Aircraft Tracking & Flight Data Recovery

The Aircraft Manufacturer View

Presented by Claude Pichavant

ROYAL AERONAUTICAL SOCIETY
Further to the last unfortunate MH 370 event, Airbus has contributed to the Aircraft Tracking Task Force (ATTF), to the ICAO High Level Safety Conference and is still working with ICAO Air Navigation Commission and is participating in various CEPT, ITU, EASA / European Commission/ FAA working groups/meetings about definition of short, mid and long term solutions.

There is a range of existing technologies and services, many are already installed on aircraft (ADS-C, ADS-B, Stand-alone Satcom positioning device, ACARS…) and can be used in the near-term on board aircraft.

This range of technologies and services will enable operators to take a performance-based approach when implementing or enhancing aircraft tracking capabilities.
Aircraft Tracking & Flight Data Recovery

Mid term solution like Space based ADS-B, will be available probably in 2018 through low earth orbit (LEO) polar orbiting satellite constellation.

The last World Radio Conference 15 makes a primary allocation in the Radio Regulations to a space service in the Earth to space direction at 1090 MHz, where the terrestrial ADS-B signals are broadcasted by aircraft and can be received by satellite in AMS(R)S (Aeronautical Mobile-Satellite (R) Service

Long term solutions like Automatic Deployable Flight Recorders or Real Time Data Streaming are currently in discussion. Autonomous (robust to power loss, tamper-proof) distress tracking solutions need to be studied.
Global Flight Tracking – Origine

May 2014 ICAO Special Meeting on Global Flight Tracking of Aircraft in response to aircraft incidents (MH370, AF447…)

- Need in near-term priority to track airline flights
- IATA raised an Aircraft Tracking Task Force (ATTF) and provided a set of recommendations for flight tracking best practices
- ATTF report and recommendation issued in Nov 2014, is included in the Concept of Operations Global Aeronautical Distress and Safety System (GADSS)
Global Aeronautical Distress and Safety System (GADSS)

Aircraft Tracking

Normal

Abnormal

Emergency

Distress

Data Recovery

15 minutes

1 minute

. Triggered by abnormal events

1 minute

. Autonomous

. Triggered by specific events, crew or ground.

. Restricted means to cease transmitting

Timely access to data

Autonomous Distress Tracking (ADT)

• To locate an airplane in distress

• To locate an accident site within 6Nm radius

Flight Data Recovery

• ADFR (deployable recorders)

or

• Performance based alternative

Can be supported by existing technologies

Will require new equipment
Current ICAO Recommended Practices

- **Normal**
  - March 2015: State Letter
  - Routine Aircraft Tracking
- **Abnormal**
  - Localizing A/C in distress
  - All Aircraft from Nov 2018*
  - Oceanic area
- **Distress**
  - All Aircraft from Jan 2021
  - Flight Data Recovery
- **Data Recovery**
  - New Type Certification from Jan 2021
  - Recommendations moved into ICAO SARPS

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

Global Aeronautical Distress and Safety System CONOPS

Guidance and criteria for operators to implement Global Flight tracking

Adopted by states during the ICAO High Level Safety Conference in February 2015

ICAO Standards and Recommended Practices (SARPS)

Recommendations published in State letter in March 2015

Recommendations transferred in to SARPS

Applicable from November 2018

States regulations

Definition of regulations on going by each State based on ICAO recommendations

Some examples:

- Amendment to Regulation (EU) No 965/2012
Aircraft tracking – Regulatory context (1/2)

ICAO SARPS (Standards And Recommended Practices)

• Definition of Aircraft Tracking:
  “A process, established by the operator, that maintains and updates, at standardized intervals, a ground-based record of the four dimensional position of individual aircraft in flight.”

