International Civil Aviation Organization

Adhoc Working Group on Aircraft Tracking

REVISED REPORT

12 June 2015

The material in this report has not been considered by the International Civil Aviation Organization. The views expressed therein should be taken as advice of a group of experts to ICAO but not as representing the views of the Organization.

INTRODUCTION

1. In May 2014 ICAO convened a multi-disciplinary meeting with States, Industry, chairs and co-chairs of several ANC panels, and related specialists to reach a common agreement on the first key steps in making global aircraft tracking a priority, to agree that there is a need to track flights and to coordinate with Industry Initiatives.

2. The meeting recommended a draft concept of operations (ConOps) on aircraft tracking be developed that includes a clear definition of the objectives of aircraft tracking that ensures that information is provided in a timely fashion to the right people to support search and rescue, recovery and accident investigation activities, as well as, the roles and responsibilities of all stakeholders.

3. The recommendation that a final high level concept of operations should be delivered to the ICAO High Level Safety Conference (HLSC 2015, February, Montreal) was approved by the ICAO Council on the 16th June. (C-DEC 202/3)

4. ICAO tasked an ad-hoc working group (AHWG) to develop the draft concept of operations, which presented an initial version to the HLSC 2015 (working paper HLSC/15-WP/2.). The HLSC endorsed the GADSS concept of operations and requested it be further updated to reflect the outcomes of the conference. The AHWG was reconvened and has now completed the revision of the document to reflect the outcomes.

MEMBERSHIP

5. The following is a complete list of all participants in the development of the revised ConOps:

Mr Henk Hof, Chairperson, ATMRPP (AHWG Chair)
Mr Leifur Hakonarson, Chairperson, OPLINKP
Mr Philippe Plantin de Hugues, Chairperson, FLIRECP
Mr Scott Constable, RCC Chief, Australia
Mr Tai Feng, Air Navigation Commissioner
Mr Declan Fitzpatrick, Air Navigation Commissioner
Mr Einar Hedinsson, Air Navigation Commissioner
Mr Miquel Marin, ICAO Secretariat
Mr Jean-Francois Grout, IATA

DISCUSSION

6. The ConOps attached as appendix A represents the completion of the AHWG terms of reference, namely to develop a Concept of Operation on the sequence of events before and after the occurrence of an accident. It includes all identified phases of such a sequence including detection of an abnormal situation, alert phase, distress phase and search and rescue activities. The Concept of Operation builds on the general flow of information between various actors of an incident/accident event and has sought to gain maximum efficiency in such cases. It also considers the responsibilities of different actors and vulnerabilities to single-point failures.

Mr Henk Hof

AHWG Chair

Concept of Operations

Global Aeronautical Distress & Safety System (GADSS)

Produced by:

Ad-hoc Working Group on Aircraft Tracking

Version 5.0

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Executive Summary

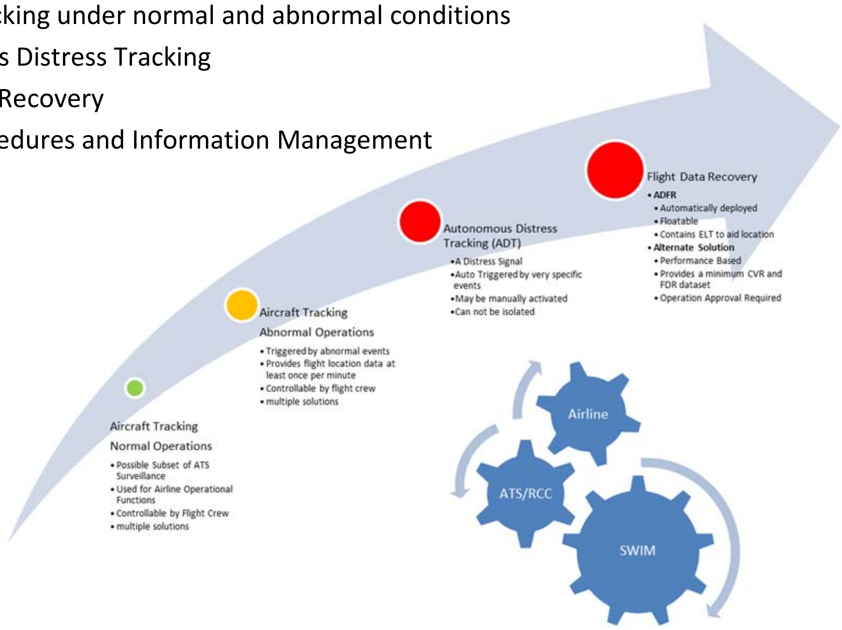
One of the many reasons why aviation maintains a high level of safety is the willingness to learn important lessons from rare events. The tragedies of Malaysia Airlines flight 370 and Air France flight 447 have highlighted vulnerabilities in the current air navigation system which have hampered timely identification and localisation of aircraft in distress. This has significantly hindered effective search and rescue efforts and recovery operations.

On the rare occasions when accidents occur, rescuing survivors has the highest priority, followed by the recovery of casualties, the wreckage and the flight recorders. Analysis of data from these recorders is very important in supporting accident investigation which may, through identification of the cause of the accident, contribute towards enhancing safety. An effective and globally consistent approach to improving the alerting of search and rescue services is essential.

The effectiveness of the current alerting of search and rescue services should be increased by addressing a number of key improvement areas and by developing and implementing a globally integrated system, the Global Aeronautical Distress and Safety System (GADSS), which addresses all phases of flight under all circumstances including distress. This system will maintain an up-to-date record of the aircraft progress and, in case of a forced landing or ditching, the location of survivors, the aircraft and recoverable flight data.

The figure below gives a high level overview of the GADSS and identifies the main components:

- Aircraft Tracking under normal and abnormal conditions
- Autonomous Distress Tracking
- Flight Data Recovery
- GADSS Procedures and Information Management



Following the ICAO multidisciplinary meeting in May 2014, IATA established the Aircraft Tracking Task Force addressing near term and voluntary aircraft tracking solutions. Concurrently, ICAO formed an Ad-hoc Working Group on Flight Tracking with the mandate to develop a Concept of Operation on the sequence of events before and after the occurrence of an accident which should include all identified phases of such a sequence including:

- detection of an abnormal situation,
- alert phase,
- distress phase, and
- search and rescue activities

Close collaboration between IATA and ICAO has ensured that the IATA solutions fit within the GADSS Concept of Operations (ConOps) developed by the ICAO Ad-hoc Working Group.

The effectiveness of the alerting and search and rescue services is only as good as the weakest link in the chain of people, procedures, systems and information. It is therefore of paramount importance that a global perspective be adopted in designing the GADSS. In addition to the technological components of the system this should include key areas of improvement such as evaluation of existing procedures, improved coordination and information sharing and enhanced training of personnel in reacting to rarely-encountered circumstances. Moreover, there is a need to improve communication infrastructure to reduce reliance on communications media that are particularly susceptible to atmospheric disturbances while ensuring global coverage.

The full GADSS concept can be realised in an evolutionary manner through the execution of actions in the short, medium and long term with each action resulting in benefits. The first steps in implementing the GADSS can be taken in the short term by implementing the voluntary Aircraft Tracking solutions proposed by the IATA Task Force for commercial air transport and by addressing the areas of improvement identified in this document.

Implementation of the GADSS will have an impact on the States and industry. For example, some aircraft will require modifications while some States may need to invest more in the implementation of its SAR responsibilities. However, any cost may be offset by the benefit of enhancing the effectiveness of the alerting, search, rescue and recovery services. Moreover, Aircraft Tracking will allow additional benefits in ATM and airline operations to be realized.

Contents

1.0 Introduction

1.0.1 In May 2014 ICAO convened a multi-disciplinary meeting with States, Industry, chairs and co-chairs of several ANC panels, and related specialists to reach a common agreement on the first key steps in making global aircraft tracking a priority, to agree that there is a need to track flights and to coordinate with Industry Initiatives.

1.0.2 The meeting recommended a draft concept of operations on aircraft tracking be developed that includes a clear definition of the objectives of aircraft tracking that ensures that information is provided in a timely fashion to the right people to support search and rescue, recovery and accident investigation activities, as well as, the roles and responsibilities of all stakeholders.

1.0.3 The recommendation that a final high level concept of operations should be delivered to the ICAO High Level Safety Conference (HLSC 2015, February, Montreal) was approved by the ICAO Council on the 16th June. (C-DEC 202/3)

1.0.4 ICAO tasked an ad-hoc working group (AHWG), consisting of ANC panel chairpersons, ANC Commissioners, Secretariat personnel and experts in the field of Search and Rescue, to develop the draft concept of operations. Coordination with IATA ATTF group was ensured through IATA participation in the AHWG.

1.0.5 The AHWG commenced its task on the 03 June 2014 utilising online conferencing facilities. The first version of the ConOps document was produced within 7 days to assist the IATA Task Force on aircraft tracking. The second draft version was released on the 31 July 2014 after the group's first face-to-face meeting held in Montreal, expanding on the original version and elaborating further on the concept. Feedback was sought from various technical experts and over 160 comments on various aspects of the document were received.

1.0.6 The AHWG reviewed these comments utilising online conferencing facilities and met for a second face-to-face meeting, held in Dublin 10-12th September 2014, to complete the elaboration of the target concept and concept steps and to finalise the draft ConOps document.

1.0.7 The GADSS was reviewed and endorsed by States at the High Level Safety Conference in February 2015 This version of the ConOps is an update including outcomes from the 2015 High Level Safety Conference and other minor amendments.

1.0.8 This version contains an introduction, a review of current areas where improvements may be achieved; it specifies the high level requirements, provides a detailed explanation of the GADSS (target concept) and provides a roadmap on how to achieve its implementation (implementation plan).

1.1 Background

1.1.1 The Air France Flight 447 (01 June 2009 - Rio de Janeiro to Paris - Airbus 330-203 - F-GZCP) accident highlighted vulnerabilities in the existing air navigation systems that have hindered the timely identification of an aircraft experiencing a 'distress' event and the subsequent search and rescue efforts. In the investigation reports the BEA recommended that ICAO study the possibility of making it mandatory for aeroplanes performing public transport flights to regularly transmit basic flight parameters (for example position, altitude, speed, heading). It also recommended, for aeroplanes making public transport flights with passengers over maritime or remote areas, as soon as an emergency situation is detected on board that ICAO:

a) make mandatory the triggering of data transmission to facilitate localisation;
b) study the possibility of making mandatory, the activation of the emergency locator transmitter (ELT); and
c) ensure ATSU acceptance of datalink logons independently of the availability of flight plan information.

1.1.2 In response to these and other recommendations, ICAO has recently established new requirements for underwater locator beacons (ULBs) which will come into force in 2018. An expert group of ICAO is continuing to review new means of expediting the location of accident sites, including deployable flight recorders and the triggered transmission of flight data and this ConOps takes account of this on-going work. Responding to engineering requirements, ATSUs were rejecting logons when a positive correlation with a flight plan could not be made automatically. ICAO has since developed provisions which instruct ATSUs to resolve such situations to allow logons to be accepted. These provisions have been developed and will be fully incorporated by 2016.

1.1.3 The unprecedented circumstances of flight MH 370 have been particularly difficult for civil aviation to resolve to this point, and the lack of data from the aircraft has made the task of the accident investigators practically impossible.

1.1.4 The preliminary report from the Malaysian MOT recommended that ICAO examine the safety benefits of introducing a standard for real time tracking of commercial air transport aircraft. There is a growing consensus in the aviation community that more needs to be done to ensure the location of an aircraft and its flight recorders will always be known.

1.2 Scope of the Concept of Operations

1.2.1 This Concept of Operations document specifies the high level requirements and objectives for a Global Aeronautical Distress and Safety System (GADSS). It is intended to apply to commercial air transport operations (Annex 6 Part 1 applicability) initially, however, the ConOps takes an overall system approach and consequently is not restrictive to a particular type of operation. The implementation of this target concept will have implications for the provision of services such as air traffic control, search and rescue and accident investigation.

1.2.2 Responding to the requirements and objectives, the ConOps specifies a high level system with a description of users and usages of flight track information during all phases of flight, both normal and abnormal flight conditions including timely and accurate positioning of an aircraft in distress. The ConOps does not prescribe specific technical solutions for Aircraft tracking but provides a framework of scenarios that can be used to verify whether a specific solution complies with the Concept. The ConOps includes a roadmap outlining the steps necessary to move from today's system to the target concept.

1.3 Definitions

1.3.1 The following definitions apply in the context of this document.

- ***Abnormal event.*** An event during flight which may trigger an emergency phase.
- **Aircraft Tracking**. A ground based process that maintains and updates, at standardised intervals, a record of the four dimensional position of individual aircraft in flight.
- ***Air navigation system.*** A generic term for all systems as detailed in the ICAO Annexes and any related systems required to interface with these aviation systems.
- ***Air traffic service (ATS).*** A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service). (Annex 11)
- ***ATS surveillance system.*** A generic term meaning variously, ADS-B, PSR, SSR or any comparable ground-based system that enables the identification of aircraft.

  Note.— A comparable ground-based system is one that has been demonstrated, by comparative assessment or other methodology, to have a level of safety and performance equal to or better than monopulse SSR. (PANS-ATM)
- ***Alerting service.*** A service provided to notify appropriate organizations regarding aircraft in need of search and rescue aid, and assist such organizations as required. (Annex 11)
- **Alerting post.** Any facility intended to serve as an intermediary between a person reporting an emergency and a rescue coordination centre or rescue sub centre. (Annex 12)
- **Autonomous Distress Tracking (ADT).** The aircraft capability to broadcast for distress situations, independent of aircraft power or systems, aircraft tracking information.
- **Commercial Air Transport Operation (CATO).** An aircraft operation involving the transport of passengers, cargo or mail for remuneration or hire. (Annex 6 Part 1)
- **Cospas-Sarsat System.** A satellite system designed to detect and locate activated distress beacons transmitting in the frequency band of 406.0-406.1 MHz. (ICAO/IMO IAMSAR Manual)

- **Emergency locator transmitter (ELT).** A generic term describing equipment which broadcast distinctive signals on designated frequencies and, depending on application, may be automatically activated by impact or be manually activated. (Annex 6)
- **Emergency phase.** A generic term meaning, as the case may be, uncertainty phase, alert phase or distress phase. (Annex 11)
  - ***Uncertainty phase***. A situation wherein uncertainty exists as to the safety of an aircraft and its occupants.
  - ***Alert phase.*** A situation wherein apprehension exists as to the safety of an aircraft and its occupants.
  - ***Distress phase***. A situation wherein there is reasonable certainty that an aircraft and its occupants are threatened by grave and imminent danger or require immediate assistance.
- **False alert.** an alert received from any source, including communications equipment intended for alerting, when no abnormal situation actually exists, and a notification of the alert should not have resulted.
- **Rescue Coordination Centre (RCC).** A unit responsible for promoting efficient organization of search and rescue services and for coordinating the conduct of search and rescue operations within a search and rescue region. (Annex 11) *NOTE – The term RCC is used in this document to apply generically to an aeronautical, maritime or joint (aeronautical and maritime) rescue coordination centre (ARCC, MRCC, JRCC respectively).*
- **Search and Rescue Region (SRR).** An area of defined dimensions, associated with a rescue coordination centre, within which search and rescue services are provided. (Annex 12)
- **Survival ELT (ELT(S)).** An ELT which is removable from an aircraft, stowed so as to facilitate its ready use in an emergency and manually activated by survivors.(Annex 6)

1.4 Annex References

1.4.1 This section briefly outlines which Annexes to the Chicago Convention have provisions related to this ConOps. Appendix A includes the detailed text of the most pertinent Annex provisions for convenience. All ICAO Annex and PANS can be accessed through the ICAONET.

Annex 2 provides provisions for flight plans, distress and urgency signals.

Annex 6 Part I provides provisions for aircraft operators. Some specific examples include requirements for ELTs and flight recorders, in-flight fuel management, and communication and navigation equipment.

Annex 8 provides provision for the design, production and maintenance of aircraft including the requirement for safety and survival equipment.

Annex 11 Chapter 5 details the provisions for an Alerting Service.

Annex 12 details the operating procedures for Search and Rescue

Annex 13 provides the provisions for accident investigation, including the availability and protection of information related to an incident or accident.

PANS-ATM details procedures including those for the filing of flight plans, position reporting, ATS surveillance service and specific procedures related to emergencies, communication failure and contingencies as well as alerting services.

PANS-OPS details procedures including the use of secondary surveillance radar transponder operation, phraseology, voice communication procedures and controller pilot data link communications operation.

1.5 Sequence of Events

1.5.1 The current system, that allows identification of an aircraft experiencing an abnormal event or distress, relies predominantly on the aircraft communicating a distress signal through either voice or data communications. A number of aircraft systems may be available to communicate to ground, prior to an accident, including VHF, HF and SATCOM voice communication or data communication through VHF, HF or satellite link. Some data communication may be automated and not require input from the flight crew. This includes ADS-C, ATS surveillance systems and systems which may automatically transmit maintenance messages to the operator. The protocols for the aircraft system to send data may be predefined by the aircraft operator.

1.5.2 Aircraft are equipped with an automated system to activate a distress signal in the event of an accident, namely, an emergency locator transmitter (ELT). An ELT may be manually activated before or after an accident. The requirements for the carriage of ELTs are contained in Annex 6. In the event the aircraft becomes submerged the flight recorder is fitted with an underwater locator beacon (ULB). ICAO has recently introduced new provisions for the installation of an additional ULB on the airframe as distinct from the flight recorder.

1.5.3 The existing capability of ground-based systems to identify an aircraft experiencing an abnormal or distress event has limitations. Air traffic control services may identify an aircraft experiencing an abnormal event when it deviates from its assigned flight path, when continuous surveillance is lost, when normal voice and data communication is lost, when the aircraft fails to report at a specific waypoint or fails to arrive as planned into a region where ATS surveillance services are provided.

1.5.4 When an air traffic service unit identifies an aircraft experiencing an abnormal event it will follow standards as contained in Annex 11 and procedures for air navigation services contained in PANS-OPS and PANS-ATM.

1.5.5 The commencement of the 'uncertainty phase', the 'alert phase' and the 'distress phase', after the aircraft experiences an abnormal event, depends on a number of criteria including, but not limited to, the ability to directly communicate with the flight crew. For example, lack of communication will first initiate the 'uncertainty phase' while direct communication can lead immediately to a 'distress phase'. In some regions the activation of an ELT will lead to the 'alert phase' and will progress to the 'distress phase' once confirmed by corroborating data while in other regions it leads directly to a 'distress phase'.

1.5.6 Figure 1a below illustrates a simplified scenario for an aircraft which experiences a loss of control event outside surveillance range and considers the timeline for alerting where communications is available and one where communication is not available. Communication with the aircraft allows for a much earlier identification of the distress phase, allowing quicker initiation of search and rescue.

