Asia/ Pacific Region ADS-B Task Force/3

Bangkok, 21 to 25 March 2005

Draft Version of the Asia/ Pacific Regional ADS-B Operations Manual

(Presented by Howard Anderson)

This working paper contains the current status of development of the Asia/ Pacific Region ADS-B Operations Manual (AOM). The draft Operations Manual is included in this Working Paper as appendix one. Task Force members are asked to endorse this document so that it can be forwarded by the Chairman to APANPIRG. This paper includes brief explanatory comments regarding layout and content of each section.

Section 1. INTRODUCTION

1.1 At the March 2004 meeting of the ADS-B SITF in Bangkok, New Zealand and the USA accepted the task of developing the draft ADS-B Operations Manual. The document has been developed to provide guidance material for ICAO states that intend to deploy ADS-B technology in an effort to enhance surveillance within their respective jurisdictions.

1.2 The attached document incorporates feedback from both the October 2004 Working Group meeting and subsequent exchanges with members.

Section 2. EXPLANATORY COMMENTS

2.1 Conventional document format

including;

- The scope of ADS-B deployment includes all Asia/ Pacific Region FIRs.
- Arrangement of the sections within the document for orientation.
- Document management (1.2 – 1.7) to control and record changes.

2.2 Acronym list and Glossary of Terms.

3 System Integrity and Monitoring

including;

3.1 Introduction

- Monitoring of integrated systems is essential to ensure integrity is assured by a validation processes.

3.2 Personnel licensing and Training

- Suitably trained and licensed users are an essential component.

3.3 Reference Documents record.

3.4 System Performance Criteria.

- System performance Criteria should be common to all users.

3.5 ATC System Validation

- ATC System Validation processes, including the selection of assessment processes, development of procedures, testing, documentation, monitoring and reporting.

3.6 System Monitoring

3.7 ADS-B Study and Implementation Task Force

3.8 Problem Reporting System (PRS)

3.9 Local data recording and analysis

3.10 ADS-B Problem report form

3.11 ADS-B Periodic Status Report form

4 ADS-B Data Message Set

5 ADS-B Procedures

5.1 Introduction

- These procedures relate to ADS-B “out” only.
- ADS-B “in” is recognised but no mandate for use has been agreed.
- Radar like characteristics differentiates ADS-B from other ADS technologies (A & C).
- Range of benefits are outlined (extending surveillance and associated safety net services, adding redundancy to existing radar services and enhancing accuracy within an existing surveillance network).

5.2 Factors to be Considered When Using ADS-B

- Use of displayed level information.
- Identifying means of ensuring the integrity of the surveillance system.
- Integration of RAIM alerts to ensure any degradation of the ADS-B service is highlighted to the controllers at each work station.

- Promotion of data sharing agreements between ICAO states to enhance the provision of a seamless surveillance service across international boundaries.

5.3 Reporting Rates

- The reporting rates achieved by ADS-B equipped aircraft are higher than that required to establish equivalency with radar.
- The displayed update/ refresh rate provided at the controller work station may be adjusted to align with the refresh rates associated with existing radar display systems.

5.4 Separation

- Equivalency with radar performance is the underlying principle in determining where radar separation standards can be applied.
- Provided equivalency with radar is established, radar identification procedures should be common to all qualified surveillance systems.
- The use of 5nm or 3nm separation standards should be limited to airspace where each state has determined that an ADS-B equivalency with existing radar technology has been established.
- Use of displayed level information should be common to both ADS-B and radar environments provided only barometric level data is displayed.

5.5 ATC Clearance Monitoring – self explanatory.

5.6 Alerting Service

- This section recognises the differences between Alerting and emergency management procedures that currently apply in Oceanic airspace which should also apply where ADS-B services are provided.

5.7 Position Reporting

- In a radar environment, RTF position reporting requirements are normally suspended once a flight is advised that it is identified. This practice would be extended to flights receiving an ADS-B service.
- Flights operating in an Oceanic area may also need to comply with a range of meteorological reporting requirements. These should not be relayed on the VHF network unless no alternative exists. Existing data link or HF voice reporting mechanisms should be employed to manage the relaying of this data.
- Controller assessment of pilot estimates for accuracy should be encouraged to maintain the integrity of the operating environment.

5.8 Phraseology

- All surveillance services that share a common level of integrity as radar should have the same phraseology standards. The only exception being when a surveillance service is terminated it makes sense to specify the relevant service. If PANS – ATM mandates a general surveillance phraseology standard this would replace the exception mentioned above.

5.11 Flight Planning

- Flight identity, Surveillance equipment designator E, Section 18 code entry

6 Emergency and Non-Routine Procedures

6.1 Emergency Procedures

- This section is primarily aimed at Oceanic traffic that may have used a relaying service (Air Radio – HF/ data link) prior to implementation of ADS-B service and clarifies the responsibility for management of communications related to emergencies.

6.2 Total Communications Failure

- This section clarifies the responsibilities of pilots and controllers faced with these rare events and confirms that radar based procedures apply equally in an ADS-B environment.

6.3 Weather Deviation Procedures

- This section removes the existing weather diversion authorities that may exist in some Oceanic airspace. Any significant diversion (eg a displacement greater than the RNP value for the route/ airspace) from the cleared track will require prior ATC approval.

7 ADS-B Implementation

This section is provided consequent to the wishes of the ADS-B SITF WG/2 meeting. The section is intended to guide and assist organisations to decide, plan and implement ADS-B technology.

7.1 Planning

- This section addresses the issues of collaborative decision making, system compatibility and integration. It includes the need for consultation and coordination prior to implementation.

7.2 Implementation Checklist

- A checklist for each activity phase from concept through design to implementation

8 End Notes

- This section is to record a summary of any changes included in the most recent amendment.

