International Civil Aviation Organization

AIR NAVIGATION SYSTEMS IMPLEMENTATION GROUP

First Meeting (ANSIG/1)
(Cairo, Egypt, 10 – 12 February 2015)

Agenda Item 4: Performance Framework for Regional Air Navigation Implementation

SAR ISSUES

(Presented by the Secretariat)

SUMMARY

This paper presents the status of implementation of the Search and Rescue (SAR) in the MID Region and the latest developments related to SAR.

Action by the meeting is at paragraph 3.

REFERENCES

- ATM SG/1 Report
- ATTF Report
- HLSC 2015
- ICAO/IMO SAR GMDSS Conference
- MMGFT Report

1. INTRODUCTION

1.1 The Standards, Recommended Practices and Procedures and guidance material related to the implementation of Search and Rescue (SAR) are contained in ICAO Annex 12, International Aeronautical and Maritime Search and Rescue Manual (IAMSAR - Doc 9731) and Regional Supplementary Procedures (Doc 7030), SAR (EUR and MID/ASIA Chapter 11).

1.2 It is to be highlighted that the updating process of the IANSAR-Doc 9731 is ongoing and the new amendment is expected to be released in 2016.

2. DISCUSSION

2.1 The meeting may wish to note that the SAR deficiencies in the MID Region concern mainly the:

a) lack of signature of SAR agreements;
b) lack of plans of operations for the conduct of SAR operations and SAR exercises;
c) training of SAR personnel and SAR inspectorate staff;
d) lack of provision of required SAR services; and
e) non-compliance with the carriage of Emergency Locator Transmitter (ELT) requirements.

2.2 The meeting may wish to note that the ATM SG/1 meeting (Cairo, Egypt, 9-12 June 2014) reviewed and updated the status of SAR agreements between ANSPs in the MID Region as at **Appendix A**.

2.3 The ATM SG/1 meeting recalled that MIDANPIRG/14 noted the concerns raised by States related to the difficulties they are facing in the implementation of ICAO Annex 12 provisions related to SAR cooperation and coordination. The meeting agreed that a step-wise approach should be followed for the implementation of these provisions. In this respect, it was highlighted that the Model of SAR Agreement available in the IAMSAR Manual (Doc 9731, Volume I, Appendix I) does not support this approach, since it covers all the Annex 12 Standards and Recommended Practices related to SAR cooperation. Accordingly, MIDANPIRG/14 agreed that a simplified MID Region Model of SAR Agreement/ Bilateral Arrangements should be developed to foster the implementation of Annex 12 provisions in a step-wise approach; and urged States to include in the Letter of Agreements (LoA) between the Area Control Centres (ACCs) a Section related to SAR cooperation.

2.4 In connection with the above, MIDANPIRG/14 meeting recalled that the national SAR Legislative and Regulatory framework should provide for the cooperation and coordination with neighboring States of the SAR operations, especially when these operations are proximate to adjacent Search and Rescue Regions (SRR).

2.5 Based on the above, MIDANPIRG/14 agreed to the following Decision:

DECISION 14/16: SEARCH AND RESCUE COOPERATION

That, the ATM Sub-Group develop a simplified MID Region Model of SAR Agreement/Bilateral Arrangements to foster the implementation of Annex 12 provisions related to SAR cooperation in a step-wise approach.

2.6 The ATM SG/1 meeting received with appreciation the proposals presented by Bahrain, Iran and UAE related to the SAR Letter of Agreement Model as well as some other proposals that might enhance the SAR services in the MID Region.

2.7 The ATM SG/1 meeting agreed to the establishment of a MID SAR Action Group composed of SAR Experts from volunteer States and ICAO. The meeting agreed that the Action Group should develop a SAR Agreement/Bilateral Arrangement Model based on the proposed models/templates, carry out a gap analysis related to the status of implementation of SAR services in the MID Region based mainly on the USOAP-CMA data; and develop necessary recommendations and guidance that would enhance the SAR services in the MID Region. The meeting agreed that the outcome of the Action Group be presented to the MSG/4 or ANSIG/1 meeting. Accordingly, the meeting agreed to the following Draft Decision:

DRAFT DECISION 1/8: MID SEARCH AND RESCUE ACTION GROUP

That, a MID SAR Action Group be established with Terms of Reference as at Appendix 7B.

a) develop a simplified MID Region Model for SAR Agreement/Bilateral Arrangements to foster the implementation of Annex 12 provisions related to SAR cooperation in a step-wise approach;

b) carry out a Gap Analysis related to the status of implementation of SAR services in the MID Region; and

c) develop necessary recommendations and guidance that would enhance the SAR services in the MID Region.

2.8 The meeting may wish to note that the SAR AG developed a draft SAR bilateral Arrangements Template to be used by the adjacent ACCs in the MID Region. The Template is also attached to the Letter of Agreement Template as Appendix I (refer to WP/19). The SAR AG also agreed to a draft matrix to be used for the analysis of the status of SAR services in the MID Region, as at **Appendix B**.

2.9 The meeting may wish to note that all MID States have designated a SAR Point of Contact (SPOC) for the reception of the COSPAS-SARSAT messages. The SPOC contact details are at **Appendix C**. States are invited to update their SPOC details, as appropriate, by accessing the COSPAS-SARSAT website through the following link: http://www.cospas-sarsat.org/en/component/cospasfrontend/ .

2.10 The MID Region SAR Focal Points List is at **Appendix D**, which is still missing the contact details of several States' focal point.

2.11 The ATM SG/1 meeting reviewed the Safety Recommendations related to SAR at **Appendix E**, which were issued further to the loss of the AFR flight 447 on 1 June 2009 over the Atlantic Ocean, and the associated follow-up actions undertaken by ICAO.

2.12 The ATM SG/1 meeting noted that events such as the loss of AF447 and the disappearance of MH370 for a prolonged period of time have reiterated the need to improve global flight tracking capabilities in the near term. Accordingly, a Multidisciplinary Meeting on Global Flight Tracking (MMGFT) was convened in Montreal, Canada, 12-13 May 2014 to address the flight tracking issues. The meeting was apprised of the Recommendations issued by the Bureau d'Enquêtes et d'Analyses pour la Sécurité de L'aviation Civile (Accident Investigation Bureau of France, BEA) related to the disappearance of AF 447 investigations and by the ICAO High-level Safety Conference (HLSC) held in Montreal, Canada, 29 March – 1 April 2010.

2.13 The ATM SG/1 meeting reviewed the Conclusions and Recommendations of the MMGFT at **Appendix F** and encouraged States and Users to take necessary measures to support the implementation of these Recommendations.

2.14 In connection with the above, the Second High Level Safety Conference 2015 (HLSC 2015) (Montreal, Canada, 2-5 February 2015) noted the developments related to global flight tracking, which were initiated during the MMGFT following the disappearance of the Malaysia Airlines Flight MH370. The MMGFT meeting concluded that global flight tracking should be pursued as a matter of urgency and as a result, two groups were formed; the ICAO ad hoc Working Group, which developed a concept of operations to support future development of a Global Aeronautical Distress and Safety System (GADSS) and the Aircraft Tracking Task Force (ATTF), an industry-led group under the ICAO framework that identified near-term capabilities for normal flight tracking using existing technologies.

2.15 The GADSS Concept of Operations (CONOPS) was presented to the HLSC 2015 for review and feedback. The HLSC 2015 provided suggestions and recommendations to enhance the GADSS with specific text; proposals for provisions; and that a performance-based approach should be included in the concepts of operation. The Conference noted the plan to finalize the GADSS by the third quarter of 2015.

2.16 The HLSC 2015 was updated on the search for MH370 and the lessons learned from this tragic occurrence. The Secretariat outlined the planned timelines for a proposed amendments to Annex 6 — *Operation of Aircraft, Part I — International Commercial Air Transport — Aeroplanes*, regarding normal flight tracking. The Conference agreed that ICAO should continue developing performance-based provisions for aircraft tracking, which provide industry with viable options, as a matter of urgency.

2.17 With regards to the flight tracking technology, the HLSC 2015 noted the ATTF Report which detailed existing technologies and services which are already installed on aircraft and which could be used to perform global aircraft tracking. This range of technologies and services will enable operators to take a performance-based approach when implementing aircraft tracking capabilities. The ATTF Report contained a set of performance-based criteria that could be used to establish a baseline level of aircraft tracking capability. Additionally, the Report also identified future technologies that could support flight tracking in oceanic and remote airspace such as satellite-based Automatic Dependent Surveillance – Broadcast (ADS-B). In this regard, the Conference supported that ICAO should encourage States and the International Telecommunication Union (ITU) to discuss allocation requirements at the World Radio communication Conference in 2015 (WRC-15) to provide the necessary frequency spectrum allocations to enable global Air Traffic Services (ATS) surveillance. The Conference strongly encouraged industry to begin implementing flight tracking on a voluntary basis.

2.18 The HLSC 2015 agreed that ICAO should lead an implementation initiative designed to expedite integration of best practices in use today, including but not limited to operator flight monitoring, ATS, SAR and civil/military cooperation. Industry stakeholders agreed to support this effort. Additionally, the Conference agreed that the implementation initiative should be conducted in a multinational context and that planning should begin shortly after the HLSC 2015; this can be concluded by 31 August 2015 to enhance guidance material used to advance normal tracking procedures.

2.19 The HLSC 2015 noted the challenges and suggestions to improve SAR activities through regional SAR organizations. The Conference agreed that regional SAR training exercises related to abnormal flight behavior can serve as a means to maintain proficiency on seldom used emergency procedures and also provide feedback to further develop the GADSS in the future. This is particularly the case when cooperation amongst several stakeholders is essential.

2.20 The HLSC 2015 noted and fully supported the ongoing work on extending the recording duration of cockpit voice recorders (CVR).

2.21 The HLSC 2015 supported the need for reviewing and improving the interaction between Annex 12 — *Search and Rescue* and Annex 13 — *Aircraft Accident and Incident Investigation* when SAR operations are completed but searching continues to locate the aircraft for investigation purposes.

2.22 The HLSC 2015, recognizing that recent occurrences had demonstrated the need for improvements in the coordination of civil and military flights in high seas airspace, called upon Contracting States to ensure proper civil/military coordination so that due regard is taken by military aircraft when using high traffic density areas over high seas.

2.23 The meeting may wish to note that the ICAO/IMO Search and Rescue-Global Maritime Distress and Safety System Conference (ICAO/IMO SAR GMDSS Conference), was successfully held in Bahrain 21-22 October 2014. The Conference was hosted by Bahrain and dedicated to the Gulf Cooperation Council (GCC) States. The Conference was attended by a total of sixty two (62) participants from five (5) States (Bahrain, Kuwait, Oman, Saudi Arabia, and UAE).

2.24 The ICAO/IMO SAR GMDSS Conference provided a forum for sharing experiences and discussing relevant matters to SAR between Civil/Military Aeronautical and Maritime representatives. The following topics were presented and discussed during the Conference:

- SAR activities in the framework of ICAO and IMO;
- SAR systems of Bahrain, Oman, Saudi Arabia and UAE;
- SAR regulatory regime in ICAO and IMO;
- Responsibilities of SAR authorities;
- Cooperation and coordination between aeronautical and maritime authorities;

- Introduction to the Global Maritime Distress and Safety System (GMDSS);
- SAR Communications; (including: COSPAS-SARSAT; Emergency Locator Transmitter (ELT); Emergency Position-Indicating Radio Beacon (EPIRB) and the use of Long-Range Identification and Tracking (LRIT) information for SAR purposes);
- Lessons learned from recent accidents;
- Continuous improvements of SAR services; and
- Examples on SAR Regional Cooperation were also presented.

2.25 The following are the main Recommendations emanating for the ICAO/IMO SAR GMDSS Conference related to Civil Aviation, inviting GCC States to:

- provide IMO and ICAO with information related to the availability of SAR services, including information on the areas of responsibility, taking into account IMO's and ICAO provisions, as soon as possible if not already done so, and keep the information up to date on a regular basis;
- noting that close cooperation between maritime and aeronautical SAR services is essential, establish a national SAR Coordinating Committee;
- develop a national SAR Plan, to the extent possible, ensuring harmonization with SAR Plans of the neighboring States, for the benefit of effective and efficient SAR cooperation;
- consider the development of a multilateral agreement on the cooperation of aeronautical and maritime SAR and the establishment of a Regional SAR Coordinating Committee, in the framework of the GCC;
- sign the SAR Letters of Agreement (LoAs) to facilitate and expedite the efficient conduct of SAR operations;
- evaluate SAR and GMDSS facilities and identify actions to be taken to improve the existing situation, including the establishment of Rescue Coordination Centres, as appropriate;
- keep record of all SAR activities and as such built up statistics for national use as well to be used in communication with IMO and ICAO, as appropriate;
- share lessons learned related to SAR activities;
- develop a short and long term programme for training of SAR personnel, including those involved in the oversight of SAR;
- conduct national, bilateral and multilateral SAR exercises and use lessons learned to identify capacity building needs; and
- request, as appropriate, either individually or in cooperation with other GCC States, IMO and/or ICAO to provide technical assistance, in particular to:

  a) assess the existing situation and provide recommendations for improvement; and

  b) support the training of personnel involved in SAR.

2.26 The meeting may wish to note that ACAC and ICAO are planning to organize a joint Workshop on SAR, in Morocco, tentatively, 20-22 May 2015, back-to-back with a full scale exercise that will be conducted by the Moroccan relevant authorities. The invitation letter to the Workshop will be issued in due course.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) review and update:

i. the Status of SAR agreements between ANSPs at **Appendix A**;

ii. the draft matrix for the analysis of the status of SAR services in the MID Region, as at **Appendix B**, as appropriate;

iii. the list of SAR Point of Contact (SPOC) for the reception of the COSPAS-SARSAT messages at **Appendix C**; and

iv. the list of SAR focal points in the MID Region at **Appendix D**;

b) urge States to take necessary measures to ensure the implementation of the ICAO provisions related to SAR;

c) encourage Sates and Users to:

i. support the implementation of the Multidisciplinary Meeting on Global Flight Tracking Conclusions and Recommendations at **Appendix F**;

ii. review the Draft Global Aeronautical Distress and Safety System (GADSS) and the Aircraft Tracking Task Force (ATTF) Report and Recommendations at **Appendices G** and **H**, respectively, and provide their comments to ICAO;

iii. take into consideration the Recommendations emanating from the ICAO/IMO SAR GMDSS Conference related to Civil Aviation at para 2.25; and

iv. attend the ACAC/ICAO SAR Workshop, Morocco, tentatively scheduled for 20-22 May 2015.

d) agree to task the ATM SG with the development of an action plan for the conduct of regional/sub-regional SAR training exercises; and

e) agree on a mechanism for the coordination of the safety-related SAR issues between MIDANPIRG and RASG-MID.