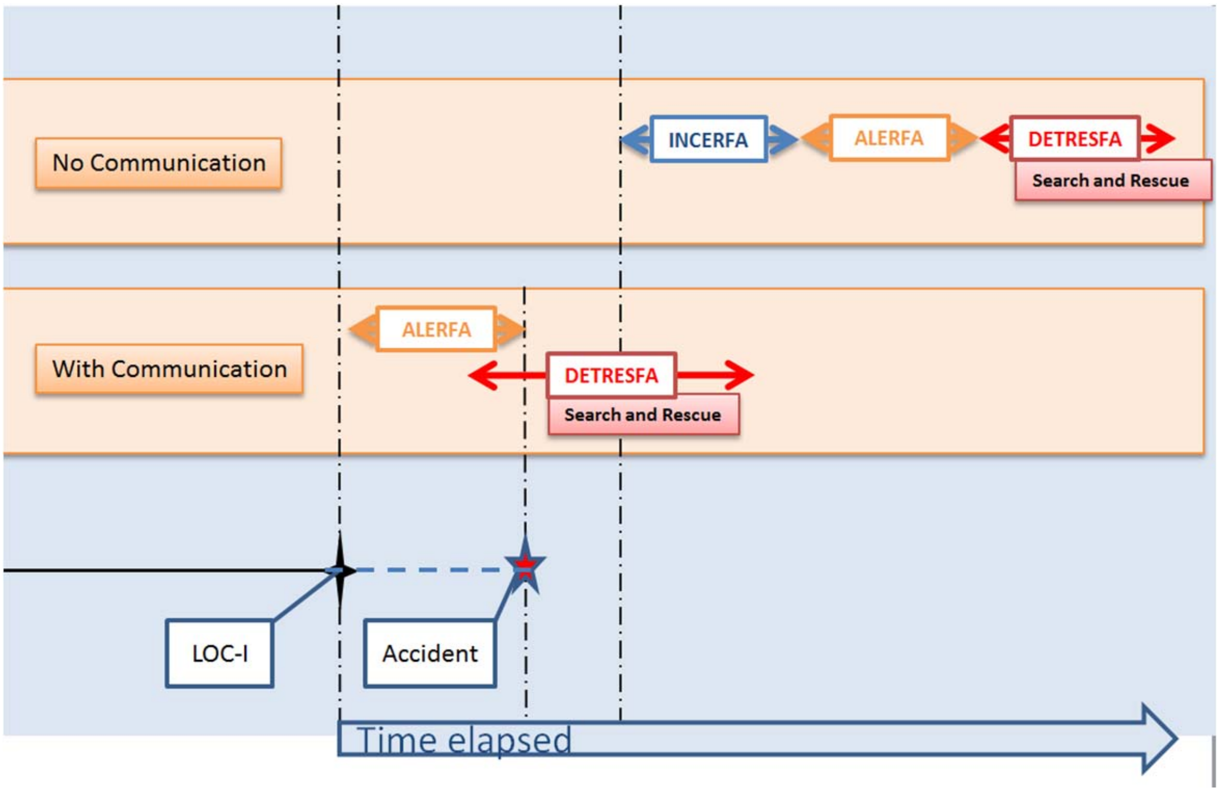


Figure 1a: timeline for alerting SAR with or without aircraft communication from a Ground perspective

1.5.7 In controlled airspace with surveillance, the position of the aircraft should be continuously known to the ATS unit at all times, however, delays may occur in commencing search and rescue due to complexities in coordination. Figure 1b provides an example scenario where the aircraft experiences a loss of control in flight at the boundary of one ATS unit (ATSU), deviates into ATSU 2 before leaving into ATSU3.

1.5.8 With communication from the aircraft the ATSU1 is made aware of the situation and may raise an ALERFA and monitor the aircraft on surveillance radar. Without communication the ATSU1 may recognise the abnormal event due to deviation from flight path and loss in altitude. It may raise an INCERFA pending confirmation of why the aircraft has deviated from its flight plan.

1.5.9 When the aircraft departs the FIR it is handed over to ATSU2. This requires direct coordination between ATSUs. Likewise, when the aircraft departs into ATSU3 further coordination is required.

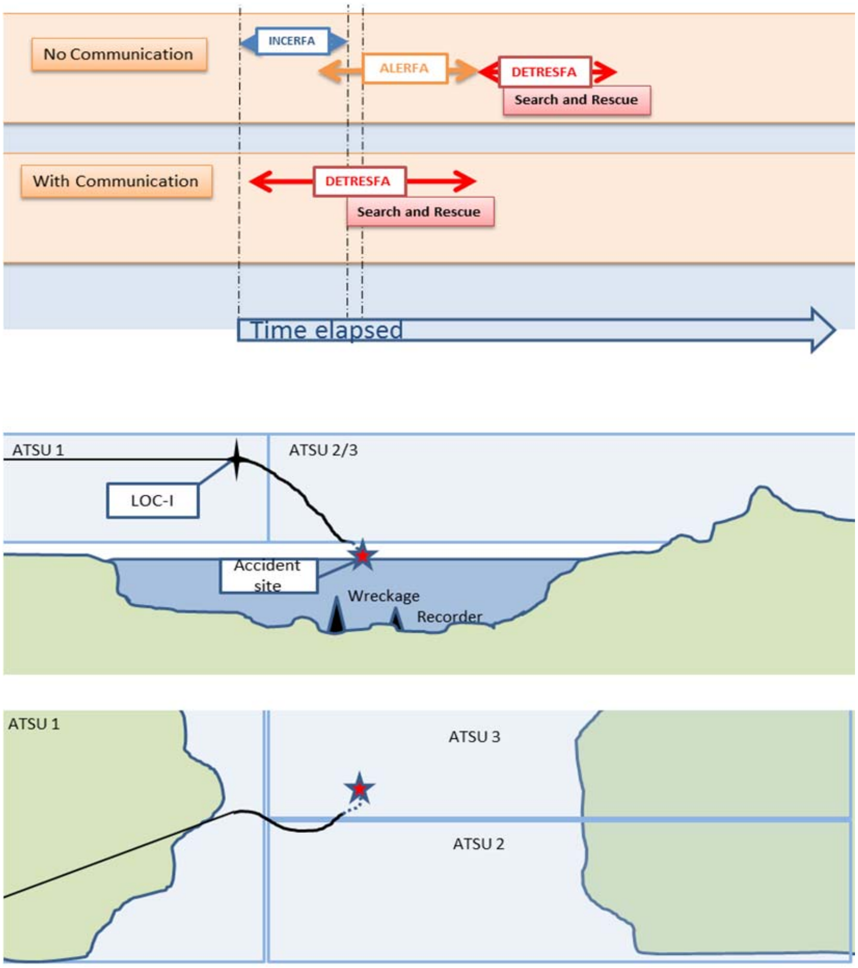


Figure 1b: timeline for alerting SAR with full surveillance & multiple ATS units involved

2.0 Improvement Areas in Current Operating Environment

2.0.1 The objective of this chapter is to provide an overview of the current operational environment and to identify and analyse any areas for potential improvement in the systems and processes. The chapter groups the identified issues under four headings: Aircraft Systems, Air Traffic Services, the Search and Rescue system and Information Management.

2.0.2 It is recognised that other areas for improvement may exist, particularly in the area of equipment usage.

2.0.3 Most of the current operational environment is dependent on the correct operation of the related system on the aircraft while others, such as flight planning and primary radar operate independently of aircraft systems. Much of the current ANS relies upon ground-based infrastructure, although increasing use is being made of GNSS, SATCOM data link and SATVOICE capabilities for navigation and communications. In the same manner that long range communications and navigation have benefitted from Satellite constellations, surveillance over oceanic and remote areas can be enhanced using that framework. ATS surveillance could be enabled through satellite reception of ADS-B signals.

2.1 Aircraft Systems

2.1.1 The main areas for potential improvement identified are:

	Improvement Areas	**Analysis**
2.1a	Reduction in the reliance on Emergency Locator Transmitters (ELT) (lack of system redundancy) to identify accident site	In regions where no surveillance is available and the aircraft is not using an aircraft tracking system the only source of accident location will be the ELT when it activates correctly. ELTs were not designed to operate in non-survivable accidents.
2.1b	Improvement in the (timely) activation of ELTs	From analysis of large transport aircraft accidents, there is a low activation rate of ELTs. Typically, they are damaged in the crash and/or are not activated either automatically or manually prior to or post an impact.
2.1c	Ensure operators are meeting the 406MHz ELT equipage requirement.	Aircraft may still be using just 121.5MHz ELTs. These are no longer detected by COSPAS-SARSAT and will only be detected by VHF radios tuned to the frequency and within range.
2.1d	Improvement in the robustness and range of location devices	Wreckage and flight recorders can be difficult to locate and retrieve, particularly in remote and oceanic regions.

	Improvement Areas	Analysis
2.1e	Improvement in the existing systems to ensure the accident investigation authority can always retrieve adequate data to allow determination of probable causes.	Current technology limited in ability to trigger and download FDR data. Civilian applications of deployable flight recorders not currently available.
2.1f	Ensure existing Emergency and Abnormal operating procedures maximise the potential of the ELT to perform effectively and provide a distress signal.	Some SOPs only call for activation of ELTs after the accident e.g. ditching procedure.
2.1g	Improvement in the overall registration of 406MHz ELTs	Distress beacon registration allows RCCs to determine beacon identification details including emergency contacts. This allows RCCs to contact beacon owners or their emergency contacts when a beacon is activated to obtain further details. The distress beacon registration emergency contact information for the owner/operator of an aircraft subject to an ELT alert may be different to the actual operator for that flight. To avoid delays in RCC response, it is essential to enable RCCs to readily identify the operator of the aircraft at the time of the distress alert.
2.1h	Improvement in the level of carriage of 406MHz survival ELTs (ELT(S)) for overwater operations	Although not mandated by ICAO SARPs many aircraft may still carry legacy 121.5/243 MHz ELT(S) beacons as part of their emergency equipment, such as slide rafts, which are no longer detected by the COSPAS-SARSAT system.
2.1i	Increase aircraft equipage for transmitting their 4D position and identity.	Not all aircraft overflying remote or oceanic airspace are equipped with long range communication systems for regular transmission of 4D position. However, most transport category aircraft are equipped with Mode S transponders which are, in accordance with Annex 10, ADS-B out capable. If that ADS-B out signal can be received and processed via Satellite, no additional equipage would be required.
2.1j	Increase the use of current aircraft capability to transmit their 4D position and identity for aircraft tracking purposes.	Aircraft operators are not using ADS-C capability to the degree possible.

	Improvement Areas	Analysis
2.1k	Expansion of space- and ground-based infrastructure to achieve global coverage during all phases of flight.	The ADS-B ground infrastructure could be supplemented with space-based ADS-B to provide global tracking capability. Spaced based ADS-B is scheduled to be available in 2017. Non-Geostationary satellite systems have complete coverage of the Globe, a particular benefit for polar route operations.
2.1l	Reduce reliance on HF as sole means of communications over remote and oceanic areas.	The unreliable nature of HF communications leads to relatively frequent occurrences of situations warranting the declaration of the uncertainty phase. The frequency of such occurrences may lead to complacency which can result in a delayed SAR response to a genuine emergency (e.g. AF447). Carriage of satellite communications equipment as a secondary means to HF will assist to confirm the safety of an aircraft, or otherwise. CPDLC and SATVOICE are potential options.

2.1.2 The ability to identify the location of an accident site in a timely manner, for the most part, relies on communication with the aircraft, whether it is direct voice or data communication, the availability of surveillance data and/or the COSPAS-SARSAT MCC providing location information determined from an ELT activated on the aircraft.

2.1.3 The potential for a failure of all aircraft communication systems is remote. Larger commercial aircraft are typically equipped with 2 or 3 independent VHF systems, one or more HF system over oceanic regions, and some satellite based communication capabilities. Likewise the aircraft will be typically equipped with two or more independent Mode S transponders (which also provide an ADS-B OUT function) to provide adequate levels of redundancy. It should be noted that in remote airspace where HF is the sole source of communications propagation issues may prevent communications for extended periods.

2.1.4 In today’s global operations, ATS surveillance does, in fact, provide a large number of commercial operators with the capability to track their aircraft during operations, particularly in high density airspace. In addition, the majority of long haul aircraft are fitted with systems that allow them to transmit their position to the ground. Many airlines currently track their fleet through their FOC. But there are still cases where, although fitted, the equipment is not used either by the airline or the ATS unit. Finally, over remote or oceanic airspaces the communication link is satellite based and the majority of the communications rely on geostationary satellites that do not provide coverage for the polar routes.

2.1.5 Figure 3 is included for illustrative purposes only and provides a simplistic fault tree for an ‘accident location unknown’ scenario, highlighting what would need to fail to result in a situation where knowledge of the flight location is unknown.

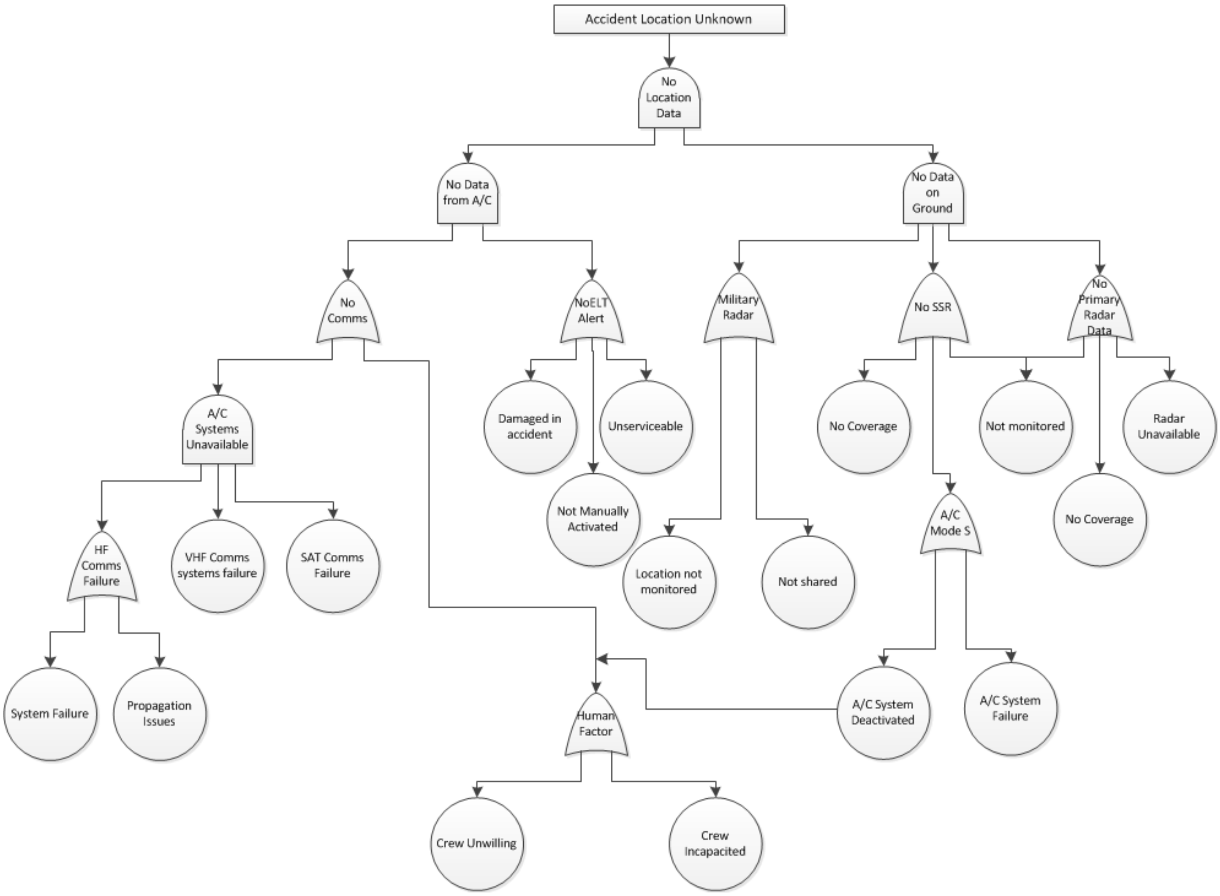


Figure 3: Simplistic Fault Tree for 'Accident Location Unknown'

Emergency Locator Transmitters (ELTs)

2.1.6 It must be highlighted that, in regions where surveillance coverage is not available, the timely identification of the accident site location may be completely dependent on the activation of an ELT.

2.1.7 ELTs are transmitters that can be tracked in order to aid in the detection and localization of aircraft in distress. They are Aeronautical radio beacons that interface worldwide with the international COSPAS-SARSAT satellite system for Search and Rescue (SAR). When activated and under satellite coverage, such beacons send out a distress signal, which, if detected by satellites, can be located by trilateration in combination with triangulation or a more accurate and timely location if the ELT can provide a GNSS derived position.

2.1.8 In the case of 406 MHz ELT, which transmit a digital signal, the beacon can be uniquely identified almost instantly (if registered). Frequently, by using the initial position provided via the satellite system, SAR aircraft and ground search units can 'home-in' on the distress signals from the beacon and locate the concerned aircraft or people.

2.1.9 ICAO mandated that ELTs will operate on 406 MHz, and 121.5 MHz for the homing, from 1 January 2005. This applies to all aeroplanes and helicopters required to be fitted with ELTs according to the provisions in Parts I, II and III of Annex 6. Since 2009, the 121.5 signal is no longer received by COSPAS-SARSAT.

2.1.10 The COSPAS-SARSAT System has been helpful for search and rescue teams in numerous aircraft accidents on a worldwide basis. Despite these successes, the detection of ELT signals after an aircraft crash remains problematic. Several reports have identified malfunctions of the beacon triggering system, disconnection of the beacon from its antenna or destruction of the beacon as a result of accidents where aircraft were destroyed or substantially damaged. Even when the beacon and its antenna are functioning properly, signals may not be adequately transmitted to the COSPAS-SARSAT satellites because of physical blockage from aircraft debris obstructing the beacon antenna, or when the antenna is under water.

2.1.11 ELTs can be activated manually or automatically by the shock typically encountered during aircraft crashes. It is possible for Flight crew to manually activate the ELT, however, existing flight operating procedures do not call for activation of the ELTs until after the incident has occurred. Activation by pilots prior to a forced landing or ditching may mitigate the risk of no location information from an ELT being available after the forced landing or ditching.

2.1.12 Possible improvements to the performance of 406 MHz ELTs during aircraft accidents have been impaired by some of the limitations of the current COSPAS-SARSAT LEOSAR and GEOSAR systems. These combined systems do not provide a complete coverage of the Earth at all times. As a consequence, beacons located outside the areas covered by the LEOSAR and GEOSAR satellites at a given moment cannot be immediately detected, and must continue to transmit until a LEOSAR satellite passes overhead.