Section 3 ACTION BY THE ASIA/ PACIFIC REGIONAL ADS-B TF/3

3.1 The above working group is invited to:

a) Review the attached draft of the ADS-B Operations Manual for the Asia Pacific region and provide the SITF Chairman with any recommended changes.

b) Indicate to the Chairman at this meeting if they endorse the principles and provisions of this draft document (subject to the incorporation of any changes agreed to by the Study and Implementation Task Force) and recommend that the Chairman propose to APANPIRG that this document is an acceptable basis for ADS-B implementation and use in the Asia / Pacific regions.

ICAO ADS-B SITF TF/3

W/Paper 003

- Appendix 1 -

ADS-B Operations Manual

Version 0.1

24 December 2004

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INTRODUCTION

The ADS-B Operations Manual (AOM) provides guidance material and provisional standards for the introduction and operational application of ADS-B technology.

The procedures and requirements detailed in the AOM are applicable in the following Asia and Pacific FIRs:
Note: The States that have filed differences are indicated by an asterix (*). Please refer to the relevant AIP for details.

- Ulan Bator, Mongolia
- Shenyang, China
- Pyongyang, North Korea
- Urumqi, China
- Beijing, China
- Lanzhou, China
- Kunming, China
- Guangzhou, China
- Wuhan, China
- Shanghai, China
- Taegu, South Korea
- Tokyo, Japan
- Anchorage, USA
- Kathmandu, Nepal
- Dhaka, India
- Calcutta, India
- Yangon, Myanma
- Bangkok, Thailand
- Vientiane, Vietnam
- Hanoi, Vietnam
- Hong Kong, China
- Taipei, Republic of China
- Naha, Japan
- Madras, India
- Phnom Penh, Cambodia
- Ho Chi Minh, Vietnam
- Manila, Phillipines
- Colombo, Sri Lanka
- Kuala Lumpur, Malaysia
- Singapore, Republic of Singapore
- Kota Kinaballi, Malaysia
- Jakarta, Republic of Indonesia
- Bali, Republic of Indonesia
- Ujung Pandang, Republic of Indonesia
- Biak, Republic of Indonesia
- Jayapura, Republic of Indonesia
- Port Moresby, Papua New Guinea
- Honiara, Phillipines
- Nauru, Republic of Nauru
- Nadi, Fiji
- Honolulu, USA

- Oakland, USA
- Tahiti, France
- Brisbane, Australia
- Auckland, New Zealand
- Tonga, Kingdom of Tonga
- Samoa, Samoa
- Cook Island, New Zealand
- Easter, Chile
- Melbourne, Australia
- Christchurch, New Zealand

1.1 ARRANGEMENT OF THE AOM

The AOM consists of the following Parts:

Section 1	Introduction and Document Management
Section 2	Acronyms
Section 3	System Integrity and Monitoring
Section 4	ADS-B Data Message Set
Section 5	ADS-B Procedures
Section 6	Emergency and Non-Routine Procedures
Section 7	ADS-B Implementation
Section 8	Endnotes

1.2 DOCUMENT MANAGEMENT

This document is owned and managed by the ICAO Asia/Pacific ADS-B Study and Implementation Task Force Working Group. It was introduced in draft form to the first Working Group meeting in Singapore on 15th October 2004, at which it was agreed to develop the draft to a working document that provides implementation guidance for States. It is intended to ultimately be superceded by ICAO PANS OPS documentation as that progressively includes ADS-B procedures and processes.

The AOM editor is Mr. Wayne Blythe of Airways New Zealand on behalf of the Chairman of the ADS-B SIT TF.

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1.3 COPIES

Paper copies are not distributed. There are four "controlled copies" which can be found at any of the following web sites:
(to be decided)

Copies may be freely downloaded from the web sites in a zip file, or by emailing the AOM Editor who will send a zipped copy by return email.

1.4 CHANGES TO THE AOM

Whenever a user identifies a need for a change to this document, a Request for Change Form (RFC) (see Section 1.6 below) should be completed and submitted to the AOM Editor. The RFC may also be given to any ADS-B Study and Implementation Task Force SIT TF Work Group member

When an RFC has been approved by a meeting of the ADS-B Study and Implementation Task Force then a new version of the AOM will be published, with the changes marked by an "|" in the margin, and an endnote indicating the relevant RFC, so a reader can see the origin of the change. If the change is in a table cell, the outside edges of the table will be highlighted; e.g.:

In those cases where a change is initiated by the editor and relates to document format rather than functional content, the change may not have an associated RFC, but the change will be marked and annotated in the same way.

1.5 EDITING CONVENTIONS

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1.6 REQUEST FOR CHANGE FORM

RFC Nr:	

Please use this form when requesting a change to any part of AOM. This form may be photocopied as required, emailed, faxed or mailed to an appropriate ADS-B Team SITF member, or emailed directly to the Editor at wayne.blythe@airways.co.nz . Alternatively fax (+64) 3 358 2790 Attn: Wayne Blythe.

1. SUBJECT:			
2. REASON FOR CHANGE:			
3. DESCRIPTION OF PROPOSAL: [expand / attach additional pages if necessary]			
4. REFERENCE(S):			
5. PERSON INITIATING:		**DATE:**	
ORGANISATION:			
TEL/FAX/EMAIL:			

6. CONSULTATION		**RESPONSE DUE BY DATE:**	
Organisation	**Name**	**Agree/Disagree**	**Date**
7. ACTION REQUIRED:			
8. AOM EDITOR		**DATE REC'D:**	
9. FEEDBACK PASSED		**DATE:**	

1.7 AMENDMENT RECORD

Version / Amendment Number	Date	Amended by	Comments
0.1	24 December 2004	W Blythe H Anderson	Modified draft following contributions from ADS-B SITF Working Group members. Incorporated to TF/3 Working paper #3.

