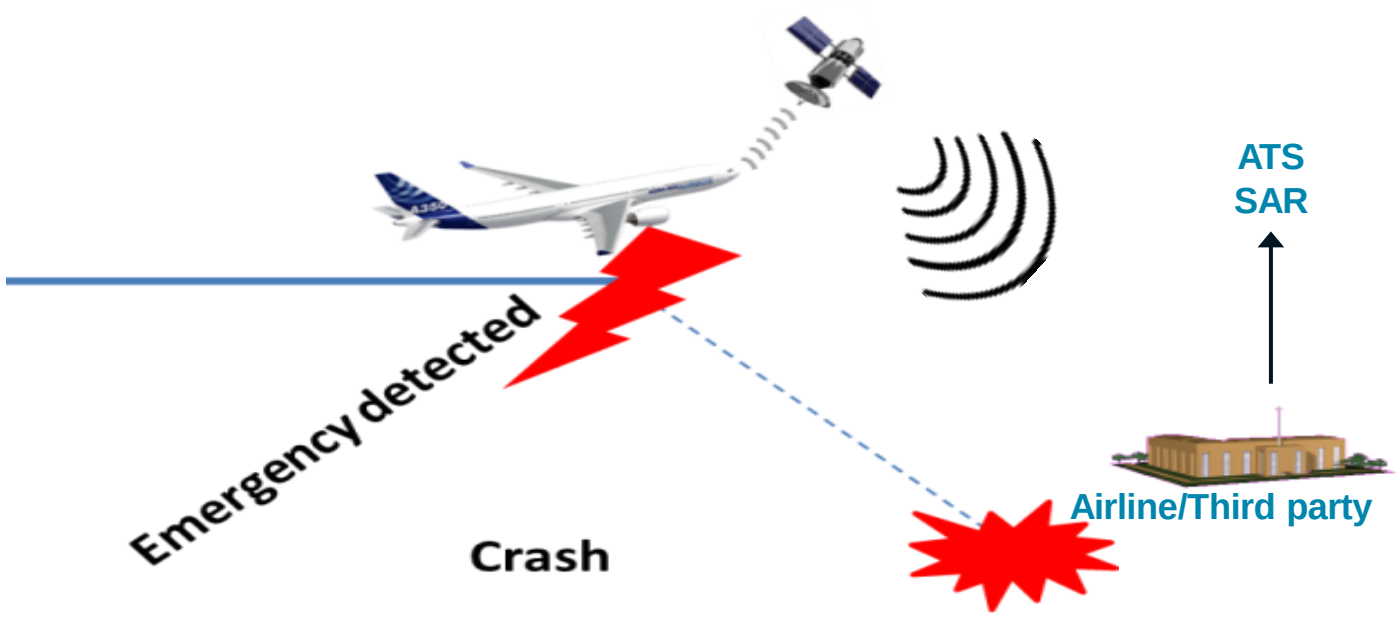
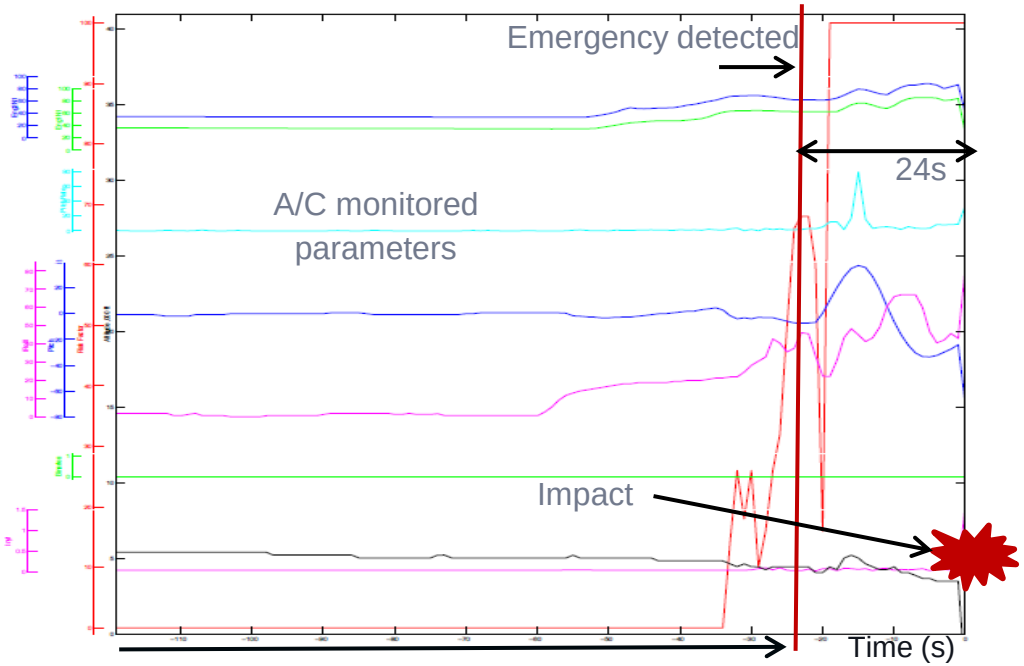
ADT -Autonomous Distress Tracking

Need new equipment on board like ELT 2nd Generation (pre-crash triggered)

- Location of an accident site within a 6 NM radius,
- Automatic transmission of 3D position +ID at a rate of 1 minute
- First burst no later than 5 seconds
- Distress will only be able to be de-activated using the same mechanism that activated it
- Standalone powered and autonomous controlled
- Could be remotely activated





Triggers for Distress Tracking are defined by EUROCAE MASPS ED-237

Note: ADFR with integrated ELT is an alternative equipment for ADT.