APPENDIX A

MID REGION SAR AGREEMENT STATUS BETWEEN ANSPS/ACCS
February 2015

STATE	CORRESPONDING STATES			REMARKS
BAHRAIN	☐ IRAN ☐ SAUDI ARABIA	☐ KUWAIT ☐ UAE	☐ QATAR	0/5
EGYPT	☒ CYPRUS ☐ JORDAN ☐ SUDAN	☐ GREECE ☒ LYBIA	☐ Israel ☐ SAUDI ARABIA	1/7
IRAN	☐ ARMENIA ☐ BAHRAIN ☐ OMAN ☐ TURKMANISTAN	☐ AZERBAIJAN ☐ IRAQ ☐ PAKISTAN ☒ UAE	☐ AFGHANISTAN ☐ KUWAIT ☐ TURKEY	1/11
IRAQ	☐ IRAN ☒ JORDAN	☐ KUWAIT ☐ SAUDI ARABIA	☐ SYRIA ☐ TURKEY	1/6
JORDAN	☐ EGYPT ☒ IRAQ	☐ ISRAEL ☐ SAUDI ARABIA	☐ SYRIA	1/5
KUWAIT	☐ BAHRAIN ☐ IRAN	☐ IRAQ	☐ SAUDI ARABIA	0/4
LEBANON	☒ CYPRUS	☐ SYRIA		1/2
LIBYA	☐ ALGERIA ☐ CHAD ☐ EGYPT	☐ MALTA ☐ NIGER	☐ SUDAN ☐ TUNIS	0/7
OMAN	☐ INDIA ☐ IRAN	☒ SAUDI ARABIA ☐ PAKISTAN	☐ UAE ☐ YEMEN	1/6
QATAR	☐ BAHRAIN	☐ SAUDI ARABIA	☐ UAE	0/3
SAUDI ARABIA	☐ BAHRAIN ☐ IRAQ ☒ OMAN ☐ UAE	☐ EGYPT ☐ JORDAN ☐ Qatar ☐ YEMEN	☐ ERITREA ☐ KUWAIT ☐ SUDAN	1/11
SUDAN	☐ CENTRAL AFRICAN ☐ CHAD ☐ EGYPT	☐ ERITREA ☐ ETHIOPIA ☐ LIBYA	☐ SAUDI ARABIA ☐ SOUTH SUDAN	0/8
SYRIA	☐ IRAQ ☐ JORDAN	☐ LEBANON ☒ CYPRUS	☒ TURKEY	2/5
UAE	☐ BAHRAIN ☒ IRAN	☐ OMAN ☐ SAUDI ARABIA	☐ QATAR	1/5
YEMEN	☐ DJIBOUTI ☐ ERITREA ☐ ETHIOPIA	☐ INDIA ☐ OMAN ☐ SAUDI ARABIA	☐ SOMALIA	0/7

☒ Agreement Signed ☐ Agreement NOT Signed Signed Agreements / Total No. of required Agreements

---

MID SAR Capability Matrix (Last Update: 2015)

	Legislation	Oversight	SAR Committee	Training	Alerting	SAR Agreements	Internal cooperation/ coordination	Communications	Quality Assurance	Civil/Military	Resources	SAREX	Library	Computerization	SAR Plan	SAR aircraft	ELTs			SPOC
																	Regulation	Registration	Test	
Bahrain																				
Egypt																				
Iran																				
Iraq																				
Jordan																				
Kuwait																				
Lebanon																				
Libya																				
Oman																				
Qatar																				
Saudi Arabia																				
Sudan																				
Syria																				
UAE																				
Yemen																				

A = Fully meets Annex 12 requirements
B = Meets Annex 12 requirements in most areas
C = Meets Annex 12 requirements in some areas
D = Initial implementation
E = Not implemented
Blank = No response

SAR Matrix Element Descriptions

Training: The appropriate level and type of training provide to RCCs and RSCs and SAR Inspectorate Staff. Availability of training programme and training plans
Oversight: the effectiveness of the States' oversight activities conducted over the RCC and RSCs
Alerting: Fast and reliable means for the rescue coordination center to receive distress alerts. (IAMSAR Manual Vol. 1, Chapter 2)
Legislative: Provisions that establish a legal foundation for establishing a SAR organization and its resources, policies, and procedures. (IAMSAR Manual Vol. I, Chapter 1)
SAR Committee: Typically established under a national SAR plan, the SAR coordinating committee is comprised of SAR stakeholders. (IAMSAR Manual Vol. 1, Chapter 6 and Appendix J)
Agreements : States should enter into agreements with neighboring States to strengthen SAR cooperation and coordination. (Chapter 3 – *Cooperation*, in both Annex 12 – Search and Rescue, and the International Convention on Maritime SAR)
Internal cooperation/ coordination: Close cooperation between services and organizations which may contribute to improving SAR service in areas such as operations, planning, training, exercises and research and development.
Communications: Communication capability for receipt of distress alerts and operational coordination among the SAR mission coordinator, the on-scene coordinator and SAR facilities. (IAMSAR Manual Vol. 1, Chapter 3)
Quality Assurance: Procedures to focus on improving the quality of SAR services so as to improve results and reduce costs. (IAMSAR Manual Vol. 1, Chapter 6)
Civil/Military: Close cooperation between the various civilian and military organizations.
Resources: The primary operational facilities made available to the national SAR system by various authorities and arrangements with others. (IAMSAR Manual Vol. 1, Chapter 5 and Appendix C)
SAR Exercise: Exercise to test and improve operational plans, provide learning experience and improve liaison and coordination skills. (IAMSAR Manual Vol. 1, Chapter 3; Annex 12, and Annex 14 regarding Airport Emergency Plan)
Library: Quick access to the applicable international, national, and agency SAR publications that provide standards, policy, procedures and guidance.
Computerization: Use of or access to output of various computer resources including databases, computer aids for SAR system management, search planning software, etc. (IAMSAR Manual Vol. 1, Chapter 2)
SAR Plan: National structure to establish, manage and support the provision and coordination of SAR services. (IAMSAR Manual Vol. 1, Chapter 1)
SAR aircraft: Number of aircraft provided with specialized equipment suitable for the efficient conduct of SAR missions (Annex 12, Chapter 2 - *Organization*)
ELT: National regulations for carriage of ELTs, and arrangements for registration of the 406 MHz beacon and rapid access to the beacon registration database. (Annex 6 – Operation of Aircraft and Annex 10 - Aeronautical Telecommunications; and IAMSAR Manual Vol. 1, Chapter 4) and if testing is carried out to ensure proper serviceability.

SPOC: A SAR Point of Contact (SPOC) designated for receipt of Cospas-Sarsat distress data, and arrangements for efficient routing of the distress data to the appropriate SAR authority (the aeronautical emergency locator transmitter ELT), maritime emergency position-indicating beacon (EPIRB), and personal locator beacon (PLB)). (Annex 12, paragraph 3.2.5 and Section 2.4; and, IAMSAR Manual Vol. 1, Chapter 4)

APPENDXI C

MID REGION SAR POINT OF CONTACT (SPOC) – COSPAS-SARSAT

STATE	SPOC NAME	ADDRESS	EMAIL	TEL	FAX	AFTN	ASS. MCC/ STATE[1]	LAST REVISION	REMARK
Bahrain	RCC ATC Bahrain	Bahrain CAA, Air Navigation Directorate P.O. Box 586 Kingdom of Bahrain	Bahatc@caa.gov.bh	(973) 17321081 17321080	(973) 17321905	OBBISARX	SAMCC Saudi Arabia	16-April-2013	
Egypt	SAR Centre	SAR Centre Almaza Air Base Heliopolis, Cairo, Egypt	jrcc136@afmic.gov.eg mmc@saregypt.net nahedh@tra.gov.eg	(202) 24184537 24184531	(202) 24184537 24184531	HECCYCYX	ALMCC Algeria	22-OCT-2013	TELEX: (91) 21095 RCCC RUN
Iran	RCC Tehran	Civil Aviation Organization SAR Coordination Centre Mehrabad Airport Tehran, Iran	SAR@cao.ir IRAN-SAR@airport.ir rcc.IRAN@airport.ir	(9821) 44544107 44544116 44544060 (9891)2417 6881	(9821) 44544117 44544106	OIIIZRZX	TRMCC Turkey	14-Jan-2013	
Iraq	CENTAF-AUAB CAOC JSRC			(974) 4503452 4364193	(974) 4327382		TRMCC Turkey	29-Sep-2009	
Jordan	RCC ATC Amman	RCC Civil Aviation Authority Amman Airport, Jordan		(9626) 4451672	(9626) 4451667	OJACZQZX	SAMCC Saudi Arabia	16-Apr-2013	
Kuwait	RCC ATC Kuwait	RCC DGCA Kuwait International Airport, P.O.Box 17, Kuwait		(965) 24760463 24762994	(965) 24346515 24346221	OKBKZQZX OKBKNSAR	SAMCC Saudi Arabia	16-Apr-2013	
Lebanon	RCC Beirut	RCC, DGCA Lebanon, Hariri Int'l Airport- Beirut, Lebanon		(961) 1628161	(961) 1628186 1629035	OLBIZQZX	SAMCC Saudi Arabia	16-Apr-2013	
Libya	CAA	CAA, Tripoli Int'l Airport, Libya	info@sar.caa.ly	(218.21) 5632332 4446799	(218.21) 563 0257 360 6868	HLLTYCYX	ALMCC Algeria	16-May-2013	TELEX (218.21) 5632332

[1] Associated COSPAS-SARSAT Mission Control Center / State where it is located

STATE	SPOC NAME	ADDRESS	EMAIL	TEL	FAX	AFTN	ASS. MCC/ STATE[1]	LAST REVISION	REMARK
				3606868					
Oman	RCC Muscat Air Force	RCC, HQ RAFO P.O.Box 730 Central Post Office Muscat Int'l Airport, Oman		(968) 24519209 24519332	(968) 24334776 24338692	OOMSYAYX	SAMCC Saudi Arabia	16-Apr-2013	
Qatar	RCC ATC			(974) 44616332 44651001 44616429	(974) 44622078 44678512	OTBDZTZX	SAMCC Saudi Arabia	16-Apr-2013	
Saudi Arabia	SAMCC	KSA.GACA / Air Navigation services P.O.Box 929 Jeddah 21421 Saudi Arabia	samcc@gaca.gov.sa	(96602) 6150170 6855812 (96650) 4601445	(96602) 6150171 6402855	OEJNJSAR	SAMCC Saudi Arabia	28-Jun-2013	TEL 3 & FAX 2 for Head of SAMCC
Sudan	ACC Khartoum	Khartoum Airport, Sudan		(249.183) 788192 784925	(249.183) 528323	HSSSYCYX	ITMCC Italy	16-Apr-2013	Thuraya +8821655524 296
Syria	RCC ATC	General Civil Aviation Authority		(963.11) 5400540	(963.11) 5400312	OSDIZQZX	SAMCC Saudi Arabia	16-Apr-2013	
UAE	AEMCC	SAR Coordination Center P.O.Box 906 GHQ Armed Forces UAE	aemcc@uae-jrcc.ae	(971.2) 4056144 4496866	(971.2) 4496844	OMADYCYX	AEMCC UAE	23-Sep-2011	
Yemen	RCC Sanaa	RCC Department of Civil Aviation Sanaa, Yemen		(967) 1344673	(967) 1345916	OYSNYCYX	SAMCC Saudi Arabia	16-April-2013	

APPENDIX D

MID REGION SAR FOCAL POINTS CONTACT DETAILS

STATE	NAME	TITLE	ADDRESS	EMAIL/AFS	FAX	TEL	MOBILE
Bahrain	ACC Duty Supervisor	ACC Duty Supervisor	Bahrain CAA P.O.Box – 586 Kingdom Of Bahrain	bahatc@caa.gov.bh	+973 17321029	+97317321081 +97317321080	
Egypt	Mr. Ibrahim Khalifa Mahmoud	General Director of Operations Centers & Crisis Management	Ministry of Civil Aviation Cairo - EGYPT	crisar@civilaviation.gov.eg	202 22681371	202 22678548	20124469052
Iran							
Iraq	Ali Muhsin Hashim	Director ATS	ANS Building, BIAP	Atc_iraqcaa@yahoo.com		964 7815762525	964 7815762525
Jordan	Mr. Khalaf Al-Shawabka	Chief Amman TACC and SAR	Queen Alia Airport	kshowbki@yahoo.co.nz	+962 445132	+ 962 4451672	96) 77790 4724
Kuwait							
Lebanon							
Libya							
Oman	RCC HQ RAFO		P.O.Box 722 Muscat P.C. 111, Oman	Hq.rafo.@rafo.gov.om AFS:- OOMSYCYX	+968 24334776	+968 24334211 +968 24334212	

STATE	NAME	TITLE	ADDRESS	EMAIL/AFS	FAX	TEL	MOBILE
Qatar							
Saudi Arabia	Mr. Ahmad B. Altunisi	Manager SAR Head of SAMCC	General Authority of Civil Aviation	jaf-2010@hotmail.com	966-2 671 9041	966-2 671 7717/1840	966-50 460 1445
Sudan							
Syria	Mr. Monif Abdulla	Head of S.A.R. Department Syrian Civil Aviation Authority	Damascus Airport	monif77@hotmail.com	963-11 540 0312	963-11 540 0312	963 932 710351
UAE	UAE ATC Duty Supervisor			atc@szc.gcaa.ae	971 2 599 6850	971 2 599 6969	
Yemen							

APPENDIX E

SAFETY RECOMMENDATIONS RELATED TO SAR (AFR 447)

1.To ensure the implementation of SAR coordination plans or regional protocols covering all of the maritime or remote areas for which international coordination would be required in the application of SAR procedures, including in the South Atlantic area	• Annex 12 — Search and Rescue, 3.1.2.1 Recommendation states that Contracting States should, in so far as practicable, **develop common SAR plans and procedures** to facilitate coordination with those of neighboring States. • This element is reviewed as part of the ICAO audit process, where **findings are often reported on the lack of SAR legislation or SAR plans**. • ICAO regional offices hold, from time to time, **regional SAR workshops** where this issue is progressed. • Also, in identifying the priority that needed to be placed on SAR in the APAC Region, APANPIRG established the **Asia/Pacific Regional Search and Rescue Task Force in 2012**. They will deliver a draft regional Search and Rescue Plan in **2015**.
2.To define the framework for the training of SAR operators in its Standards and Recommended practices	• Annex 12, paragraph 2.1.1.3 refers to the need for States **to establish processes to improve service provisio**n, **domestic and cooperative arrangements and training**. • The International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual, Volume II — Mission Co-ordination (Doc 9731), Section 1.8, **provides the guidance on training of SAR operators**. • The extent that this section of the IAMSAR Manual needs to be enhanced is being reviewed during 2013 and 2014 by the ICAO/IMO Joint Working Group (JWG) on SAR.
3.To ensure each Member State has a national point of contact and makes his/her contact information available	• Annex 12, paragraph 3.2.5 requires States to **designate a SAR point of contact** for the receipt of COSPAS-SARSAT distress data. • COSPAS-SARSAT verifies, from time to time, the validity of the SAR point of contact details and reports back to the ICAO-IMO JWG on SAR on their **findings**. • COSPAS-SARSAT and the ICAO regional offices follow up with States accordingly. In addition, **this aspect is reviewed during ICAO audits**. Follow-up of this recommendation will take place at the next ICAO-IMO JWG on SAR. (October 2014)
4. To amend Annex 12 on search and rescue operations so as to encourage Contracting States to equip their search aircraft with buoys to measure drift and to drop them, when these units are involved in the search for persons lost at sea.	This item is being discussed by the ICAO/IMO Joint Working Group (JWG) on SAR, and the **concept is supported**. The JWG will be proposing an amendment to the IAMSAR Manual in 2014 that is expected to be published in 2015/2016

APPENDIX F

CONCLUSIONS AND RECOMMENDATIONS
SPECIAL MEETING ON GLOBAL FLIGHT TRACKING
MONTRÉAL, 12-13 MAY 2014

The International Civil Aviation Organization (ICAO), upon the completion of this Special Meeting on Global Flight Tracking of Aircraft, forged consensus among its Member States and the international air transport industry sector on the near-term priority to track airline flights, no matter their global location or destination. Furthermore, the meeting established a framework for future efforts in this regard for the medium and long term.

