INTERNATIONAL CIVIL AVIATION ORGANIZATION

ASIA AND PACIFIC OFFICE

REPORT OF

THE THIRD MEETING OF THE SOUTH EAST ASIA SUB-REGIONAL ADS-B IMPLEMENTATION WORKING GROUP

(SEA ADS-B WG/3)

Putrajaya, Malaysia, 2-3 July 2008

Table of Contents

HISTORY OF THE MEETING **Page**

Introduction..... i-1
Attendance i-1
Officers and Secretariat..... i-1
Organization, Working arrangements and Language..... i-1

SUMMARY OF DISCUSSIONS

1. Adoption of Agenda.....1

2. Review the outcome of the ADS-B SITF/7 Meeting 1

3. Review Terms of Reference.....2

4. Review States' activities and issue on regional trials and implementation of ADS-B including catalogue ATC system capabilities and requirements for ATC service delivery 3

5. Review of action items from the SEA ADS-B WG/2.....4
   - Review progress of South East Asia ADS-B project made by IATA
   - Discuss projects proposed at ADS-B SITF/7

6. Review sub-regional implementation plan 5

7. Any Other Business 7

8. Date and Venue for the Next Meeting 9

APPENDIX

Appendix A: Revised TOR of SEA ADS-B Working Group

Appendix B: Outline for the Enhancement of safety and Efficiency using ADS-B in SEA Sub-region

Appendix C: PHASE I - SEA ADS-B Implementation Plan (data sharing among ISV)

Appendix D: Baseline document - AMC20-24 and proposed changes

ATTACHMENT

Attachment 1: List of participants

Attachment 2: List of working and information papers

1. INTRODUCTION

1.1 The Third Meeting of the South East Asia Sub-Regional ADS-B Implementation Working Group, hosted by DCAC Malaysia was held from 2-3 July 2008 at the Department of Civil Aviation (DCA), Putrajaya, Malaysia.

1.2 Mr. Ahmad Nizar Zolfakar, Director of Air Traffic Management DCA Malaysia welcomed the participants to Putrajaya, the Federal Government Administrative Centre of Malaysia. In his opening remarks, he highlighted the need to enhance surveillance system in order to increase efficiency and to maximize capacity. He stated that ADS-B has the potential to fulfill the gaps of existing surveillance system and those areas that can not be covered by traditional system. He encouraged participants to continue working to realize the implementation of ADS-B within the South East Asia Region.

1.3 Director General of Civil Aviation Malaysia, Dato' Azharuddin Abdul Rahman opened the meeting. He extended welcome to all the participants from States and International Organizations to Malaysia. He emphasized the importance of supporting the high growth in aviation with a safe and efficient surveillance system. There is a need to increase confidence of the airspace users especially when flying on routes beyond radar coverage. He had mentioned how efficiency in the surveillance system can help airlines in coping with the ever increasing the price of fuel. He also mentioned about Malaysia's commitment in introducing new technology as long as it can bring operational advantage to the air traffic control system and bring benefit to DCA customers by quoting the installation of Multilateration (MLAT) system in KLIA. Finally he commended on the good works done by the working group and hoped that the outcome of the working group will help the department during decision making process.

2. ATTENDANCE

2.1 The meeting was attended by 31 Participants from Australia, Cambodia Indonesia, Malaysia, the Philippines, Singapore, Thailand, Viet Nam, CANSO, IATA, SITA and 16 representatives from airlines and the industry. List of participants is at **Attachment 1**.

3. OFFICERS AND SECRETARIAT

3.1 Mr. Ahmad Nizar Zolfakar, Director of Air Traffic Management and moderator nominated by Malaysia chaired the Meeting. Mr. Li Peng, Regional Officer, CNS of the ICAO Asia and Pacific Regional Office was the Secretary for the meeting. The meeting was also facilitated by Mr. Jamil Khir Mohamed Deputy Director ATM Sector, DCA Malaysia.