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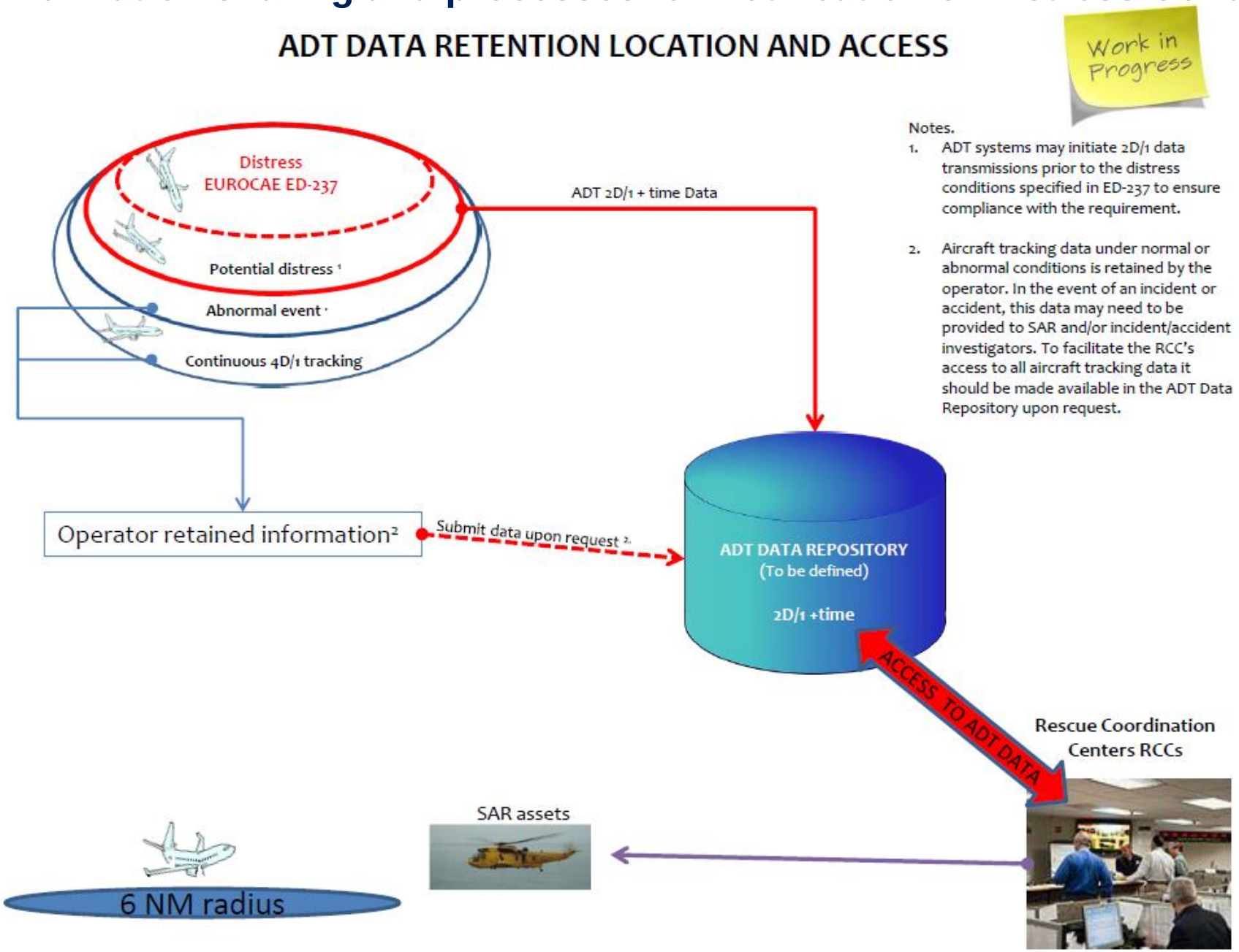
ADT –GADSS information sharing and processes for Notification of Distress Condition

GADSS Extract



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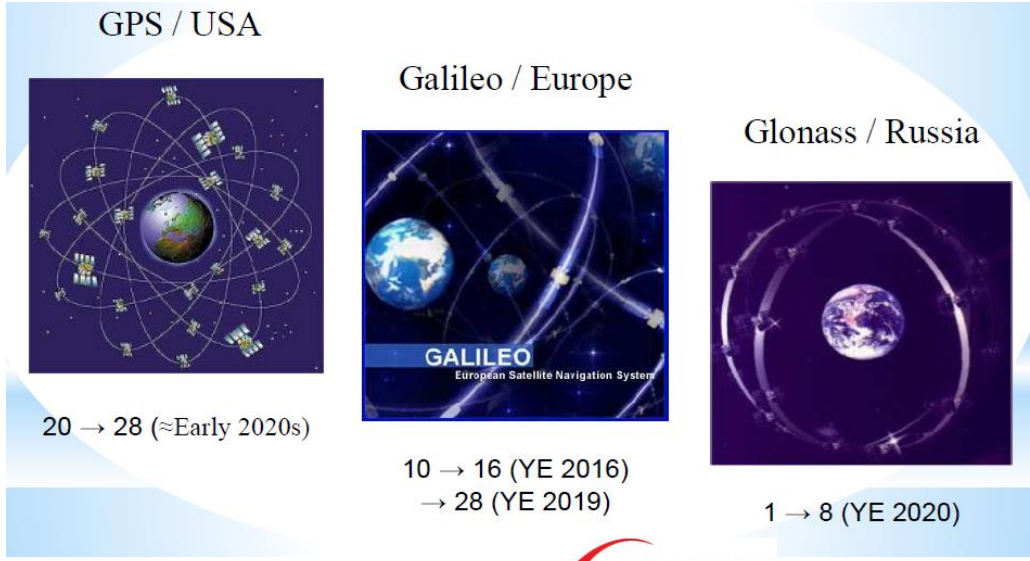
ADT- Autonomous Distress Tracking
2nd Generation ELT- Main new features

- Pre-Crash-Activation according to defined triggers e.g. Unusual attitudes, Unusual speed conditions, Unusual altitudes, Loss of power on all engines…
- GPS position information embedded in distress signal
- Use of new COSPAS-SARSAT -MEOSAR constellation based on payloads on GPS, Glonass and Galileo satellites
- 100% worldwide coverage reached
  - **first burst will be spotted by satellite anywhere in the world, at any time**
- Potential Return Link Service
- Availability expected 2018-20