Carriage of legacy analogue ELTs and distress beacons

2.1.13 A recent incident involving a wide-body airliner revealed, although it was fitted with a fixed 406MHz digital ELT which was not detected, it was also carrying legacy analogue (non-406MHz) portable distress beacons in its slide rafts.

2.1.14 As briefly mentioned earlier, the global distress beacon detection system, COSPAS-SARSAT no longer detects 121.5MHz distress beacon signals. Only 406MHz digital distress beacons (ELTs, EPIRBs and PLBs) are now capable of detection by satellite. Analogue beacon signals may be received by other aircraft within VHF range but there may not be such aircraft a) within range at the time of beacon transmission and b) monitoring 121.5MHz.

2.1.15 It is difficult to determine whether there is widespread carriage of legacy analogue, non-406MHz distress beacons in the current worldwide aircraft fleet and it is a possible issue which may contribute to effective SAR response.

Flight Recorders

2.1.16 Besides the wreckage itself, a major tool in the investigation of any accident is the availability of flight recorder information, namely the cockpit voice recorder and the flight data recorder. The recorders provide the accident investigators with knowledge of the flight conditions and cockpit environment and are often essential to determining the probable cause of an accident.

2.1.17 When accidents occur in oceanic regions it can be difficult, lengthy and costly to recover the current mandated flight recorders, particularly where they have sunk in deep waters. To assist the recovery of the recorders in water they are fitted with underwater locator beacons, however, they may not survive the impact (certified up to 1000G) and are limited in their underwater range and duration.

2.1.18 ICAO annex 6 was amended in 2012 to increase the duration of ULB transmission from 30 days to 90 days and to mandate the installation of a low frequency ULB attached to the airframe.

2.2 Air Traffic Services (ATS)

2.2.1 The main areas of potential improvement identified are:

	Improvement Areas	Analysis
2.2a	Improvement in existing ATS capabilities where voice is the only means to ensure the timely identification of abnormal events experienced by aircraft, where voice is the only means of position reporting.	Outside ATS surveillance airspace the absence of position reports for a set period is the only indication of an abnormal event. Regular communication problems and related complacency may even extend this period in practice. Other than using ADS-C, there is no airborne and/or ground ATS capability to detect an abnormal event based on defined and measurable triggers.
2.2b	Improvement in existing ATS procedures to ensure, on a worldwide basis, that the location of an accident site will be identified to a degree of accuracy, in a timeframe and to a level of confidence acceptable to the stakeholders	The current provisions for position reporting (frequency and information contents) in remote and oceanic areas are not based on the accuracy requirements for accident site location.
2.2c	Improvements in Airspace coordination to prevent any compromise in the mechanism for ensuring receipt of overdue position reports	Lack of clarity on the responsibility to ensure all position reports including those from an aircraft that has exited the airspace or area of jurisdiction.

	Improvement Areas	Analysis
2.2d	Improvements by ANSPs in consistently sharing data with other ANSPs and operators	There is currently no international requirement for sharing position data. Some ANSPs share this data with operators while others do not.
2.2e	Increased experience in using emergency procedures preventing decreased proficiency when required	The extremely low frequency of emergency situations with an accident risk necessitates regular drills and exercises to be held to ensure that proficiency with applicable procedures, cooperation between all actors and use of systems is maintained.
2.2f	Reduction in complacency due to 'normalised' lack of HF communications	Aircraft routinely unable to report their position (and be unreachable by the ATS unit) can lead to complacency and subsequent failure to follow the prescribed procedures
2.2g	Improved civil / military coordination and information sharing in support of emergency situations	There is no consistent sharing of relevant information between civil /military.
2.2h	Improved ICAO SARPs for raising of an INCERFA	ICAO SARPs which use a time based (waiting 30 minutes after scheduled reporting time before raising an INCERFA) gate mechanism to avoid spurious or unnecessary reports compromises the need for quick identification of an event. The period of 30 minutes has been set in 1960 and may no longer be adequate. Some States have reduced the 30 minutes period to 15 minutes.

2.2.2 In general the current operational ATS environment has the means to adequately react in emergency situations, in accordance with the provisions in Annex 11 and Annex 12. The extremely low frequency of emergency situations with an accident risk necessitates regular drills and exercises to be held to ensure that proficiency with applicable procedures, cooperation between all actors and use of systems is maintained.

2.2.3 Globally, differences exist in terms of quality and reliability of surveillance and communication systems and effectiveness in timely sharing of critical information for the execution of relevant procedures. These differences have an impact on the performance of ATS unit Alerting and SAR.

ATS in Oceanic and Remote Airspace

2.2.4 Where surveillance tools such as radar and ADS-B are not available (such as oceanic and remote airspace), *procedural* methods are used to ensure separation in controlled airspace, or flight information services outside controlled airspace. Procedural methods are based on aircraft position reports and, depending on airspace, these may be provided solely by voice or by a mixture of voice and datalink.

2.2.5 Voice communications are primarily effected via high frequency (HF). While HF provides an acceptable means of communications under most conditions, there are times when atmospheric conditions make it very unreliable. The extent of such disruptions varies from region to region, and can be affected by the time of day, solar flare and thunderstorm activity. There is also considerable seasonal and diurnal variation. There are occasions where *lack* of HF communications, sometimes for extended periods, becomes the norm rather than the exception.

2.2.6 Another means of voice communications which has become increasingly available is satellite telephony, commonly referred to as "SATvoice". All aircraft equipped with FANS-1/A data link (see below) possess this capability, as do many business aircraft that do not have data link. There are however certain restrictions, firstly not all satellites offer global coverage (the area near the poles being outside the service area of geostationary satellites) and not all aircraft operators have enabled the use of the equipment for ATS purposes.

2.2.7 With air/ground voice communications, under these circumstances, being fairly complicated they are sometimes operated separately from air traffic management, either by a different department or even by a different agency. There are even cases where ATM and air/ground voice communications within the same airspace are provided by different States. This arrangement has been referred to by many names, the term "third-party communications" being one. It is worth noting that many of the "aeradio stations" operated for this purpose have in place agreements with aircraft operators whereby all position reports are relayed to the operator for flight-following purposes.

2.2.8 As an alternative to voice, data link is attractive for a number of reasons, one being its lack of sensitivity to the propagation issues with which HF voice communication has to contend. The percentage of datalink-equipped aircraft undoubtedly varies from region to region but is steadily increasing, among long-haul airliners it is estimated above 75%. This does not, however, tell the whole story. The ATS unit has to provide the appropriate datalink service and not all ATS units have yet completed implementation of systems with that capability. There are also strict requirements for correlation of the information presented by the aircraft upon initiation of a data link connections with a flight plan held by the ATS unit and lapses in the FPL dissemination process may therefore prevent data link communications. This issue is being addressed by ICAO.

2.2.9 Where voice position reports are relayed to ATS unit's by radio operators they will normally also be sent to the aircraft operator. When datalink replaces voices reporting such forwarding typically ceases though in theory the service would remain feasible, albeit at the cost of some system development.

2.2.10 The responsibility for monitoring the safety of aircraft under their jurisdiction rests with ATS Units . The stepwise elevation of the state of urgency when doubt exists as to the safety of a flight is detailed in Annex 11 Chapter 5. This covers both situations where information as to the safety of aircraft is missing and when positive information is received indicating the possible impairment of an aircraft's safety. This process has shown its worth on numerous occasions where aircraft have been lost in accidents and alerting has resulted in a timely and efficient search and rescue effort. However, there are conditions where the process is impaired, especially where it is the lack of information, rather than the receipt thereof, which is concerned. Some of the challenges are described below.

2.2.11 When it becomes a routine occurrence for aircraft to be unable to report their position (and be unreachable by the ATS unit) there is a danger of complacency setting in and the prescribed procedures not to be followed. Aircraft emerge safely from the area of impaired communications and repeated elevation of the state of alert is seen as counter-productive and labour-intensive and may therefore not be done.

2.2.12 Another factor which further compounds the problems associated with frequent lack of position updates is the frequent transition between the areas of responsibility of ATS units. Should a position report be found missing, the incentive to obtain it is reduced once the responsibility for the aircraft has passed to a different unit. This is not so much a weakness of the system (the ATS unit is responsible for ensuring that the alert is raised at the appropriate time even when the aircraft has passed to another unit) as it is another opportunity for human error to occur.

2.3 The Search and Rescue (SAR) System

2.3.1 The main areas of potential improvement identified are:

	Improvement Areas	Analysis
2.3a	Improvement by States to ensure Aeronautical Search and Rescue regions are always aligned with the FIRs.	Differences in boundaries increases coordination complexity and response time
2.3b	Improvement by States to ensure Aeronautical Search and Rescue regions are always aligned with maritime SRRs.	Differences in boundaries increases coordination complexity and response time

	Improvement Areas	Analysis
2.3c	Improved Compliance by States with ICAO Annex 12 obligations in relation to SAR.	Many States do not meet the requirements of Annex 12 to provide SAR capabilities in their State, and/or between States, often where there is high density overflight traffic. Existing deficiencies may result in: • Delayed and/or inadequate SAR response • Higher risk of loss of life Lack of coordination, cooperation and communication between RCCs, between ATS units and RCC, and between civil and military authorities and other stakeholders
2.3d	Improved ability for RCCs to quickly determine the actual geographic air traffic picture within its area of responsibility.	RCCs with this facility would benefit from an enhanced situational awareness, not only for aircraft subject to an emergency, but also other aircraft in the area that may be able to assist (diversion, communications relay, etc). Integration of GIS information such as airspace, terrain, etc would enhance this.
2.3e	Improved understanding of responsibilities and coordination for the transition of Annex 12 to Annex 13	In the existing SARPS of Annex 12 and Annex 13 transition from rescue to recovery responsibilities is not clearly defined. (i.e.: who is responsible for a rescue operation and when that phase ends, so it became primarily a recovery/investigation operation under Annex 13).
2.3f	Increased experience in using SAR procedures preventing decreased proficiency when required.	The extremely low frequency of SAR situations in some SRRs necessitates regular drills and exercises to be held to ensure that proficiency with applicable procedures, cooperation between all actors and use of systems is maintained.
2.3g	Improvement and definition of the co-ordination of In-Flight Emergency Response (IFER)	It is not clear in this situation whether an ATS unit or RCC has coordination responsibility of an emergency for an aircraft whilst it is still in flight, or where the coordination responsibility begins/ends. Management of In-Flight Emergency Response (IFER) and the interface between ATS and RCCs is an issue that will be affected by global tracking.

2.3.2 The Standards and Recommended Practices (SARPs) for the SAR service are specified within Annex 12 to the Chicago Convention. Annex 12 is applicable to the establishment, maintenance and operation of SAR services in the territories of Contracting States and over the high seas, and to the coordination of such services between States. Contracting States are required to provide SAR services on a 24-hour basis.

2.3.3 Annex 12 is supplemented by the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual, a joint ICAO/IMO (International Maritime Organization) publication. States are encouraged to use this manual to develop and improve their SAR services.

2.3.4 Annex 11 to the Convention on International Civil Aviation specifies the SARPs applicable to the provision of the ATS. The Air Traffic Service (ATS) is comprised of three services: air traffic control (ATC) service, flight information service (FIS) and alerting service.

2.3.5 The ATS and SAR services are to act in support of each other and operate closely together during aircraft emergency situations. RCCs rely on ATS units (ATS units) alerting them to aircraft emergencies, although this is not the only method for RCCs to be alerted.

2.3.6 In a similar manner to ICAO, the International Maritime Organization (IMO) oversees the global maritime SAR service for vessels at sea. ICAO and IMO work together to harmonise global aeronautical and maritime SAR services.

Search and Rescue Regions (SRRs)

2.3.7 The purpose of having SRRs is to clearly define who has primary responsibility for coordinating SAR responses in every area of the world. The delineation of aeronautical SRRs is contained with ICAO Regional Air Navigation Plans (RANPs). Maritime SRRs are published in the IMO SAR Plan, and are similar, but not necessarily identical, to aeronautical SRRs.

2.3.8 Annex 12 recommends that SRRs should, in so far as practicable, be coincident with corresponding Flight Information Regions (FIRs) and, with respect to those areas over the high seas, maritime SRRs. In reality, many areas of the world have non-coincident aeronautical and maritime SRRs. There are oceanic areas of the world today where aircraft routinely fly through the aeronautical SRR of one State but over the maritime SRR of a different State.

2.3.9 SRRs are established to ensure the provision of adequate communication infrastructure, efficient distress alert routing and proper operational coordination to effectively support SAR services. Neighbouring States may cooperate to establish SAR services within a single SAR region.

Rescue Coordination Centres (RCCs)

2.3.10 RCCs are operational facilities responsible for promoting efficient organization of SAR services and for coordinating the conduct of SAR operations within an SRR. An RCC coordinates, but does not necessarily provide, SAR facilities throughout its designated SRR.

2.3.11 Aeronautical SAR responsibility may be met through an aeronautical RCC (ARCC). Coastal States with the added responsibility for maritime SAR incidents may meet this with a maritime RCC (MRCC).

Therefore it is common for States to have both ARCCs and MRCCs in different locations, in separate facilities and administered by different agencies.

2.3.12 Some States combine their SAR resources into a joint RCC (JRCC) with responsibility for both aeronautical and maritime SAR incidents, or may collocate their ARCCs and MRCCs. ICAO and IMO encourage States, where practicable, to establish JRCCs for several reasons.

2.3.13 Rescue sub-centres (RSCs) may also be established by States to provide a more effective service. RSCs normally operate under delegation to a parent RCC. Use of the generic term RCC may apply to an ARCC, MRCC, JRCC and RSCs. ARCCs are often co-located with an ATS facility (such as an ATC centre/unit, or a Flight Information Centre) and may not necessarily always be staffed on a 24-hour basis, but are activated only if required. However there must always be a reliable 24-hour point of contact available to immediately activate the ARCC if required, such as an ATS facility.

2.3.14 In distress scenarios involving aircraft over oceanic areas, it is imperative that ARCCs and MRCCs work closely together to enable the most efficient response. JRCCs address this issue.

Role of Air Traffic Services (ATS) Units

2.3.15 The ATS alerting service is provided to notify appropriate organizations regarding aircraft in need of SAR aid and assist such organizations as required. ATS units which provide either an ATC and/or FIS provide an alerting service.

2.3.16 ATS units receive information on most aircraft flights and are periodically in contact with them. Reports of an actual or possible emergency will most often come from the aircraft itself reporting directly to an ATS unit. An aircraft emergency and its development is therefore likely to come to their notice first. It is for these reasons that each ATS unit provides alerting services to all aircraft flights known to it; and area control centres and flight information centres serve as a collecting point for all information concerning an aircraft emergency within its flight information region (FIR).

2.3.17 An ATS unit will notify its associated RCC when an aircraft is actually, or likely to be, in a state of emergency. (Note - when the nature of the emergency is such that local rescue facilities can deal with it, such as when an incident occurs at or near an aerodrome, the RCC may not be informed).

2.3.18 A Maritime RCC (MRCC) may also request an ATS unit to provide the information in the case of an aeronautical incident at sea. The MRCC should communicate first with a local ATS unit, such as an aerodrome tower. An Aeronautical Rescue Coordination Centre (ARCC), a Flight Information Centre (FIC) or an Area Control Centre (ACC) may also have relevant information, or may be able to assist with investigations using aeronautical communications and resources.

RCCs- Alerting and Aircraft Position Information

2.3.19 To enable a rapid and efficient SAR response to be activated to an aircraft emergency, RCCs need to first be alerted. Any delay in notification to an RCC will delay the SAR response. When an RCC is alerted it also needs to know the most accurate available position to plan it's response.

2.3.20 For a ditching or forced landing scenario, the accuracy of the actual ditching or forced landing position directly relates to how quickly responding SAR units may arrive at the distress location.

2.3.21 A very accurate distress location on the ground or water has the ability to take the "search" out of search and rescue and allow RCCs to concentrate efforts more towards the rescue response. A very accurate distress location may be provided, for example, by a GNSS capable 406 MHz ELT, which will normally provide a location to within a 120 metre accuracy. In a ditching scenario, a fixed 406 MHz ELT is vulnerable to sinking underwater and it is therefore wise for aircraft which operate over water to also be equipped with portable 406 MHz distress beacons for the marine environment (such as an EPIRB) to be carried by survivors and/or in life rafts.

2.3.22 Even when a distress location is known within a reasonable degree of accuracy RCCs need to take into account a range of factors when calculating the search area, particularly if the last known position was airborne. For example, where a last known position of an aircraft is derived from ATC RADAR, elements such as the navigation error applicable to the RADAR position, aircraft altitude, speed, track, rate of descent and possible pilot actions outside RADAR coverage need to be applied. Over the ocean the pilot may decide to alter course to track to the nearest point of land.

2.3.23 The difference between a forced landing location on land and a ditching location in the ocean also needs to be noted. Whereas a forced landing location is fixed, a ditching location will be affected by oceanic drift. For a ditching location in a remote oceanic area, it may be many hours before SAR units can reach the distress location and the search area will normally expand over time.

2.3.24 Where the aircraft's position is in doubt, RCCs will need to develop a search plan and a rescue plan. This will involve calculating search areas, despatching search units to search the area and deploying rescue units to perform a rescue when the distress aircraft is located.

2.3.25 Where RCCs are not notified in a timely manner the chances of survival for distressed persons diminish. For oceanic areas, the search area normally expands commensurate with oceanic drift. The time of operation of any battery powered electronic emergency signalling devices also diminishes, such as ELTs and ULBs.

2.3.26 The primary issues related to aircraft tracking where RCCs are required to initiate a SAR response are:

1. Ensuring rapid identification and alerting of an emergency to the responsible RCC, and
2. Provision of an accurate aircraft location to the responsible RCC.

2.3.27 It will assist RCCs to be provided, for the last known in-flight position, with:

- the most accurate position location in latitude and longitude
- an accurate time for that position
- the estimated degree of uncertainty of this position
- aircraft altitude
- aircraft ground speed
- aircraft track (not heading)

Implementation of SAR System by States

2.3.28 There is concern within the global SAR community regarding the capability of ICAO Contracting States to fulfil the requirements of Annex 12.

2.3.29 Using the ICAO Asia/Pacific Region as an example, there are large oceanic areas where some States, having the responsibility to provide SAR services within their agreed SRRs, have known deficiencies. A growing number of high capacity airline aircraft fly through these areas on a regular basis.

2.3.30 ICAO's Asia/Pacific Regional Office maintains details on compliance with Annex 12 for regional member States according to what each State notifies to that office. States are requested to provide a self-assessment of their current compliance. The latest compliance is displayed in Figure 4 below.