4. ORGANIZATION, WORKING ARRANGEMENTS AND LANGUAGE

4.1 The meeting met as a single body. The working language was English only inclusive of all documentation and this Report. The meeting considered 7 working papers and 6 information papers. List of Working Papers and Information Papers is provided at **Attachment 2.**

Agenda Item 1: Adoption of Agenda

1.1 The agenda adopted by the meeting was as follows:

Agenda Item 1: Adoption of Agenda

Agenda Item 2: Review the outcome of the ADS-B SITF/7 meeting

Agenda Item 3: Review Terms of Reference

Agenda Item 4: Review States' activities and issue on regional trials and implementation of ADS-B including catalogue ATC system capabilities and requirements for ATC service delivery

Agenda Item 5: Review of action items from the SEA ADS-B WG/2

- Review progress of South East Asia ADS-B project made by IATA
- Discuss projects proposed at ADS-B SITF/7.

Agenda Item 6: Review of sub-regional implementation plan

Agenda Item 7: Any other Business

Agenda Item 8: Date and Venue for the Next Meeting

Agenda Item 2: Review the outcome of the ADS-B SITF/7

2.1 The meeting reviewed outcome of the seventh meeting of ADS-B Study and Implementation Task Force held in China from 9-11 April 2008. The Task Force meeting noted the following achievements progressed by the first and the second meeting of the SEA ADS-B Working Group:

a) developed the cost apportionment framework for ADS-B Ground Stations and ADS-B Surveillance Data Sharing;

b) agreed guidelines to be used for the development of implementation plan;

c) developed a sample agreement for ADS-B Data Sharing;

d) agreed upon an ADS-B implementation study project to be undertaken by IATA for the sub-region; and

e) worked out an initial sub-regional ADS-B implementation plan to be further enhanced at subsequent meetings. Some surveillance gaps were identified in the plan and two possible additional sites were proposed to cover a gap in the South China Sea. States concerned were requested to consider the feasibility of installing ADS-B stations at these sites. Viet Nam offered two additional ADS-B sites viz Song Tu Tay Island (11°25'N, 114°21'E) and Truong Sa Island (8°38'N, 111°55'E) at the second meeting to cover the ADS-B coverage gap in the South China Sea. The Philippines also identified a possible site to fill the gap, but it is a private airport operated by RIO TUBA Nickel Mining Corporation (8°31'N, 117°24'E). Thus they have to evaluate and study further.

2.2 The Task Force meeting appreciated the efforts and progress made by the SEA ADS-B WG.CANSO highly commended the group for the result achieved and IATA expressed its full support to the work being carried out by the group.

2.3 The meeting noted the guidance materials endorsed by the Task Force meeting including guidelines for development of implementation plan by States and a sample agreement for ADS-B Data Sharing developed by the working group.

2.4 The meeting further noted the proposals and comments made by South East Asia ad hoc working group established during the Task Force meeting. The ad hoc working group identified potential 5 projects in two phases 1st phase of which will be up till 2011 and the second phase up till 2013.

2.5 Recognizing that the ADS-B technology is spreading widely and support for work going on throughout the region, the meeting identified the need for harmonized certification process.

Agenda Item 3: Review Terms of Reference

3.1 The meeting recalled that APANPIRG/18 meeting under Conclusion 18/38 agreed to the establishment of a sub-regional ADS-B implementation Working Group in the South-East Asia area (SEA ADS-B WG) to develop the terms of cooperation and an implementation plan for near-term ADS-B applications in the sub-region.

3.2 The SEA ADS-B WG/1 meeting developed Terms of Reference for the working group based on a proposal made by Singapore. The seventh meeting of ADS-B SITF held in early April 2008 in China noted the progress made by the SEA ADS-B Working Group. While reviewing the achievements of the 1st and 2nd meeting of the Working Group, the Task Force meeting noted that Laos and Cambodia are not currently participating in the task force and working group meeting. It was suggested that Malaysia who is hosting the next working group meeting invite these countries as well as Brunei for the next working group meeting to explore other possibilities of collaboration.

3.3 The meeting reviewed the TOR and agreed to revise the TOR to include Cambodia and CANSO as members of the working group. The secretariat was requested to contact Laos and Brunei to see if they wish to join the working group.

3.3.1 It was further pointed out by IATA that the working group should be opened to all members nominated by States in the Sub-region. The group should be inclusive rather than exclusive. The other States having interest should also be welcomed to participate in the meetings of the working group.