For Normal Tracking:
• 4D position (Lat, Long, Alt, Time) + A/C identification sent every 15 minutes
• Applicable on and after 8 November 2018 (mandatory over Oceanic areas)
• Applicable to all in-service commercial air transport A/C, with a maximum certificated take-off mass of over 27,000 kg and a seating capacity greater than 19.
For Abnormal Tracking:

- No SARPS abnormal tracking proposal from ICAO as of today
- ICAO ConOps Guidance Material for Global Aeronautical Distress and Safety System (GADSS) includes Objectives of implementing abnormal tracking capabilities

National Aviation Authorities (NAA)

- NAA define their regulation in accordance with ICAO recommendations
  (Ex for EU, After 2021, reporting rate increases to 3 minutes, unless equipped for distress tracking)
- Operators will have to check with their local NAA what is the relevant applicable regulation regarding Aircraft tracking
Aircraft Tracking & Flight Data Recovery

• Airbus objective is to be compliant with regulations with the best solution for the operator:
  • Recurring and Non-recurring costs,
  • Installation,
  • Maintenance tasks,
  • Communication cost…

• Solutions optimized and adapted per model family ie A320 / A330 and A380 / A350
As is

<table>
<thead>
<tr>
<th>Aim</th>
<th>Solution</th>
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<tbody>
<tr>
<td>Track and alert</td>
<td><strong>ACARS</strong> (AOC, Maintenance, ADS-C), <strong>ADS-B</strong>)</td>
</tr>
<tr>
<td>Retrieve data</td>
<td>Fixed recorders, with <strong>ULB</strong> attached</td>
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<tr>
<td>Locate wreckage</td>
<td>Crash triggered <strong>ELT</strong></td>
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<tr>
<td>Locate Recorders</td>
<td>30 days- 37.5KHz <strong>ULB</strong>, attached to recorders</td>
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**Communication means**

**Ground segments:** Airline, ATC, SAR

**ELT** (crash triggered)

**Sea surface**

**30 days-ULB** attached to recorders

**RAes - Aircraft Tracking - The Airframer view**

April 2016

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**ADS-B / C:** Automatic Dependent Surveillance-Broadcast / Contract

**AOC:** Airline Operational Communication

**FANS:** Future Air Navigation System

**ELT:** Emergency Locator Transmitter

**ULB:** Underwater Locator Beacon
New requirements

- 90 days ULB “Underwater Locator Beacons” attached to recorders (replacement of 30 days ULB) (January 2018 Fwd & Retrofit).
- Low Frequency ULD “Underwater Locating Devices” (8,8Khz) attached to the aircraft or a means determining the A/C impact location (2018 or 2019 Fwd & Retrofit).
- Aircraft Tracking Normal & Abnormal Conditions (Nov or Dec 2018 Fwd & Retrofit).
- 25 hours CVR (Jan 2021 - Fwd fit).
- Location and tracking of an Airplane in Distress (Jan 2021 - Fwd-fit).
- Flight Data Recovery (Jan 2021 – new TC), proposing the following alternative means:
  - Solution based on Real-Time Data Streaming (CVR and FDR data content)
  - or ADFR “Automatic Deployable Flight Recorders” (with integrated ELT).
Foreseen solutions

**Aim**

- **Track and alert**
  - Aircraft tracking (4D position at least)
  - Aircraft Distress Tracking

- **Locate, retrieve data**
  - Floating deployable Recorders with ELT

- **Locate wreckage**
  - Low Freq 8.8KHz ULD, airframe attached

- **Locate Recorders**
  - 90 days 37.5KHz ULB, fix recorders attached

**Solution**

- 2nd ELT Generation

**Ground segments:** Airline, ATC, SAR

- Deployable recorder with ELT or Data streaming

- Pre-crash activated ELT (second generation): considered but not short term
Today Air-Ground Systems

Secondary Surveillance Radar

High Frequency Data Link (HFDL)

Very High Frequency Data Link (VDL)

SATCOM ADS-C via GSO networks or LEO systems

ADS-B or UAT (Terrestrial)

ATC Controller

OCC = Operational Control Center
MCC = Maintenance Control Center

Airlines
Air segment solutions: Aircraft position report

The following main near term solution families are possible:

1) Use or modify what is already existing on Airbus A/C (ACARS, ACMS, AOC, ADS-C…) with associated Com means.