COSPAS SARSAT

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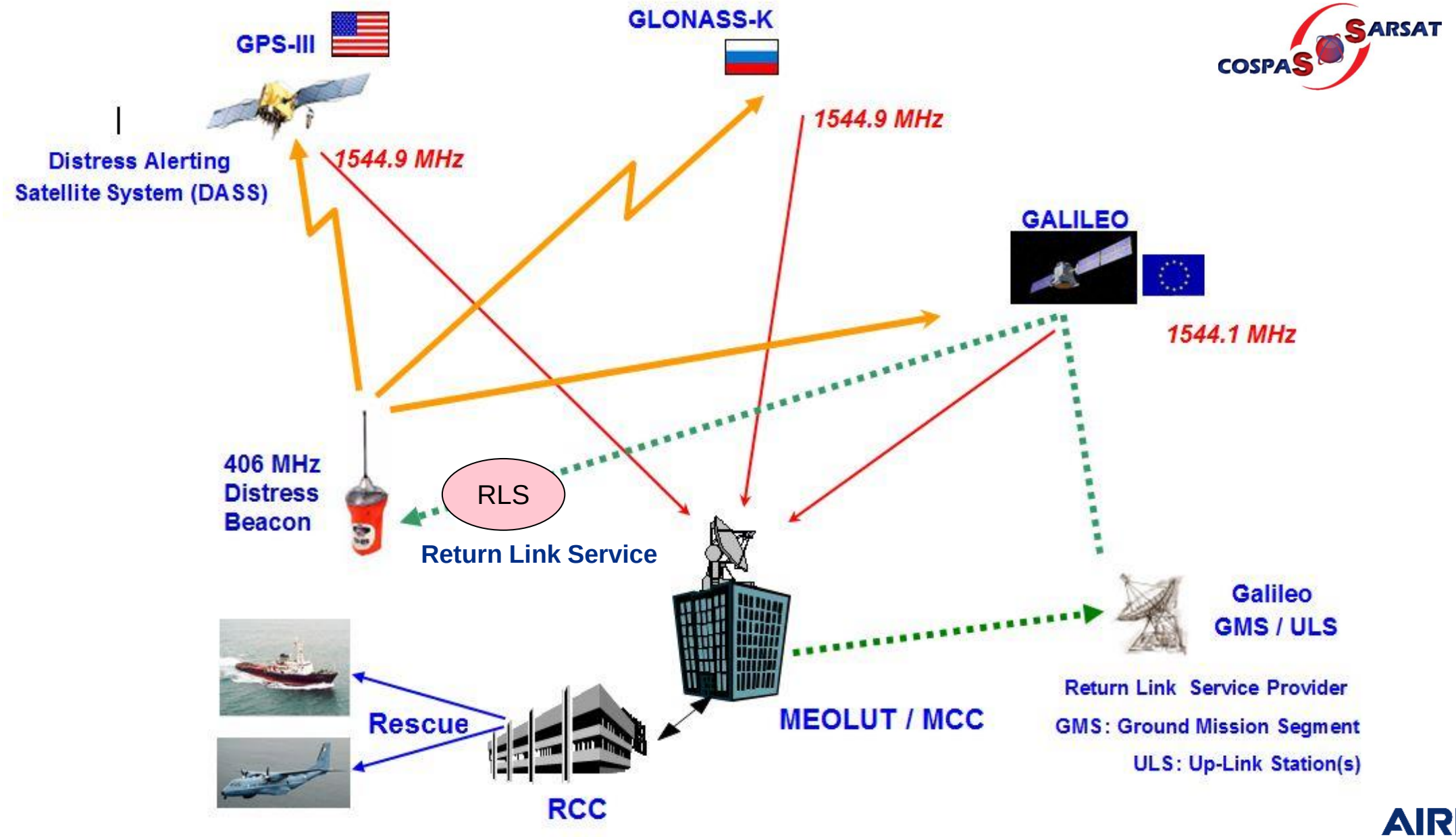
Typical MEOSAR System- Configuration with RLS



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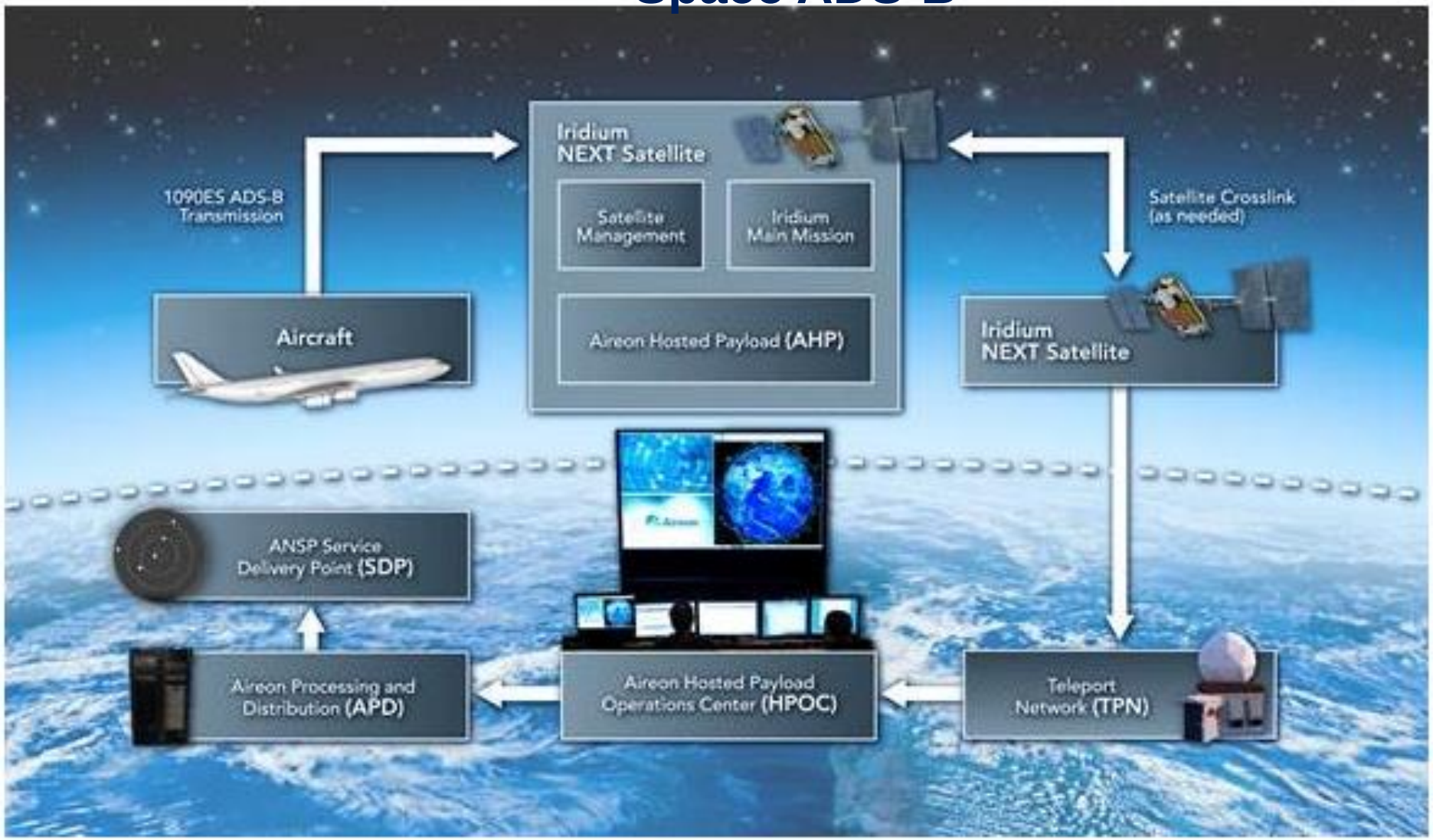
Autonomous Distress Tracking (ADT) - Example of other proposed solutions: Space ADS-B



Aireon ALERT solution will provide GPS location and real-time tracking data to assist rescue coordination centers in emergency situations.