3.3.2 The meeting discussed the issue of developing model document for possible use by States on establishing ADS-B avionics fitment mandate. The meeting agreed that it should concentrate on the technical requirement and timing for avionics fitment. The meeting recalled that the initial draft for the sample document presented to the first meeting was not endorsed by the meeting. The meeting was of the view that some template form containing technical requirements should be developed for consideration and reference by the States.

3.3.3 The meeting proposed to include “Coordination for implementation of the plan” as sub-paragraph c) into the revised TOR. The need for some editorial changes in *the Reporting* was also identified. In addition to the ADS-B ground stations, the requirement for provision of VHF radio communication service was also identified to be included in the TOR.

3.4 The revised TOR agreed by the meeting is placed in **Appendix A** to this report for further consideration by the CNS/MET Sub-group. Accordingly, the meeting formulates the following Decision:

Decision 3/1 - TOR of SEA ADS-B Working Group

That, the TOR of SEA ADS-B WG as placed in the **Appendix A** to Report of SEA ADS-B WG/3 Meeting be adopted.

Agenda Item 4: Review States' activities and issue on regional trials and implementation of ADS-B including catalogue ATC system capabilities and requirements for ATC service delivery

Indonesia

4.1 Indonesia provided following updates to the meeting on status of planning and implementation of ADS-B in Indonesia.

- Additional 13 ADS-B ground stations will be installed by the end of 2008;
- DGCA, Indonesia will be assisted by Airservices Australia to make transition planning for operational and safety assessment;
- DGCA, Indonesia has a plan to share data with Australia and Singapore;
- ADS-B data derived from Sorong, Makassar, Kupang will be provided through RCMS (Remote Control and Monitoring System) for display on Makassar Advance Air Traffic Services (MAATS) and DGCA Headquarters; and
- Aircraft equipped with ADS-B can be monitored at Natuna, Sorong, Makassar and DGCA Headquarters.

4.1.1 In response to a query, Indonesia clarified that the issues related certification for ADS-B (Out) avionics will be addressed and preparation will start in 2010.

4.1.2 The meeting congratulated Indonesia for the progress made.

Australia

4.2 Australia made a presentation on the progress of ADS-B over the last 6 months:

Thursday islands ADS-B is operational and it will be possible to share from this installation with Indonesia and PNG;

- In April 2008, more than 50% of international flights were observed to be equipped with ADS-B avionics that CASA has agreed can be used to deliver ADS-B services. The domestic equipage rate is 20%;
- Australia will install ADS-B receivers at all en-route radar and at some defence radar locations. These will remain in operation even if the radars are decommissioned;
- Another 5 ADS-B ground stations of the UAP Programme will be commissioned in 2008;
- Some regional aircraft (SAAB340) are now equipped in Australia; and
- Some GA ADS-B products have been announced at reasonable price.

4.2.1 The meeting was informed that Qantas had found a way to upload flight ID from Flight Operation Centre (OPS) and this was expected to reduce flight ID entry errors.

4.2.2 The ATLAS project has been re-inaugurated. Australia is hopeful of a decision later this year. The ATLAS programme, if approved, will bring an ADS-B mandate for all aircraft currently required to operate an ATC transponder. The project will also decommission enroute radars and approximately 50% of conventional navaids (NDB, VOR) in lieu of GNSS navigation.

Singapore

4.3 Singapore informed the meeting that an ADS-B ground station will be installed at Changi Airport. Tender has been invited and commissioning of the ground station is planned for the 4th quarter of 2009.

Thailand

4.4 The meeting was informed that the ADS-B Project was on going. The project is estimated to be completed in early 2009.

Agenda Item 5: Review of action items from the SEA ADS-B WG/2

Review progress of South East Asia ADS-B project

5.1 Under this agenda item, the meeting reviewed a draft project proposal for the enhancement of safety and efficiency using ADS-B OUT presented by IATA. The proposal was prepared in accordance with ADS-B WG/2 Decision 2/2. The main points of consideration for the project were outlined in the proposal. It was emphasized that in order to enable real benefits to users, the provision of the enhanced surveillance must be supported by significant infrastructure, in particular Direct Controller Pilot Communication (DCPC VHF voice communication), ATM integration and staffing.