The meeting concluded that:

NEAR-TERM

a) global tracking of airline flights will be pursued as a matter of priority to provide early notice of and response to abnormal flight behaviour;

b) a DRAFT concept of operations on flight tracking will be developed that includes a clear definition of the objectives of flight 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;

c) under the ICAO framework, the contribution by the industry through an Aircraft Tracking Task Force (ATTF) will help address the near-term needs for flight tracking;

d) ICAO will consider establishing a short term joint ICAO/IATA advisory group to support the global tracking initiative;

e) airlines will be encouraged to use existing equipment and procedures to the extent possible to support flight tracking pending the outcome of the AATF;

f) in partnership with the Task Force, ICAO will develop guidance material, based on available flight tracking best practices;

g) a FINAL high level concept of operations should be delivered to the ICAO High Level Safety Conference (HLSC 2015, February, Montreal);

h) ICAO should increase its resources allocated to the Search and Rescue in order to improve the effectiveness across national and regional boundaries;

i) ICAO should, in collaboration with a pool of search and rescue experts, identify and address operational search and rescue challenges with implementation of existing Annex 12 provisions, and provide assistance to States, including aiding in the setting of priorities for the mid and long term;

j) ICAO should facilitate the sharing of experience and lessons learned from States that were recently involved in accidents where flight tracking could have facilitated search and rescue efforts to all other States;

k) ICAO should strongly encourage States to regularly run practice exercises involving airlines operation centres, air navigation service providers (ANSPs) and rescue coordination centres (RCCs) to test and verify their ability to respond and coordinate together in an integrated manner to abnormal flight behaviour scenarios;

MID-TERM

l) ICAO performance based provisions should be developed, using a multidisciplinary approach, on flight tracking to support the location of an accident site in a timely manner for the purpose of search and rescue and accident investigation;

m) ICAO performance based provisions addressing flight tracking requirements should be sufficiently flexible to accommodate regional needs and be commensurate to operational situations;

n) ICAO should encourage States and International Telecommunication Union (ITU) to take action, at the earliest opportunity, to provide the necessary spectrum allocations as emerging aviation needs are identified. This includes spectrum for satellite and radio services used for safety of life aviation services. ICAO encourages ITU to place this on the Agenda for the upcoming ITU World Radio Conference 2015;

o) COSPAS-SARSAT should be invited to continue to investigate, within its own program and in partnership with the industry, the means of improving the reliability and utility of emergency locator transmitter (ELTs), particularly in the context of flight tracking during a distress event; and

LONG-TERM

p) ICAO should work in coordination with ITU to develop aviation requirements for network communications associated with remote storage of flight information.

- End -

English only

Concept of Operations

Global Aeronautical Distress & Safety System (GADSS)

Produced by:

Ad-hoc Working Group on Aircraft Tracking

Final Draft – Version 4.1

Document Version:	Final Draft – V4.1
Date Published:	10/10/2014
Approved on behalf of the AHWG:	Mr Henk Hof, Chairperson of the AHWG

Executive Summary

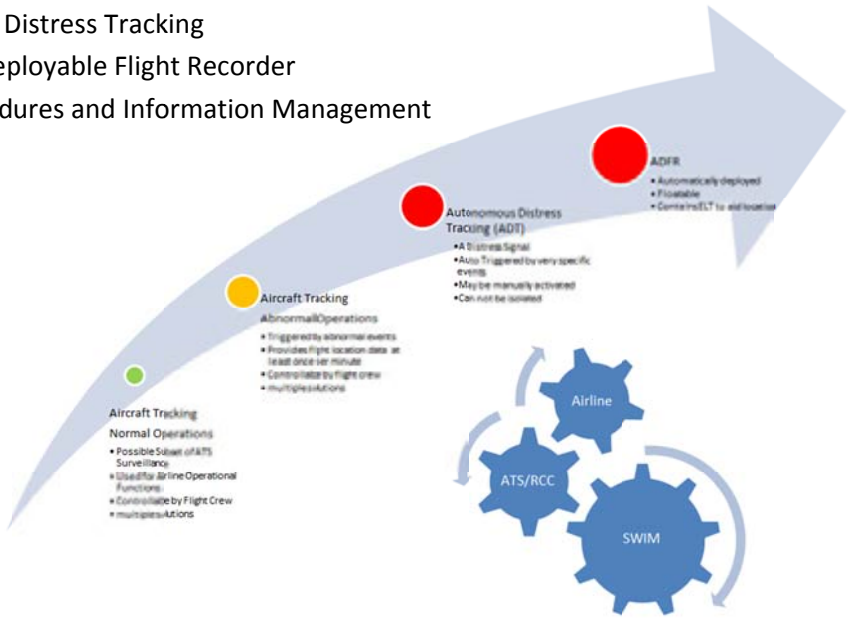
One of the many reasons why aviation maintains a high level of safety is the willingness to learn important lessons from rare events. The tragedies of Malaysia Airlines flight 370 and Air France flight 447 have highlighted vulnerabilities in the current air navigation system which have hampered timely 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 alerting, search and rescue services is essential.

The effectiveness of the current alerting and 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 recorders.

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
- Automatic Deployable Flight Recorder
- 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 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

Executive Summary **3**

1.0 Introduction **7**

1.1 Background 8

1.2 Scope of the Concept of Operations 8

1.3 Definitions 9

1.4 Annex References 10

1.5 Sequence of Events 11

2.0 Improvement Areas in Current Operating Environment **14**

2.1 Aircraft Systems 14

Emergency Locator Transmitters (ELTs) 17

Carriage of legacy analogue ELTs and distress beacons 18

Flight Recorders 19

2.2 Air Traffic Services (ATS) 19

ATS in Oceanic and Remote Airspace 20

2.3 The Search and Rescue (SAR) System 22

Search and Rescue Regions (SRRs) 24

Rescue Coordination Centres (RCCs) 24

Role of Air Traffic Services (ATS) Units 25

RCCs- Alerting and Aircraft Position Information 25

Implementation of SAR System by States 27

Non-coincident SRRs 28

2.4 Information Management 29

ATSU and RCC relationship with Aircraft Operators and their FOCs 30

Aircraft operating in the vicinity of an aircraft in a state of emergency 31

Aircraft Emergencies and RCC Response 31

3.0 High Level Requirements **33**

4.0 Target Concept **34**

4.1 Aircraft tracking 35

Users of Aircraft tracking Service 35

Aircraft Tracking Service Providers 35
4.2 Autonomous Distress Tracking 36
4.3 Automatically Deployed Flight Recorders 37
4.4 GADSS Information Management 37
System Wide Information Management 37
Information repositories services 39
4.5 GADSS Procedures 39
General 39
Procedures for declaring emergency phases 41
Procedures for emergency phase 43
Procedures for recovery from emergency phase 47
5.0 Concept Steps 48
6.0 Concept Scenarios 51

Appendix A: Terms and abbreviations 52
Appendix B: Related Reference Data 53
Appendix C: Concept Scenario 54
Appendix D: Impact Assessment 60
Appendix E: Cross Reference Table 63

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 This version of the ConOps represents the completion of the AHWG terms of reference. It 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 (Concept steps).

1.0.8 The AHWG chair and members remain available to ICAO, in advance of the High Level Safety Conference February 2015, to provide further revisions of the document if required.

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 and
b) study the possibility of making mandatory, the activation of the emergency locator transmitter (ELT).
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. The Flight Recorder Panel 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 will take effect in late 2014.

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)
- ***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.

PAN-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 shall 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 communication 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.

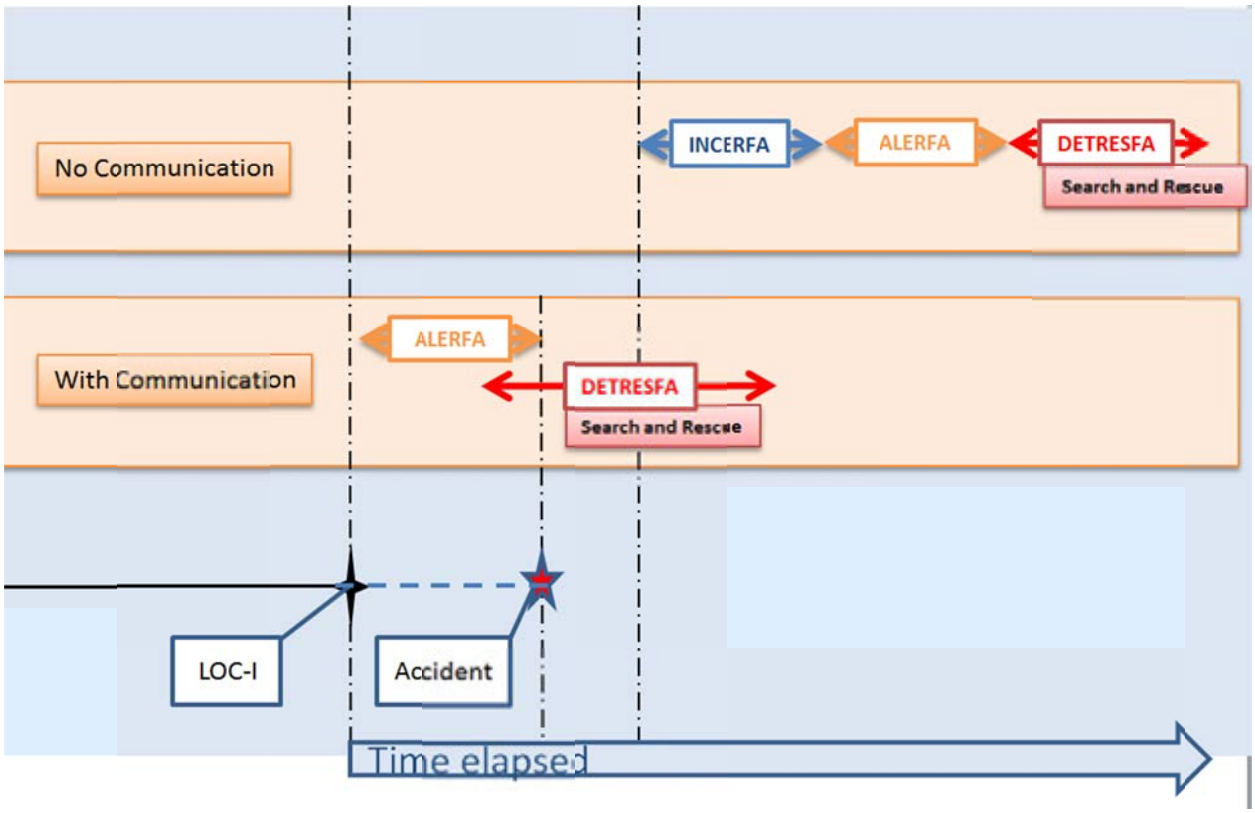


Figure 1a: timeline for alerting SAR with or without aircraft communication from a Ground perspective

1.5.7 In controlled airspace with surveillance, the position of the aircraft should be continuously known to the ATSU 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 Air Navigation Service Provider (ANSP), deviates into ANSP 2 before leaving into ANSP3.

1.5.8 With communication from the aircraft the ANSP1 is made aware of the situation and may raise an ALERFA and monitor the aircraft on surveillance radar. Without communication the ANSP1 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 ANSP2. This requires direct coordination between ANSPs. Likewise, when the aircraft departs into ANSP3 further coordination is required.

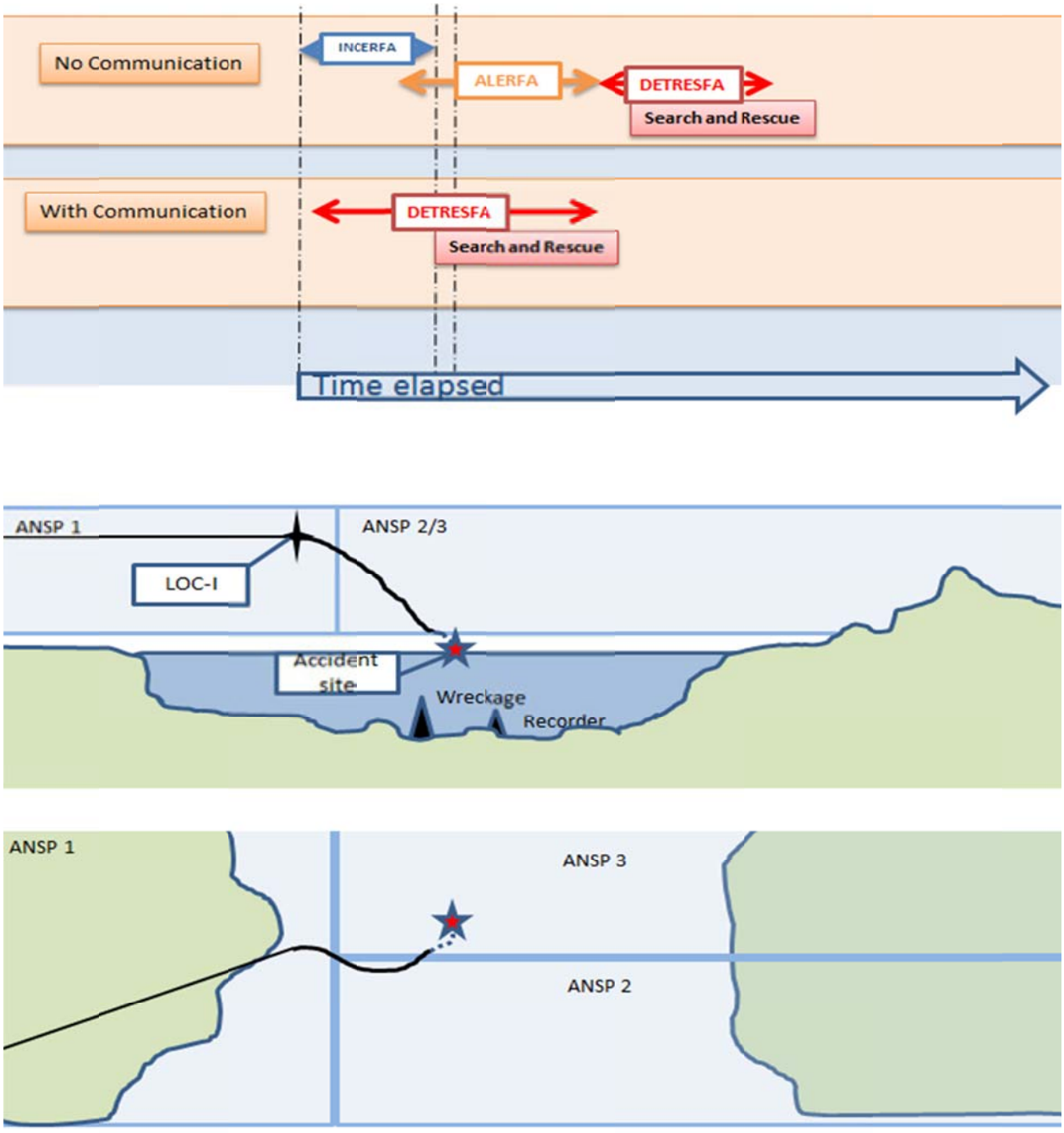


Figure 1b: timeline for alerting SAR with full surveillance & multiple ANSPs involved

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 surveillance (primary radar), are ground-based.