2. ACRONYM LIST & GLOSSARY OF TERMS

2.1 ACRONYM LIST

ACID	Aircraft Identification
ADS-B	Automatic Dependent Surveillance - Broadcast
AIP	Aeronautical Information Publication
AIT	ADS-B Implementation Team
AMSL	Above Mean Sea Level
APANPIRG	Asia/Pacific Air Navigation Planning and Implementation Regional Group
ARINC	Aeronautical Radio Incorporate
ATC	Air Traffic Control (or Air Traffic Controller)
ATM	Air Traffic Management
ATS	Air Traffic Services
ATSP	ATS Provider
ATSU	ATS unit
CNS	Communications, Navigation, Surveillance
CRC	Cyclic Redundancy Check
DAIW	Danger Area Infringement Warning
FIR	Flight Information Region
FMS	Flight Management System
FOM	Figure of Merit
GPS	Global Positioning System (USA)
HPL	Horizontal Protection Level
ICAO	International Civil Aviation Organisation
MSAW	Minimum Safe Altitude Warning
MTBF	Mean Time Between Failures
MTCA	Medium Term Conflict Alert
MTTR	Mean Time To Restore
NAC	Navigation Accuracy Category
NIC	Navigation Integrity Category
PRS	Problem Reporting System
RAI	Restricted Area Intrusion
RAM	Route Adherence Monitoring
RAIM	Receiver Autonomous Integrity Monitoring
RNP	Required Navigation Performance
SIL	Surveillance Integrity Level
SITF	Study and Implementation Task Force
STCA	Short Term Conflict Alert

2.2 GLOSSARY OF TERMS

ADS-B In	An ADS-B system feature that enables the display of real time ADS-B tracks on a situation display in the aircraft cockpit.
ADS-B Out	An ADS-B system feature that enables the frequent broadcast of accurate aircraft position and vector data together with other information.
Asterix 21	An American standard format for data message exchange
CRC (Cyclic Redundancy Check)	
FOM (Figure of Merit)	A numeric value that is used to determine the accuracy and integrity of associated position data.
HPL (Horizontal Position Limit)	The containment radius within which the true position of the aircraft will be found for 95% of the time.
NAC (Navigational Accuracy Category)	A 4-Bit subfield used to announce the 95% accuracy limits for the horizontal position data being broadcast.
NIC (Navigational Integrity Category)	A 1-Bit subfield used to specify the containment radius integrity associated with horizontal position data.
NUCp (Navigation Uncertainty Category)	A numeric value (between 0 and 9) that announces the integrity of the associated horizontal position data being broadcast.
SIL (Surveillance Integrity Level)	A 2- Bit subfield used to specify the probability of the true position lying outside the containment radius defined by NIC without being alerted.

3. SYSTEM INTEGRITY AND MONITORING

3.1 INTRODUCTION

The CNS/ATM environment is an integrated system including physical systems (hardware, software, and communication networks), human elements (pilots and controllers), and the procedures for use by pilots and controllers. ADS-B is a surveillance system that is capable of integration with other surveillance technologies or may operate as an independent source of surveillance data within a CNS/ATM system.

Because of the integrated nature of the system and the degree of interaction among its components, comprehensive system monitoring is recommended. The procedures described in this section aim to ensure system integrity by validation, and the identification, reporting and tracking of any problems revealed by monitoring.

These procedures **do not replace** the ATS incident reporting procedures and requirements, as specified in *PANS/ATM*, Appendix 4; *ICAO Air Traffic Services Planning Manual (Doc 9426)*, Chapter 3; or applicable State regulations, affecting the reporting responsibilities of parties directly involved in a potential ATS incident.

3.2 PERSONNEL LICENSING AND TRAINING

Prior to operating any element of the ADS-B system pilots and controllers shall receive appropriate training in accordance with Annex 1 and Annex 6 to the Convention on International Civil Aviation.

Notwithstanding the above requirement, special arrangements may be agreed between an operator and an ATSU for the purposes of undertaking limited trials of the ADS-B system.

3.3 REFERENCE DOCUMENTS

Id	Name of the document	Reference	Date	Origin	Domain
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					

3.4 SYSTEM PERFORMANCE CRITERIA FOR AN ATC SEPARATION SERVICE

The table below defines the minimum values to be achieved and verified to demonstrate the equivalence of ADS-B with an Enroute Radar system. This process must be completed prior to any ADS-B system being used to provide a separation service.

Criteria	Definition	Values
Performance	Equivalent criteria to those applied to a radar surveillance system near maximum range.	HPL<0.5 / (107) Horizontal Error <0.25nmi / 95%
Availability	The ability of the network data link service to perform a required function under given conditions at a given time: The mean time to restore (MTTR) ∗	99.5% 60 minutes
Reliability	The ability of a data link application/system to perform a required function under given conditions for a given time interval: it can be expressed in MTBF (Mean Time Between Failure) *	99.5% 200 hours
Integrity	The probability of an undetected failure, event or occurrence within a given time interval.	10^{-7}/hour

∗ Availability = MTBF x 100/(MTBF+MTTR)

3.5 ATC SYSTEM VALIDATION

3.5.1 Safety Assessment Guidelines

To meet system integrity requirements, States should conduct a validation process that confirms the integrity of their equipment and procedures. The processes shall include:

a) A system safety assessment which demonstrates that the ATS Provider's system will meet the safety objectives;
b) Integration test results confirming interoperability for operational use of airborne and ground systems; and
c) Confirmation that the ATS Operation Manuals are compatible with those of adjacent providers where the system is used across a common boundary.

3.5.2 System safety assessment

The objective of the system safety assessment is to satisfy the State that introduction and operation of ADS-B is safe. This can be achieved through a functional hazard analysis or a documented system safety case. The safety assessment should be conducted for initial implementation as well as any future enhancements and should include:

a) Identifying failure conditions;
b) Assigning levels of criticality;
c) Determining risks/ probabilities for occurrence; and
d) Identifying mitigating measures.
e) Categorising the degree of acceptability of risks.

Following the safety assessment, States should institute measures to offset any identified failure conditions that are not already categorized as acceptable, to reduce the probability of their occurrence to an acceptable level. This could be accomplished through automation or procedures.