Space ADS-B based on Iridium Next constellation

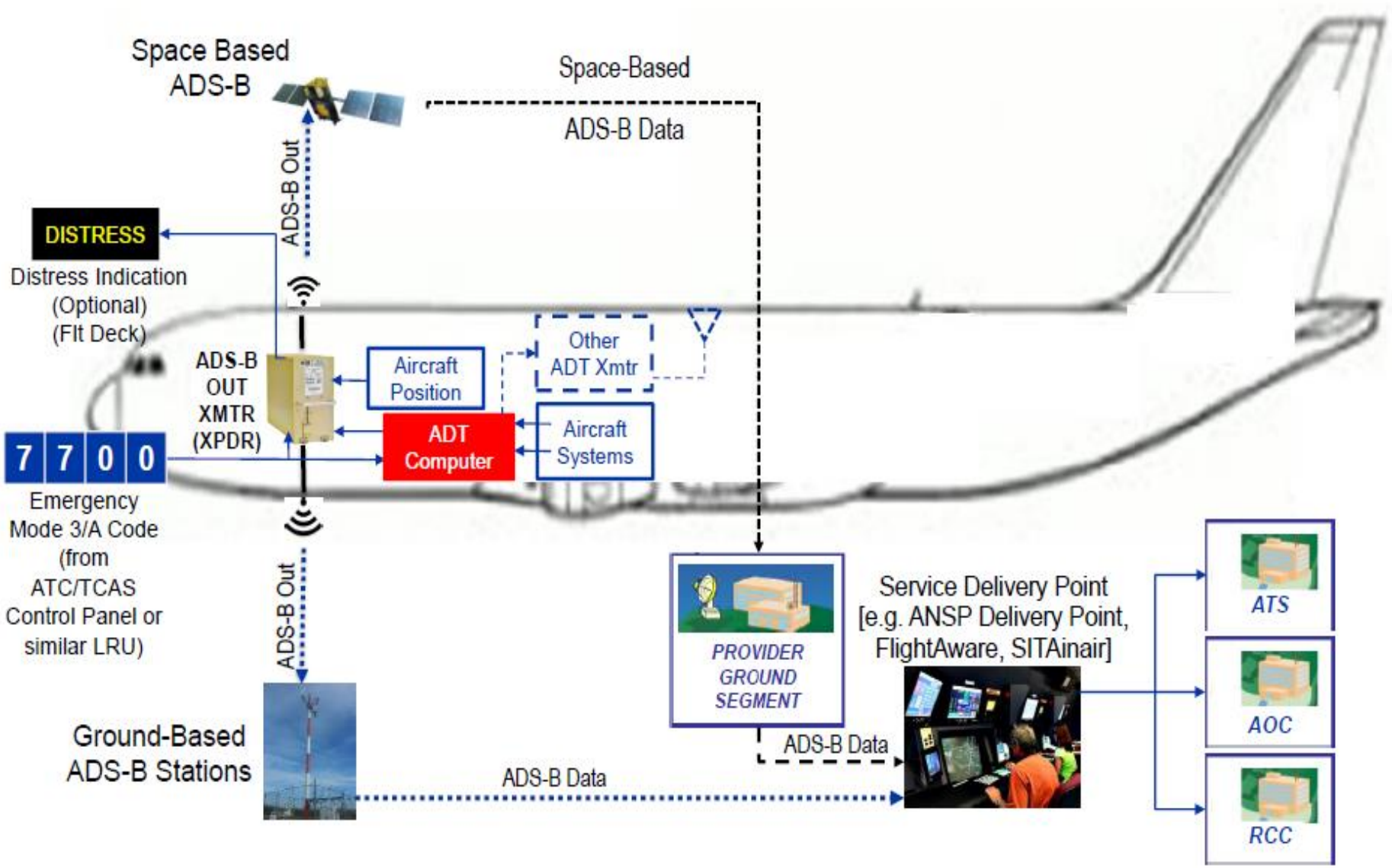
- Satellites in orbit: 66
  - 11 satellites per plane
  - Plus 6 in-orbit spare satellites
  - 9 ground spare satellites
- Orbital Planes: 6
- Availability: ≥ 0.999
- Typical Lifecycle: 14 years
- Operational altitude: At only 476 miles (780 km) from the Earth

Aireon

Further the last rocket launch during December 2017, 40 satellites are currently in orbit.

Intention to launch 35 additional satellites during 2018 thus completing the constellation

ADS-B Architecture for Distress Tracking (Transponder use Example)



Standardization of Autonomous Distress Tracking (ADT)

ARINC INDUSTRY ACTIVITIES℠
An SAE ITC Program

In order to specifically address expected, forthcoming ADT mandate in the most effective way (accounting for system complexity, cost, schedule, risk, etc.), the aviation industry proposed to launch a standardization activity through ARINC.

The work is structured in 3 main phases:

- Definition of requirements and main functional block diagrams (First Draft Report available)
- Proposition of candidate architectures (Report) . Activity has started
- Develop detailed equipment, interfaces, and aircraft installation requirements, for selected architecture(s). Define accordingly new ARINC or updated Characteristics.

Global Aircraft Tracking Working Group at full speed…

>>> Completed work expected Jan 2019

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Outcome of AEEC GAT group, scope of ADT

Autonomous Distress Tracking (ADT) activities :

- Phase 1: Initial Requirements - Complete
- Phase 2: Architecture Teams developing proposed architectures:
  - Emergency Locator Transmitter – Distress Tracking (ELT-DT)
  - Spaced-Based Automatic Dependent Surveillance – Broadcast (SB ADS-B)
  - SATCOM-based Tracker (Inmarsat)
  - SATCOM-based Tracker (Iridium)
  - Other (ie stand alone solution)…

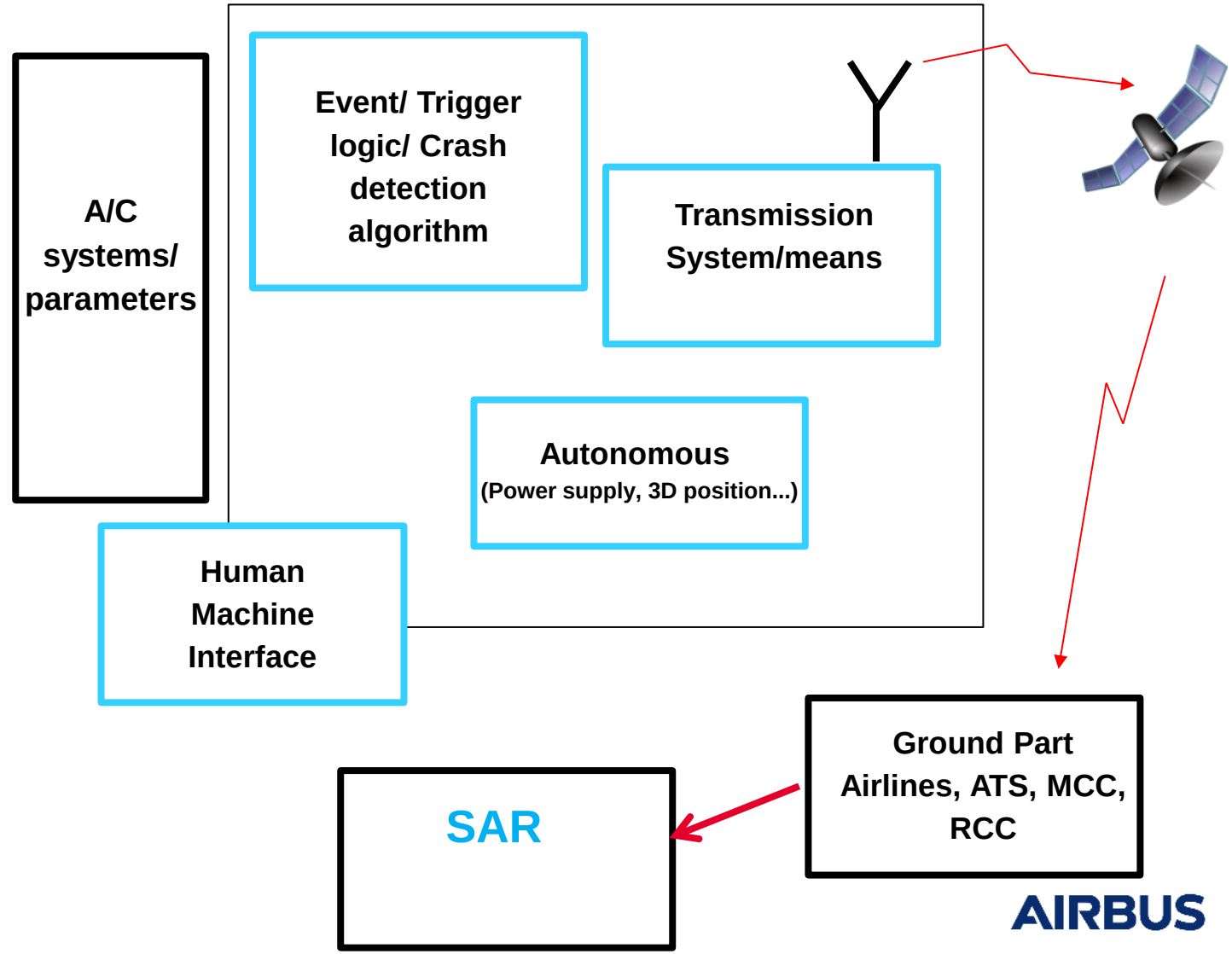
Good support from industry: Airlines, Suppliers, Airframers, Service providers, and government agencies