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.
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.

	Improvement Areas	Analysis
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 for continuous transmission of 4D position.
2.1j	Increase the use of 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.
2.1k	Expansion of space- and ground-based infrastructure to achieve global coverage during all phases of flight.	The ADS-B ground infrastructure is not complete enough to provide adequate global tracking capability. Spaced based ADS-B is not yet available. Existing Geostationary satellite systems tend to have incomplete coverage of the Globe, particularly 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.

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 ATC transponders (SSR or ADS-B) 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 ANSP. 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.

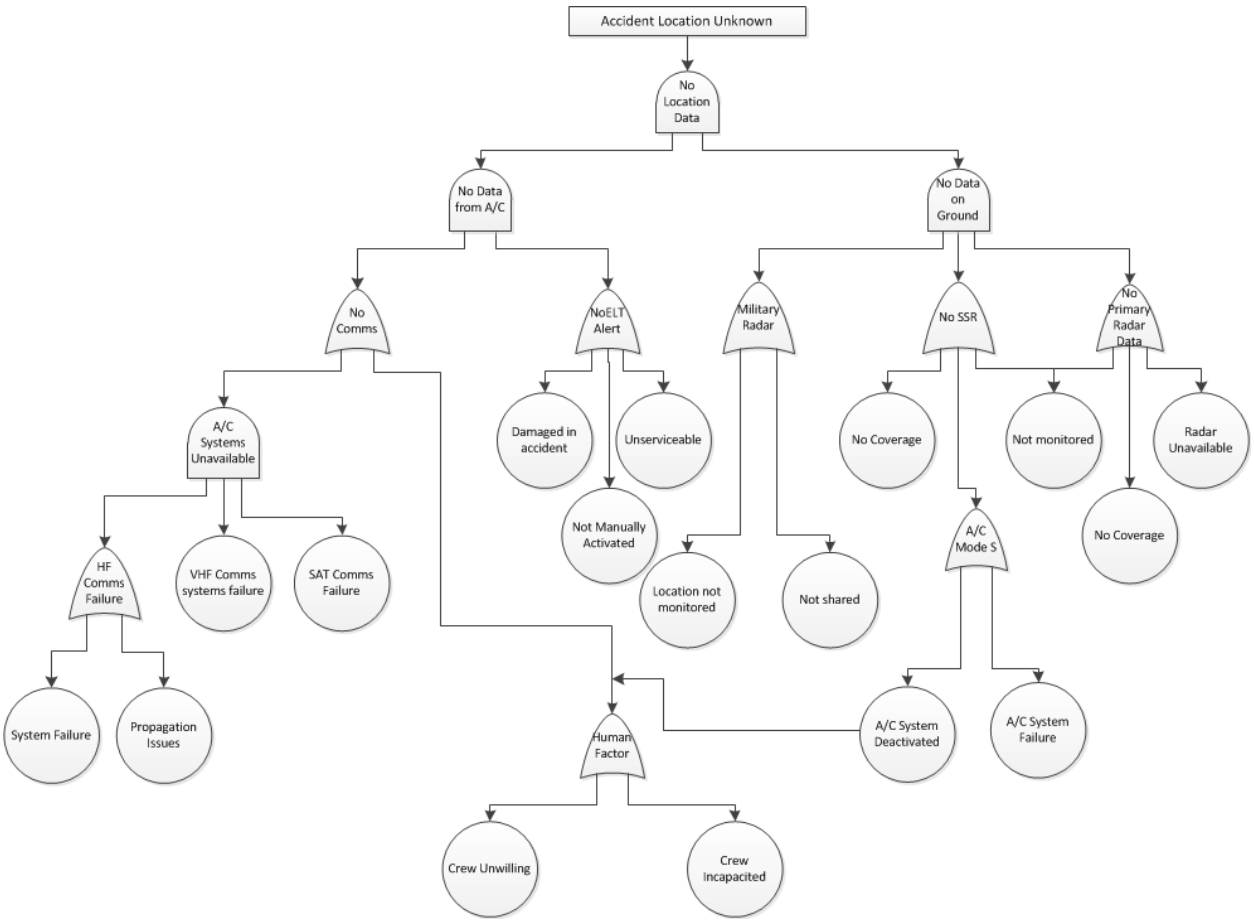


Figure 3: Simplistic Fault Tree for 'Accident Location Unknown'

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 shall 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 time. 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. There is no airborne and/or ground automation 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.
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.

	Improvement Areas	Analysis
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 ATSU) 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 ATSU 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 ATSU has to provide the appropriate datalink service and not all ANSPs 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 ATSU 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 ATSU’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 Air Traffic Service Units (ATSUs). 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 ATSU) 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 ATSUs. 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 ATSU 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
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 ATSUs and RCC, and between civil and military authorities and other stakeholders

	Improvement Areas	Analysis
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 ATSU 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 shall 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 (ATSUs) 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.

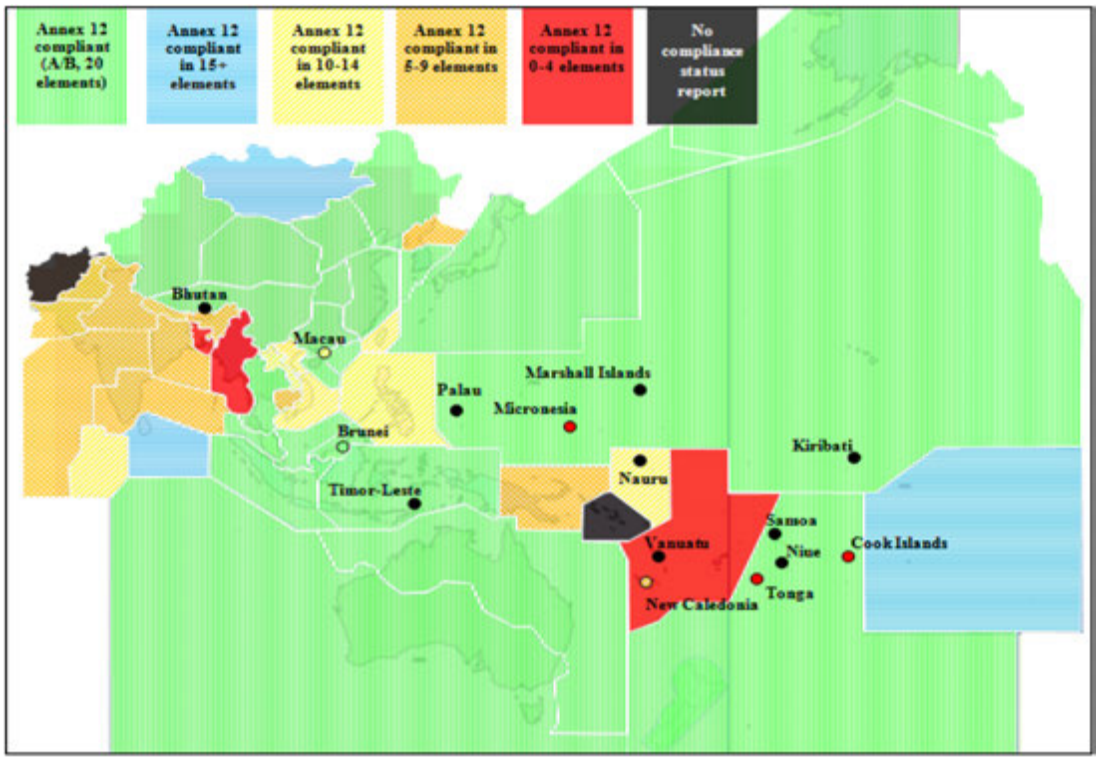


Figure 4 – ICAO Asia/Pacific Regional SAR Overview of Compliance with Annex 12.

(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.

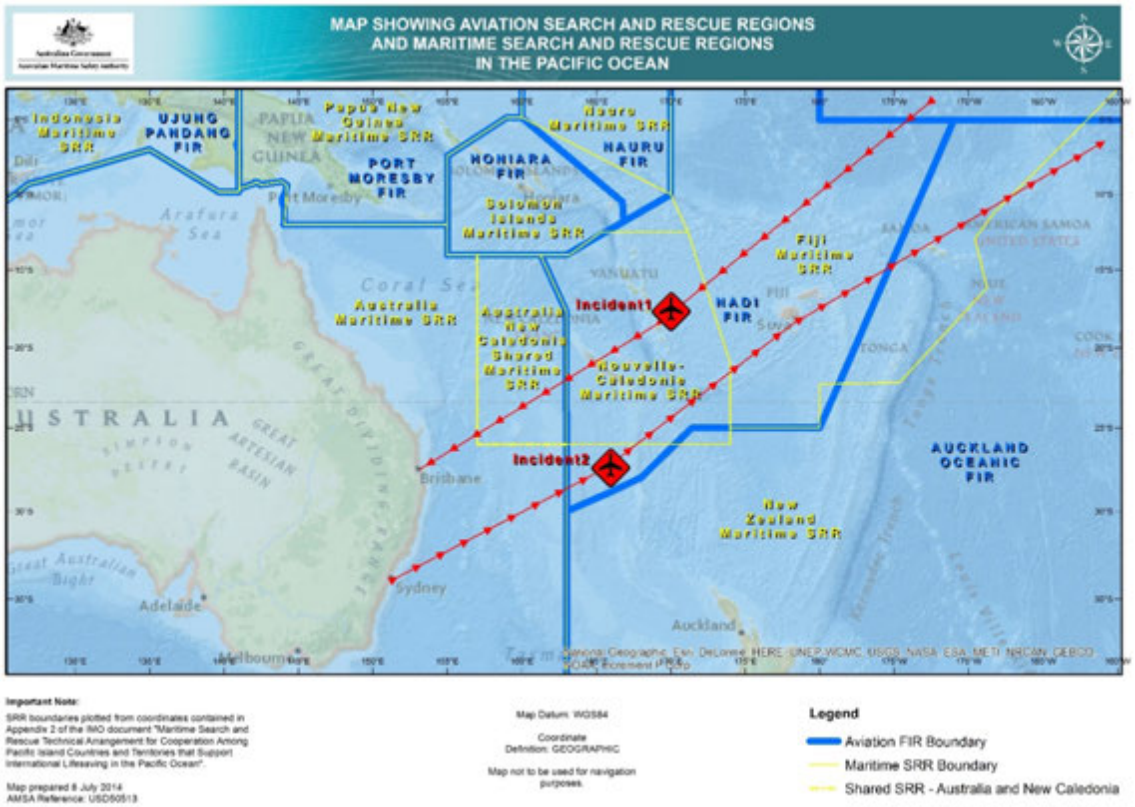


Figure 5: Example of non-coincident aeronautical and maritime SSRs

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
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

	Improvement Areas	Analysis
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 (ATSU, RCC, Aircraft Operator)	Time may be lost due to language issues between the operational staff of aircraft operations centres, ATSUs 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 ATSUs 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 ATSUs/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.

ATSU 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 ATSUs/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 shall, 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 shall, whenever practicable, also be communicated, without delay, to the 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 shall:

- **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 ATSU boundaries**

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

- **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 shall 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 ATSU 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.

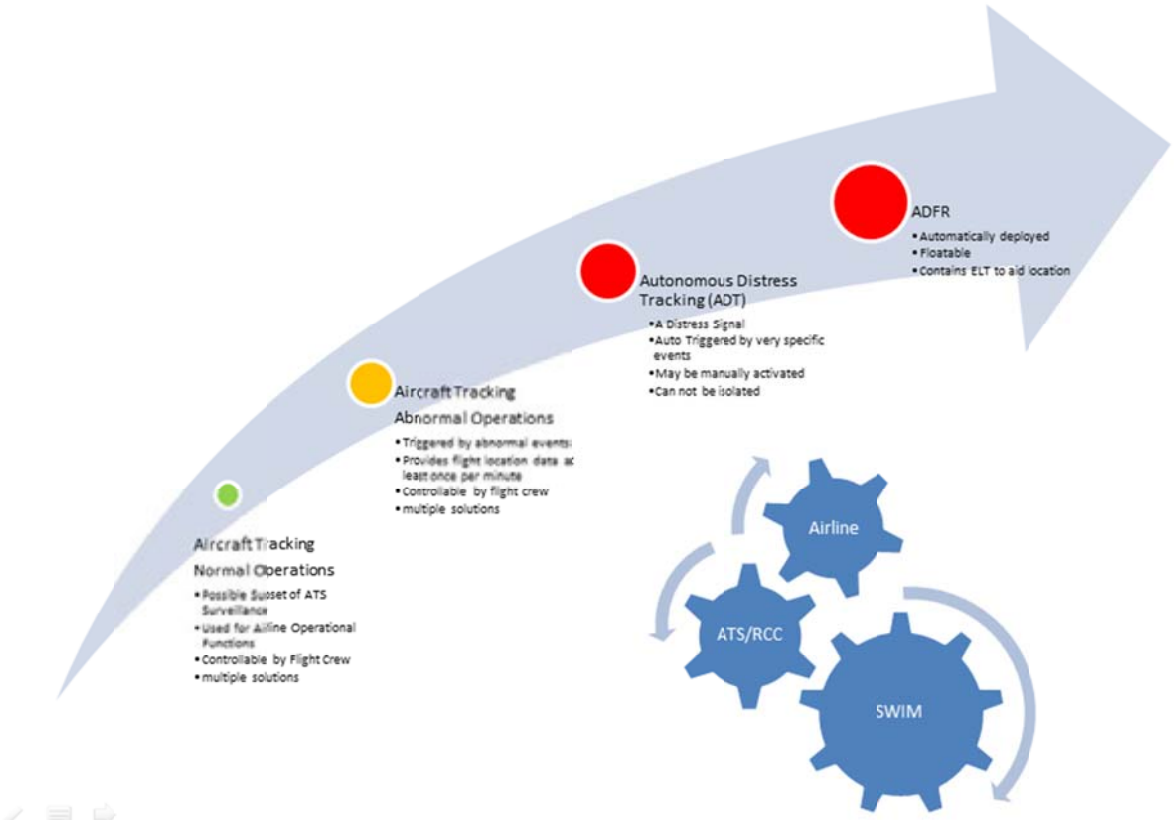
4.0.3 The efficiency and effectiveness of ATSU Alerting and SAR services rely on timely and accurate information. GADSS operates on a world-wide scale for all flights that meet the applicable criteria as defined in standards/regulations to provide incremental position and other relevant flight information.

4.0.4 The GADSS consists of the following main system components:

- ***Aircraft tracking System*** and
- ***Autonomous Distress Tracking System*** *and*
- ***Automatic Deployable Flight Recorder.***

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.

4.1 Aircraft tracking

4.1.1 Each commercial air transport operator ensures that it has the capability to track its aircraft throughout its potential area of operations (an aircraft tracking service). The service provides an aircraft 4D position and identification. This information is typically generated by the aircraft but may also be derived from or combined with other sources such as ATC surveillance data. The performance of the aircraft tracking service should be seamless across ATSU boundaries with no loss of information.