3.5.3 Integration test

States should conduct trials with suitably equipped aircraft to ensure they meet the technical requirements for interoperability previously specified in this document. Alternatively, they may be satisfied by test results and analysis conducted by another State or organisation deemed competent to provide this service. Where this process is followed, the tests conducted by another State or organisation should be comparable (i.e. using similar equipment under similar conditions).

3.5.4 ATS Operation Manuals

States should coordinate with adjacent States to confirm that their ATS Operation Manuals contain standard operating procedures to ensure harmonization of procedures that impact across common boundaries.

3.5.5 ATS System Integrity

With automated ATM control systems, data changes, software upgrades, and system failures can impact on adjacent units. States shall ensure that:

a) A conservative approach is taken to managing any changes to the system.

b) Aircrew, aircraft operating companies and adjacent ATSU(s) are notified of any planned system changes in advance, where that system is used across a common boundary.

c) ATSUs have procedures in place to ensure that following any system changes, displayed data is both correct and accurate.

d) ATSUs have formalised procedures for timely notification to adjacent units of system failures, software upgrades (or downgrades) or other changes, which may impact on surrounding ATS units. Such notification procedures will normally be detailed in Letters of Agreement between adjacent units.

e) ADS-B surveillance data is provided with an equivalent or better level of protection/ security as surveillance radar data.

3.6 SYSTEM MONITORING

Routine collection of data is necessary in order to ensure that the system continues to meet or exceed its performance, safety and interoperability requirements, and that operational service delivery and procedures are working as intended. The monitoring program is a two-fold process. First, summarised statistical data should be produced periodically showing the performance of the system. This is accomplished through ADS-B Periodic Status Reports. In addition, as problems or abnormalities arise, they should be identified, tracked, analyzed and corrected and information disseminated as required, utilizing the ADS-B Problem Report. This process should remain in effect until PANSOPS procedures authorise an alternative mechanism.

3.6.1 The monitoring process

When problems or abnormalities are discovered, the initial analysis should be performed by the organization(s) identifying the problem. In addition, a copy of the problem report should be entered in to the Problem Reporting System (PRS) which will assign a tracking number. As some problems or abnormalities may involve more than one organization, the originator should be responsible for follow-up action to rectify the problem and forward the information to the PRS. It is essential that all information relating to the problem is documented and recorded and resolved in a timely manner.

The following groups should be involved in the monitoring process and problem tracking to ensure a comprehensive review and analysis of the collected data:

a) ATS Providers;
b) Organizations responsible for ATS system maintenance (where different from the ATS provider);
c) Relevant State regulatory authorities;
d) Communication Service Providers being used;
e) Aircraft operators; and
f) Aircraft and avionics manufacturers.

3.6.2 Distribution of confidential information

It is important that information that may have an operational impact on other parties be distributed by the authorised investigator to all authorised groups that are likely to be affected, as soon as possible. In this way, each party is made aware of problems already encountered by others, and may be able to contribute further information to aid in the solution of these problems.

3.6.3 ADS-B problem reports

Problem reports may originate from many sources, but most will fall within two categories; reports based on observation of one or more specific events, or reports generated from the routine analysis of data. The user would document the problem, resolve it with the appropriate party and forward a copy of the report to the PRS for tracking and distribution. While one ncident may appear to be an isolated case, the receipt of numerous similar reports by the PRS could indicate that an area needs more detailed analysis.

To effectively resolve problems and track progress, the problem reports should be sent to the nominated point of contact at the appropriate organisation and the PRS. The resolution of the identified problems may require:

a) Re-training of system operators, or revision of training procedures to ensure compliance with existing procedures;
b) Change to operating procedures;
c) Change to system requirements, including performance and interoperability; or
d) Change to system design.

3.6.4 ADS-B periodic status report

The ATS Providers should complete the ADS-B Periodic Status Report annually and deliver the report to the regional meeting of the ADS-B SITF. The Periodic Status Report should give an indication of system performance

and identify any trend in system deficiencies, the resultant operational implications, and the proposed resolution, if applicable.

Communications Service Providers, if used, are also expected to submit Periodic Status Reports on the performance of the networks carrying ADS-B data at the annual regional meeting of the ADS-B SITF. These reports could also contain the details of planned or current upgrades to the network.

3.6.5 Processing of Reports

Each group in the monitoring process should nominate a single point of contact for receipt of problem reports and coordination with the other parties. This list will be distributed by the PRS Administrator to all parties to the monitoring process.

Each State should establish mechanisms within its ATS Provider and regulatory authority to:

a) Assess problem reports and refer them to the appropriate technical or operational expertise for investigation and resolution;
b) Coordinate with aircraft operators;
c) Develop interim operational procedures to mitigate the effects of problems until such time as the problem is resolved;
d) Monitor the progress of problem resolution;
e) Prepare a report on problems encountered and their operational implications and forward these to the PRS; and
f) Prepare the ADS-B periodic status report at pre-determined times and forward these to the Secretary of the annual meeting of the ADS-B SITF.
g) Coordinate with any Communication Service Providers used.

3.7 ADS-B STUDY AND IMPLEMENTATION TASK FORCE

The ADS-B SITF shall oversee the monitoring process to ensure the ADS-B system continues to meet its performance and safety requirements, and that operational procedures are working as intended. The ADS-B SITF objectives are to:

a) review Periodic Status Reports and any significant Problem Reports; and
b) highlight successful problem resolutions to ADS-B SITF members; and;
c) monitor the progress of outstanding problem resolutions;
d) prepare summaries of problems encountered and their operational implications;
e) assess system performance based on information in the PRS and Periodic Status Reports;

3.8 PROBLEM REPORTING SYSTEM (PRS)

The Problem Reporting System is tasked with the collection, storage and regular dissemination of data based on reports received from ADS-B SITF members. The PRS tracks problem reports and publish information from those reports to ADS-B SITF members. Problem resolution is the responsibility of the appropriate ADS-B SITF members.