Outcome of AEEC GAT group, scope of ADT

Main ADT Function Blocks

- Aircraft State
- Distress Detection Logic
- Triggering Criteria Logic
- Distress Tracking Transmission
- Distress Report

Typical ADT Block Diagram architecture whatever Com means



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Post Flight Localization and Recovery :

- **localization systems**: ***only protected aeronautical safety spectrum, or protected distress spectrum (e.g., 406.1 MHz), can be used***

- **flight recorder data recovery system**: ***Use of any type of spectrum properly allocated, [on a primary basis], for the function being performed***

To be confirmed according to ITU and ICAO on going discussions

Global Aeronautical Distress Safety System

Performance Based Solutions

- **Make it available in a timely manner**
- **approved by the State of the Operator**
  - **Data Streaming**
    - **Ensures a minimum dataset of CVR and DFDR information**
  - **ADFR (Automatic Deployable Flight Recorder)**
    - **Floatable**
    - **Contains ELT to aid location**

PFLR

- Post Flight Localization & Recovery

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Main ICAO activities

ICAO GADSS-Advisory Group activities are on going, a work programme has been establish related to the GADSS implementation .

ICAO is also working on Manual Doc 10054 on Location of Aircraft in Distress and Flight Recorder Data Recovery.

This document 10054 is a Manual of Guidelines /Requirements of the various means of compliance for both Autonomous Distress and Post Flight Localization & Recovery.

This document is currently defined by an ICAO “Flight Recorder” Working Group.

>>> First draft of ICAO Doc 10054 is expected to be ready for beginning 2018

PFLR: Deployable Combined Recorder with integrated ELT

1. Sensors detect the start of a crash

2 . ADFR immediately initiates the Emergency Locator Transmitter (ELT) and then releases from aircraft

3. ELT transmits aircraft ID and country of origin as well as Aircraft location via COSPAS-SARSAT satellites to SAR authorities.

Source: DRS

4. Deployable lands safely and floats on water ensuring quick recovery.

5. ELT in the deployable recorder continues to update its position using its embedded GNSS receiver. It acts also as homing device for rescue crews..

6. SAR personnel recover survivors and Deployable Recorder to enable quickly data accident analysis

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Airbus Official Announcement

On June 21st 2017, during Paris Air Show, AIRBUS announced a new Recording System architecture

This new architecture is composed of:

- A combined Cockpit Voice and Data Recorder (CVDR)
- An Automatic Deployable Flight Recorder (ADFR)
- A Recorder Interface Unit (RIU)

PFLR: Deployable Combined Recorder with integrated ELT

<u>Airbus plan</u>: Forward- fit application of ADFR (Automatic Deployable Flight Recorder) on all long range operations aircraft:
A380, A350, A330, and A321LR

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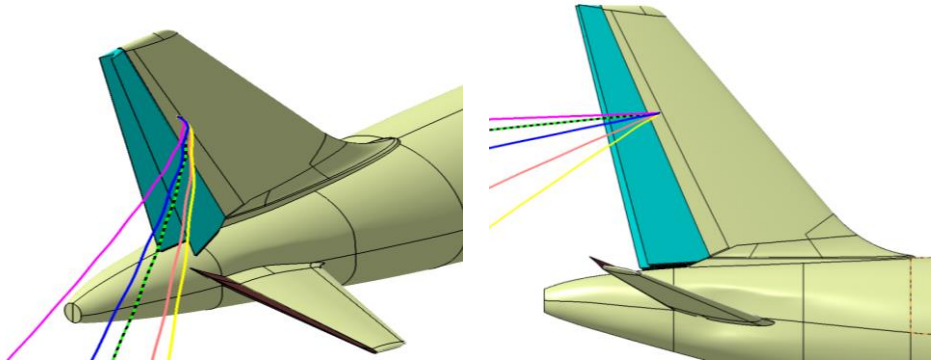
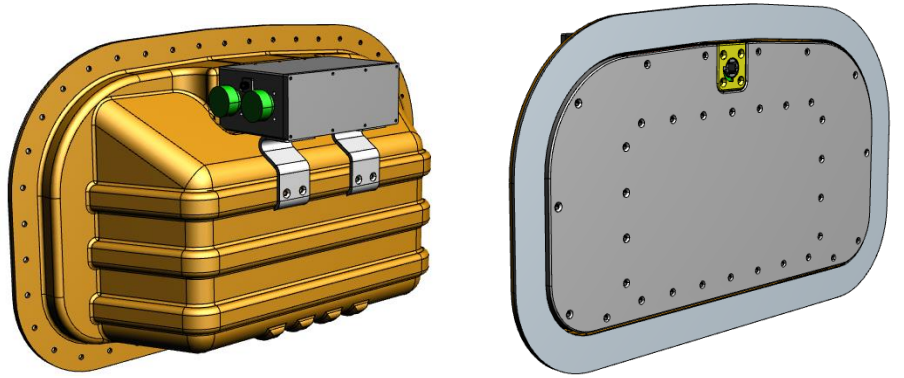
PFLR: Deployable Combined Recorder with ELT

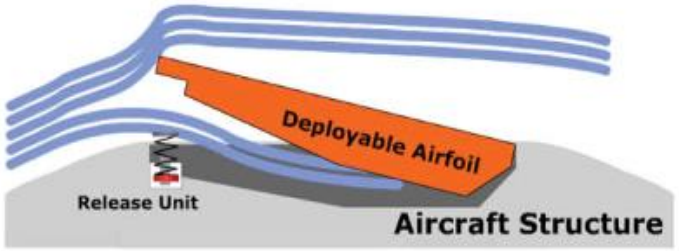
Technology:

- Dual Combination Recording System with:
  - ADFR with integrated ELT/ADT installed in Vertical Fin
  - Crash detection circuits (significant structural deformation or water submersion)
  - CVDR installed in Avionics Bay
  - 25 hours recording
  - Common system across Airbus fleet A350, A380, A330, A321 LR
- Entry Into Service expected before mandate date



Ejection principle





» Airfoil releases from aircraft within milliseconds

» Aerodynamic force "lifts" airfoil away from the aircraft

» Floats on water indefinitely

L3 Technologies

DRS TECHNOLOGIES a LEONARDO company

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PFLR: Deployable Combined Recorder with ELT

Deployable Beacon Airfoil Unit (BAU):

- Crash Survivable Memory Module
- ELT/ADT Transmitter
- GNSS Receiver
- Antennas (ELT and GNSS)
- Battery Pack

BAU Tray:

- Mounts conformal to aircraft skin
- No aerodynamic impact
- Holds BAU securely on Aircraft
- Provides mounting points for Recorder Release Unit, Hydrostatic Switch(s)

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PFLR: Deployable Combined Recorder Architecture

Main Architecture/ locations

Dual combination recording with ADFR and CVDR

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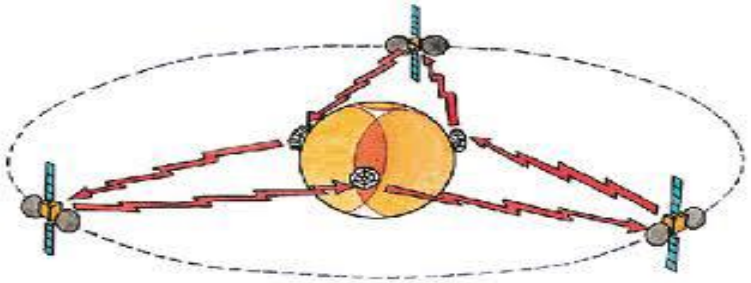
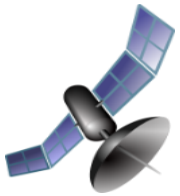
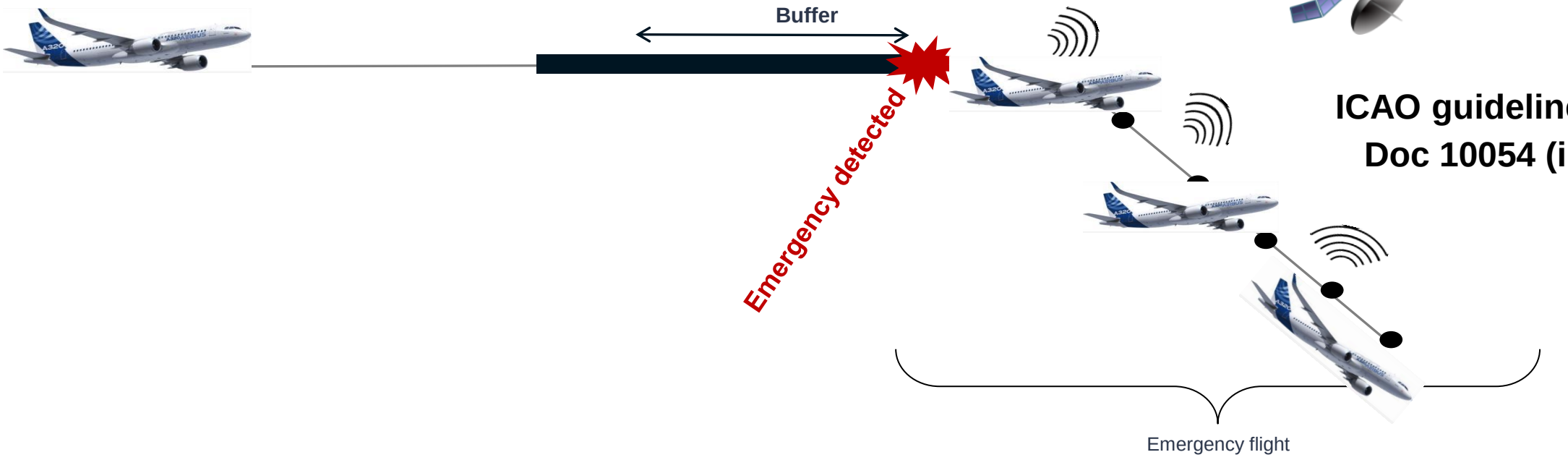
PFLR: Flight Data Streaming



SATCOM GSO or LEO coverages
(L / Ku / Ka bands…)





ICAO guidelines defined by
Doc 10054 (in progress)

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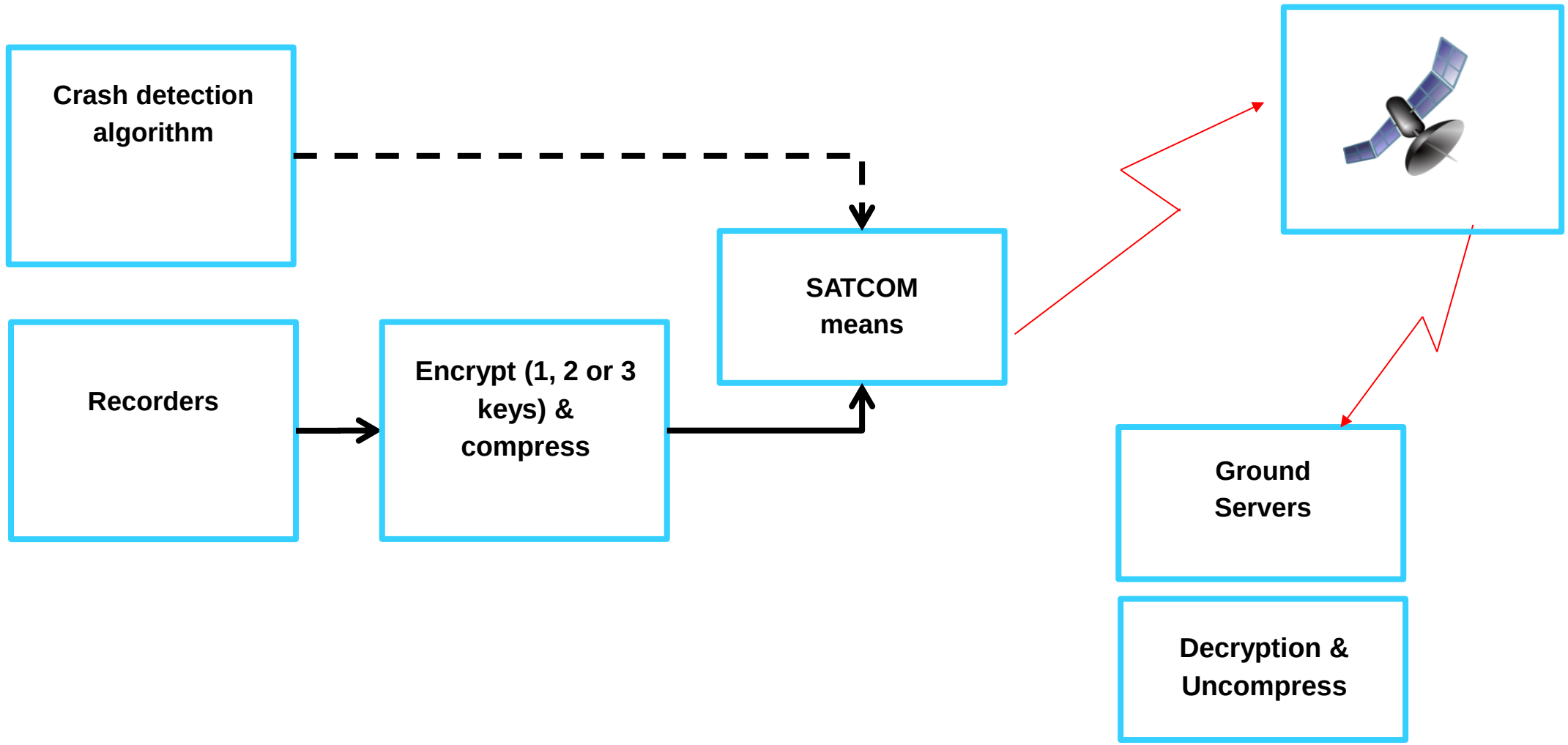
PFLR: Flight Data Streaming -Functional description