4.1.2 The aircraft tracking service is activated at take-off and remains operational throughout the flight. The system seamlessly provides the position of the aircraft at least every 15 minutes. The aircraft position update rate is changed to around 1 minute interval when an abnormal event is detected.

Note: An abnormal event requires immediate crew action and involves an increased risk to the flight. An increased reporting rate may lead to communication between the aircraft operator and ATSU and subsequently to an emergency phase.

Users of Aircraft tracking Service

4.1.3 The users of the Aircraft tracking service are the commercial air transport operators, to enable them locate their aircraft within their potential area of operations and to share relevant information with the authorities and actors responsible for coordination during any emergency phases.

4.1.4 During abnormal phases the users of the aircraft tracking service may also include:

- **ATSUs** to enable timely and effective decision making (e.g. on Emergency Status) and information sharing during abnormal flight phases. The ATSU may wish to obtain the aircraft tracking information directly for aircraft in its area of jurisdiction.
- **RCCs** for timely and effective SAR operations. The RCC may wish to obtain the aircraft tracking information for its area of jurisdiction.

4.1.5 It should be noted that communication of the escalation of an emergency phase to an RCC is performed by the ATSU and not the commercial air transport operation.

Aircraft Tracking Service Providers

4.1.6 The aircraft tracking responsibility lies with the commercial air transport operator. However, the service can be provided by a third party contracted by the public commercial air transport operator and/or make use of surveillance information provided by ATSU's through a formal agreement.

4.1.7 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.

4.1.8 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 or may be manually activated at any time. In case of false alarm or recovery from a 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 triggers for activation of the system
- Autonomy and failure-mode capability
- The reception of the data on the ground

4.2.3 Autonomous Distress Tracking (ADT) operates independently from aircraft tracking and may be activated in case of failure or risk of failure of the related aircraft tracking systems.

4.2.4 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.

4.2.5 Automatic airborne activation shall be triggered by:

- Unusual attitude, speed or acceleration
- Failure of aircraft surveillance and tracking system
- Complete Loss of engine power

Note: The performance specifications for the in-flight triggering criteria and broadcasting rate to be used will be detailed on EUROCAE/RTCA documents under development.

4.3 Automatically Deployed Flight Recorders

4.3.1 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.

4.3.2 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.

4.3.3 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.

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

4.3.5 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.

4.4 GADSS Information Management

The data supplied by aircraft tracking, autonomous distress tracking and the automatic deployable flight recorder must be effectively shared among all stakeholders as necessary to ensure the effective operation of the GADSS. This section outlines the applicable processes necessary, including any related enabling systems or technologies.

System Wide Information Management

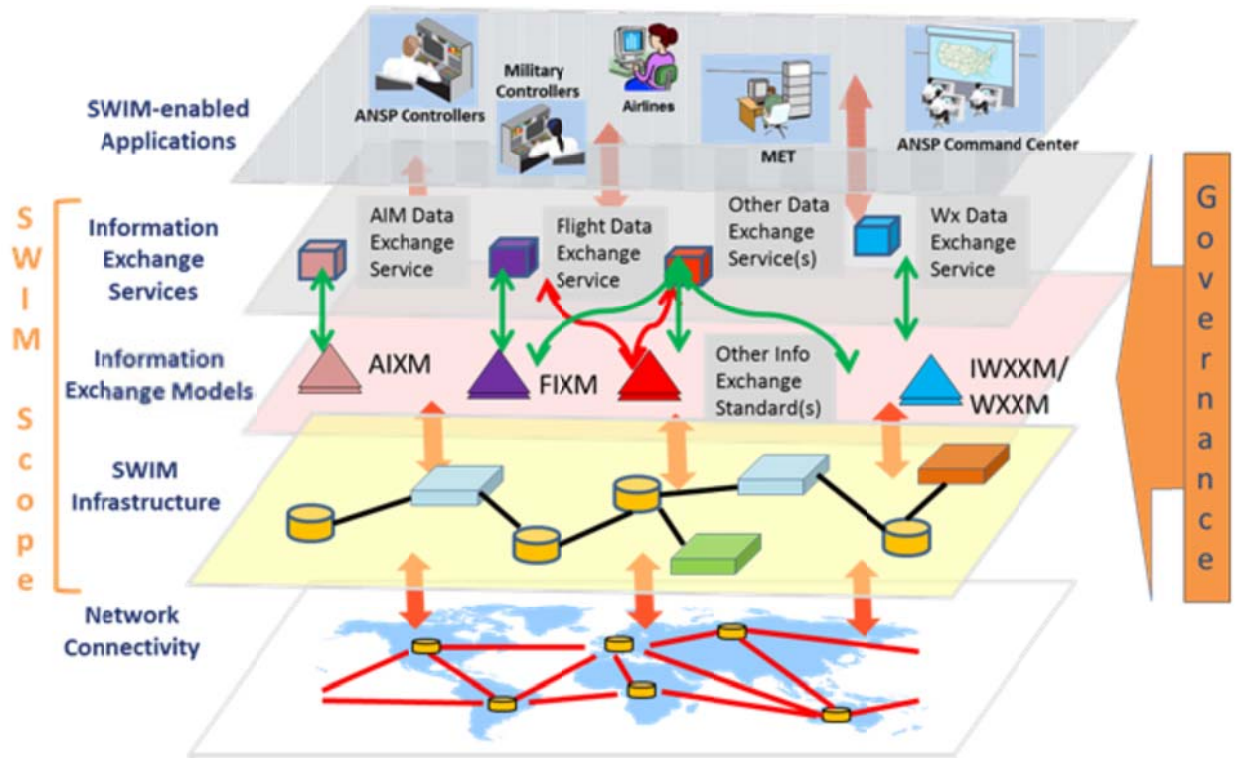
SWIM consists of standards, infrastructure and governance enabling the management of ATM related information and its exchange between qualified parties via interoperable services.

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 ATSU confirmation the involved subscribed stakeholders (e.g. ATSU/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 ATSU('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 ATSU 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 ATSU and RCC responsible for the area of jurisdiction in which the position fits
- In case the position is near to an ATSU boundary also the neighbouring ATSU 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.

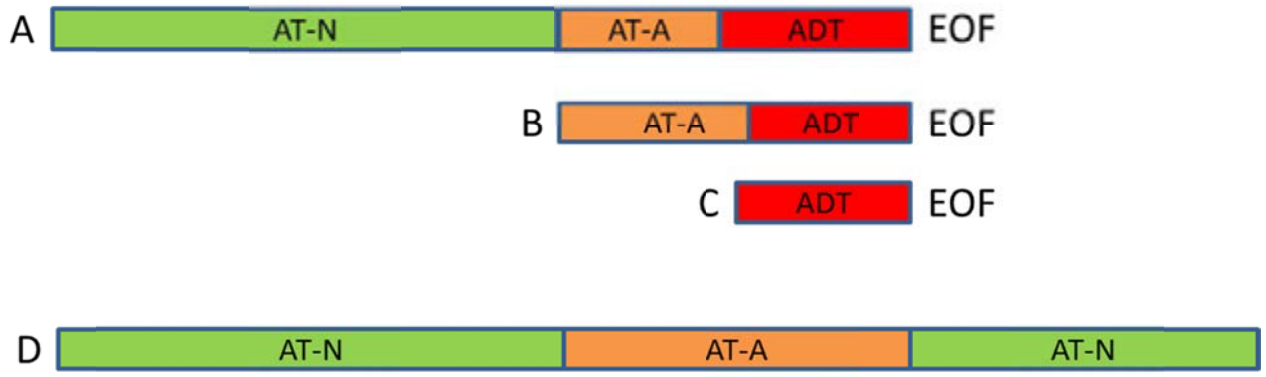
4.5 GADSS Procedures

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 AO), Aircraft tracking information which increased reporting rates and information plus enhanced distribution of information to enable execution of procedures as defined in Annex 11. 4.2.7 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 ATSU 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 emergency phases

4.5.7 The ATSU is responsible for setting the Emergency status for flights in its jurisdiction. The emergency status shall be included in the aircraft tracking information made available to all actors.

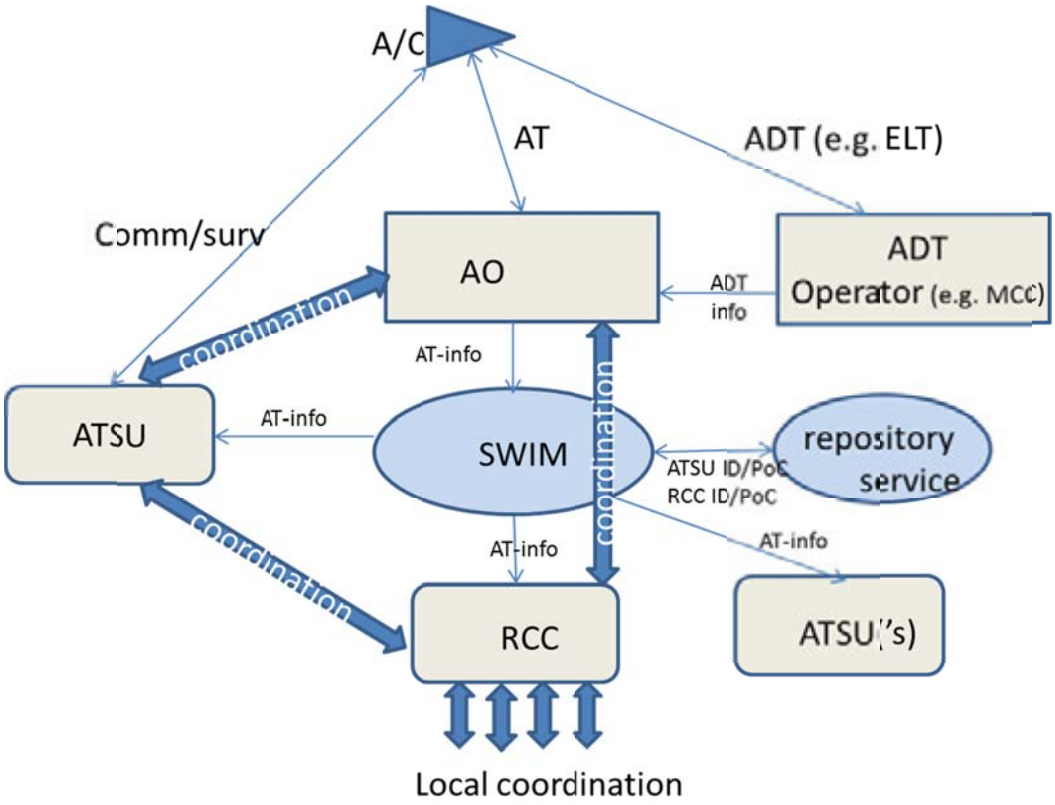
4.5.8 Communications will be established between the ATSU and the relevant airline in order to identify the nature of the situation and any corrective measures that can be applied. It will also allow identifying situations that can evolve to an emergency, allowing for early preparation. This will also help eliminate any time lag regarding the establishment of the communications themselves and analysis both by the operator and the ATSU of action required. This phase will be initiated when the regular 15 minute tracking information is not received; the rate is increased, and or communications cannot be established within 15 minutes of the first attempt by the ATCO.

4.5.9 When the aircraft operator detects an abnormal event it shall contact the ATSU corresponding with the latest known position of the aircraft and may use the repository service for obtaining the ATSU ID and Point of Contact. Once the ATSU confirms the emergency status, the aircraft operator shall make available the aircraft tracking information including the emergency status. The inclusion of the emergency status will ensure that the information is received by the RCC and possibly other ATSU's. Note that this may only be the case when the Emergency is an alert or distress phase (i.e. not during the uncertainty phase).

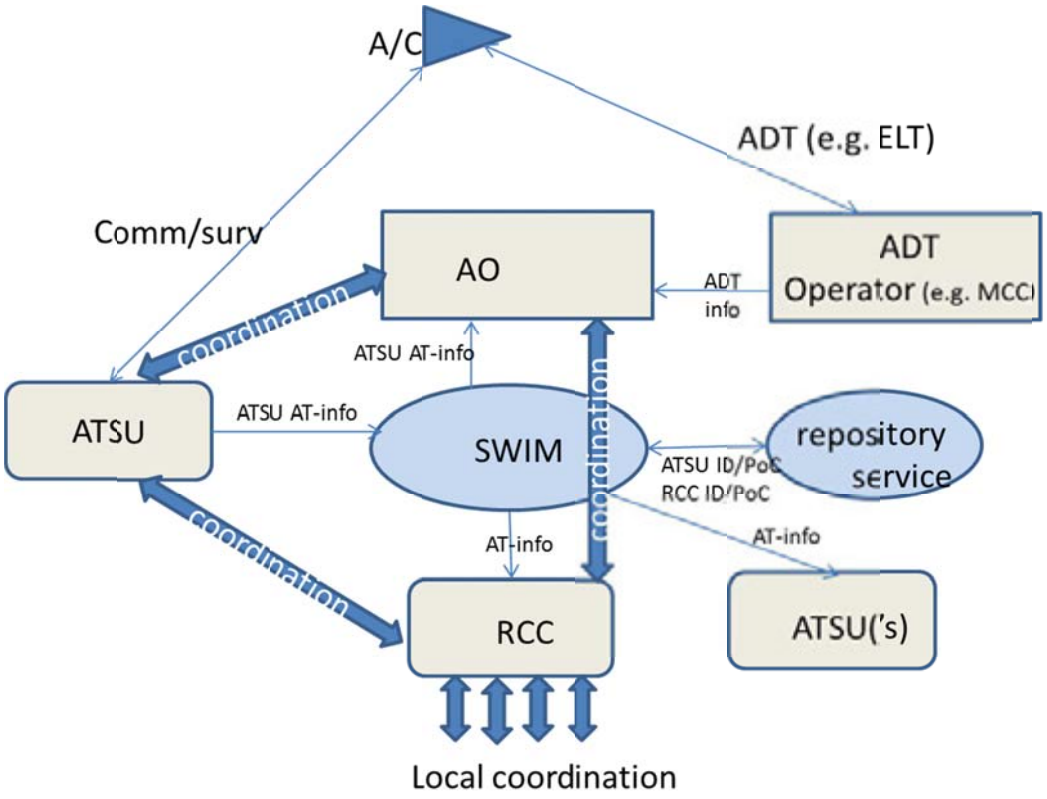
4.5.10 When the ATSU detects the abnormal event it shall determine and monitor the emergency status and communicate this to the aircraft operator. The aircraft operator (as the aircraft tracking service provider) shall make available the aircraft tracking information including the emergency status. The inclusion of the emergency phase will ensure that the information is received by the RCC and possibly other ATSU's. Note that this may only be the case when the Emergency is an alert or distress phase (i.e. not during the uncertainty phase).

4.5.11 Once the Emergency has been set it shall be monitored by the ATSU with the involvement of the actors. The objective of the monitoring is to timely activate the emergency phases or to activate the procedures for recovery.

4.5.12 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 ATSU may make use of additional sources of information and share this with the actors. Other ATSU's 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. ATSU). 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.



Procedures for emergency phase

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

4.5.15 Upon initial notification, a search and rescue (SAR) incident is classified by the notified RCC or ATSU 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.

4.5.16 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.

4.5.17 Notification by ATS units to RCCs shall 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.

4.5.18 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 shall, 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.