The PRS Administrator shall:

a) prepare consolidated problem report summaries for each ADS-B SITF meeting; and
b) collect and consolidate ADS-B Problem Reports;

c) maintain a functional website (with controlled access) to manage the problem reporting function.

3.9 LOCAL DATA RECORDING AND ANALYSIS

3.9.1 Data recording

ATS Providers and Communication Service Providers shall retain the records defined below for at least 31 days to allow for accident/incident investigation processes. These records should be made available on request to the relevant State safety authority. Where data is sought from an adjacent State, the usual State to State channels should be used.

These recordings shall be in a form that permits a replay of the situation and identification of the messages that were received by the ATS system.

3.9.2 Local data collection

ATS providers and communications service providers shall identify and record ADS-B system component failures that have the potential to negatively impact the safety of controlled flights or compromise service continuity.

3.10 ADS-B PROBLEM REPORT

3.10.1 Report Form

			PRS Number:
Date UTC		**Time UTC**	
Registration		**Flight Callsign/ ICAO 24 Bit Code**	
Flight Sector			
Originator		**Aircraft Type**	
Organization			
Active Center		**Next Center**	
Position			
Description			

3.10.2 Description of Fields

Field	Meaning
Number	A unique identification number assigned to this problem report. Organizations writing problem reports are encouraged to maintain their own internal list of these problems for tracking purposes. Once the problems have been reported to the PRS and incorporated in the database, a number will be assigned by the PRS and used for tracking by the ADS-B SITF.
Date UTC	UTC date when the event occurred.
Time UTC	UTC time (or range of times) at which the event occurred.
Registration	Registration number (tail number) of the aircraft involved.
Flight Callsign/ ICAO 24 Bit Code	Flight identifier (call sign) of the flight involved. Unique aircraft address.
Flight Sector	The departure airport and destination airport for the sector being flown by the aircraft involved in the event. These should be the ICAO identifiers of those airports.
Originator	Point of contact at the originating organization for this report (usually the author).
Aircraft Type	The aircraft model involved.
Organization	The name of the organization (airline, ATS provider or communications service provider) that created the report.
Active Center	ICAO identifier of the ATC Center controlling the aircraft at the time of the event.
Next Center	If the problem involves a handover between ATC Centers, or occurs close to the time of a handover, then this should contain the ICAO identifier of the Center to which control was being handed over.
Position	Location of the aircraft at the time of the event. This could be the latitude and longitude, but could also be specified relative to a waypoint on the route or an FIR boundary.
Description	This should provide as complete a description of the situation leading up to the problem as is possible. Where the organization reporting the problem is not able to provide all the information (e.g. the controller may not know everything that happens on the aircraft), it would be helpful if they would coordinate with the other parties to obtain the necessary information. The description should include: • A complete description of the problem that is being reported • The route contained in the FMS and flight plan • Any flight deck indications • Any indications provided to the controller when the problem occurred • Any additional information that the originator of the problem report considers might be helpful but is not included on the list above IF NECESSARY TO CONTAIN ALL THE INFORMATION, ADDITIONAL PAGES MAY BE ADDED. IF THE ORIGINATOR CONSIDERS IT MIGHT BE HELPFUL, DIAGRAMS AND OTHER ADDITIONAL INFORMATION (SUCH AS PRINTOUTS OF MESSAGE LOGS) MAY BE APPENDED TO THE REPORT.

3.11 ADS-B PERIODIC STATUS REPORT FORM

Originating Organization			
Date of submission		**Originator**	
Status for [Month/Year]			
Performance Measure	**Data**		
UNAVAILABILITY **(Actual time windows of scheduled outages)** □ **(Actual time windows of unscheduled outages)** □	For each window of unavailability, list start and end **times and dates**. Denote if notification was given to operators in each case. **From: To: Notification (Y/N) Comments**		
OPERATIONAL SERVICE **(e.g. ATS Providers - Instances of inability to communicate with individual aircraft)**	Description of operational service issue & frequency of occurrence.		
ANOMALOUS PERFORMANCE **(e.g.- Unexpected "RAIM hole", un flagged erroneous positional data, un flagged erroneous other data, no data from equipped aircraft or avionics failures)**	Description of anomaly & Frequency of occurrence.		
GENERAL COMMENTS			

4 ADS-B DATA MESSAGE SET

This Section contains a complete listing of the data message content for all ADS-B messages as defined by the OPLINK Panel. (DF 17 & 18)

TYPE	Format
Identity / Callsign	Mode S 24 Bit code / ACID / Aircraft Registration
Position	Compact Latitude and Longitude
Velocity Vector	Ground Speed = Knots / Direction = degrees /True?
Barometric Altitude	Feet above AMSL or Flight Level. Note: Metric users will need a conversion feature in the ATM system to display metric level data.
Integrity Value	NUC or NIC/ NAC/ SIL value (scale 0 – 9) Note: Min. value of 5 required for track data to be used in provision of separation service
Aircraft Status Message	TBD
Cyclic Error Message	TBD

Note 1: ASTERIX 21 category – especially for cross boundary data sharing network.
Note 2: FAA considering moving to ASTERIX 33 format for their internal data sharing.
Note 3: DO260a incorporates the following fields: 4096 code, call-sign and NIC/ NAC/ SIL values.

ADS-B data shall be passed between ATS Providers using Asterix Category 21 version (tba) with amendments agreed as follows:

- (list amendments)
-
-

ATC systems shall use information from Asterix Category 21 messages in the following ways:

a) Positional data: Used for traffic situation display.
b) FOM is used by the ATC provider to check integrity level of the data.
c) Barometric altitude: Used in the same way as for radar.