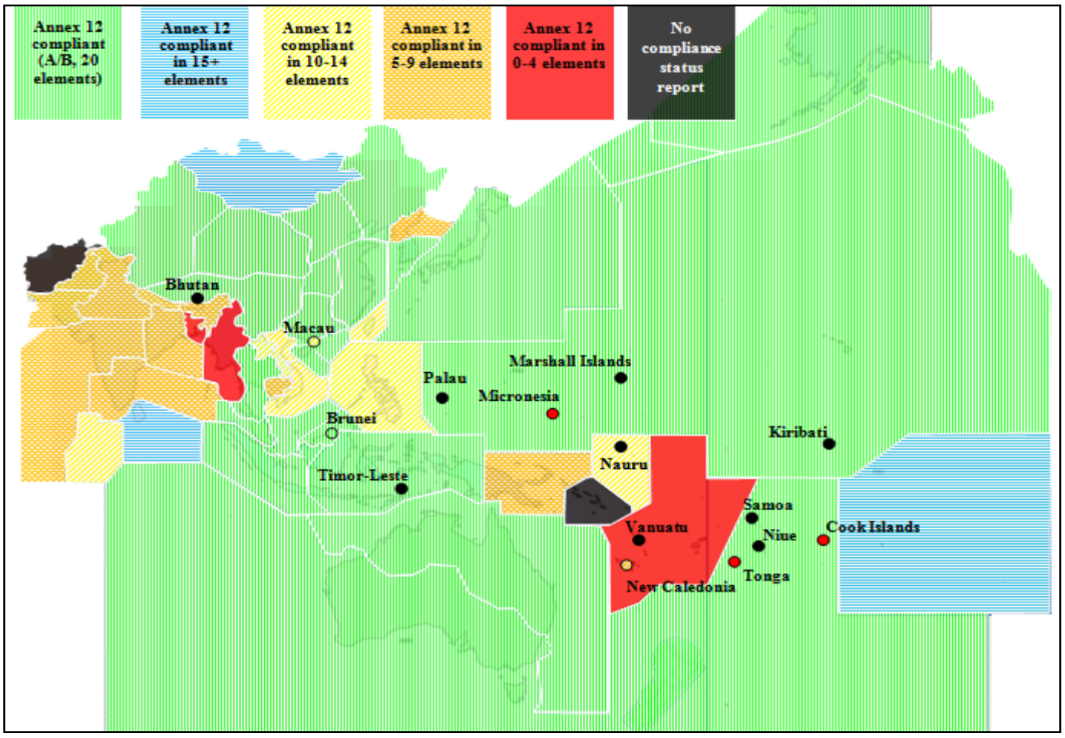


Figure 4 – ICAO Asia/Pacific Regional SAR Overview of Compliance with Annex 12.

(Source: Report of the Second Meeting of the Asia/Pacific Regional Search and Rescue Task Force (APSAR/TF/2) Singapore, 27 – 30 January 2014)

2.3.31 The activation of an aircraft's 406 MHz distress beacon is designed to be detected by the COSPAS-SARSAT system and delivered to the nominated 24-hour Single Point of Contact of States. RCCs will receive the detection information and will contact the aircraft operator or nominated emergency contact provided in its registration details, provided the beacon is correctly registered. In some instances the 24-hour single point of contact is not staffed and therefore the emergency cannot be relayed.

Non-coincident SRRs

2.3.32 As briefly noted in the Search and Rescue Region (SRR) section earlier, there are regions of the world where efficiency of SAR coordination is influenced by non-coincident aviation and maritime SRRs. An example for the South-West Pacific region is provided below.

2.3.33 Figure 5 displays an actual example of where aeronautical and maritime SRRs are not coincident. IAMSAR manual (Ref. Volume I, 2.1.1) states 'for aeronautical purposes SRRs often coincide with FIRs'. The aeronautical boundaries are defined in the regional air navigation plans. Note also that Australia and French New Caledonia have overlapping Maritime SRRs. JRCC Australia and MRCC Noumea share the responsibility for SAR response in this area.

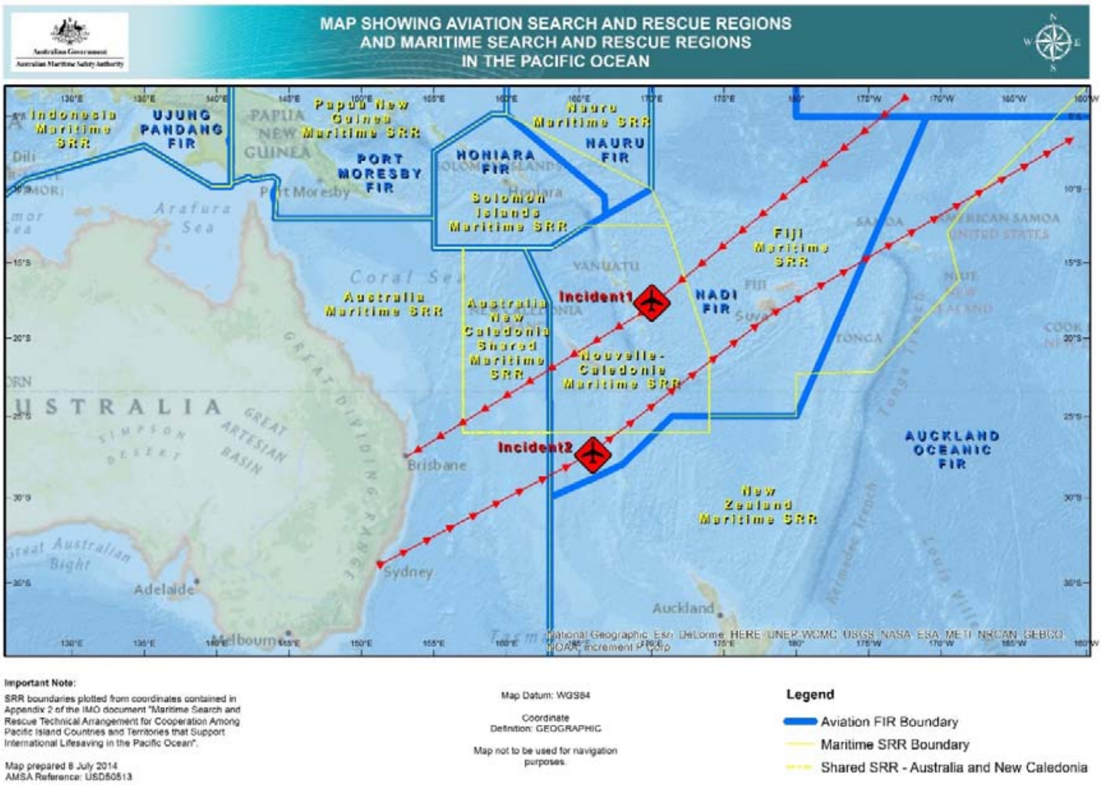


Figure 5: Example of non-coincident aeronautical and maritime SSRs

2.3.34 To highlight issues associated with the coordination of aircraft emergencies in these areas, two scenarios are represented as **Incident 1** and **Incident 2**.

2.3.35 For **Incident 1**, an aircraft is flying from the north-east inbound to Brisbane, Australia when it experiences an in-flight emergency which will likely result in a ditching at the location represented by the red and black aircraft symbol. The aircraft is within the Nadi (Fiji) FIR under the jurisdiction of Nadi ATC but overhead the French New Caledonia Maritime SRR. In this case, Nadi ATC would declare a Distress phase and both the ARCC in Nadi and MRCC in Noumea will need to be alerted. Both RCCs involved will need to coordinate the appropriate SAR response.

2.3.36 For **Incident 2**, an aircraft outbound from Sydney, Australia experiences a distress situation where a ditching is likely. This aircraft is within the Nadi FIR but overhead the New Zealand SRR. New Zealand operates a JRCC responsible for both aeronautical and maritime SAR response. In this case, Nadi ATC will need to alert the ARCC in Nadi and the JRCC in Wellington, New Zealand. Both RCCs will need to coordinate the appropriate SAR response.

2.3.37 The above example highlights the need for aircraft operators to be able to readily and rapidly determine which ATS unit and/or RCC they need to contact. Similarly, there needs to be provision for the ability of ATS units and RCCs to readily and rapidly determine the correct aircraft operator's emergency point of contact.

2.4 Information Management

2.4.1 The main areas of potential improvement identified are:

	Improvement Areas	Analysis
2.4a	Improved abilities to identify the responsible RCC for the region in which the aircraft experiences the emergency.	There is no worldwide chart(s) publication of Aeronautical Search and Rescue Regions which allows stakeholders to quickly identify the relevant RCC(s) to contact. There is no automated system support in correlating the aircrafts position with the RCC area of responsibility

	Improvement Areas	Analysis
2.4b	Improved ability to reach operational staff of ATS Centres/Units and RCC's.	There is no consolidated contact list of worldwide ATS Centres/Units or RCCs to enable rapid identification and contact between these stakeholders. There is no automated system support in providing contact details of operational staff
2.4c	Improved ability to reach operations staff of aircraft operators.	There is no consolidated contact list of worldwide aircraft operators to enable rapid identification and contact between these stakeholders. There is no automated system support in providing contact details of operational staff
2.4d	Improved ground communication capabilities	The Aeronautical Fixed Telecommunications Network is quite limited in its capabilities, especially in terms of interactivity and the exchange of large quantities of data. The AFTN is limited in its capabilities for future use in the context of the GADSS
2.4e	Enhance provisions for effective use of English language by Points of Contact (ATS unit, RCC, Aircraft Operator)	Time may be lost due to language issues between the operational staff of aircraft operations centres, ATS units and RCCs. Stakeholder points of contact should be proficient in English.

2.4.2 The communications arrangements currently in place between aircraft operators and the air traffic service system are based on the Aeronautical Fixed Telecommunications Network (AFTN). Flight plans are disseminated over this network; subsequent movement messages (flight plan changes, departure and arrival reports) and SAR alerting messages also flow over the AFTN. The network (which predates the internet by many decades) is global in extent and, being dedicated to aviation, provides a robust and fault-resistant communications environment. It is however also quite limited in its capabilities, especially in terms of interactivity and the exchange of large quantities of data.

2.4.3 Furthermore, while ATS units and RCCs are reachable over the AFTN by means of their standardised address (FIR designator and agency suffix), this presupposes knowledge of the FIR and Search and Rescue Region (SRR) within which the aircraft is operating. Deriving this information from a geographic position requires global knowledge of FIR/SRR boundaries and algorithms for mapping position data onto the appropriate FIR/SRR.

2.4.4 Another consideration is the current lack of the ability for ATS units/RCCs to reach the aircraft operator's staff e.g. the flight Operations Centre (FOC). The only addressing information normally possessed is the AFTN address from with the aircraft's flight plan originated; messages to that address frequently go unanswered. This may have concrete adverse consequences (inability to retrieve supplementary safety information for the flight) but also greatly restricts the ability for operational consultations between air traffic controllers, RCC coordinators and airline operations staff.

ATS unit and RCC relationship with Aircraft Operators and their FOCs

2.4.5 ATS units and RCCs will normally interact with aircraft operators or their FOC when there is a need due to an emergency involving one of their aircraft. Some ATS units/RCCs and aircraft operators may collaborate for emergency planning or exercise purposes.

2.4.6 When an area control or a flight information centre decides that an aircraft is in the uncertainty or the alert phase, it will, when practicable, advise the aircraft operator prior to notifying the RCC. If an aircraft is in the distress phase, the RCC has to be notified immediately. All information notified to the RCC by an area control or flight information centre will, whenever practicable, also be communicated, without delay, to the aircraft operator.

2.4.7 During aircraft emergency events, where ATS units and/or RCCs need to contact the aircraft's operator, this often presents a problem when the aircraft operator's contact details are not readily available. The same will often apply where an aircraft operator wishes to quickly contact the relevant ATS unit and/or RCC.

Aircraft operating in the vicinity of an aircraft in a state of emergency (Annex 11, 5.6)

2.4.8 Current ICAO provisions require data to be shared with other aircraft. When it has been established that an aircraft is in a state of emergency, other aircraft known to be in the vicinity of the aircraft involved are (except in cases of known or suspected unlawful interference) informed of the nature of the emergency as soon as practicable. When it is considered subject to unlawful interference, no reference is made in ATS air-ground communications to the nature of the emergency unless it has first been referred to in communications from the aircraft involved and it is certain that such reference will not aggravate the situation.

2.4.9 ATS units and/or RCCs may request aircraft to assist such as attempt to communicate with and/or relay communications for the subject aircraft, divert and hold overhead a forced landing/ditching location, monitor 121.5MHz for an ELT, or relay communications for a responding SAR aircraft, etc. ATS units and/or RCCs should notify the aircraft operator when this occurs.

Aircraft Emergencies and RCC Response

2.4.10 For aircraft emergencies RCCs require the timely alert notification of the emergency, and the aircraft's location as accurately as possible. The quality of these two critical pieces of information allows RCCs to mount the best available response and despatch rescue resources directly to a distress location.

2.4.11 Where RCCs are notified in a timely manner about an emergency, but the position is in doubt, a search will need to be planned concurrently with a rescue plan. This will involve calculating search areas, and if large, despatching multiple search assets.

2.4.12 Even when a distress location is known within a reasonable degree of accuracy RCCs need to take into account a range of factors when calculating the search area. For example, where a last known position of an aircraft is derived from ATC RADAR, elements such as the navigation error applicable to the RADAR position, aircraft altitude, speed, track, rate of descent and possible pilot actions outside RADAR coverage need to be applied. Over the ocean the pilot may decide to alter course to track to the nearest point of land. Therefore, the best available positional information for aircraft subject to an emergency is essential to enable the best and quickest RCC response.

2.4.13 Where RCCs are not notified in a timely manner the chances of survival for distressed persons diminish. For oceanic areas, the search area normally expands commensurate with oceanic drift. The time of operation of any battery powered electronic emergency signalling devices diminishes, such as ELTs and ULBs.

3.0 High Level Requirements

3.1 This chapter provides high level requirements applicable to the target concept. The implementation of these requirements is subject to planning covering the short, medium and long term.

3.2 Implementation of this Concept of Operation will:

- **Enhance the ability to rescue survivors**
- **Provide immediate notification when an aircraft experiences an abnormal event**
- **Ensure that the location of an accident site can be identified to a degree of accuracy, in a timeframe and to a level of confidence acceptable to the stakeholders**
- **Function worldwide**
- **Be specified using performance based standards and independent of any one prescriptive technology**
- **Be sufficiently flexible to accommodate diverse regional needs**
- **Not cause degradation of the baseline SAR service**
- **Be seamless across ATS unit boundaries**

3.3 As a consequence of the above high level requirements the GADSS will:

- **Provide enhanced capability to provide RCCs with timely notification of an emergency event together with accurate location information**
- **Leverage the benefit for routine ATM and FOC purposes**
- **Ensure relevant stakeholders are contactable when required**
- **Ensure the system, including all processes, are regularly tested**
- **Be capable of transmitting aircraft tracking data from the aircraft under all circumstances**
- **Assist the accident investigation authority in locating the wreckage and flight data recorders**

3.4 In assessing the possible solutions the following will be considered:

- **Impact on overall safety level**
- **Robustness of system to on-board technical failures**
- **Airworthiness certification requirements**
- **The effects of human factors that may affect performance of the system**
- **The effects on Flight Crew workload**
- **The cost effectiveness of the solutions**
- **Information security and confidentiality**
- **Maximising the use of existing systems and infrastructure**
- **Any limitations on its geographical application**
- **Applicability by retrofit or for new build aircraft**
- **Compliance with the concepts of the Global Air Navigation Plan**

4.0 Target Concept

4.0.1 This chapter details the key characteristics needed to deliver on the high level requirements of the Global Aeronautical Distress and Safety System (GADSS).

4.0.2 The Target Concept describes how GADSS enables efficient and effective ATS unit alerting and SAR operations during the emergency phases. The notion of "target" refers to an ideal end stage, setting a direction for more short term and concrete Concept Steps provided in the next chapter.

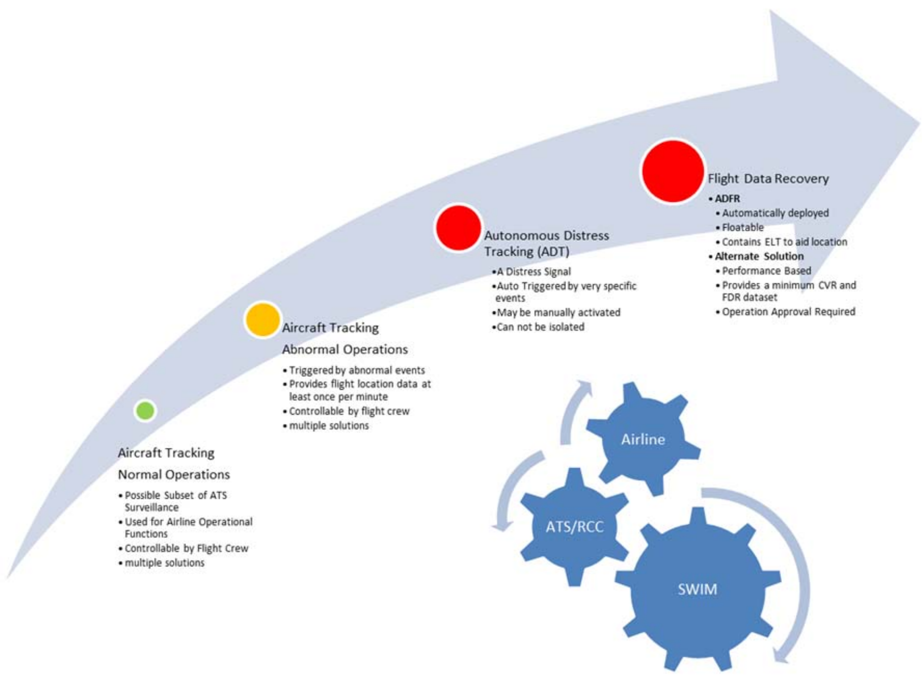
4.0.3 The efficiency and effectiveness of ATS unit Alerting and SAR services rely on timely and accurate information. GADSS operates on a world-wide scale for all flights that meet the applicable criteria as defined in standards/regulations to provide incremental position and other relevant flight information.

4.0.4 The GADSS consists of the following main system components:

- ***Aircraft tracking System*** and
- ***Autonomous Distress Tracking System*** *and*
- ***Flight Data Recovery.***

and is enabled (in its end state) by:

- ***System Wide Information Management*** *and*
- ***Information repository service***



4.0.5 This chapter is structured to first detail the target concept for the aircraft-centric systems and then the ground-centric procedures, recognising that all are interdependent when fulfilling the overall requirements of the GADSS. While the GADSS concept may apply to all aircraft, it is intended that the aircraft-centric provisions will only apply to commercial air transport in the shorter term; this is reflected in the implementation plan in Chapter 5.

4.1 Aircraft tracking

4.1.1 The aircraft operator will ensure that its aircraft are tracked throughout their area of operations.

4.1.2 The aircraft's position should be reported at least every 15 minutes.

4.1.3 The tracking capability requires the aircraft operator to ensure the aircraft is tracked, but is not required to know the aircraft position, if air traffic control uses ATS surveillance services or ADS-C to obtain an aircraft position at least every 15 minutes. Having confirmed the air traffic services satisfy this requirement, an aircraft operator does not need to independently track its aircraft.