2) New small, low cost, stand-alone systems (possibly independent of any A/C interface except power supply) using Low Earth Orbit constellations

3) ADS-B space based solutions (End 2017 - beg 2018 according to new LEO constellation)
## Normal/Abnormal Flight Tracking – Recommendations

<table>
<thead>
<tr>
<th></th>
<th>Routine Tracking</th>
<th>Abnormal Tracking*</th>
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</thead>
<tbody>
<tr>
<td>Aircraft data</td>
<td>Aircraft 4D position and Aircraft identification</td>
<td>Aircraft 4D position and Aircraft identification</td>
</tr>
<tr>
<td>Reporting Frequency</td>
<td>$\leq 15\text{ min}$</td>
<td>1 min</td>
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</tbody>
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*Triggers for abnormal tracking are not yet defined in ICAO documents, Airbus has studied adapted triggers to support airlines in implementing Abnormal flight tracking.

Associated Com kit distributed to Airlines: OIT 999.0158/15 Rev 00 and ISI 23.21.00007
Normal/Abnormal Flight Tracking – Available solutions

Solutions based on current datalink applications:

- Airline Operational Communication (AOC)
- Aircraft Condition Monitoring System (ACMS)
- Automatic Dependent Surveillance-Contract (ADS-C)

(Standalone solutions installed by STC)

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

ATS = Air Traffic Service
OCC = Operational Control Center
MCC = Maintenance Control Center
STC = Supplemental Type Certification
Normal/Abnormal Flight Tracking – Other future solution

ADS-B (new link) granted during last WRC15

Other future technology

Automatic Dependent Surveillance – Broadcast (ADS-B) space based. Iridium Next constellation will be available end 2017 – beg 2018

No expected change on aircraft or avionics for ADS-B out capable aircraft
Space ADS-B - Aireon
Autonomous Distress Tracking (ADT)

• Need new equipment on board like ELT 2nd Generation (pre-crash triggered)
  • To be within the 6 NM objective in 95% of the accidents from the last possible reported position, transmission of position is performed at a frequency of 1 minute
• Standalone powered and autonomous controlled (Tamper proof) using satellite constellation
• Can be remotely activated
Autonomous Distress Tracking (ADT)

<table>
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<th>Distress Tracking *</th>
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<tbody>
<tr>
<td>Aircraft data</td>
</tr>
<tr>
<td>Aircraft 4D position and Aircraft identification</td>
</tr>
<tr>
<td>Reporting Frequency</td>
</tr>
<tr>
<td>1 min when triggered</td>
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Distress will only be able to be deactivated using the same mechanism that activated it or, in any case, from the ground.

*Triggers for Distress tracking are defined by EUROCAE ED-237 (released)
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 is 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

• Availability planned after 2019 (MEOSAR constellation and new beacons)
Recorders & ULB

90 days ULB (January 2018)  
Already certified  
37.5Khz - 2.5NM range

25 hours CVR (Jan 2021 - forward fit).

Example of ULD attached to the A/C structure  
8.8Khz - 12NM range
Deployable Recorder Takes the “Search” out of “Search and Rescue”

1. Sensors detect the start of a crash

2. Deployable releases from aircraft

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

4. Integrated ELT in the deployable recorder transmits Location and ID of the Aircraft via satellite to SAR authorities.

5. Deployable acts as homing device for rescue crews, essential for accidents over water or in remote locations.

6. SAR personnel recover survivors and Deployable Recorder quickly allowing same day accident analysis.

Source: DRS
Real Time Data Streaming

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

Buffer

Emergency detected

Emergency flight
Implementation proposal

According to impacted programs, application dates, Forward fit /Retrofit aspects, combination of solutions can be defined to comply with applicable regulations:

One example:

**Forward fit:**
- Double Combined Recording Architecture with:
  - one deployable combination recorder (25h) with integrated ELT
  - one fixed combined recorder with 90 days ULB
- Low Frequency ULB airframe attached
- Aircraft Tracking via AOC

**Retrofit:**
- 2 fix recorders (25h) with 90 days ULB
- Low Frequency ULB airframe attached
- Aircraft tracking via AOC
Next steps

For mid and long term solutions i.e.