5 ADS-B PROCEDURES

5.1 INTRODUCTION

In CNS/ATM environments, surveillance may be provided by the Automatic Dependent Surveillance - Broadcast (ADS-B) system. The following procedures relate to the ADS-B "Out" operating mode. A future edition of the AOM will address the procedures that relate to the ADS-B "In" operating mode. Until these procedures are developed, flights that are equipped with cockpit display of traffic information (CDTI) may use the displayed data to assist pilots in maintaining situational awareness but this data may not be used as a sole means of determining separation.

ADS-B enables the transmission of specific data messages from the aircraft's avionics system and ground based surveillance systems. These data messages are broadcast from ADS-B equipped aircraft at 0.5 second intervals and received at compatible ground stations that relay these messages to single or networked ATSU(s). Aircraft that have CDTI capability will receive ADS-B data directly from ADS-B equipped aircraft within range and display the information with similar levels of accuracy and integrity as achieved by the ATSU(s).

The implementation of the ADS-B system will support the provision of "radar-like" surveillance, both in and outside controlled airspace, enhancing flight safety, facilitating the reduction of separation minima and better accommodating user-preferred flight profiles. ADS-B may be used as an aircraft surveillance system in an ADS-B only surveillance environment or a mixed ADS-B/radar surveillance environment.

The ADS-B system may be used to provide both Air Traffic Control Service and Flight Information Service.

5.2 FACTORS TO BE CONSIDERED WHEN USING ADS-B

5.2.1 Use of ADS-B Level data

The accuracy and integrity of barometric level information provided in the ADS-B messages are considered equivalent to Mode C level data provided through an SSR sensor and subject to the same operational procedures as those used in an SSR environment. Where the ATM system converts ADS-B level data to display metric equivalent level data, the displayed data should not be used to determine vertical separation until the data is verified by comparison with a pilot reported metric level.

5.2.2 Navigational Performance Criteria

The ADS-B data messages from the aircrafts Mode S /1090ES will include an assessment of the associated horizontal position data, expressed as the Figure of Merit (FOM). This figure is determined from NIC/ NAC/ SIL values for DO260a certified avionics and NUC values for DO260 certified avionics. If the FOM is less than 5 the data does not meet the performance criteria for 5NM ADS-B separation and therefore should not be used for such separation unless an alternative means of determining equivalence is available. Whenever FOM values are used to determine compliance with the performance criteria, ADS-B position data with a FOM value of less than 5 may be presented on situation displays, provided the controller is alerted (e.g. by a change in symbology and/or visual alert) to the change and the

implications for the provision of separation. An ANS Provider may elect not to display ADS-B tracks that fail to meet the Navigational Performance Criteria for a separation service.

5.2.3 RAIM Prediction Service

Wherever ATS Providers elect to use RAIM service to assist them in determining the future integrity of ADS-B data, the following information and recommendation applies: The RAIM Prediction service alerts users to potential future loss or degradation of the ADS-B service in defined areas. When these alerts are displayed, the system is indicating to its users that at some time in the future the ADS-B positional data may be inadequate to support the application of ADS-B separation. Therefore the RAIM prediction service should be made available to each ATSU that is employing ADS-B to provide a separation service, to ensure that Air Traffic Controllers are alerted in advance of any predicted degradation of the GNSS service and the associated reduction in their ability to provide ADS-B separation to flights that are within the affected area. This is similar to having advance warning of a planned radar outage for maintenance.

5.2.3.1 Impact of Predicted RAIM Loss on Separation Service

ADS-B separation should not be applied within airspace that is subject to a RAIM warning for the duration of the warning.

5.2.3.2 Impact of Unpredicted RAIM Loss on Separation Service

If an unpredicted loss of integrity occurs (including a RAIM warning report from aircrew) then;
(a) ADS-B separation should not be applied by ATC to the particular aircraft reporting the RAIM warning; and
(b) The controller should check with other aircraft in the vicinity of the aircraft reporting the RAIM warning, to determine if they have also been affected and establish alternative forms of separation if necessary.

5.2.4 Sharing of ADS-B Data

Member States should consider the benefits of sharing ADS-B data received from aircraft operating in the proximity of their international airspace boundaries with adjacent States that have compatible technology in an effort to maximize the service benefits and promote operational safety. Any agreement on the sharing of surveillance data should be incorporated in Letters of Agreement between the States concerned.

5.3 REPORTING RATES

5.3.1 General

The ADS-B system shall maintain a reporting rate that ensures at least an equivalent degree of accuracy, integrity and availability as for a radar system that is used to provide a similar ATC service. The standard reporting rate is 0.5 second but the rate of update provided to the ATM system (for the situation display) may be less frequent (e.g. 5 seconds), provided the equivalency with radar is preserved.

All safety net features (MSAW, STCA, MTCA, RAM and DAIW/ RAI etc) should possess the same responsiveness as equivalent radar safety net features.

5.4 SEPARATION

5.4.1 General

ADS-B may be used for the application of separation within an ADS-B environment or in a mixed surveillance environment, such as airspace where any combination of radar, ADS-B or alternative surveillance tracks are available, provided:
a) Each surveillance technology used in a mixed surveillance environment is equivalent to or better than, radar in terms of accuracy, integrity, and availability;
b) Direct two-way voice communications are available between the controller providing the separation and the flights receiving the separation service and the communications performance standards that apply to radar control services also apply to ADS-B services.
c) The aircraft positions are displayed on the same situation display.

5.4.2 Identification Methods

The methods approved by ICAO for establishing identification with radar, may be employed with ADS-B. In addition, a controller may identify the flight using the ACID derived from the ADS-B data observed on the situation display.

5.4.3 ADS-B Separation Standard

State Authorities may approve a minimum ADS-B separation standard of 5NM horizontal separation within controlled airspace provided they have established an equivalency between ADS-B and Enroute radar. Where a State has established equivalency between ADS-B and a radar system that provides 3NM separation, the same separation standard (with all associated restrictions) may be applied using ADS-B.
Those States that do not have experience with radar systems may base their separation standard approval on published regional supplementary procedures for their region.
The application of ADS-B separation is limited to the territorial limits of each State until such time as ICAO authorise the use of this separation in International Airspace by regional supplement or in PANSOPS.