4.1.4 To facilitate aircraft operators in determining where they need to track aircraft, ANSPs shall make available details of the air traffic services provided.

4.1.5 In response to unanticipated operational events, e.g. altitude deviations or changes to potential area of operation, there may be a need for the reporting rate to be increased. For aircraft operators who receive tracking information directly from the aircraft they will need to ensure that procedures are in place to respond to instances of missed reporting. If the conditions that led to increased reporting rate cease to exist then the reporting may revert to the original rate.

4.1.6 Key stakeholders in routine aircraft tracking depend on the option(s) selected by the individual aircraft operator and can include:

- The aircraft operators' flight operations or flight planning organization;
- The airline Operations Control Center, or Mission Control Center or Rescue Coordination Centers (RCCs);
- Air Navigation Service Providers;
- Other aircraft tracking service providers selected by the operator;
- Communication service provider(s)

Aircraft Tracking Performance Criteria

4.1.7 This section provides the performance criteria to describe a baseline for aircraft tracking functionality. These criteria must be considered in their entirety by air carriers when implementing or enhancing aircraft tracking capabilities:

a. The aircraft tracking function should track aircraft within potential areas of operation and range;
b. The aircraft tracking functionality should be available and operating while the aircraft is airborne;
c. The information required for aircraft tracking should include the aircraft 4D position (latitude, longitude, altitude and time) and aircraft identification;
d. When transmitted by the aircraft, the tracking accuracy of the position report should be within 1 NM, however, may be greater than 1NM depending on the aircraft's existing navigation system capability;
e. The aircraft tracking function should report at least every 15 minutes. In airspace where ATS surveillance services or ADS-C identifies the position of the aircraft at least every 15 minutes the aircraft operator may rely on that system for tracking information;
f. The aircraft tracking system should have the ability to increase its reporting rate based on established triggering parameters;
g. A communications protocol must exist between the airline and the air traffic service unit to facilitate coordination during the alert phase of an event that may be detected through aircraft tracking;
h. Operators who receive tracking information directly from the aircraft should ensure that procedures are in place to address instances where required reporting does not occur;
i. Any new airborne equipment or modification to existing equipment shall meet the appropriate airworthiness requirements.

4.1.8 These criteria were developed to enable effective, near term implementation and can be achieved through a combination of existing technologies and procedures. More elaborate solutions can be developed in the longer term and integrated into global air navigation infrastructure evolution through ICAO's Aviation System Block Upgrades.

Aircraft Tracking Service Providers

4.1.9 The aircraft tracking responsibility lies with the aircraft operator. However, the service can be provided by a third party contracted by the aircraft operator through a formal agreement.

4.1.10 The aircraft tracking service provider is responsible for recording the aircraft tracking information. The full record will be kept for a duration defined in applicable standards and regulations.

4.1.11 During any emergency phases the service makes available, with defined intervals, a log with the position of the aircraft and other information relevant to the emergency phase.

4.2 Autonomous Distress Tracking

4.2.1 The Autonomous Distress Tracking system uses on board systems that can broadcast 4D position, or distinctive distress signals from which the 4D position can be derived, on protected frequencies and, depending on its application on each aircraft, shall be automatically activated on-board or may be manually activated at any time. Aircraft state can be analysed in real-time by on-board equipment and the use of in-flight event detection and triggering criteria logic can activate transmission of information to locate the aircraft in distress. In case of false alarm (nuisance trigger) or recovery from the distress phase the ADT needs to de-activated, however, the deactivation can only be done by the activating mechanism.

4.2.2 Key differences between aircraft tracking and autonomous distress tracking are:

- The triggering logic for activation of the transmission
- Autonomy and failure-mode capability of the system
- The delivery of the data on the ground to SAR

4.2.3 It may be necessary to include functionality that allows a responsible ground authority to (de-) activate the ADT when there is emergency distress and a (risk of) failure of the aircraft tracking systems or it is necessary to deactivate the ADT after a confirmed nuisance activation.

4.2.4 Automatic in-flight activation will be triggered by an in-flight event detection system using one or more criteria. These criteria should detect a wide range of situations precursors to accidents. The list below represents the minimum set of situations which should be detected by an algorithm, individually and/or in combination, and used to trigger the transmission of sufficient information for the purpose of locating an accident site:

- Unusual attitude beyond which the recovering of a safe attitude is unlikely: This scenario may comprise excessive roll value or excessive pitch value or yaw rate or combination of roll/pitch value and roll/pitch rate.
- Unusual speed conditions: this scenario may comprise excessive vertical speed or stall condition or low airspeed or overspeed or combination of various speed conditions.
- Unusual Altitude: Inadvertent closure to terrain that, if left uncorrected, would likely result in an accident.
- Total loss of thrust/propulsion on all engines.
- in-flight inhibition of the in-flight event detection and triggering criteria logic.

Note: The performance specifications for the in-flight event detection and triggering criteria are detailed on EUROCAE ED-237 document.

4.2.5 Autonomous Distress Tracking (ADT) may also be activated in case of failure or inflight inhibition of the event and triggering criteria logic.

4.3 Flight Data Recovery

4.3.1 When an accident occurs over water it is beneficial for the investigation to recover critical flight data in a timely manner. Once recovered, flight recorders have been highly reliable. However, there have been instances in which the search for recorders has been very long, flight data has never been recovered or where data was lost due to damage from exposure to severe fire or underwater conditions.

4.3.2 To assist the accident investigation authority to obtain timely access to the flight recorder information and to help locate physical wreckage the aircraft will be equipped with an automatically deployable flight recorder or an alternative solution for retrieval of flight recorder information.

Automatically Deployable Flight Recorder

4.3.3 Definition for deployable recorder as included on the EUROCAE MOPS ED-112A: Any crash-protected recorder (CVR, FDR or other) which is designed to be automatically separated from the aircraft only in the event of an accident.

4.3.4 A deployable recorder is a recording medium housed in a crash-protected memory module that is automatically deployed (released) from the aircraft at the start of an accident sequence. Its characteristics have the objective of enabling it to land at low speeds clear of the main aircraft wreckage, or, in the event of an over-water accident, its flotation characteristics enable it to float on water. Since the recorder is no longer with the aircraft it should be equipped with an ELT to locate it.

4.3.5 This type of recorder is attached to the exterior of the airframe, and under normal conditions, functions in the same manner as a fixed recorder. The Recorder Memory Unit, Beacon Transmitters, Antennas, Battery Pack and the survival packaging for these units are all an integral part of the Automatic Deployable Package.

4.3.6 The deployable Package incorporates flight characteristics that enable it to deploy and rapidly establish a flight trajectory that clears the airframe.

4.3.7 The deployable recorder deploys upon aircraft impact with the ground or water so that the maximum amount of data is recorded up to the time of the crash. It may also deploy in a mid-air collision or explosion. The deployable recorder should not deploy in a non-catastrophic event such as a hard landing or tail strike.

Other alternatives for flight data recovery

4.3.8 Other technologies based on transmission of flight data, prior to an accident, may be useful to recover some CVR and FDR data quickly without any search required. Such data streamed from an aircraft in distress or streamed continuously throughout the flight may enable near real time trend analysis on the ground that could potentially allow early detection and mitigation of factors that might lead to an accident. Such streaming technology is evolving and already exists to some degree on some airframes. As the performance of datalink technology improves, these practices are expected to be more widely adopted due to the potential economic and safety benefits that result from the availability of near real-time flight data.

4.3.9 Accident investigators need information, after an accident, as soon as possible to identify probable causes and issue safety directives as appropriate. In past accidents, where the accident site took a long time to find, a few parameters that were obtained from streaming maintenance monitoring systems allowed investigation agencies to issues corrective safety recommendations based on that information. The overall probability of retrieving flight recorder information needs to consider both the immediate and subsequent needs of accident investigation. The following are two examples of how this could be achieved on an aeroplane that is required to have two combination recorders (FDR/CVR):

- Replacing one combination recorder with a means of making the full dataset available and for the same duration, as it would be recorded on a combination recorder, in a timely manner after an accident.
- Adding a system autonomously transmitting information for locating an aeroplane in distress and a means of making a set of flight data available in a timely manner after an accident. The dataset could be limited to a subset of FDR and CVR data because the full dataset will be available from at least one of the two combination recorders when recovered.

4.3.10 The retrieval of flight recorder information allows a timely determination of the probable cause of the accident to the extent possible. Regardless of the system used (e.g. ADFR, streaming), in many cases the ultimate root cause of an accident can only be definitively determined after physical examination of the wreckage and detailed analysis of on-board computers and flight recorders data .

4.3.11 Alternative flight data recovery systems should, with a reasonable degree of certainty, ensure that the data being transmitted reaches its intended destination with the required level of integrity. The following high-level performance criteria should be considered:

a) Selection of appropriate audio and flight parameter set
b) Appropriate minimum duration of transmitted information
c) Accuracy and sampling of parameters being transmitted
d) Quality and integrity of data being transmitted
e) Audio Bandwidth or capacity requirements of communication link
f) Robustness of the communication Link, including timely recovery after Link-loss during unusual attitudes
g) Security (encryption) of transmitted data
h) Global coverage

4.4 GADSS Information Management

The data supplied by aircraft tracking and autonomous distress tracking must be effectively shared among all stakeholders as necessary to ensure the effective operation of the GADSS. ATS units are encouraged to make available aircraft position information. This information is useful to:

- ***Establish areas of surveillance coverage***
- ***Provide support for flight management in general to be used by aircraft operators and commercial service providers***

This section outlines the applicable processes necessary, including any related enabling systems or technologies.

System Wide Information Management

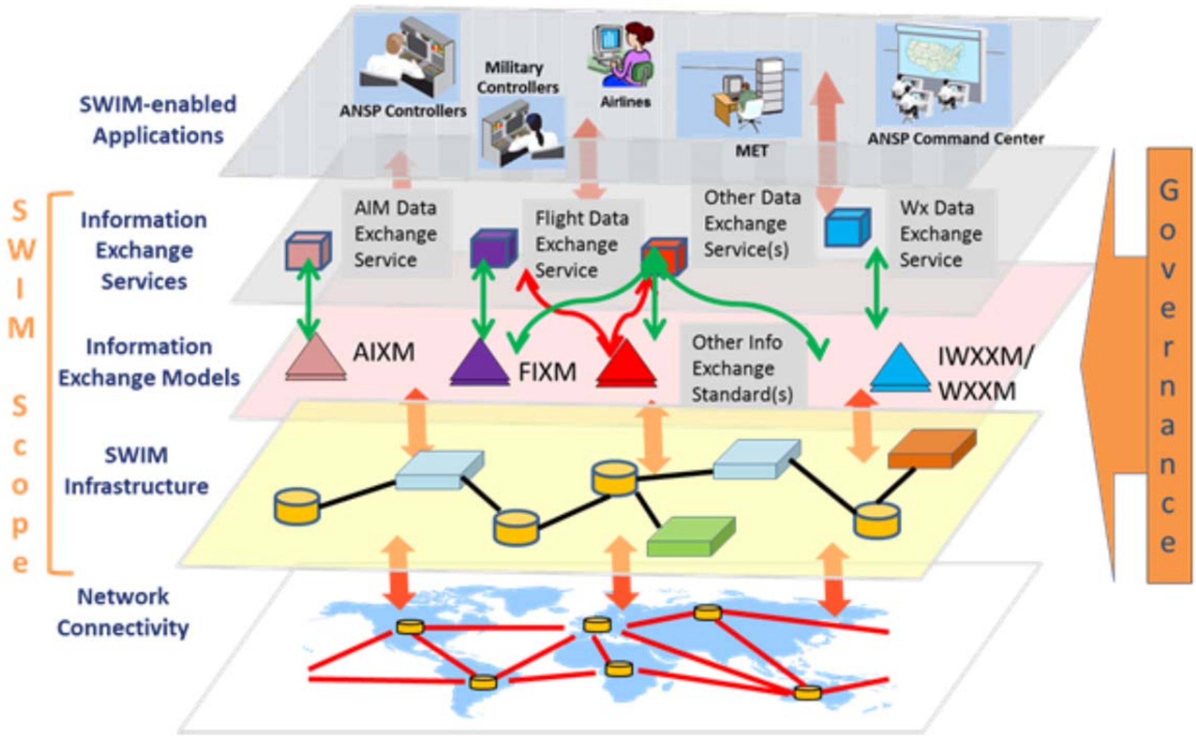
SWIM consists of standards, infrastructure and governance enabling the management of ATM related information and its exchange between qualified parties via interoperable services.

4.4.1 In a SWIM environment the sharing of aircraft tracking information is enabled by a set of agreed and implemented rules. It will for example ensure that only in Emergency Situations and following ATS unit confirmation the involved subscribed stakeholders (e.g. ATS unit/RCC/aircraft operator) will receive essential tracking information. It also ensures that all stakeholders share the same information on the emergency case and that the information is maintained.

4.4.2 SWIM contributes to the following benefits to improved decision making by all stakeholders during all strategic and tactical phases of flight (pre-flight, in-flight and post-flight) through:

- improved shared situational awareness;
- improved availability of quality data and information from authoritative sources;
- increased system performance;
- more flexible and cost-effective communications by the application of common standards for information exchange;
- loose coupling which minimizes the impact of changes between information producers and consumers;
- and support of ATM Service Delivery Management

4.4.3 The figure below illustrates the SWIM layers and how they support SWIM enabled applications



4.4.4 In the target concept the aircraft tracking service makes use of SWIM enabled applications. When an emergency situation is detected, the aircraft tracking service provider starts to broadcast the aircraft tracking information. From that moment it is, in principle, available worldwide but subject to agreed and implemented access rules.

4.4.5 The position of the aircraft in an emergency situation determines the ATS unit('s) and RCC('s) who should receive the information. Both are subscribed to information relevant to their area of jurisdiction.

4.4.6 SWIM enables the right information to be instantly available to the right actors without human interventions. It also enables information relevant to the emergency to be augmented and be kept together so that all actors have the same situational awareness reducing the need for time consuming human interactions. This is a key benefit.

4.4.7 The implementation of SWIM will take place in an evolutionary and benefit driven manner as outlined in the ICAO GANP. For the near/medium term aircraft tracking information may be shared using dedicated web based solutions.

4.4.8 In principle, Aircraft tracking information should be available at a global scale subject to agreed access and subscription rules. It is important to develop and implement appropriate measures to minimise the probability of misuse of the system and information. Therefore, cyber security is an important area of attention in developing and implementing the GADSS in the short, medium and long term.

Information repositories services

4.4.9 Aircraft position information can be correlated with ATS unit and RCC areas of responsibility by a SWIM enabled Information repository service. The following minimum information can be returned by submitting a position:

- The identification and Point of Contact of the ATS unit and RCC responsible for the area of jurisdiction in which the position fits
- In case the position is near to an ATS unit boundary also the neighbouring ATS unit Identification and Point of Contact will be provided
- In case the position is near to an RCC boundary also the neighbouring RCC Identification and Point of Contact will be provided.

4.4.10 The service will be available 24/7 and its content is subject to a maintenance process that ensures that the information is accurate and complete to the maximum extent possible and practical.

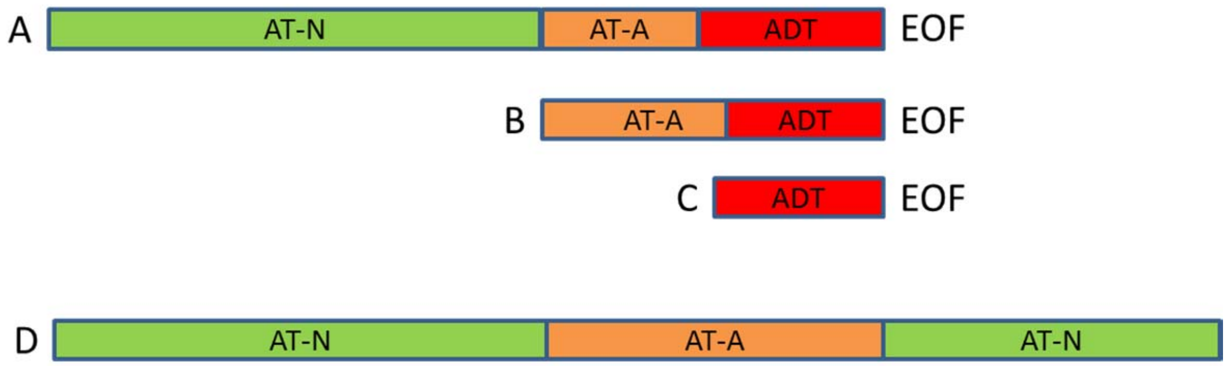
4.5 GADSS Procedures

General

4.5.1 Before any active flight the aircraft operator identifies the point of contact for emergency phases contactable during the execution of the flight in the flight plan if different from the information in the repository. The flight plan may need to include additional information (e.g. GADSS capability) in support of the GADSS.

4.5.2 The aircraft operator or its aircraft tracking service provider should have the capability to associate the aircraft's position with the ATSU areas of jurisdiction. This capability makes use of up-to-date central information repositories discussed earlier.

4.5.3 Following detection of an abnormal event (e.g. by ATSU or aircraft operator), will lead to increased reporting rates and information from the Aircraft tracking plus enhanced distribution of information to enable execution of procedures as defined in Annex 11. The figure below shows some (non-exhaustive) examples of type of aircraft tracking progression:



AT-N: Aircraft tracking normal operations
AT-A: Aircraft tracking in abnormal situations
ADT: Autonomous Distress Tracking
EOF: End of Flight

4.5.4 The figure above illustrates the use of aircraft tracking. Case A, starts with aircraft tracking under normal conditions changing, following detection of an abnormal event, to emergency phases. Autonomous Distress Tracking (ADT) is activated as the last resort following triggered activation.

4.5.5 In case B there is no aircraft tracking for normal operations (e.g. flight operates in a area with good surveillance coverage and it is not considered necessary for the airline operation). Following an abnormal event the aircraft tracking is activated and later the ADT. It is noted that in cases A and B AT-A may operate concurrently with ADT. Example C shows a direct activation of the ADT. Example D shows a recovery from an abnormal situation and a return to normal operations.

4.5.6 It should be noted that communication of the escalation of an emergency phase to the RCC is performed by the ATS unit and not the commercial air transport operation. This is different for an activation of an ADT where the distress alert may be forwarded directly to the RCC.

Procedures for declaring an emergency phase

4.5.7 The ATS unit is responsible for setting the Emergency status for flights in its jurisdiction. In an Emergency status, aircraft tracking information made available must be available to all actors.

4.5.8 Communications will be established between the ATS unit and the relevant aircraft operator in order to identify the nature of the situation and any corrective measures that can be applied. It will also allow identifying situations that can evolve to an emergency, allowing for early preparation. This will also help eliminate any time lag regarding the establishment of the communications themselves and analysis both by the aircraft operator and the ATS unit of action required.