4.5.19 During emergency phases additional (from aircraft tracking information) sources of information for locating and tracking aircraft may be used. Any relevant information shall 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

4.5.20 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.

4.5.21 **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.

4.5.22 **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.

4.5.23 **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.

4.5.24 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)

4.5.25 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 ATSUs/RCCs and aircraft operators may collaborate for emergency planning or exercise purposes.

ATS information to the operator (Annex 11, 5.5)

4.5.26 When an area control or a flight information centre decides that an aircraft is in the uncertainty or the alert phase, it shall, 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 shall, whenever practicable, also be communicated, without delay, to the operator.

Procedures for recovery from emergency phase

4.5.27 The emergency status is monitored by the ATSU. 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, ATSU, aircraft operator and RCC if applicable.

5.0 Concept Steps

5.0.1 This chapter provides a high-level summary of the 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	Timeline		
Aircraft tracking	AT.01 - Resolve ADS-C tracking initiation issues linked to FPL correlation.	Block 0		
	AT.02 - Assess and identify possible means of compliance.	Block 0		
	AT.03 - Develop and implement basic provisions for Aircraft tracking.	Block 0		
	AT.04 - Develop and implement revised provisions for aircraft tracking based on operational experience.		Block 1	
	AT.05 - Assess extending applicability to other aircraft operations.			Block 2
ADT	ADT.01 - Develop and implement performance based Standards for Autonomous Distress Tracking.	Block 0		
	ADT.02 - Assess and identify possible means of compliance.	Block 0		
	ADT.03 - Specification for new generation ELTs including in flight triggering criteria.	Block 0		
	ADT.04 - Assess issue of non-carriage and/or non-registration of 406 ELTs and taken appropriate measures.	Block 0		
	ADT.05 - Rationalisation of existing ELT SARPs.		Block 1	
	ADT.06 - Assess extending applicability to other aircraft operations.			Block 2
ADFR	ADFR.01 - Develop and implement performance based standards for automatic deployable flight recorders.	Block 0		
	ADFR.02 - Assess extending applicability to other aircraft operations.			Block 2

	Task	Timeline		
SWIM	SWIM.01 - Develop GADSS Information Management framework including data formats taking account of information ownership, security and confidentiality.	Block 0		
	SWIM.02 - Develop GADSS Communication framework including analysis of communication needs and constraints of current communication infrastructures.	Block 0		
	SWIM.03 - Identify FF-ICE information elements in support of GADSS (e.g. to associate ADT messages to the aircraft operator).	Block 0		
Information repositories services	IRS.01 - Set-up GADSS repository (including Point of Contact information and areas of jurisdiction).	Block 0		
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		
	PROC.02 - Assessment of the impact of FIR and SRR boundaries (non-coincidental, overlapping and gaps).	Block 0		
	PROC.03 - Assessment of compliance to existing Annex 12 standards and development of an action plan.	Block 0		
	PROC.04 - Review of Standard Operating Procedures (SOP) for in-flight activation of ELTs.	Block 0		
	PROC.05 - Review of Annex 11 Chapter 5 (emergency phases and time sequence including initial 30 minute period).	Block 0		
	PROC.06 - Develop guidance material on initial and recurrent inflight emergency training for ATSUs.	Block 0		
	PROC.07 - Explore ways to enhance SatVoice usability in distress situations (see INMARSAT-C).	Block 0		
	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		
	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		
	PROC.10 - Assess feasibility of new provisions to require ANSPs to share aircraft position data.	Block 0		
	PROC.11 – Review and assess the coordination responsibilities during the transition of operations from Annex 12 to Annex 13.	Block 0		

	Task	Timeline		
	PROC.12 - Review ATS and SAR procedures to take account of aircraft tracking and Autonomous Distress Tracking.	Block 0		
OTHER	OTHR.01 - Ensure spectrum protection of frequencies used in the GADSS (e.g. frequency used by space based ADS-B)	Block 0		
	OTHR.02 - Update of the GANP	Block 0		
	OTHR.03 - Resolve datalink delivery assurance for downlink messages (ATN baseline 2 deployment)			Block 2

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 samples of 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

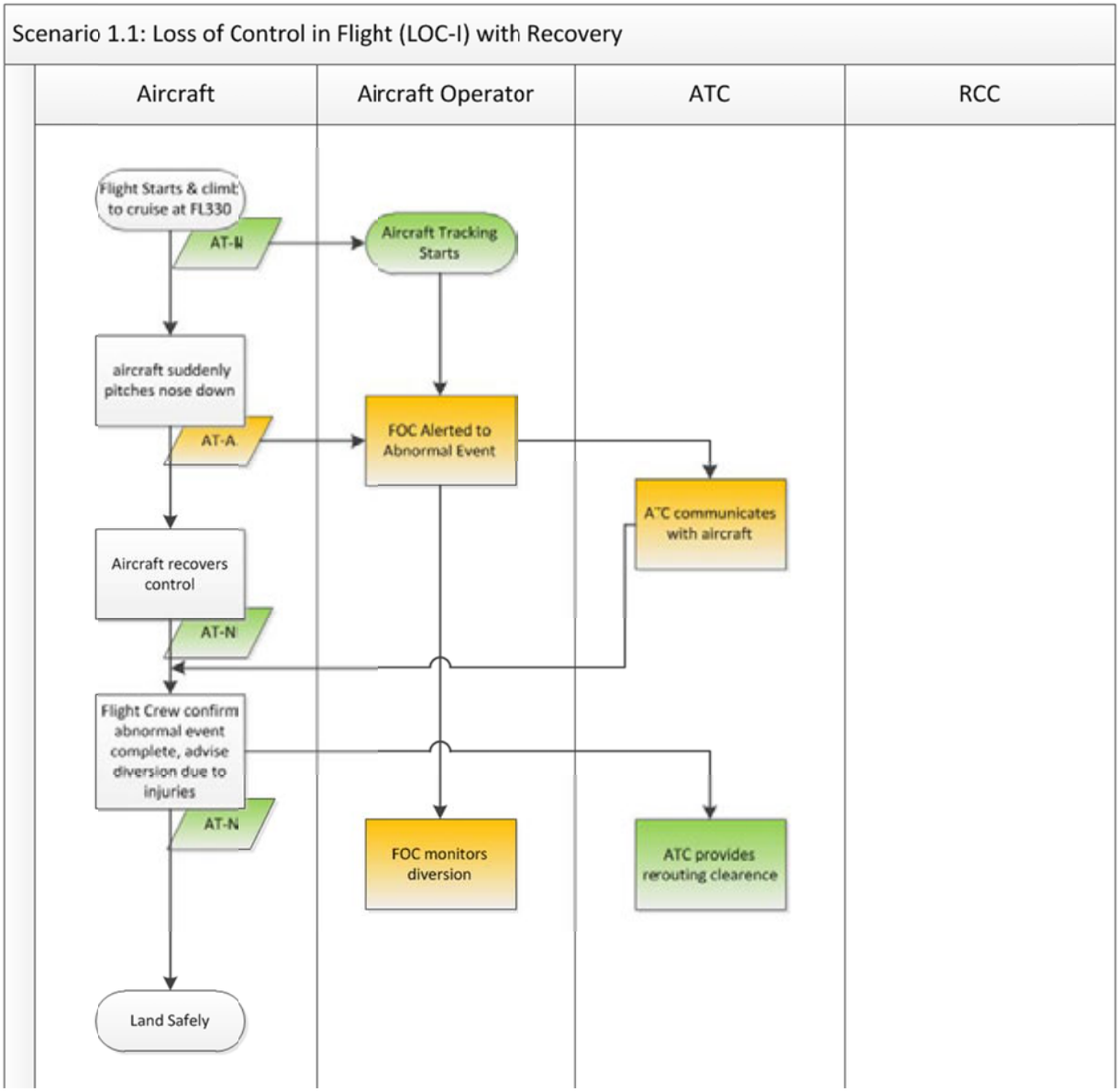
Appendix C: Concept Scenario

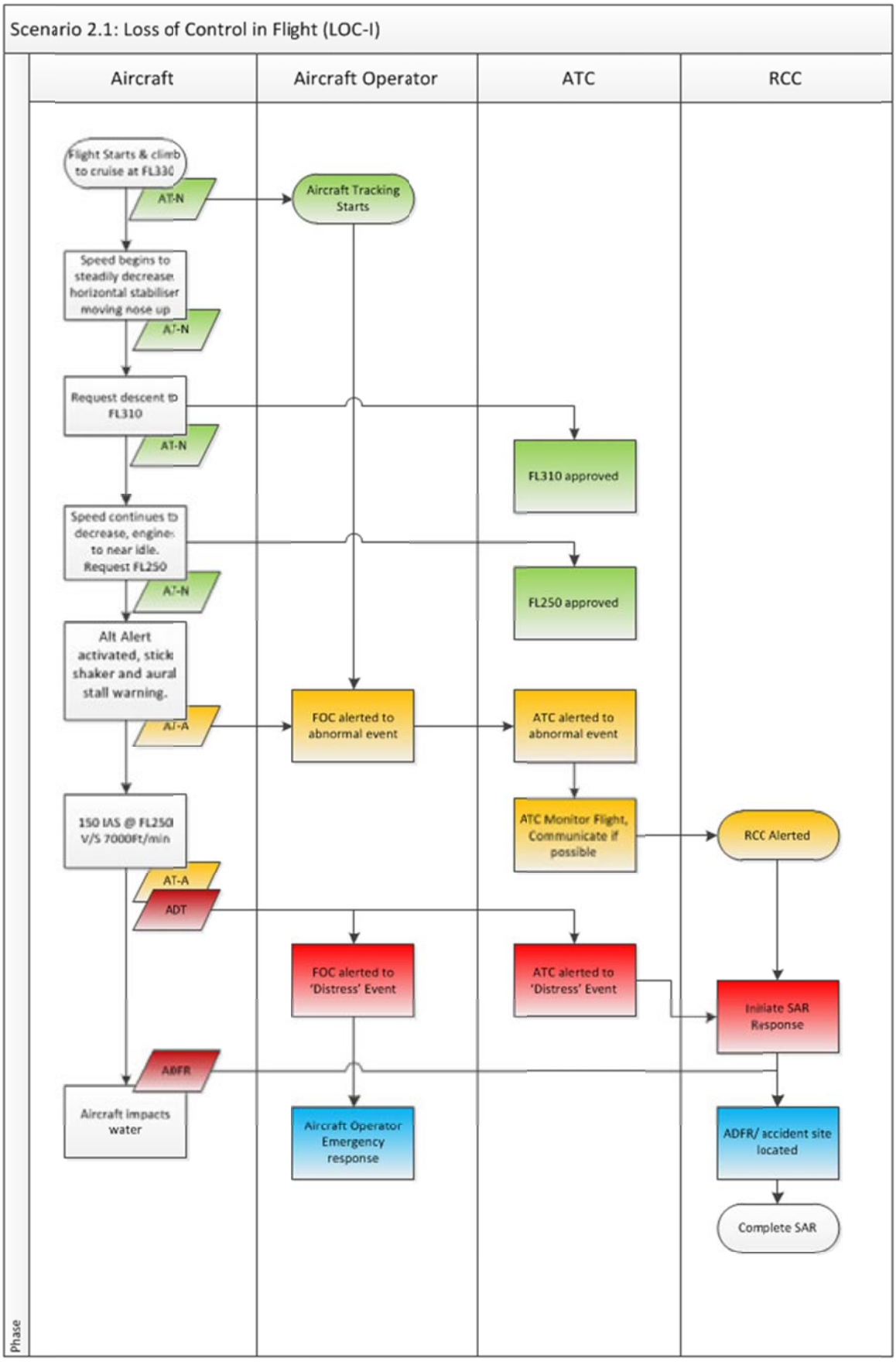
The following are some typical example scenarios:

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

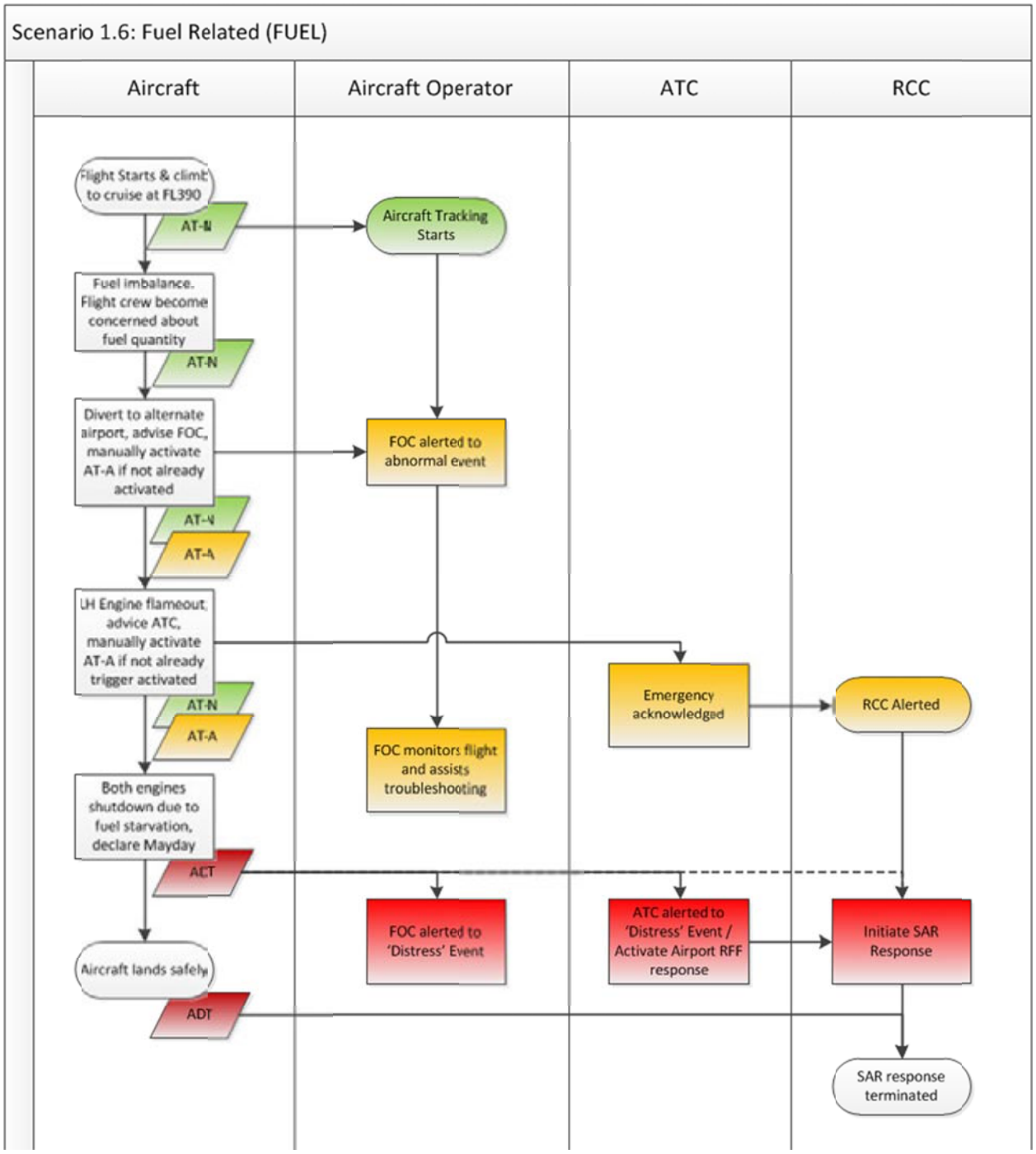
	and airfoil anti-ice. The flight crew requests permission to descend to FL310, which was approved. The autopilot is disconnected and the airplane starts to descend. As the airplane is descending past about FL315, the airspeed continued to decrease and the engine EPR decreased to about flight idle. A 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 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.