(Note: equivalency = accuracy, integrity and availability that are **equal to or better** than radar).

5.4.4 Vertical separation

5.4.4.1 Introduction

The ADS-B level data presented on the controllers situation display shall normally be derived from barometric altitude. In the event that Geometric altitude data is presented on the situation display, the controller should be alerted to this difference.

5.4.4.2 Vertical tolerance standard

The vertical tolerances for ADS-B level information should be consistent with those applied to Mode C level information.

5.4.4.3 Verification of ADS-B level information

The verification procedures for ADS-B level information shall be the same as those employed for the verification of Mode C level data in a radar environment.

5.5 AIR TRAFFIC CONTROL CLEARANCE MONITORING

5.5.1 General

ADS-B track data can be used to monitor conformance with air traffic control clearances.

5.5.2 Deviations from ATC clearances

The ATC requirements relating to monitoring of ADS-B traffic on the situation display should be similar to those contained in PANS-ATM Ch.8.

5.6 ALERTING SERVICE

For ADS-B equipped aircraft, the provision of an alerting service should be based on the same criteria as applied within a radar environment. The pilot of a flight receiving a control service based on the ADS-B system shall be required to maintain a continuous listening watch on the designated ATC frequency.

5.7 POSITION REPORTING

5.7.1 Position reporting requirements in ADS-B airspace

Pilots shall cease making position reports by voice or CPDLC once they have been advised that ATC has established identification.

5.7.2 Meteorological reporting requirements in ADS-B airspace

ATSUs may promulgate in the AIP meteorological reporting requirements that apply within the nominated FIR. The meteorological reporting data required and the transmission methods available to aircrew shall be incorporated in these documents.

5.8 PHRASEOLOGY

5.8.1 Phraseology Standard

The ICAO phraseology standards that apply to a radar control service should be applied to an ADS-B control service except as prescribed below:
(To be included: OPLINK PANS ATM phraseology)

5.9 FLIGHT PLANNING

5.9.1 ADS-B Flight Planning Requirement – Flight Identity

The aircraft identification (ACID) must be accurately recorded in section 7 of the ICAO Flight Plan form as per the following instructions:

Aircraft Identification, not exceeding 7 characters is to be entered in item 7 of the flight plan **and** set in the aircraft as follows:

Either,

a) The ICAO three-letter designator for the aircraft operating agency followed by the flight identification (e.g. KLM511, BAW213, JTR25), when:

   in radiotelephony the callsign used consists of the ICAO telephony designator for the operating agency followed by the flight identification (e.g. KLM 511, SPEEDBIRD 213, HERBIE 25).

Or,

b) The registration marking of the aircraft (e.g. EIAKO, 4XBCD, OOTEK), when:

   1) in radiotelephony the callsign used consists of the registration marking alone (e.g. EIAKO), or preceded by the ICAO telephony designator for the operating agency (e.g. SVENAIR EIAKO),

   2) the aircraft is not equipped with radio.

Note 1 No zeros, dashes or spaces are to be added when the Aircraft Identification consists of less than 7 characters.

Note 2 Appendix 2 to ICAO Doc 4444 *[PANS-ATM]*, refers. ICAO designators and telephony designators for aircraft operating agencies are contained in ICAO Doc 8585.

5.9.2 ADS-B Flight Planning Requirements

5.9.2.1 Surveillance Equipment Designator

The letter **E** shall be entered in section 10b of the ICAO flight plan to indicate that the flight is equipped with ADS-B that utilises Mode S / 1090 extended squitter as the data link.

5.9.2.2 Mode S 24 Bit Code

The aircrafts unique Mode S identity code shall be recorded in section 18 of the ICAO flight plan as per the following example:

CODE/7C432B

6 EMERGENCY AND NON-ROUTINE PROCEDURES

6.1 EMERGENCY PROCEDURES

The ADS-B avionics will transmit emergency status messages to any ADS-B ground station within coverage. The controller receiving these messages shall acknowledge receipt, determine the nature of the emergency and ascertain any assistance required.

6.1.1 Executive control responsibility

The responsibility for control of the flight rests with the ATSU within whose airspace the aircraft is operating. However, if the pilot takes action contrary to a clearance that has already been coordinated with another sector or ATSU and further coordination is not possible in the time available, the responsibility for this action would rest with the pilot in command, and performed under the pilot's emergency authority.

6.1.2 Emergency procedures

The emergency response procedures that apply to a radar control service should be applied to flights receiving an ADS-B service.

6.2 TOTAL COMMUNICATIONS FAILURE

The current ICAO procedures that apply to a complete communications failure while receiving a radar control service, shall apply to flights receiving an ADS-B control service.

6.3 WEATHER DEVIATION PROCEDURES

The weather deviation procedures that apply to a radar control environment shall also apply to an ADS-B control environment.

7 ADS-B IMPLEMENTATION

7.1 PLANNING

7.1.1 There are a range of activities needed to progress ADS-B from initial concept level to operational use. This section addresses the issues of collaborative decision making, system compatibility and integration, while the second section of this chapter provides a checklist to assist States with the management of ADS-B implementation activities.

7.1.2 Implementation team to ensure international coordination

7.1.2.1 Any decision to implement ADS-B by a State should include consultation with the wider ATM community. Moreover, where ADS-B procedures or requirements will affect traffic transiting between states, the implementation should also be coordinated between States and Regions, in order to achieve maximum benefits for airspace users and service providers.

7.1.2.2 An effective means of coordinating the various demands of the affected organizations is to establish an implementation team. Team composition may vary by State or Region, but the core group responsible for ADS-B implementation planning should include members with multidiscipline operational expertise from affected aviation disciplines, with access to other specialists where required.