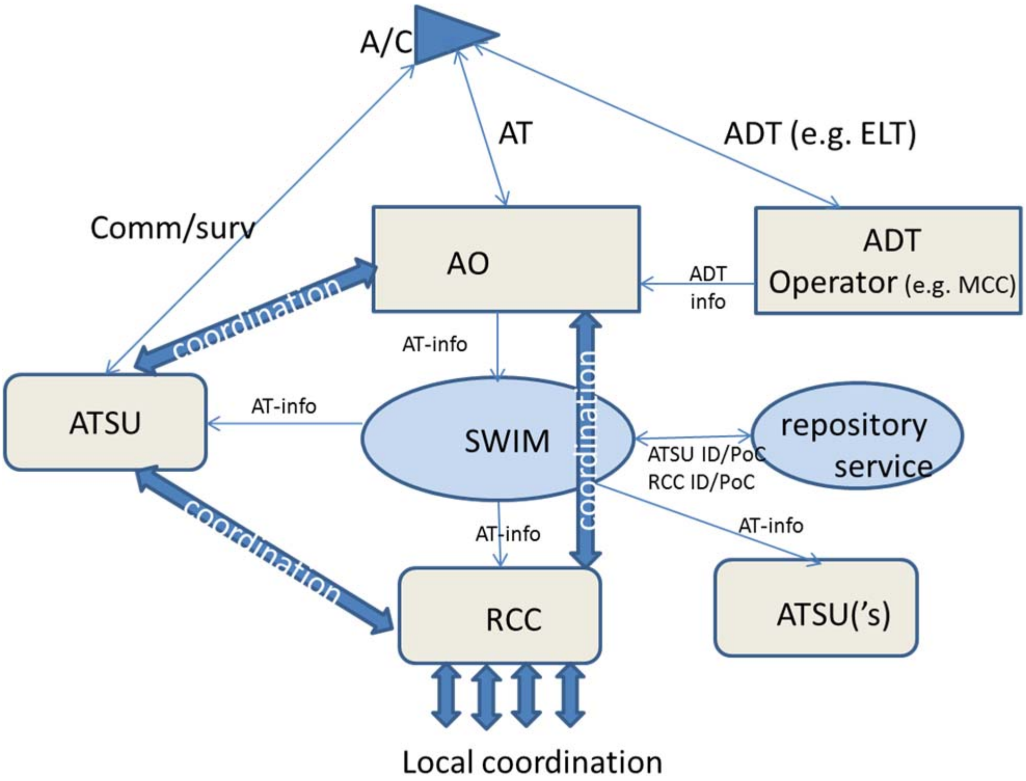
4.5.8.1 When the ATS unit detects an abnormal event it will monitor the situation and communicate, if possible, with the aircraft. The ATS unit may contact the aircraft operator to seek additional information and if deemed applicable initiate an emergency phase. The repository service may be used for obtaining the Aircraft operator Point of Contact.

4.5.8.2 When the aircraft operator detects an abnormal event it will contact the ATS unit corresponding with the latest known position of the aircraft. The aircraft operator will provide the ATS unit any additional information deemed relevant including the event that initiated the aircraft operator action. If at that point, the ATS unit is unsuccessful in establishing contact with the aircraft, the appropriate emergency phase should be initiated. The repository service may be used for obtaining the ATS unit ID and Point of Contact.

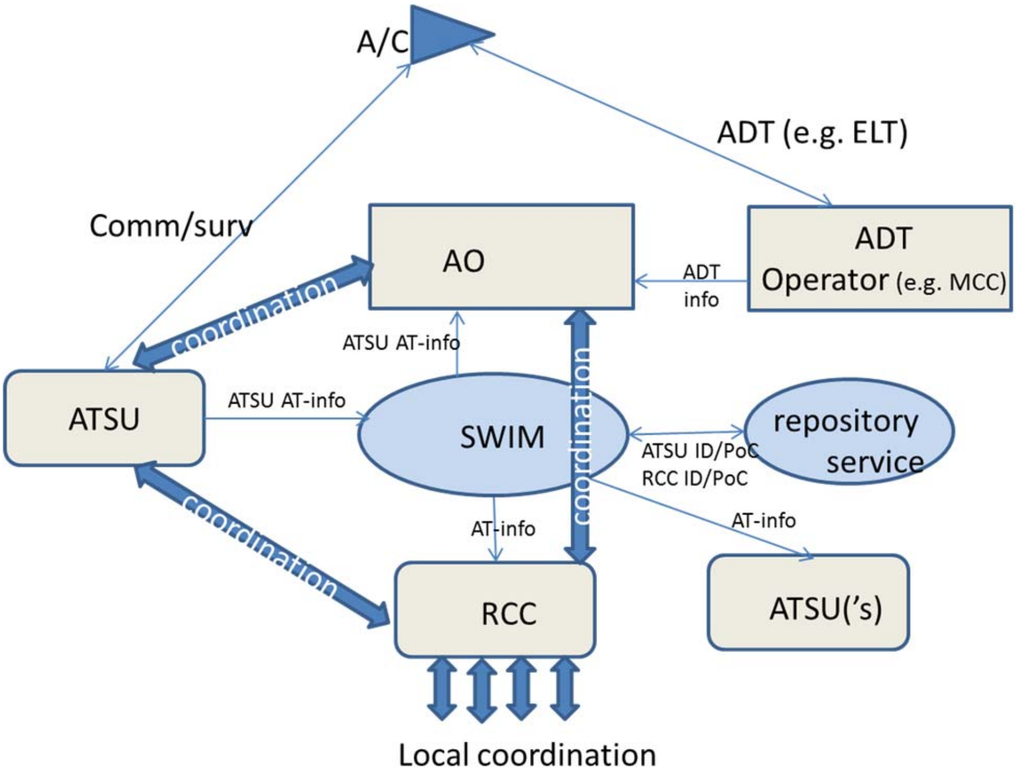
Procedures for the emergency phase

4.5.9 Emergency phases are used as a standardised method in the ATS system (ATS units and RCCs) based on the level of concern for the safety of persons or aircraft which may be in danger.

4.5.10 The figure below illustrates the main information and coordination links for an emergency requiring the sharing of aircraft tracking information. As a result of on board triggers the ADT can be activated and the information forwarded by the MCC to the FTSP and RCC. The ATS unit may make use of additional sources of information and share this with the actors. Other ATS units may also be subscribed to the aircraft tracking information for example when there is a probability that the flight will enter their area of jurisdiction.



4.5.13 The figure below illustrates the main information and coordination links in case the aircraft operator relies on information to be provided by a third party (e.g. ATS unit). Although not shown the aircraft operator may have the capability to communicate by voice with the a/c. The procedures as described before are the same.



4.5.11 Upon initial notification, a search and rescue (SAR) incident is classified by the notified RCC or ATS unit as being in one of three emergency phases: Uncertainty (INCERFA), Alert (ALERFA), or Distress (DETRESFA). The emergency phase may be reclassified as the situation develops. The current emergency phase should be used in all communications about the incident as a means of informing all interested parties of the current level of concern for the safety of persons or craft which may be in need of assistance.

4.5.12 Annex 11 categorises emergency phases as follows:

a) ***Uncertainty phase*** when:

1) no communication has been received from an aircraft within a period of thirty minutes after the time a communication should have been received, or from the time an unsuccessful attempt to establish communication with such aircraft was first made, whichever is the earlier, or when

2) an aircraft fails to arrive within thirty minutes of the estimated time of arrival last notified to or estimated by air traffic services units, whichever is the later, except when no doubt exists as to the safety of the aircraft and its occupants.

b) ***Alert phase*** when:

1) following the uncertainty phase, subsequent attempts to establish communication with the aircraft or inquiries to other relevant sources have failed to reveal any news of the aircraft, or when

2) an aircraft has been cleared to land and fails to land within five minutes of the estimated time of landing and communication has not been re-established with the aircraft, or when

3) information has been received which indicates that the operating efficiency of the aircraft has been impaired, but not to the extent that a forced landing is likely, except when evidence exists that would allay apprehension as to the safety of the aircraft and its occupants, or when

4) an aircraft is known or believed to be the subject of unlawful interference.

c) ***Distress phase*** when:

1) following the alert phase, further unsuccessful attempts to establish communication with the aircraft and more widespread unsuccessful inquiries point to the probability that the aircraft is in distress, or when

2) the fuel on board is considered to be exhausted, or to be insufficient to enable the aircraft to reach safety, or when

3) information is received which indicates that the operating efficiency of the aircraft has been impaired to the extent that a forced landing is likely, or when

4) information is received or it is reasonably certain that the aircraft is about to make or has made a forced landing, except when there is reasonable certainty that the aircraft and its occupants are not threatened by grave and imminent danger and do not require immediate assistance.

4.5.13 Notification by ATS units to RCCs will contain such of the following information as is available in the order listed: *(NOTE – the information below is a consolidated list from Annex 11 and the IAMSAR Manual)*

a) **INCERFA, ALERFA** or **DETRESFA**, as appropriate to the phase of the emergency;

b) agency and person calling;

c) nature of the emergency;

d) significant information from the flight plan, including:

- Aircraft call sign and type;
- point of departure and departure time;
- route of flight;
- destination and estimated time of arrival (ETA);
- number of persons on board;
- endurance;
- colour and distinctive markings;
- survival equipment carried;
- dangerous goods carried;
- telephone number of pilot in command;

e) unit which made last contact, time and means used;

f) last position report and how determined (course, speed, altitude);

i) any action taken by reporting office;

j) any direction finder equipment available; and

j) other pertinent remarks.

4.5.14 Information which is not available at the time notification is made to a RCC should be sought by an ATS unit prior to the declaration of a distress phase, if there is reasonable certainty that this phase will eventuate. Further notification to the RCC will, without delay, be furnished by ATS units with:

a) any useful additional information, especially on the development of the state of emergency through subsequent phases; or

b) information that the emergency situation no longer exists.

Note - The cancellation of action initiated by the RCC is the responsibility of that centre.

4.5.15 During emergency phases additional (from aircraft tracking information) sources of information for locating and tracking aircraft may be used. Any relevant information will be made available as needed to involved actors. Flight information centres or area control centres are the first responsible to act as central point for collecting all information relevant to the state of emergency of an aircraft operating in its area of jurisdiction (ref Annex 11, 5.1.2). Coordination and information sharing agreements and procedures should be established between civil and military authorities to ensure that all possible means and information can be made available without delay in case of emergency situations.

RCC Actions during Emergency Phases

4.5.16 Basic procedures may be adopted for each phase of emergency by RCCs. These procedures are not restrictive to RCCs who should act with flexibility as required to suite specific circumstances. A full description of procedures is outlined within the ICAO/IMO IAMSAR Manual, however the level of RCC response is guided by the current emergency phase.

4.5.17 **At the Uncertainty phase,** RCCs will normally engage in actions such as conducting basic notifications, gathering basic information on the aircraft and its flight, plotting the aircraft information on a chart and commence a communication search to attempt contact with the aircraft by all available means, including the aircraft operator. A communications search is supplementary to the initial communications checks which should have been completed by ATS prior to phase declaration. Departure, destination and alternate aerodromes will also normally be alerted.

4.5.18 **At the Alert phase,** RCCs will start to escalate SAR actions which may include alerting SAR resources such as SAR aircraft and vessels, conduct wider enquiries with communications stations which may have received transmissions from the aircraft, checks of potential airports where the aircraft may have diverted, plotting its most probable position and maximum range from the last known position, plotting known aircraft and ships known to be in the vicinity and initiate search planning and calculations.

4.5.19 **At the Distress phase,** RCCs undertake actions with the aim of rapidly locating and rescuing survivors. Many concurrent actions will be undertaken including detailed search action planning and despatch SAR aircraft and vessels to the planned search area. The search action plan will include on-going development of search plans, allocation and coordination of search assets, a rescue plan, communications plan, intelligence gathering plan, media response plan and so on commensurate with the requirements appropriate to the situation.

4.5.20 Note that on the initial alert, RCCs may go directly to the Alert or Distress phase if appropriate to the situation and initiate a SAR response accordingly. For example, a MAYDAY call will immediately trigger a Distress phase and the despatch of SAR units.

ATS and RCC relationship with Aircraft Operators and Flight Operations Centres (FOCs)

4.5.21 ATS units and RCCs will normally interact with aircraft operators or FOCs when there is a need due to an emergency involving one of their aircraft. Some ATS units/RCCs and aircraft operators may collaborate for emergency planning or exercise purposes.

ATS information to the aircraft operator (Annex 11, 5.5)

4.5.22 When an area control or a flight information centre decides that an aircraft is in the uncertainty or the alert phase, it will, when practicable, advise the operator prior to notifying the RCC. If an aircraft is in the distress phase, the RCC has to be notified immediately. All information notified to the RCC by an area control or flight information centre will, whenever practicable, also be communicated, without delay, to the aircraft operator.

Procedures for recovery from emergency phase

4.5.23 The emergency status is monitored by the ATS unit. The Emergency phase may be closed as a result of detection of a false alarm or disappearance of the cause of the emergency. Confirmation needs to be received from the crew, ATS unit, aircraft operator and RCC if applicable.

5.0 Implementation Plan

5.0.1 This chapter provides an initial overview of relevant tasks necessary to fully implement the target concept.

5.0.2 All the necessary tasks identified are detailed in the table below. The Block 0, Block 1, Block 2 referred to in the timeline relates to the timelines outlined in the ICAO Global Air Navigation Plan (GANP) - see http://www.icao.int/sustainability/pages/GANP.aspx. The ICAO Block Upgrades refer to the target availability timelines for a group of operational improvements (technologies and procedures) that will eventually realize a fully-harmonized global air navigation system. By way of example, Block 0 (2013) features modules characterized by operational improvements which have already been developed and implemented in many parts of the world today. It therefore has a near-term implementation period of 2013–2018.

	Task	Block	Lead	Due Date	Status	Notes
Aircraft tracking	AT.01 - Resolve ADS-C tracking initiation issues linked to FPL correlation.	Block 0	CP	Nov-14	Complete	In Annex 10 proposal from OPLINKP
	AT.02 - Assess and identify possible means of compliance.	Block 0	ATTF	Sep-14	Complete	
	AT.03 - Develop and implement basic provisions for Aircraft tracking.	Block 0	ICAO	Nov-16	In Progress	Proposed SARPS published in State Letter AN 11/1.1.29-15/12 issued 25 February 2015
	AT.04 - Develop and implement revised provisions for aircraft tracking based on operational experience.	Block 1	FLTOPSP	Nov-18	Not Started	Pending completion of AT.03 and industry experience
	AT.05 - Assess extending applicability to other aircraft operations.	Block 2	FLTOPSP	Nov-22	Not Started	Pending Completion of AT.04
ADT	ADT.01 - Develop and implement performance based Standards for Autonomous Distress Tracking.	Block 0	FLTOPSP-FLIREC WG	Mar-16	In Progress	Proposed SARPS published in State Letter AN 11/1.1.29-15/15 issued 15 May 2015
	ADT.02 - Assess and identify possible means of compliance.	Block 0	ICAO / INDUSTRY	Mar-16	In Progress	
	ADT.03 - Specification for flight event detection and triggering criteria.	Block 0	EUROCAE	Feb-16	In Progress	
	ADT.04 - Specification for new generation ELTs	Block 0	EUROCAE/ RTCA	April-17	In Progress	

	Task	Block	Lead	Due Date	Status	Notes
	ADT.05 - Assess issue of non-carriage and/or non-registration of 406 ELTs and taken appropriate measures.	Block 0	ICAO	Nov-15	In Progress	PIRGS and COSPAS/SARSAT to provide information
	ADT.06 - Rationalisation of existing ELT SARPs.	Block 1	FLTOPSP-FLIREC WG		Late	Existing jobcard addresses this issue
	ADT.07 - Assess extending applicability to other aircraft operations.	Block 2	FLTOPSP-FLIREC WG	Nov-18	Not Started	
	ADT.08 – Specifications for ADT	Block 1	EUROCAE/ RTCA	Mar-18	Not Started	Requires development of MOPS for ADT
Flight Data Recovery	ADFR.01 - Develop and implement performance based standards for automatic deployable flight recorders.	Block 0	FLTOPSP-FLIREC WG	Mar-16	In Progress	Proposed SARPS published in State Letter AN 11/1.1.29-15/YY issued XX May 2015
	ADFR.02 - Develop and implement performance based standards for alternative means of flight data recovery	Block 1	FLTOPSP-FLIREC WG	Mar-18	Not Started	Requires development of MOPS for 'streaming' of flight recorder data
	ADFR.03 - Assess extending applicability to other aircraft operations.	Block 2	FLTOPSP-FLIREC WG	Nov-21	Not Started	Pending completion of ADFR.01
SWIM	SWIM.01 - Develop GADSS Information Management framework including data formats taking account of information ownership, security and confidentiality.	Block 1	IMP	Mar-18	Not Started	
	SWIM.02 - Develop GADSS Communication framework including analysis of communication needs and constraints of current communication infrastructures.	Block 1	IMP	Mar-18	Not Started	
	SWIM.03 - Identify FF-ICE information elements in support of GADSS (e.g. to associate ADT messages to the aircraft operator).	Block 2	ATMRPP	Mar-20	Not Started	
Info repository services	IRS.01 - Set-up GADSS repository (including Point of Contact information and areas of jurisdiction).	Block 0	ICAO	Sep-16	Not Started	

	Task	Block	Lead	Due Date	Status	Notes
GADSS Procedures	PROC.01 - Assess the shortcomings in coordination and information sharing between ANSPs and between Civil/Military in support of emergency and SAR situations.	Block 0	ICAO		Not Started	Circ 330 to be revised.
	PROC.02 - Assessment of the impact of FIR and SRR boundaries (non-coincidental, overlapping and gaps).	Block 0	ICAO		Not Started	Seconded expert from Australia
	PROC.03 - Assessment of compliance to existing Annex 12 standards and development of an action plan.	Block 0	ICAO		Not Started	Seconded expert from Australia
	PROC.04 - Review of Standard Operating Procedures (SOP) for in-flight activation of ELTs.	Block 0	FLTOPSP/ INDUSTRY		Not Started	
	PROC.05 - Review of Annex 11 Chapter 5 (emergency phases and time sequence including initial 30 minute period).	Block 0	ICAO		Not Started	Seconded expert from Australia
	PROC.06 - Develop guidance material on initial and recurrent inflight emergency training for ATS units.	Block 0	ICAO		Not Started	
	PROC.07 - Explore ways to enhance SatVoice usability in distress situations (see INMARSAT-C).	Block 0	ATMOPSP		Not Started	
	PROC.08 - Assess current status (inventory) of the world airline fleet's carriage of distress beacons other than fixed ELT's (legacy 121.5 MHz versus 406 MHz beacons).	Block 0	ICAO/ COSPAS SARSAT		Not Started	Seconded expert from Australia
	PROC.09 - Raise awareness among airlines of the impact carriage of legacy 121.5 beacons (that are no longer detected by the COSPAS SARSAT system).	Block 0	ICAO/IATA		Not Started	Seconded expert from Australia
	PROC.10 - Assess feasibility of new provisions to require ANSPs to share aircraft position data.	Block 0	ICAO		Not Started	

	Task	Block	Lead	Due Date	Status	Notes
	PROC.11 – Review and assess the coordination responsibilities during the transition of operations from Annex 12 to Annex 13.	Block 0	AIGP		Not Started	First AIGP meeting in Spring 2015
	PROC.12 - Review ATS and SAR procedures to take account of aircraft tracking and Autonomous Distress Tracking.	Block 0	ATMOPSP		Not Started	
OTHER	OTHR.01 - Ensure spectrum protection of frequencies used in the GADSS (e.g. frequency used by space based ADS-B)	Block 0	FSMP		In progress	ITU WRC 2015
	OTHR.02 - Update of the GANP	Block 0	ICAO	Apr-16	In progress	Needs to include 'ASBU' on GADSS
	OTHR.03 - Resolve datalink delivery assurance for downlink messages (ATN baseline 2 deployment)	Block 2	CP-OPLINK		In progress	

6.0 Concept Scenarios

6.0.1 An important element of any ConOps is to analyse how the target concept will operate from the user's perspective. To do this, various operational scenarios are developed that will test the proposed solution and help identify any shortcomings.