Performances & Requirements
are in definition by ICAO Working Group (Manual 10054)



Standardization of Timely Recovery of Flight Data (TRFD)

ARINC INDUSTRY ACTIVITIES℠
An SAE ITC Program

In order to specifically address expected, forthcoming PLFR mandate in the most effective way (accounting for system complexity, cost, schedule, risk, etc.), the aviation industry proposed to launch a standardization activity through ARINC.

The APIM propose to structure the work in 3 main phases:

- Document the end to end system , Data Security and privacy requirements, develop System Functional Block Diagram (Report)
- Develop candidate architectures) / choose architecture(s) (Report)
- Develop detailed equipment, interface, and aircraft installation requirements, as well for selected architecture(s). Define accordingly new ARINC or updated Characteristics

Standardization of Timely Recovery of Flight Data (TRFD)

ARINC INDUSTRY ACTIVITIES℠
An SAE ITC Program

There are two potential TRFD architectures that are expected to be evaluated, including (but not limited to) the following:

- Automatic Deployable Flight Recorder (ADFR) - a combination flight recorder (Cockpit Voice Recorder (CVR)/Flight Data Recorder (FDR)) with integrated ELT installed on the aircraft which is capable of automatically deploying from the aircraft

- Flight Data Streaming (FDS) – the ability to stream flight data from the airplane while in flight

>>> Completed work expected Sept 2020

GADSS Spectrum summary

GADSS ConOps table shows which types of frequency bands considered for the various categories of functions specified under the GADSS.

Function	Spectrum Category
Aircraft Tracking system	A
ATC Surveillance systems	B
Distress Tracking systems	C
Post Flight Localization and Recovery – Localization systems	C
Post Flight Localization and Recovery - Flight Recorder Data Recovery system	A

A: any type of spectrum properly allocated, on a primary basis, for the function being performed.
B: only protected aeronautical safety spectrum can be used.
C: only protected aeronautical safety spectrum, or protected distress spectrum (e.g. 406.1 MHz), can be used.
*This chart is not intended to imply that any new spectrum allocations are necessary to support GADSS.

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Underwater Locator Devices

- Aircraft are equipped with flight recorders with Underwater Locator Beacons (ULBs) attached.

The detectable acoustic range of the currently used Flight Recorder ULBs is limited due to the transmit frequency of **37.5 kHz**. Duration time has been increased to 90 days (from 30 days) .

ULB attached on CVR / DFDR

<u>Airbus plan</u>: already installed basically on all Airbus programs
Service Bulletins available for retrofit

- 90 days Low Frequency ULB “Underwater Locating Beacons ” (8,8Khz) attached to the aircraft for long-range over-water flights

Transmission range is increased by a factor 4 using lower frequency.

ULB Type	Frequency	Transmission Range
Conventional ULB	37,5 kHz	5km (~2,5NM)
LF-ULB	8,8 kHz	22km (~12NM)

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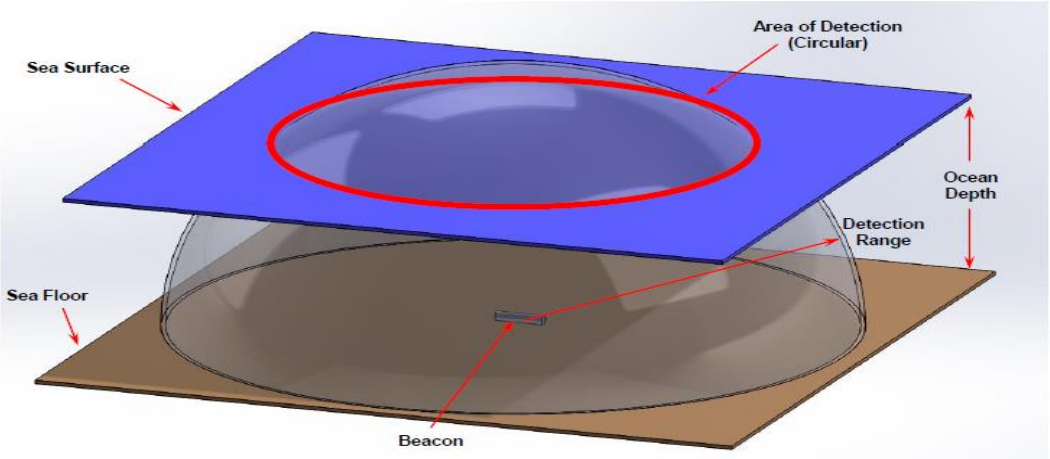
Underwater Locator Devices-Low Frequency Underwater Locator Beacons (LF-ULB)

- Compliance with ARINC 677 specification to harmonize the LF-ULB footprint to aircraft interface

- Guidance manual published by EASA in December 2015:
  - Define the installation position on the fuselage (Attached to the aircraft structure)
  - Define the applicable means for fixation (aircraft bracket)
  - **(E)TSO c200a** qualification
  - Retrofitability (zone not modified after A/C Type Certification)