5.1.1 Viet Nam confirmed to the meeting that for the first phase Viet Nam will install only three ADS-B stations at Con Son, Song Tu Tay and Truong Sa islands.

5.1.2 Regarding the equipage requirements in the project proposal, the meeting recognized that due to the nature of ADS-B, it will be necessary to mandate the equipage requirements prior to utilizing the technology for separation purposes. The meeting discussed a staged approach with airspace becoming exclusionary over a period of several years, allowing capable users short-term benefits but also allowing those without the capability limited access. The meeting was generally in favour of the staged approach. As the proposal to create an exclusionary airspace in the portion of the South China Sea that may have an impact on airspace capacity and the operation of the aircraft in the area, Thailand is of the view that further studies should be conducted by the Working Group and the results presented for further consideration by ATM/AIS/SAR Sub-Group prior to taking any decision on the matter.

5.1.3 In view of the above observations, the project proposal was amended. The meeting then endorsed the project proposal as the outline for further developing ADS-B enhancements within the region. The outline endorsed by the meeting as mechanism to further develop ADS-B surveillance enhancements is placed at **Appendix B** to this report.

5.1.4 The members of the working group were requested to support the process as the project is formalized and they were requested to provide required data to enable a full cost benefit analysis to be undertaken. In response to a query for what type of data need to be provided by States, IATA indicated that requirements for the data will be provided. CANSO agreed to join IATA for

progressing the project and the cost and benefit analysis. The further development of the project will be reported to the next meeting of the working group.

Discuss projects proposed at ADS-B SITF/7

5.2 The meeting further reviewed the five projects for the South East Asia area identified by ad hoc working groups at the seventh meeting of ADS-B Study and Implementation Task Force.

5.2.1 Under project 1, Australia indicated possibility for Indonesia to share ADS-B data derived at Thursday Island in the first phase.

5.2.2 For project 2, updates by Indonesia, Malaysia and Singapore are reflected in WP5 under Agenda Item 6.

5.2.3 For project 3, Indonesia indicated that ADS-B ground station at Aceh will be installed at the end of 2008. Radar has been installed at the same site. Malaysia was advised that the ADS-B Study and Implementation Task Force would be the appropriate forum for discussing with India on the possibility of setting up an ADS-B ground station at Port Blair and sharing ADS-B data from the station.

5.2.4 No updates to project 4.

5.2.5 Regarding project 5, the need and how to share ADS-B data are subject to further discussion between Cambodia, Laos, Thailand and Vietnam. Cambodia informed the meeting that air space of the Cambodia is fully covered by Radar.

Agenda Item 6: Review of sub-regional implementation plan

ADS-B collaborated Implementation Plan over South China Sea

6.1 Under this agenda item, the meeting reviewed an ADS-B Collaborated implementation plan presented by Indonesia, Singapore and Viet Nam. The plan was developed based on the project 2 agreed at the seventh meeting of the ADS-B Study and Implementation Task Force. The plan includes the following five ADS-B ground stations at the following sites whereby ADS-B data can be shared between adjacent States of FIR boundaries within the coverage:

- Natuna (Indonesia);
- Singapore;
- Con Son (Viet Nam);
- Song Tu Tay (Viet Nam); and
- Truong Sa (Viet Nam).

6.1.1 The initial implementation plan identified the technical and operational benefit of ADS-B data sharing and defined the implementation schedule. Various aspects of implementation are also addressed in the plan. The implementation plan for the project endorsed by the meeting is placed at **Appendix C** to this report.