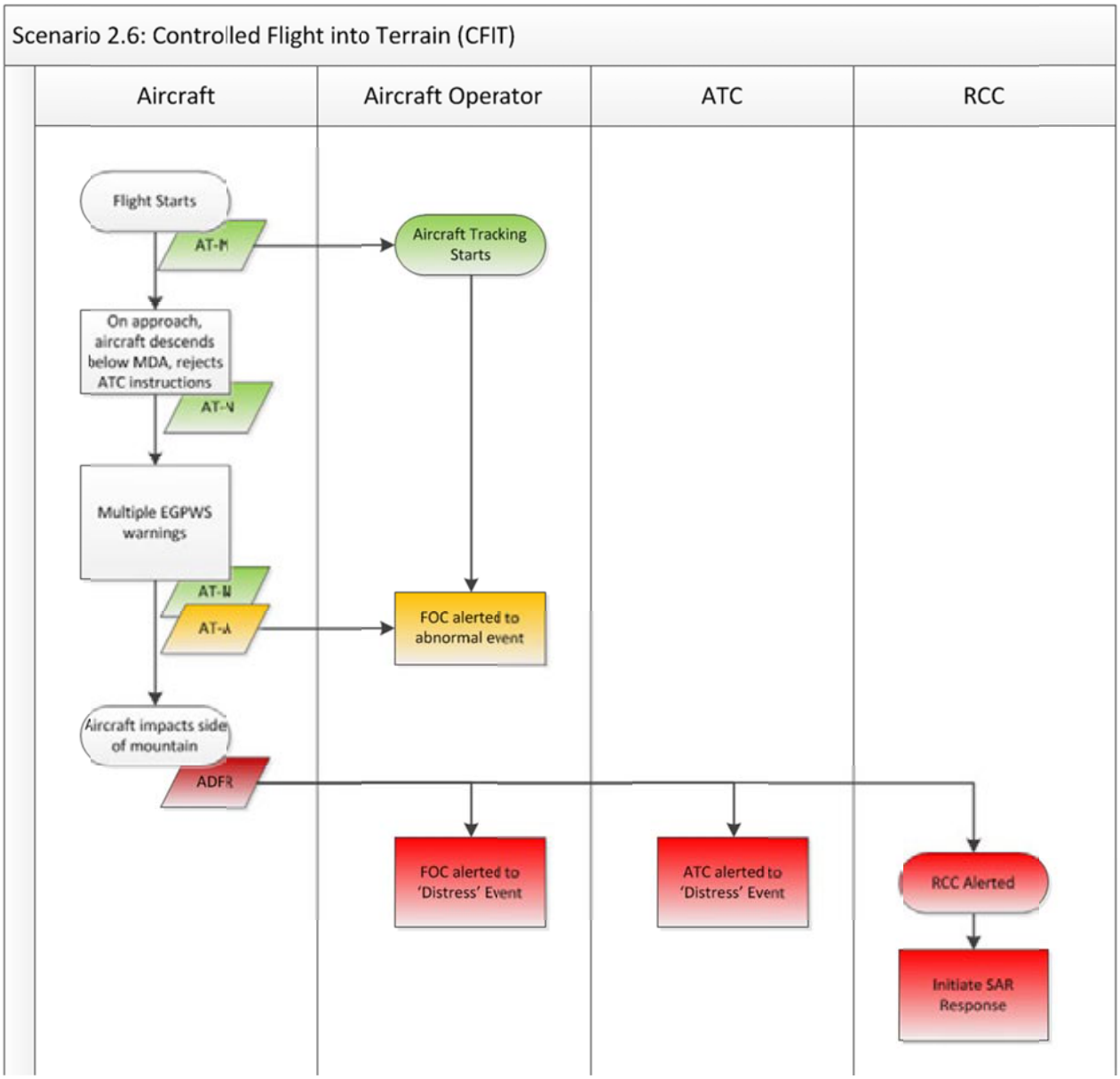
The analysis of the concept should be conducted in a consistent manner to allow objective comparison of alternative solutions. The 'swim-lane' methodology is one approach that may be appropriate for this ConOps and is used below for illustrative purposes.




Scenario 2.1: Loss of Control in Flight (LOC-I)
Aircraft
Aircraft Operator
ATC
RCC
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
AT-A
ADT
ATC Monitor Flight, Communicate if possible
RCC Alerted
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
Phase

Ad-


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
ACT
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-M
Aircraft Tracking Starts
On approach, aircraft descends below MDA, rejects ATC instructions
AT-N
Multiple EGPWS warnings
AT-W
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
2.1j	Increase the use of 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

— END —

Aircraft Tracking Task Force

Report and Recommendations

November 11, 2014

Table of Contents

I. **Executive Summary**

II. **Overview**

III. **Current State of Global Aircraft Tracking**

IV. **Assessment of Aircraft Tracking Capabilities**

V. **Concept of Operations**

VI. **Aircraft Tracking Performance Criteria**

VII. **Conclusions and Recommendations**

Explanation of Terms (Appendix A)

I. Executive Summary

Introduction

The Aircraft Tracking Task Force (ATTF) was established by the International Air Transport Association (IATA) following the tragic disappearance of Malaysia Airlines Flight 370 on March 8th, 2014. The ATTF's charter was straightforward: assess what can be done to improve global aircraft tracking capabilities. The so far unexplained loss of a modern commercial aircraft operating in government controlled air traffic airspace is an extreme anomaly for an industry that provides the safest mode of transportation available today. During a typical day almost 100,000 airline flights are completed without incident. Continued public confidence in this industry is essential to its future growth.

Aviation is and remains safe because its culture is one of seeking continuous improvement and learning from all events that can affect aircraft operations. While the circumstances surrounding MH370's disappearance are still unknown the ATTF has developed this Report with these three principles:

1. The safety of passengers and crew is the primary consideration of the airline industry.
2. There are technologies and best practices in use today to conduct aircraft tracking.
3. Technologies will continue to evolve, and as they do so will the ability to continue to improve global aircraft tracking.

The ATTF was endorsed and actively supported by the International Civil Aviation Organization (ICAO), demonstrating that industry and government continue to work together to improve aviation globally. An integrated approach is critical to improving and sustaining global aircraft tracking capabilities, both in the near term as well as the longer term.

Key Findings

After evaluating the current state of aircraft tracking and conducting an assessment of available and planned aircraft tracking products, services, and practices the ATTF findings are that:

1. There is a range of existing technologies and services, many already installed on aircraft, which can be used to enhance worldwide aircraft tracking in the near-term.

2. This range of technologies and services will enable operators to take a performance-based approach when implementing or enhancing aircraft tracking capabilities.
3. There is a need both to amend existing procedures and to develop new or improved communications protocols between airlines and air navigation service providers.
4. A set of performance based criteria will establish a baseline level of aircraft tracking capability.
5. Any equipment changes to address unlawful interference are a long term prospect owing to significant design, operational, procedural, certification, and safety considerations.
6. Additional options will become available in the future as new products and services are integrated into the global air navigation infrastructure through ICAO's Aviation System Block Upgrades.

Consistent with these key findings, the ATTF developed a set of performance criteria, defined in Section VI of this Report, to establish a baseline level of aircraft tracking capability. These criteria are intended for use by aircraft operators, air navigation service providers, tracking and communications service providers, and ICAO and its Member States when implementing the recommendations detailed in Section VII of this Report.

Conclusion

Commercial aviation is not sustainable if the public does not have confidence in the safety of the system. The ATTF recognizes that public trust and confidence in aviation is at risk when a large and modern aircraft cannot be located and that, in the absence of confirmed facts, speculation defines the incident. Driven by this speculation, public perception compels questions on complex issues such as making equipment on board aircraft resistant to unlawful interference. The ATTF has attempted to consider these aspects, including internal protective measures currently installed in aircraft, in developing this Report. The ATTF also believes that the content of this Report will serve to improve the collective ability to identify and track aircraft globally, significantly reducing the remote probability of such an occurrence. The ATTF Members/Observers who contributed to the development of this Report and Recommendations include representatives from:

The International Air Transport Association
The International Civil Aviation Organization
Airlines for America
The Association of Asia Pacific Airlines

The Civil Air Navigation Services Organization
The Flight Safety Foundation
The International Federation of Air Line Pilots' Associations
The International Coordinating Council of the Aerospace Industries Associations
The Boeing Company
Airbus SAS
Embraer Commercial Aviation
Bombardier Aerospace
The MITRE Corporation Center for Advanced Aviation System Development

II. Overview

The formation of an Aircraft Tracking Task Force (ATTF) was announced by IATA on April 1st, 2014 following the disappearance of Malaysia Airlines Flight 370. The still unexplained loss of a modern, highly sophisticated aircraft brought together senior experts from across the aviation industry, including representatives from airlines, air navigation service providers, safety organizations, pilot groups, airframe and equipment manufacturers, and civil aviation authorities represented by ICAO. These experts came together from May until September 2014 with the purpose of assessing the current state of global aircraft tracking capabilities and identifying what can be done to enhance that state.

In conjunction with the industry led initiative, ICAO hosted a Special Multi-disciplinary Meeting on Global Flight Tracking on May 12-13, 2014. That meeting resulted in number of outcomes, including an agreement that industry, through the ATTF, would identify near term options for enhancing global aircraft tracking and that governments, through ICAO, would assess mid-term and long-term actions that may be needed.

The ICAO meeting also concluded that a comprehensive concept of operations was needed for aircraft tracking. In parallel with the ATTF deliberations throughout the summer of 2014, ICAO formed a working group to develop an overall Global Aeronautical Distress and Safety System (GADSS) Concept of Operations. GADSS addresses the role of governments, airlines, air navigation service providers, and search and rescue agencies in both routine and non-routine aircraft tracking situations and the ATTF contributed to this work by developing the routine aircraft tracking concept portion of the document.

This Report and Recommendations will be submitted to IATA and to ICAO in order for industry and civil aviation authorities to determine the way forward. The ATTF will address any required clarifications to this Report.

III. Current State of Global Aircraft Tracking

The ATTF looked at information from ICAO, airlines, air navigation service providers (ANSPs), communication service providers, and manufacturers in order to conduct an analysis on the current state of global aircraft tracking and determine where "gaps" in tracking capabilities exist. Unfortunately, owing to limited time and available information, the picture is not as complete as had originally been anticipated. The ATTF did receive enough information, however, to conduct a general assessment of how aircraft tracking is done today, whether through ANSP provided surveillance services or by the airlines themselves. This current state assessment also relates directly with the information contained in capabilities assessment in Section IV of this Report—most notably with the technologies and services that are identified as being available today.

Aircraft Tracking via Surveillance Services

Commercial aircraft are under air traffic control/air traffic services (ATC/ATS) throughout all phases of their flight(s). ATC/ATS includes essential communication, navigation, and surveillance services; surveillance is used to manage aircraft separation requirements. Because surveillance services provide the location and identification of an aircraft in order to manage separation it also can serve as a form of aircraft tracking. In fact, a large number of commercial aircraft operators currently use ATS surveillance services for the purpose of tracking their aircraft, particularly in medium to high density airspace. Surveillance services can be disrupted, however, due to planned or unplanned maintenance issues or equipment availability. For ground based radars that provide surveillance services, there can be permanent or periodic line of sight limitations due to obstructions and the curvature of the earth. These disruptions need to be taken into account when considering aircraft tracking options.

In low density airspace—commonly referred to as oceanic or remote airspace—aircraft location and identification is approached differently. This information is often provided by periodic position reports and voice communications between the flight crew and the ANSP. In some low density airspace, Automatic Dependent Surveillance - Contract (ADS-C) is used to obtain position reports; however, this use of ADS-C is limited either because the ANSP does not support ADS-C or the aircraft is not equipped.

Aircraft Tracking by Airlines

In an effort to verify tracking practices in use today the ATTF conducted a limited survey of airlines to obtain information based on areas of operation, fleet size and type, and business models. The main points addressed by the survey included whether or not the airline currently tracked their aircraft or had plans to do so, whether or not a triggering capability was available, reporting intervals being used, and what communications,

navigation, and/or surveillance technologies were in use to support the tracking function.

The results showed that many airlines track their fleets through their Operations Control Center (OCC) using ACARS, a digital datalink system that transmits short messages between the aircraft and ground stations via VHF/HF radio or satellite communications. The results also indicated that there are areas of the world where aircraft tracking capabilities are limited by lack of communications infrastructure, interference issues, or other factors that impact use of technology. The results were considered in the development of the performance criteria contained in the Report.

In order to obtain a more robust assessment of current and planned aircraft tracking capabilities by airlines a more systematic and rigorous survey would be needed. It is also important to underscore that this current state assessment does not discuss in detail planned upgrades to ATS surveillance capabilities, fleet upgrades, or any other future improvements that would potentially impact tracking capabilities by either ANSPs or airlines.

As part of the current state assessment, the ATTF also considered the issue of human intervention with respect to equipment on board aircraft. Equipment such as transponders that are used for ATS surveillance can be disabled by the flight crew for operational or aircraft safety reasons. A malfunctioning airborne component may adversely impact ATC operations. For this reason it is necessary that means exist to deactivate such components if they are not working properly. From a safety perspective, all electrical components on board an aircraft must have the ability to have their power source interrupted in the event of an electrical system malfunction or fire. While these types of operational and safety related events are rare, the fact remains that equipment on board aircraft can be disabled.

This section of the ATTF Report is not intended to be a definitive description as current capabilities and practices vary and may also change in response to airline operations, air traffic services, or other factors which are part of the global aviation system on any given day.

IV. Assessment of Aircraft Tracking Capabilities

In evaluating the current state of aircraft tracking the ATTF was able to verify that there are many products, services, and procedures available and in use today that provide air carriers the ability to locate and track their aircraft. The ATTF determined that a summary of this information would be helpful to air carriers who need to implement or enhance their tracking capabilities. Similarly, the ATTF recognized that emerging technologies such as space-based ADS-B are expected to be available in the next three to four years and determined that these longer term options should also be reflected in the summary.

In order to provide a level of consistency in summarizing both existing and planned capabilities the ATTF and ICAO developed a survey that was sent to a limited number of systems and/or applications vendors whose products and/or services either currently support aircraft tracking or are expected to become available in the mid to longer term. Following an analysis of the survey results the ATTF invited those respondents whose products and services best and most completely addressed the items in the questionnaire to give a detailed overview of their product/service and to answer questions that had been identified during the evaluations.

Based on the survey information and discussion the following is an assessment of current and planned aircraft tracking capabilities:

Air Traffic Service Surveillance Systems

1. As noted in the current state assessment, most continental airspace with medium to high traffic density has ATS surveillance systems in place, such as Secondary Surveillance Radar (SSR), Multi-lateration, and/or ground-based Automatic Dependent Surveillance –Broadcast (ADS-B). As also noted in the current state assessment, there are commercial airlines that use ATS surveillance information to locate and identify their aircraft.