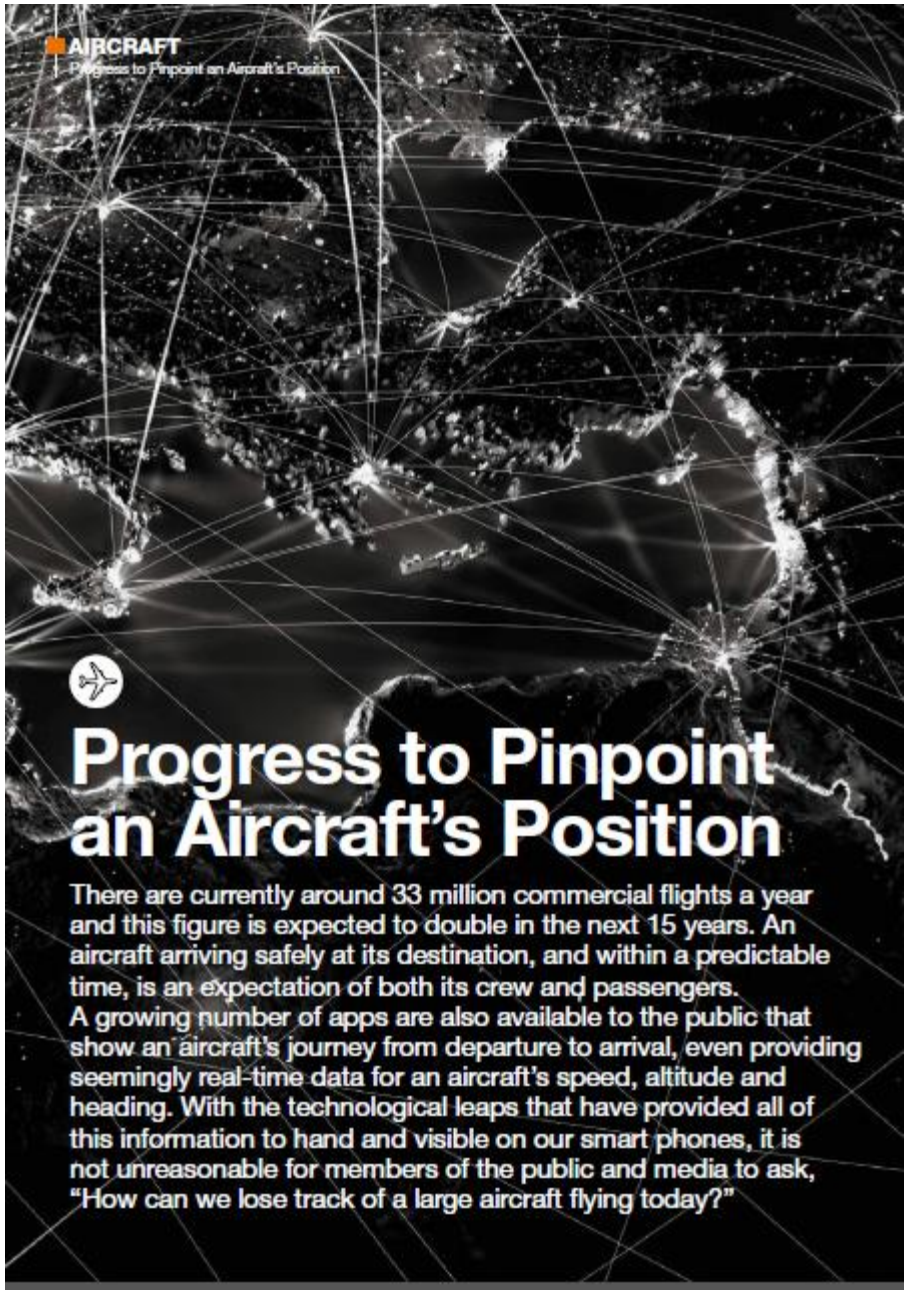
Independent LF-ULB on A/C structure

<u>Airbus plan</u>: Forward- fit application on all Airbus programs : A380, A350, A330, and A320 families

Service Bulletins available for retrofit

AIRBUS

Lot of Working Groups are active, Airbus is involved in majority of them…



Aircraft Tracking article in Safety First Airbus Magazine

Claude PICHAVANT
Senior Expert Communications& Surveillance
Manage Flight Systems

Geraldine VALLEE
Director of Flight Safety
Safety Enhancement

Article available on demand

AIRBUS

Glossary

ACARS: Aircraft Communication Addressing and Reporting System
ACMS: Aircraft Condition Monitoring System
ACR: Avionics Communication Router
A/C: Aircraft
ADFR: Automatic Deployable Flight Recorder
ADS-B: Automatic Dependent Surveillance-Broadcast
ADS-C: Automatic Dependent Surveillance-Contract
ADT: Autonomous Distress Tracking
AEEC: Airlines Electronic Engineering Committee
A/L: Airlines
AOC: Airlines Operational Control
APC: Airlines Passenger Communications
APIM: ARINC Project Initiation/Modification
AT: Aircraft Tracking
ATC: Air Traffic Control
AtG: Air to Ground
ATM: Air Traffic Management
ATS: Air Traffic Services
ATSU :Air Traffic Service Unit
ATTF: Aircraft Tracking Task Force
CAAS : Civil Aviation Authority of Singapore
CEPT: Conférence Européenne des administrations des Postes et Télécommunications
CONOPS: CONcept of OPerationS
CVR: Cockpit Voice Recorder
CVDR: Cockpit Voice Data Recorder
DAR: Digital Access Recorder
DB: Data Base
DFDR: Digital Flight Data Recorder
DLK: Data Link
DSP: Datalink Service Provider
EASA: European Aviation Safety Agency
ELT: Emergency Locator Transmitter
EU: European Union
FAA: Federal Aviation AdministratFANS: Future Air Navigation System
FDR: Flight Data Recorder
FDS: Flight Data Streaming
FMS: Flight Management System
GADSS : Global Aeronautical Distress and Safety System
GEO: Geostationary Earth Orbit
GPS: Global Positioning System
GSO: Geo Stationary Orbit
HF: High Frequency
HFDL:HF Data Link
HFDR : HF Data Radio
HLSC: High Level Safety Conference
IATA: International Air Transport Association
ICAO: International Civil Aviation Organisation
ID: Ident
IP: Internet Protocol
ITU: International Telecommunication Union
LEO: Low Earth Orbit
MASPS: Minimum Aviation System Performance Specification
MCC :Mission Control Center
NAA: National Aviation Authorities
NATII: Normal Aircraft Tracking Implementation Initiative
NM: Nautical Miles

Glossary

OCC = Operational Control Center
OEM: Original Equipment Manufacturer
OPS: Operations
PFLR: Post Flight Localization & Recovery
QoS: Quality of Service
RCC: Rescue Coordination Center
RLS : Return Link Service
RTCA: Radio Technical Commission for Aeronautics
SAI : System Architectures and Interfaces
SAR: Search And Rescue
SARPs: Standards And Recommended Practices
SSCVR: Solid State Cockpit Voice Recorder
STC: Supplemental Type Certification
TRFD: Timely Recovery of Flight Data
ULB: Underwater Locator Beacon
ULD: : Underwater Locating Device
VDR: VHF Data Radio
VDL: VHF Data Link
VHF: Very High Frequency
VTP: Vertical Tail Plane
WRC: World Radio Conference

Thank you