6.0.2 Scenarios may also be used to validate and further develop the target concept and to test possible solutions. The set of scenarios used should be designed to test all elements of the system including equipment design, human interface and operational processes.

6.0.3 Appendix C provides some typical example scenarios. It also includes a basic analysis of four of the scenarios, provided as guidance on how to document the analysis of a proposed solution against each scenario.

Appendix A: Terms and abbreviations

The following list is provided to help explain terms and abbreviations used in this document.

TERM	Explanation
ADT	Autonomous Distress Tracking
AHWG	Ad-hoc Working Group on Aircraft Tracking
ARCC	Aeronautical rescue coordination centre
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
ATSU	Air Traffic Service Unit
ELT	Emergency Locator Transmitter
FF-ICE	Flight and Flow Information for a Collaborative Environment
FIC	Flight Information Centre
FIR	Flight Information Region
FIS	Flight Information Service
FOC	(Airline) Flight Operations Centre
FPL	Flight Plan
HF	High Frequency
ICAO	International Civil Aviation Organisation
IMO	International Maritime Organisation
JRCC	Joint Rescue Coordination Centre
MRCC	Maritime rescue coordination centre
RCC	Rescue Coordination Centre
RSC	Rescue sub-centre
SAR	Search and Rescue
SOP	Standard Operating Procedures
SRR	Search and Rescue Region
SWIM	System wide information management
ULB	Underwater Locator Beacon
VHF	Very High Frequency

Appendix B: Related Reference Data

Details on the initial aircraft tracking meeting including working papers and recommendations may be found on the ICAO website at:
http://www.icao.int/meetings/GTM/Pages/default.aspx

Possible tracking solutions previously identified by an international working group established by the French BEA may be viewed at:
http://www.bea.aero/en/enquetes/flight.af.447/flight.data.recovery.working.group.final.report.pdf

BEA analysis on triggering may be viewed at:
http://www.bea.aero/en/enquetes/flight.af.447/triggered.transmission.of.flight.data.pdf

Details of the work performed by Eurocontrol in the OPTIMI project may be viewed at:
http://www.eurocontrol.int/articles/src-position-papers-review-reports

Details of Research on effectiveness of ELTs conducted by the Australian Transport Safety Board may be viewed at:
http://www.atsb.gov.au/publications/2012/ar-2012-128.aspx

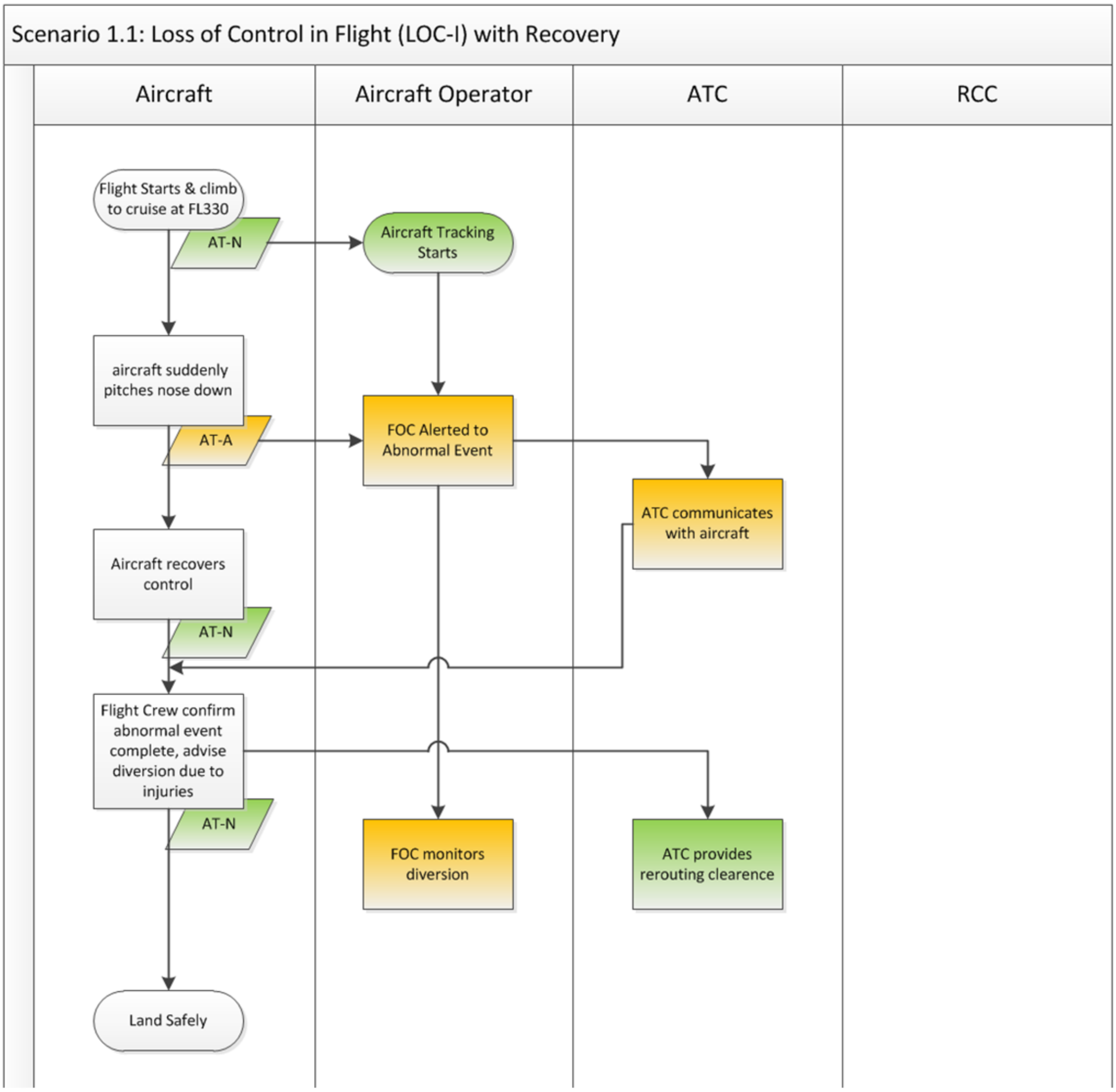
Appendix C: Concept Scenario

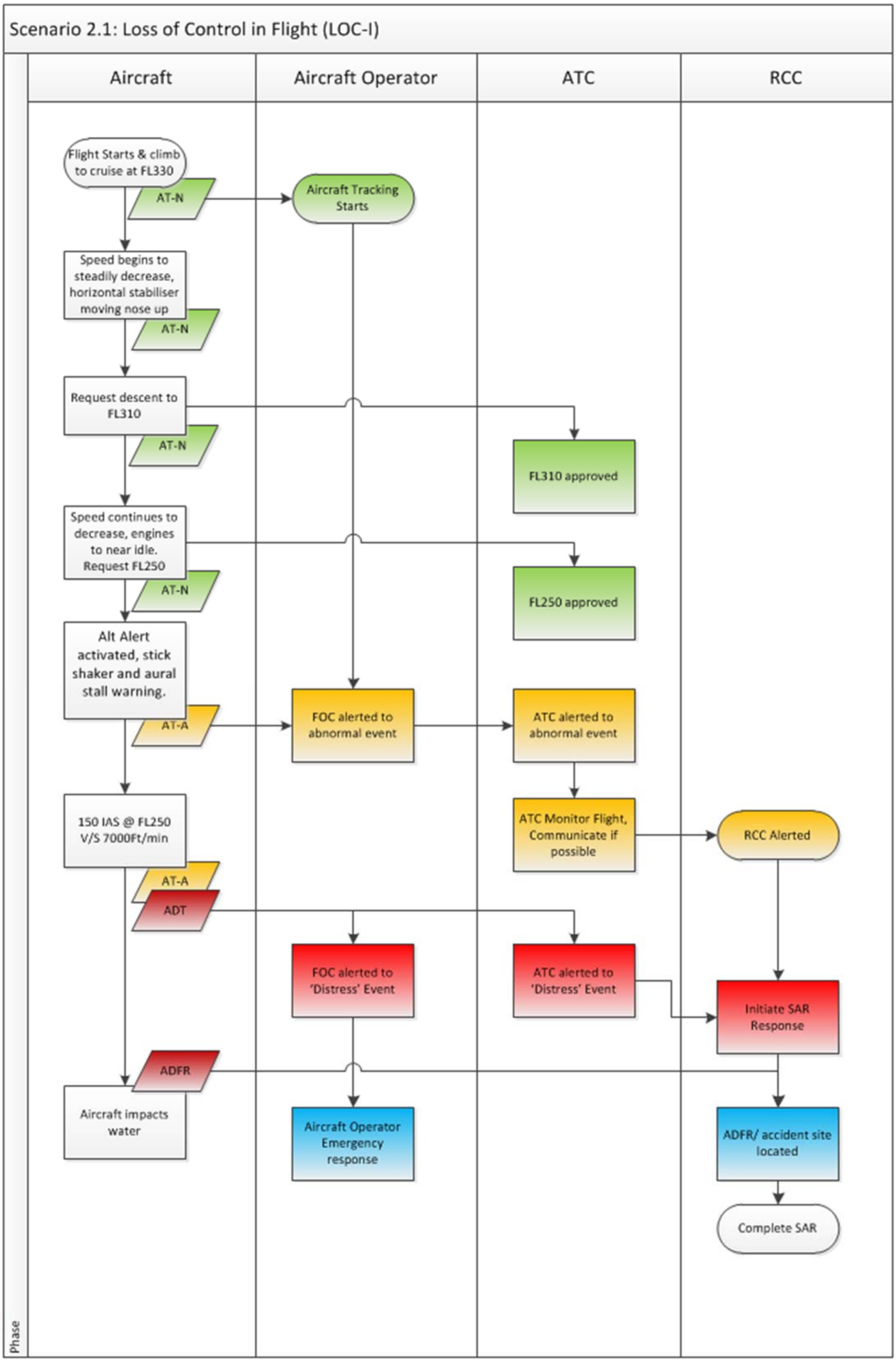
The following are some typical example scenarios:

Event	Summary
1	***Aircraft experiences an in-flight abnormal event and recovers***
1.1	**Loss of control in-Flight (LOC-I) with recovery** The aircraft suddenly pitches nose down while in the cruise at Flight Level (FL) 330. Within 27 seconds, the aircraft lost 4,440 feet, before the self-protection system initiated a recovery back towards controlled flight. The aircraft diverted to an airport and lands safely. The resulting negative g forces are sufficient for almost all of the unrestrained passengers and crew to be thrown towards the ceiling, resulting in a number of minor injuries.
1.2	**Engine failure in flight** As the aircraft takes-off, the fan cowl doors from both engines detached, puncturing a fuel pipe on the right engine, damaging the airframe, and some aircraft systems. The flight crew elects to return to the departure airport. On the approach to land an external fire develops on the right engine. The left engine continues to perform normally throughout the flight. The right engine is shut down and the aircraft lands safely. The emergency services extinguish the fire in the right engine. The passengers and crew are evacuating the aircraft via the escape slides. Subsequent investigation revealed that the fan cowl doors on both engines were left unlatched during maintenance and this was not identified prior to aircraft departure.
1.4	**Failure of communication system, failure to report position or operational status** The aircraft was dispatched with VHF1 unserviceable for return to its main base. During the flight the aircraft experienced a communication systems fault which resulted in loss of all VHF communication, with no alternative voice communication system available. The aircraft followed standard procedures for loss of communications and landed safely.
1.5	**System Component Failure (non-powerplant)** While the aircraft is in cruise at 37,000 feet, one of the aircraft's three air data inertial reference units started outputting intermittent, incorrect values (spikes) on all flight parameters to other aircraft systems. Two minutes later, in response to spikes in angle of attack (AOA) data, the aircraft's flight control primary computers commanded the aircraft to pitch down. Many passengers and crew members were injured. The flight crew recovered the aircraft and landed safely
1.6	**Fuel related (FUEL)** While en route at FL390 over oceanic area, the crew becomes aware of a fuel imbalance between the left and right-wing main fuel tanks. Five minutes later the crew is concerned about the lower-than-expected fuel quantity indication, and decides to divert to a diverting Airport. When the crew ascertains that a fuel leak could be the reason for the possible fuel loss, an emergency is declared to Oceanic Control. At 85 nm from diverting airport and at an altitude of about FL345, the second engine flames out. An engines-out visual approach is carried out and the aircraft landed safely.
2	***Aircraft experiences an in-flight abnormal event which leads to an accident***
2.1	**Loss of control in-Flight (LOC-I)** The aircraft is at its cruising altitude of FL330. The speed begins to steadily decrease. The horizontal stabilizer is moving nose up during this deceleration. The flight crew is discussing weather concerns that included possible icing conditions and the possible need to turn on engine

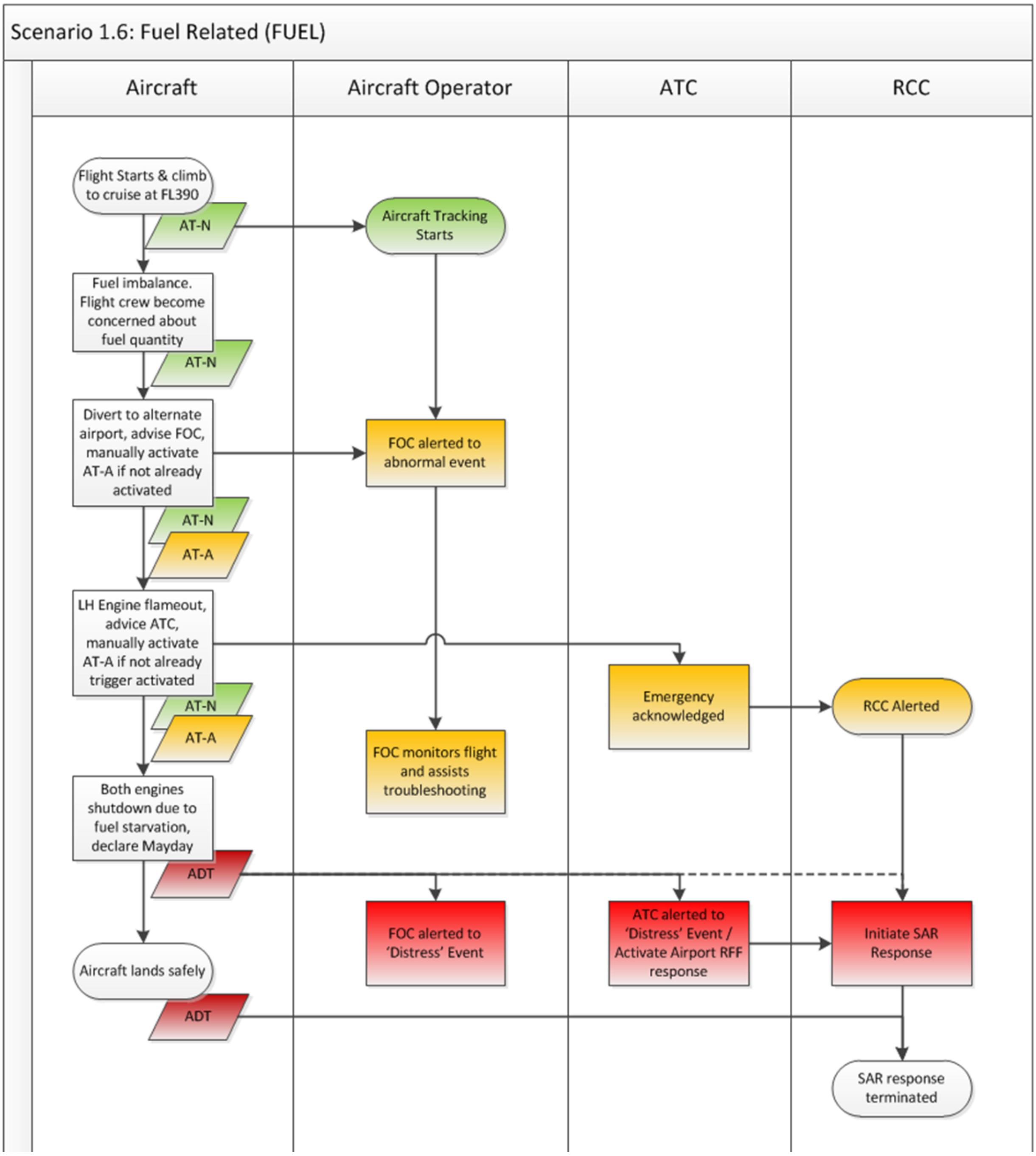
	and airfoil anti-ice. The flight crew requests permission to descend to FL310, which was approved. The autopilot is disconnected and the airplane starts to descend. As the airplane is descending past about FL315, the airspeed continued to decrease and the engine EPR decreased to about flight idle. A few minutes later a further descent to FL240 is requested. In the meantime, the altitude alert warning is activated, followed by the stick shaker and the aural stall warning alert. The airspeed is reaching a minimum of about 150 indicated air speed (IAS) knots at about FL250. The aircraft descends at 7000 ft/min, and finally crashed. The entire descent from FL330 has taken approx. 3 minutes and 30 seconds.
2.2	**Mid-Air Collision (MAC)** Two aircraft are flying at the same altitude on the same route on opposite direction. The crews of both aircraft received a Resolution Advisory (RA)-command from their TCAS. One of the crew complies with the order and initiates a descent. At the same time the other crew is trying to deal with the conflicting descent (by ATC) and climb (TCAS) instructions. The crew then decided to follow the ATC controller's instructions. Just prior to the collision, both crews detected the other aircraft, and reacted to avoid the collision by attempting appropriate flight maneuvers. Nevertheless, both aircraft collide.
2.3	**In-flight break-up** The aircraft is flying at a cruising altitude of FL350. An explosion on board causes the aircraft to crash. The explosive device is located in the cargo hold. The device is most probably hidden in baggage.
2.4	**Powerplant system/component failure or malfunction (SCF-PP)** After take-off as the aircraft is reaching an altitude of 3000 feet the crew sees a formation of Canada geese. Several loud thuds are heard. The ingestion of large birds into each engine, results in an almost total loss of thrust in both engines. The crew decides that they would not be able to land safely. The crew descends over the river until it ditches.
2.5	**Fire (F)** The aircraft is flying in cruise over oceanic area. The pilots detect an unusual odor in the cockpit. They determine that some smoke is present in the cockpit. Four minutes later a Pan Pan radio call is made. The pilots report that there is smoke in the cockpit and request an immediate return to a convenient airport. The ATC controller immediately clears the aircraft to descend to FL310. At this time, the pilots are using their oxygen masks. The controller clears the aircraft to descend to 10000 feet. The aircraft is descending through approximately FL210 when the pilots decide to dump fuel. The flight is vectored to dump fuel. The pilots declare Emergency. Last radio contact is lost one minute later. The fire had propagated, causing severe disturbances of the electric system.
2.6	**CFIT** During an approach the aircraft descended below Minimum Descent Altitude (MDA), and the crew was losing visual contact with the airfield due to weather conditions. The crew then decided not to follow the published procedures, thus transgressing out of the protected airspace. The crew did not respond to more than 20 EGPWS warnings related to approaching rising terrain and pull up. The airplane flew into the side of a mountain.
2.7	**Aircraft communication system Failure** While on route at cruising altitude ,all communication with the aircraft is lost. The aircraft never reaches its final destination and disappears from civilian and military radars.