   The limitations of this approach to aircraft tracking is that these surveillance systems are not available in all parts of the world, and in some cases where the service does exist, coverage can be disrupted or limited.

   As a final consideration, most ATS surveillance systems have airborne components such as transponders. As noted in the current state assessment, this equipment is designed to allow for deactivation in the event of operational or aircraft safety needs. Once a transponder is deactivated the aircraft is “invisible” to ATS outside areas with primary radar coverage. However, there are established procedures for the flight crew and ATS to follow to confirm the

position of the aircraft and ensure that separation is maintained. The ATTF considered the issue of transponder deactivation in the broader context of unlawful interference to flight systems and discussed the issue in detail with aircraft and avionics manufacturers. The ATTF concluded that any changes to the ability to deactivate equipment on board aircraft are a long term prospect owing to significant design, operational, certification, and procedural considerations.

2. A substantial percentage of the current wide-body fleet of aircraft are equipped and capable of transmitting Automatic Dependent Surveillance–Contract (ADS-C) positions using FANS 1/A datalink equipment. This provides a near-term capability for aircraft tracking where ATS surveillance systems are not available. ADS-C has both advantages and limitations:

    a. Position reports from ADS-C enabled aircraft meet the performance criteria identified in this Report. ADS-C also provides the capability to initiate reports based on deviations from the intended lateral and vertical flight profiles through conformance monitoring; for example, deviations from planned flight routes, level range deviations, and vertical rates.

    b. ADS-C service has been implemented by many ANSPs. The geographical coverage is dependent on the satellite constellation used for communications as geostationary systems do not cover portions of the Polar Regions. Once an ADS-C contract is established between a capable aircraft and a capable ANSP, the aircraft position information can be shared with an airline over the existing communication service providers (CSP) networks.

    c. In areas where ATS surveillance is not available, a direct ADS-C feed can be provided to airline Operations Control Centers (OCC), as well as authorized third parties, through existing CSP networks, independent of the ANSP's capability to support this service. Airlines that use a direct contract to receive ADS-C position reports may incur full end-to-end transmission costs for the sole purpose of aircraft tracking.

ACARS

3. ACARS position reports can also fulfill the near term aircraft tracking criteria independent of ADS-C. ACARS uses FMS derived position information and is used today by many airlines to track their flights. The use of ACARS is still

dependent upon the use of the existing communication service provider networks and there are associated costs. Unlike ADS-C, ACARS does not provide conformance monitoring, although it is possible for an OCC to monitor flight path conformance using customized software.

Some airlines have added tracking capabilities to their ACARS maintenance reporting system with software modifications to their on board equipment. This modification provides position reports every 10 minutes, with increased reporting frequency triggered by unanticipated altitude changes or flight levels below a pre-determined altitude. In addition, flight track deviations are flagged to the OCC through dedicated software.

Stand-alone GNSS Position Reporting Devices using Satellite Communications

4. Many aircraft operating beyond the range of ATS surveillance systems are not equipped with ADS-C or, in some cases, ACARS. There are products available today that determine the aircraft position using Global Navigation Satellite System (GNSS) and transmit that information using satellite relay. For the most part, these products are assumed to be lower cost alternatives to integrated avionics solutions as some of them are small units that could be attached to an airframe. Based on available information the majority will offer global coverage once full satellite constellations are in place. The ATTF also noted that certification requirements could potentially and significantly impact both the cost and availability of these products for commercial aviation use.

Space- Based ADS-B

5. Space- based ADS-B is expected to have a significant impact on global ATS surveillance services and thus on global aircraft tracking capability. Space-based ADS-B will use signals from Mode-S transponders which are already installed or planned to be installed on most commercial aircraft.

   Space-based ADS-B should be available in 2018. In addition to the launch of satellites, frequency allocation is a critical element to making this capability a reality. At present, the 1090 MHz band is allocated to the Aeronautical Radio Navigation Service. For satellites to receive aircraft transmitted ADS-B signals, as required for at least one space based ADS-B concept, the band would also need to be designated for the Aeronautical Mobile Satellite Route Service by the International Telecommunications Union. Efforts are underway to obtain this designation.

Aircraft tracking should be considered on a global, rather than a regional or national, basis. Aircraft often cross several regional boundaries in a single flight. Different coverage, capabilities, and practices may be required to ensure that the aircraft is tracked from the moment it is airborne until it touches down. Specifically, aircraft operators need to assess their network and operations from an end-to-end perspective when considering implementation of or enhancement to aircraft tracking capabilities.

The ATTF recognizes that there are many other products and/or services either available today or which will be available in the future which may meet the performance criteria for routine aircraft tracking. This capabilities assessment is not comprehensive nor is it intended to recommend the use of any specific vendors, technologies, or services. It was developed to help aircraft operators when considering existing and future options to implement or enhance aircraft tracking.

Finally, the ATTF received only limited information from vendors on the costs of their products and services. Where applicable, the ATTF has identified potential cost considerations for each of the capabilities noted.

Summary Table of Aircraft Tracking Capabilities as Assessed by the ATTF

Technology	Timeframe	Benefits	Limitations/Cost Considerations
ATS surveillance systems (SSR, Multi-lateration, ADS-B)	Near term	• Viable alternative to OCC aircraft tracking • Widely available • Cost-effective if already in use for ATS	• Line of sight • Information not always shared with OCCs and other ANSPs
ADS-C through an ANSP	Near term	• Information available through existing networks • Global coverage (depending upon the satellite constellation) • Conformance monitoring	• Not all ANSPs are ADS-C capable • Not all aircraft are ADS-C enabled • Increased costs when reporting intervals are more frequent than ATS requirements • Installation costs • Geographical limitations due to satellite footprint
ADS-C direct to the OCC	Near term	• Aircraft tracking independent of ANSP capabilities • Global coverage (depending upon the satellite constellation)	• Investment required to support OCC functionality • Additional data transmission costs • Installation costs • Geographical limitations due to satellite footprint
ACARS	Near term	• Independent of ADS-C • Presently in use and configurable for enhanced aircraft tracking capabilities	• Reporting costs • Data transmission costs • Installation costs
Stand-Alone GNSS Positioning Devices using Satellite Communications	Near term for certified devices; mid to long term for non-certified	• Global coverage (depending on the satellite constellation) • Independent of ADS-B and ADS-C • Flexibility—some products can be configured to meet customer requirements • Potential to isolate device on aircraft	• Installation, maintenance, data transmission, and possible certification costs • Not widely used on air transport class airplanes • Reporting costs
Space-based ADS-B	Longer term	• Uses existing equipage (Mode-S transponders) • Global coverage	• Frequency allocation dependent • Undetermined cost of service • Some concepts require additional aircraft equipment

V. Concept of Operations

The following describes the desired characteristics of commercial aircraft tracking during routine operation, provides an overview of the required communication protocol between stakeholders, and highlights the point at which aircraft tracking may no longer be considered routine. This concept is also incorporated into the routine tracking section of the ICAO GADSS document.

Aircraft Tracking

In order to be effective, the aircraft tracking functionality needs to be active at take-off and remain operational while the aircraft is airborne. The aircraft's position should be reported at least every 15 minutes. In airspace where ATS surveillance services or ADS-C identifies the position at least every 15 minutes, the aircraft operator may rely on those systems for tracking information.

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. At this point an analysis must be conducted to determine if a move to an alert phase is warranted. This analysis may require a dialogue between the aircraft operator and the air traffic service provider. 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.

In airspace where aircraft tracking is provided through ANSP surveillance services and there is no agreement in place between that ANSP and the aircraft operator for transmission of routine tracking information, the ANSP will make information available to the aircraft operator when/if required in a non-routine situation.

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;
- Air Navigation Service Providers;
- Other aircraft tracking service providers selected by the operator
- Communication service provider(s)

Communication Procedures and Protocol

When establishing an aircraft tracking functionality the aircraft operator must ensure that responsibility for aircraft tracking is assigned to a specific sector within the company; this sector has either the capability to receive and assess the specific aircraft position information, or the ability to conduct qualified decisions based on the information received from an external tracking service provider. If the aircraft operator is using an external tracking service provider the operator needs to ensure that clearly defined communication procedures are in place and that the operator's contact information is forwarded to all relevant stakeholders.

The operator's designated sector will monitor the aircraft position information to ensure that it meets the performance criteria or will act based on information received by the service provider. If the information received from the aircraft or the service provider indicates unpredicted or unexplainable developments, or is missing completely, the operator's designated sector will use established procedures to gather more detailed information. This can include additional information from other airlines or external stakeholders including ANSPs.

Based on this information, the operator's designated sector and the air traffic service unit (ATSU) will evaluate whether the circumstances meet the criteria to initiate an alert phase or return to routine aircraft tracking. If the criteria are met, coordination between the airline and the ATSU will be conducted using an established communications protocol and maintained throughout the situation. If the tracking service is provided by an ANSP they will contact the operator's designated sector according to the established communications protocol.

If an alert phase is initiated the ATSU will contact the appropriate Rescue Coordination Center (RCC).

VI. Aircraft Tracking Performance Criteria

The ATTF has developed a set of performance criteria to describe a baseline for aircraft tracking functionality based on information from the current state assessment, the capabilities assessment, and the concept of operations. These criteria must be considered in their entirety by air carriers when implementing or enhancing aircraft tracking capabilities:

1. The aircraft tracking function should track aircraft within potential areas of operation and range;

2. The aircraft tracking functionality should be available and operating while the aircraft is airborne;

3. The information required for aircraft tracking should include the aircraft 4D position (latitude, longitude, altitude and time) and aircraft identification;

4. When transmitted by the aircraft, the tracking accuracy of the position report should be at least 1 NM or better depending on the aircraft's navigation system capability;

5. 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;

6. The aircraft tracking system should have the ability to increase its reporting rate based on established triggering parameters;

7. 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;

8. 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;

9. Any new airborne equipment or modification to existing equipment shall meet the appropriate airworthiness requirements.

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.

VII. Conclusions and Recommendations

The ATTF has concluded that comprehensive and sustained improvement to global aircraft tracking can only be attained through commitment and support from regulators, ANSPs, and aircraft operators. While this Report is focused on providing guidance to commercial aircraft operators to implement or enhance their aircraft tracking capabilities it also considers the role of ICAO and ANSPs in the process.

As presented in Section VI of this Report, the ATTF has developed a set of performance criteria and hereby recommends that:

1. Aircraft operators, air navigation service providers, tracking and communications service providers evaluate their current aircraft tracking capabilities against these performance criteria;
2. Operators not currently meeting these criteria implement measures do so within 12 months of the issuance of this ATTF Report;
3. Operators exchange best practices regarding aircraft tracking via a venue and methodology to be defined by IATA;
4. Any future ICAO provisions for aircraft tracking be performance-based and take into consideration experience gained by operators in implementing these criteria;
5. Any future ICAO aircraft tracking standards not prescribe specific solutions in order to allow industry to make best use of existing and emerging technologies appropriate to their operation;
6. ICAO encourage Member States to require ANSPs to establish communication protocols between themselves and aircraft operators;
7. ICAO encourage Member States to conduct practice exercises involving airline operation centers, air navigation service providers, and rescue coordination centers to test and verify their ability to respond and coordinate in an integrated manner to abnormal flight scenarios.

The ATTF submits this report to IATA and ICAO for review, consideration, and identification of next steps by both industry and governments.

APPENDIX A—Explanation of Terms

The ATTF determined that a common understanding of terms would help to facilitate the deliberations and the outcomes discussed in this document. The terms contained herein are used in the context of this document only and except where indicated, have no official status within ICAO or other regulatory body.

Aircraft Identification (PANS-ATM)
The identification of a particular aircraft by a defined group of letters or figures, which allow the recognition of an individual aircraft by the parties involved in aircraft tracking.

Aircraft position (location) (new)
The position of an individual aircraft defined by latitude, longitude, and altitude at a given time.

Aircraft Tracking (new)
A ground based process that maintains and updates, at standardized intervals, a record of the four dimension (4D) position of individual aircraft in flight.

Air Navigation Service Provider (ANSP) (new)
An organization responsible and authorized to provide air navigation services.

Air Traffic Service (ATS) (PANS-ATM)
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).

Air Traffic Services Unit (ATSU) (PANS-ATM)
A generic term meaning variously, air traffic control unit, flight information center or air traffic services reporting office

ATS Surveillance System (PANS-ATM)
A generic term meaning variously, ADS-B, PSR, SSR or any comparable ground-based system which enables the identification of aircraft.

Automatic Dependent Surveillance — Broadcast (ADS-B) (PANS-ATM)
A means by which aircraft, aerodrome vehicles and other objects can automatically transmit and/or receive data such as identification, position and additional data, as appropriate, in a broadcast mode via a data link.

Automatic Dependent Surveillance — Contract (ADS-C) (PANS-ATM)
A means by which the terms of an ADS-C agreement will be exchanged between the ground system and the aircraft, via a data link, specifying under what conditions ADS-C reports would be initiated, and what data would be contained in the reports.

ADS-C Agreement (PANS-ATM)
A reporting plan which establishes the conditions of ADS-C data reporting.
Note: *Data required by the air traffic services unit and the frequency of ADS-C reports have to be agreed to prior to using ADS-C in the provision of air traffic services.*

ADS-C Position Report (new)
An automatic position report made to an ATS unit in the form of a data block.
Note: *The requirements for the transmission and contents of ADS-C reports are established by the controlling ATS unit on the basis of current operational conditions and communicated to the aircraft and acknowledged through an ADS-C agreement.*

Capability (new)
The ability to perform or achieve certain actions or outcomes through a set of controllable and measurable faculties, features, functions, processes, or services.

Commercial Air Operations (new)
That part of civil aviation which involves operating aircraft for hire to transport passengers or cargo.

Conformance Monitoring (new)
A function that compares the present position of the aircraft with the current flight plan and indicates deviation within set parameters.

Data Link (PANS-ATM)
An electronic means of transmitting and receiving digital information

FANS 1/A (new)
An avionics system which provides direct data link communication between the pilot and ATC that includes air traffic control clearances, pilot requests, and position reporting. FANS 1/A design is a range of Future Air Navigation System (FANS) products; FANS-1 refers to the Boeing solution, while FANS-A is the Airbus solution

Flight Monitoring (New)
The active tracking of a flight by suitably qualified operational control personnel throughout all phases of the flight.

Global Navigation Satellite System (GNSS) (PANS-OPS)
A worldwide position and time determination system that includes one or more satellite constellations, aircraft receivers and system integrity monitoring, augmented as necessary to support the required navigation performance for the intended operation.

Near term (new)
Refers to those technical and operational aircraft tracking capabilities that are currently available and which may be implemented with relatively limited effort and at reasonable expense.

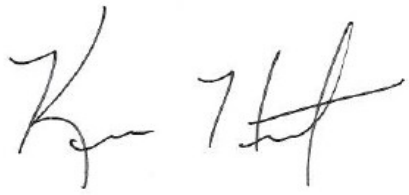
Potential Area of Operation (new)
The area in which a particular aircraft can operate according to its flight plan, including alternate airports and/or eventual diversion.

The ATTF Report and Recommendations

This document has been submitted to the International Civil Aviation Organization to be a part of the Global Aeronautical Distress and Safety System (GADSS) Concept of Operations.

Date of submission to ICAO is December 8, 2014

Respectfully,



Kevin L. Hiatt

Chairman - ATTF Task Force

Senior Vice-President - IATA