Space ADS-B,
Tamper proof and autonomous systems

Automatic Deployable Flight Recorder,
Real Time Data Streaming,
...

Performance based regulation
(Avoiding prescriptive specification of particular solutions)

Discussions are still ongoing within the field of International Standardization and Airworthiness bodies/committees
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
A/L: Airlines
AOC: Airlines Operational Communications
APC: Airlines Passenger Communications
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
CEPT: Conférence Européenne des administrations des Postes et Télécommunications
CONOPS: CONcept of OPerations
CVR: Cockpit Voice Recorder
DAR: Digital Access Recorder
DLK: Data Link
EASA: European Aviation Safety Agency
ELT: Emergency Locator Transmitter
EU: European Union
FAA: Federal Aviation Administration
FANS: Future Air Navigation System
FDR: Flight Data Recorder
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
HFDR: HF Data Radio
IATA: International Air Transport Association
ICAO: International Civil Aviation Organisation
IP: Internet Protocol
ITU: International Telecommunication Union
LEO: Low Earth Orbit
MCC = Maintenance Control Center
NRC: Non Recurring Cost
OCC = Operational Control Center
OPS: Operations
RC: Recurring Cost
QoS: Quality of Service
RTCA: Radio Technical Commission for Aeronautics
SAR: Search And Rescue
SARPs: Standards And Recommended Practices
SSCVR: Solid State Cockpit Voice Recorder
STC: Supplemental Type Certification
ULB: Underwater Locator Beacon
ULD: Underwater Locating Device
VDR: VHF Data Radio
VHF: Very High Frequency
Global Flight Tracking

ICAO High Level Safety Conference outcomes regarding GLOBAL FLIGHT TRACKING:

• CONCLUSION
  a) Recent events, such as the accident to Flight AF447 and the disappearance of Flight MH370, have shown that there is a need for provisions requiring operators to determine the position of an aircraft at any time in any location;
  
b) States and the industry should begin voluntary implementation of global tracking using available technologies as a matter of urgency;

• RECOMMENDATION
  a) ICAO should finalize and use the Global Aeronautical Distress and Safety System (GADSS) for the implementation of normal, abnormal and distress flight tracking, search and rescue (SAR) activities and retrieval of cockpit voice recorders (CVRs) and flight data recorders (FDRs) data;
  
b) ICAO should continue developing performance-based provisions for aircraft tracking, which provide industry with viable options, as a matter of urgency;
  
c) ICAO should lead a global aircraft tracking implementation initiative in a multinational context designed to integrate into guidance material best practices in use today;
  
d) ICAO should support regional SAR training exercises related to abnormal flight behaviour and share the outcomes with the international community;
  
e) ICAO should review the interaction between Annex 12 — Search and Rescue and Annex 13 — Aircraft Accident and Incident Investigation and clarify the relevant provisions when an aircraft remains missing at the end of the search and rescue phase and the search continues to locate the aircraft for investigation purposes;
  
f) 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;
WRC 15 Decision for GFT

Agreement has been reached at the World Radiocommunication Conference in Geneva on the allocation of radiofrequency spectrum for global flight tracking in civil aviation.

• The frequency band 1087.7-1092.3 MHz has been allocated to the aeronautical mobile-satellite service (Earth-to-space) for reception by space stations of Automatic Dependent Surveillance-Broadcast (ADS-B) emissions from aircraft transmitters.

• The frequency band 1087.7-1092.3 MHz is currently being utilized for the transmission of ADS-B signals from aircraft to terrestrial stations within line-of-sight. The World Radiocommunication Conference (WRC-15) has now allocated this frequency band in the Earth-to-space direction to enable transmissions from aircraft to satellites. This extends ADS-B signals beyond line-of-sight to facilitate reporting the position of aircraft equipped with ADS-B anywhere in the world, including oceanic, polar and other remote areas.

• WRC-15 recognized that as the standards and recommended practices (SARP) for systems enabling position determination and tracking of aircraft are developed by the International Civil Aviation Organization (ICAO), the performance criteria for satellite reception of ADS-B signals will also need to be addressed by ICAO.
Thank You !