7.1.2.3 Ideally, such a team should comprise representatives from the ATS providers, regulators and airspace users, as well as other stakeholders likely to be influenced by the introduction of ADS-B, such as manufacturers and military authorities. All identified stakeholders should participate as early as possible in this process so that their requirements can be identified prior to the making of schedules or contracts.

7.1.2.4 The role of the implementation team is to consult widely with stakeholders, identify operational needs, resolve conflicting demands and make recommendations to the various stakeholders managing the implementation. To this end, the implementation team should have appropriate access to the decision-makers.

7.1.3 System compatibility

7.1.3.1 ADS-B has potential use in almost all environments and operations and is likely to become a mainstay of the future ATM system. In addition to traditional radar-like services, it is likely that ADS-B will also be used for niche application where radar surveillance is not available or possible. The isolated use of ADS-B has the potential to foster a variety of standards and practices that, once expanded to a wider environment, may prove to be incompatible with neighbouring areas.

7.1.3.2 Given the international nature of aviation, special efforts should be taken to ensure harmonization though compliance with ICAO Standards and Recommended Practices (SARPs). The choice of systems to support ADS-B

should consider not only the required performance of individual components, but also their compatibility with other CNS systems.

7.1.3.3 The future concept of ATM encompasses the advantages of interoperable and seamless transition across flight information region (FIR) boundaries and, where necessary, ADS-B implementation teams should conduct simulations, trials and cost/benefit analysis to support these objectives.

7.1.4 **Integration**

7.1.4.1 ADS-B implementation plans should include the development of both business and safety cases. The adoption of any new CNS system has major implications for service providers, regulators and airspace users and special planning should be considered for the integration of ADS-B into the existing and foreseen CNS/ATM system. The following briefly discusses each element.

7.1.4.2 Communication system

7.1.4.2.1 The communication system is an essential element within CNS. An air traffic controller can now monitor an aircraft position in real time using ADS-B where previously only voice position reports were available. However, a communication system that will support the new services that result from the improved surveillance may be necessary. Consequently, there is an impact of the ongoing ADS-B related work on the communication infrastructure developments.

7.1.4.3 Navigation system infrastructure

7.1.4.3.1 ADS-B is dependent upon the data obtained from a navigation system (typically GNSS), in order to enable its functions and performance. Therefore, the navigation infrastructure should fulfill the corresponding requirements of the ADS-B application, in terms of:

a) Data items; and
b) Performance (e.g. accuracy, integrity, availability etc.).

7.1.4.3.2 This has an obvious impact on the navigation system development, which evolves in parallel with the development of the surveillance system.

7.1.4.4 Other surveillance infrastructure

7.1.4.4.1 ADS-B may be used to supplement existing surveillance systems or as the principal source of surveillance data. Ideally, surveillance systems will incorporate data from ADS-B and other sources to provide a coherent picture that improves both the amount and utility of surveillance data to the user. The choice of the optimal mix of data sources will be defined on the basis of operational demands, available technology, safety and cost-benefit considerations.

7.2 IMPLEMENTATION CHECKLIST

7.2.1 Introduction

The purpose of this implementation checklist is to document the range of activities that needs to be completed to bring an ADS-B application from an initial concept to operational use. This checklist may form the basis of the terms of reference for an ADS-B implementation team, although some activities may be specific to individual stakeholders.

7.2.2 Activity Sequence

The activities are listed in an approximate sequential order. However, each activity does not have to be completed prior to starting the next activity. In many cases, a parallel and iterative process should be used to feed data and experience from one activity to another. It should be noted that not all activities will be required for all applications.

7.2.3 Concept Phase

a) construct operational concept:
- 1) purpose;
- 2) operational environment;
- 3) ATM functions; and
- 4) infrastructure;

b) identify benefits:
- 1) safety enhancements;
- 2) efficiency;
- 3) capacity;
- 4) environmental;
- 5) cost reductions;
- 6) access; and
- 7) other metrics (e.g. predictability, flexibility, usefulness);

c) identify constraints:
- 1) pair-wise equipage;
- 2) compatibility with non-equipped aircraft;
- 3) need for exclusive airspace;
- 4) required ground infrastructure;
- 5) RF spectrum;
- 6) integration with existing technology; and
- 7) technology availability;

d) prepare business case:
- 1) cost benefit analysis; and
- 2) demand and justification.

7.2.4 Design Phase

a) identify operational requirements:
- 1) security; and
- 2) systems interoperability;

b) identify human factors issues:
1) human-machine interfaces;
2) training development and validation;
3) workload demands;
4) role of automation vs. role of human;
5) crew coordination/pilot decision-making interactions; and
6) ATM collaborative decision-making;

c) identify technical requirements:
1) standards development;
2) data required;
3) functional processing;
4) functional performance; and
5) required certification levels;

d) equipment development, test, and evaluation:
1) prototype systems built to existing or draft standards/specifications;
2) developmental bench and flight tests; and
3) acceptance test parameters; and
4) select technology;

e) develop procedures:
1) pilot and controller actions and responsibilities;
2) phraseologies;
3) separation/spacing criteria and requirements;
4) controller's responsibility to maintain a monitoring function, if appropriate;
5) contingency procedures; and
6) emergency procedures;

f) prepare design phase safety case:
1) safety rationale;
2) safety budget and allocation; and
3) functional hazard assessment.

7.2.5 Implementation phase

a) prepare implementation phase safety case;

b) conduct operational test and evaluation:
1) flight deck and ATC validation simulations; and
2) flight tests and operational trials;

c) obtain systems certification:
1) aircraft equipment; and
2) ground systems;

d) obtain regulatory approvals:
1) flight operations; and
2) air traffic certification of use;

e) implementation transition:
1) continue data collection and analysis;

2) resolve any unforeseen issues; and
3) continue feedback into standards development processes; and

f) performance monitoring to ensure that the agreed performance is maintained.

7.2.5.1 Once the implementation project is complete, ongoing maintenance and upgrading of both ADS-B operations and infrastructure should continue to be monitored, through the appropriate forums.

8 ENDNOTES

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