The analysis of the concept should be conducted in a consistent manner to allow objective comparison of alternative solutions. The 'swim-lane' methodology is one approach that may be appropriate for this ConOps and is used below for illustrative purposes.

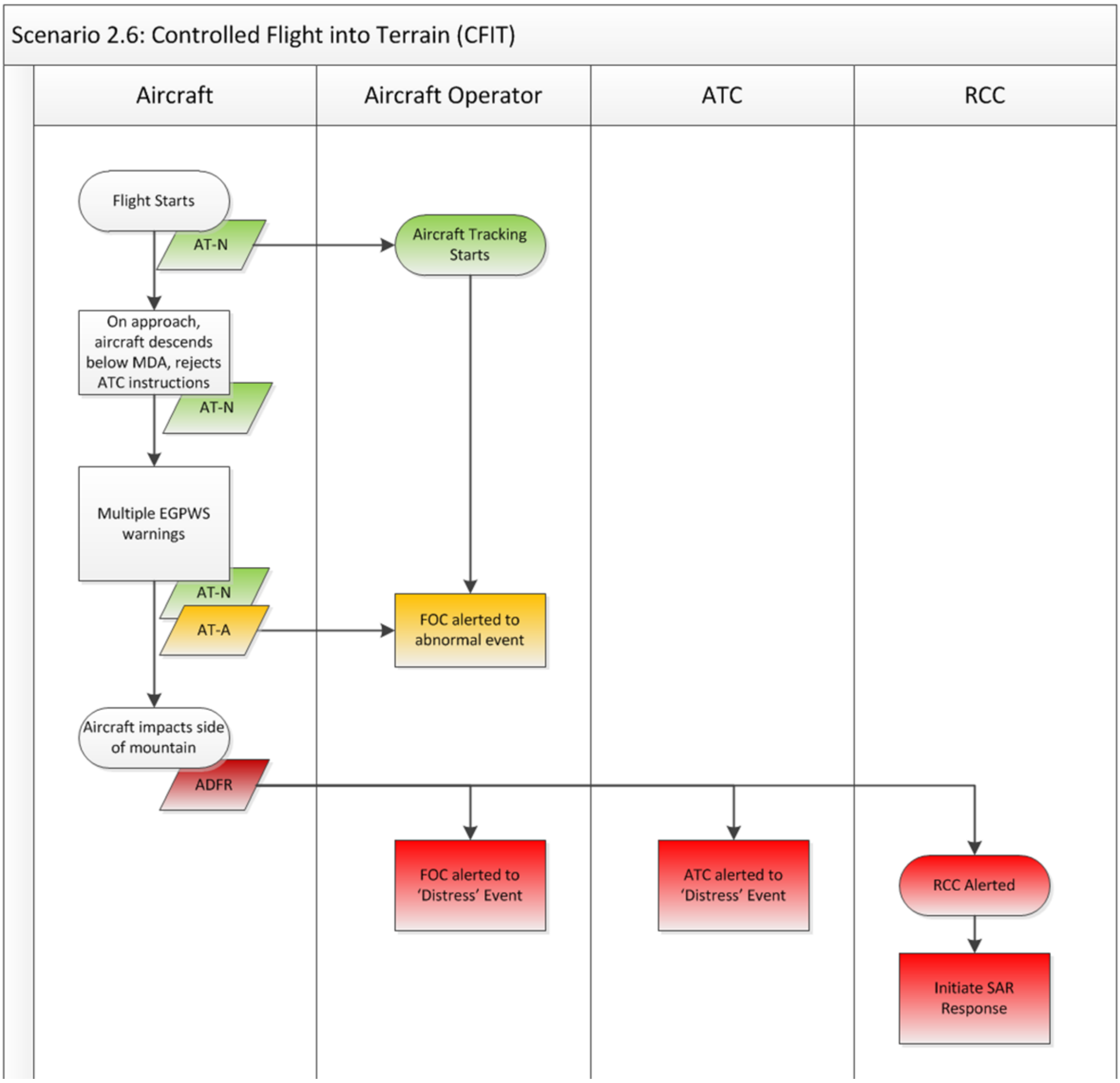




Scenario 2.1: Loss of Control in Flight (LOC-I)
Aircraft
Aircraft Operator
ATC
RCC
Phase
Flight Starts & climb to cruise at FL330
AT-N
Aircraft Tracking Starts
Speed begins to steadily decrease, horizontal stabiliser moving nose up
AT-N
Request descent to FL310
AT-N
FL310 approved
Speed continues to decrease, engines to near idle. Request FL250
AT-N
FL250 approved
Alt Alert activated, stick shaker and aural stall warning.
AT-A
FOC alerted to abnormal event
ATC alerted to abnormal event
150 IAS @ FL250 V/S 7000Ft/min
ATC Monitor Flight, Communicate if possible
RCC Alerted
AT-A
ADT
FOC alerted to 'Distress' Event
ATC alerted to 'Distress' Event
Initiate SAR Response
ADFR
Aircraft impacts water
Aircraft Operator Emergency response
ADFR/ accident site located
Complete SAR



Scenario 1.6: Fuel Related (FUEL)
Aircraft
Aircraft Operator
ATC
RCC
Flight Starts & climb to cruise at FL390
AT-N
Aircraft Tracking Starts
Fuel imbalance. Flight crew become concerned about fuel quantity
AT-N
Divert to alternate airport, advise FOC, manually activate AT-A if not already activated
FOC alerted to abnormal event
AT-N
AT-A
LH Engine flameout, advice ATC, manually activate AT-A if not already trigger activated
Emergency acknowledged
RCC Alerted
AT-N
AT-A
FOC monitors flight and assists troubleshooting
Both engines shutdown due to fuel starvation, declare Mayday
ADT
FOC alerted to 'Distress' Event
ATC alerted to 'Distress' Event / Activate Airport RFF response
Initiate SAR Response
Aircraft lands safely
ADT
SAR response terminated


Scenario 2.6: Controlled Flight into Terrain (CFIT)
Aircraft
Aircraft Operator
ATC
RCC
Flight Starts
AT-N
Aircraft Tracking Starts
On approach, aircraft descends below MDA, rejects ATC instructions
AT-N
Multiple EGPWS warnings
AT-N
AT-A
FOC alerted to abnormal event
Aircraft impacts side of mountain
ADFR
FOC alerted to 'Distress' Event
ATC alerted to 'Distress' Event
RCC Alerted
Initiate SAR Response

Appendix D: Impact Assessment

New SARP / PANS Proposal

IMPACT ASSESSMENT

1.What is the problem that this proposal is designed to solve?

Please include reference to Jobcard / ASBU / work programme item, as applicable **Ensure that information is provided in a timely fashion to the right people to support search and rescue, recovery and accident investigation activities as outlined in the Concept of Operations for a Global Aeronautical Distress & Safety System (GADSS)**

2. What alternatives to SARPs/PANs were considered to solve the problem?

None	Circular	Manual	Policy	Other (*please explain*)
				Voluntary implementation of Aircraft tracking by industry

3a. What is the impact of this proposal on a **State**?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The impact of this proposal represents a large financial cost to the State (rulemaking, hiring, training, oversight, capital, etc)	*Large cost*			X	*Negligible cost*
Rationale: ***The implementation of the GADSS will represent a cost to States to implement the new provisions in national law and some possible changes to the State's processes for SAR, however, the provisions will be implemented as part of the normal ICAO Annex amendment cycle over the next 6 years. The implementation of GADSS will enable more efficient search, rescue and recovery operations, reducing cost to States***					
Implementing this proposal will have a positive safety impact	*Increased safety*	X			*Reduced safety*
Rationale: ***The implementation of the GADSS will improve the ability of SAR to efficiently determine an aircraft is in a distress phase and to locate and rescue survivors. It will also ensure flight recorder data can be retrieved effectively, allowing earlier identification of any possible safety related issues. Furthermore, due to GADSS ability to provide a reduced search area it reduces the scale of SAR operations and hence reduces the risk to SAR crews.***					
Implementing this proposal will have a positive security impact	*Enhanced security*		X		*Reduced Security*

Rationale: ***The implementation of the GADSS will improve the ability of a State to recognise whether an aircraft is a security threat or not. ADT will allow the location of the aircraft to be continuously sent independently of the other aircraft systems and power supply.***					
Implementing this proposal will have a positive environmental impact (reduction in atmospheric or surface pollutants, noise, etc)	*Reduced Environmental Impact*		X		*Increased Environmental Impact*
Rationale: ***Any impact is considered negligible.***					
Implementing this proposal will have a positive impact on the efficiency of the air transportation system	*Increased efficiency*		X		*Decreased efficiency*
Rationale: ***Any impact is considered negligible.***					

3b. Do the benefits of this proposal justify the cost of implementing the proposal?

Yes	No	Not sure	Not applicable
X			

4a. What is the impact of this proposal on **Industry**?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The impact of this proposal represents a large financial cost to industry (compliance, new equipment, training, etc)	*Large cost*	X			*Negligible cost*
Rationale: ***The implementation of the GADSS will represent a cost to airlines. It is envisaged that the installation of the complete GADSS requires installation of new equipment on newly delivered aircraft after 2020, however, this cost should be mitigated by a consolidation of other equipment requirements in Annex 6 and other possible benefits that aircraft tracking may provide. The on-going operational cost of aircraft tracking will depend on the individual solutions adopted by airlines. ATSUs will be required to implement SWIM, however, the GADSS is only one of the functions of SWIM and should not be considered the primary reason for capital investment. There will be process and training related costs for industry.***					
Implementing this proposal will have a positive safety impact	*Increased safety*	X			*Reduced safety*
Rationale: ***The implementation of the GADSS will improve the ability of an operator to quickly recognise if an aircraft is in distress and to implement its emergency plans as necessary. The GADSS will improve ATSU knowledge of flights where surveillance is not available, allowing earlier detection of the necessary emergency phase.***					
Implementing this proposal will have a positive security impact	*Enhanced security*	X			*Reduced Security*

Rationale: ***The implementation of the GADSS will improve the ability of an airline or an ATSU to recognise whether an aircraft is a security threat or not. ADT will allow the location of the aircraft to be continuously sent independently of the other aircraft systems and power supply.***					
Implementing this proposal will have a positive environmental impact (reduction in atmospheric or surface pollutants, noise, etc)	*Reduced Environmental impact*		X		*Increased Environmental Impact*
Rationale: ***Any impact is considered negligible***					
Implementing this proposal will have a positive impact on the efficiency of the air transportation system	*Increased efficiency*		X		*Decreased efficiency*
Rationale: ***Any impact is considered negligible***					

4b. Do the benefits of this proposal justify the cost of implementing the proposal?

Yes	No	Not sure	Not applicable
X			

5. How long would it take for States and Industry to implement this proposal?

Already implemented	0-1 yrs	1-2 yrs	2-5 yrs	5-10 yrs	more than 10 yrs
			Aircraft Tracking	**SWIM**	**ADT & ADFR**

Appendix E: Cross Reference Table

	Area of Improvement	Primary High Level Requirement	Target Concept	Concept Steps
2.1a	Reduction in the reliance on Emergency Locator Transmitters (ELT) (lack of system redundancy) to identify accident site	Enhance the ability to rescue survivors	ADT	ADT.01 – ADT.03 ADFR.01 – ADFR.02
2.1b	Improvement in the (timely) activation of ELTs	Enhance the ability to rescue survivors	ADT	ADT.03
2.1c	Ensure operators are meeting the 406MHz ELT equipage requirement.	Enhance the ability to rescue survivors	ADT	ADT.04
2.1d	Improvement in the robustness and range of location devices	Enhance the ability to rescue survivors	ADT	ADT.03
2.1e	Improvement in the existing systems to ensure the accident investigation authority can always retrieve adequate data to allow determination of probable causes.	Ensure that the location of an accident site can be identified to a degree of accuracy, in a timeframe and to a level of confidence acceptable to the stakeholders.	ADFR	ADFR.01 – ADFR.02 ADT.05 – ADT.06
2.1f	Ensure existing Emergency and Abnormal operating procedures maximise the potential of the ELT to perform effectively and provide a distress signal.	Enhance the ability to rescue survivors	ADT	PROC.04
2.1g	Improvement in the overall registration of 406MHz ELTs	Enhance the ability to rescue survivors	ADT	ADT.04
2.1h	Improvement in the level of carriage of 406MHz survival ELTs (ELT(S)) for overwater operations	Enhance the ability to rescue survivors	ADT	PROC.08, PROC.09
2.1i	Increase aircraft equipage for transmitting their 4D position and identity.	Enhance the ability to rescue survivors	AT	AT.02, AT.03, OTHR.01
2.1j	Increase the use of current aircraft capability to transmit their 4D position and identity for aircraft tracking purposes.	Enhance the ability to rescue survivors	AT	AT.01, PROC.07 OTHR.02 – OTHR.03

	Area of Improvement	Primary High Level Requirement	Target Concept	Concept Steps
2.1k	Expansion of space- and ground- based infrastructure to achieve global coverage during all phases of flight.	Function worldwide	AT	AT.02-AT.04 OTHR.01
2.1l	Reduce reliance on HF as sole means of communications over remote and oceanic areas.	Provide immediate notification when an aircraft experiences an abnormal event	AT	AT.02
2.2a	Improvement in existing ATS capabilities where voice is the only means to ensure the timely identification of abnormal events experienced by aircraft, where voice is the only means of position reporting.	Provide immediate notification when an aircraft experiences an abnormal event	AT	AT.02-AT.05
2.2b	Improvement in existing ATS procedures to ensure, on a worldwide basis, that the location of an accident site will be identified to a degree of accuracy, in a timeframe and to a level of confidence acceptable to the stakeholders	Ensure that the location of an accident site can be identified to a degree of accuracy, in a timeframe and to a level of confidence acceptable to the stakeholders.	GADSS Procedures	PROC.05
2.2c	Improvements in Airspace coordination to prevent any compromise in the mechanism for ensuring receipt of overdue position reports	Provide immediate notification when an aircraft experiences an abnormal event	GADSS Procedures	PROC.02
2.2d	Improvements by ANSPs in consistently sharing data with other ANSPs and operators	Provide immediate notification when an aircraft experiences an abnormal event	GADSS Procedures	SWIM.01 – SWIM.03 PROC.10
2.2e	Increased experience in using emergency procedures preventing decreased proficiency when required	Provide immediate notification when an aircraft experiences an abnormal event	GADSS Procedures	PROC.06

	Area of Improvement	Primary High Level Requirement	Target Concept	Concept Steps
2.2f	Reduction in complacency due to 'normalised' lack of HF communications	Provide immediate notification when an aircraft experiences an abnormal event	GADSS Procedures	PROC.05
2.2g	Improved civil / military coordination and information sharing in support of emergency situations	Provide immediate notification when an aircraft experiences an abnormal event	GADSS Procedures	PROC.01
2.2h	Improved ICAO SARPs for raising of an INCERFA	Provide immediate notification when an aircraft experiences an abnormal event	GADSS Procedures	PROC.05
2.3a	Improvement by States to ensure Aeronautical Search and Rescue regions are always aligned with the FIRs.	Enhance the ability to rescue survivors	GADSS Procedures	PROC.02 – PROC.03
2.3b	Improvement by States to ensure Aeronautical Search and Rescue regions are always aligned with maritime SRRs.	Enhance the ability to rescue survivors	GADSS Procedures	PROC.02
2.3c	Improved Compliance by States with ICAO Annex 12 obligations in relation to SAR.	Function worldwide	GADSS Procedures	PROC.03
2.3d	Improved ability for RCCs to quickly determine the actual geographic air traffic picture within its area of responsibility.	Enhance the ability to rescue survivors	AT/SWIM	SWIM.01-SWIM.03
2.3e	Improved understanding of responsibilities and coordination for the transition of Annex 12 to Annex 13	Not cause degradation of the baseline SAR service	GADSS Procedures	PROC.11

	Area of Improvement	Primary High Level Requirement	Target Concept	Concept Steps
2.3f	Increased experience in using SAR procedures preventing decreased proficiency when required.	Function worldwide	GADSS Procedures	PROC.06
2.3g	Improvement and definition of the co-ordination of In-Flight Emergency Response (IFER)	Not cause degradation of the baseline SAR service	GADSS Procedures	PROC.12
2.4a	Improved abilities to identify the responsible RCC for the region in which the aircraft experiences the emergency.	Provide immediate notification when an aircraft experiences an abnormal event	Information Repository	IRS.01
2.4b	Improved ability to reach operational staff of ATS Centres/Units and RCC's.	Function Worldwide	Information Repository / SWIM	IRS.01
2.4c	Improved ability to reach operations staff of aircraft operators.	Function Worldwide	Information Repository / SWIM	IRS.01
2.4d	Improved ground communication capabilities	Function Worldwide	SWIM	SWIM.01 – SWIM.03
2.4e	Enhance provisions for effective use of English language by Points of Contact (ATSU, RCC, Aircraft Operator)	Function Worldwide	GADSS Procedures	SWIM.01 – SWIM.03