Requirements for providing VHF radio voice communication

6.1.2 The meeting noted in the plan that Indonesia would consider installing VHF stations at Natuna and Matak for use by Singapore's Air Traffic Control. Viet Nam would consider a similar proposal form Singapore for the requirement for VHF communication. In order for the States to seek

approval from relevant authorities, need for APANPIRG to develop a policy on supporting DCPC requirements of adjacent States in conjunction with ADS-B data sharing between adjacent States was identified. The meeting recognized that to enable radar like separation, ADS-B based surveillance service must be complemented by DCPC such as VHF radio voice communication. Without supporting communication infrastructure, the ADS-B based surveillance will provide minimal operational benefits to the air space users. As a result of lengthy discussion on the subject, the meeting agreed to develop a regional policy to support associated DCPC capability and formulated the following draft Conclusion:

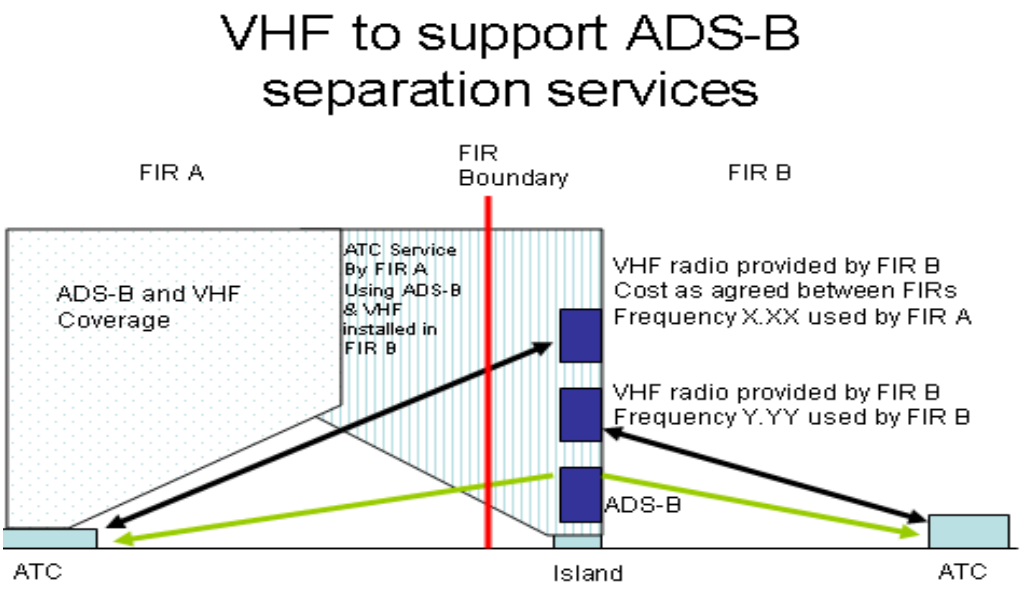
Draft Conclusion 3/2 - Support provision of VHF radio voice communication associated with ADS-B data sharing between adjacent States

That, States are urged to consider following regional policy on supporting provision of direct controller pilot communication capability associated with ADS-B data sharing between adjacent FIRs of States.

"In order to provide radar like separation services using ADS-B, it is necessary for the controllers to have direct controller pilot communication (DCPC). In some cases, to achieve radar like separation services it may be necessary for the States to provide VHF radio communication services for use by adjacent States.

It is therefore recommended that States capable to do so support provision of VHF radio communication services to adjacent States when this is required to support delivery of ADS-B based separation services. Costs of such service provision shall be agreed between the States concerned."

6.1.3 The meeting reviewed the following general concept for the provision of complimentary direct controller pilot communication (DCPC) capability to ADS-B data sharing using VHF voice communication presented by Australia. It was recognized that 5 NM separation services can only be provided with DCPC. In cases where 5 NM services are required, VHF voice communication between pilot and controller is required. Both VHF and ADS-B are "line of sight" systems and can be easily installed at the same location. The situation is shown below:



6.1.4 A number of issues were identified for further investigation by member States of the working group regarding use of VHF Voice Communication facilities in the neighboring FIR such as:

- the Telecommunications legislation in each state;
- the conditions under which an ANSP is willing to install and maintain a VHF service for the benefit of an adjacent FIR and smooth air traffic flow; and
- the conditions under which an aviation regulator would approve a radar like separation service when the VHF service component is provided from an adjacent ANSP under a service agreement.

ATMnet

6.2 SITA provided an information paper to illustrate the benefits of establishing an Air Traffic Management IPVPN community network called "ATMnet". SITA highlighted the operational requirements needed to establish ATMnet to support ADS-B data sharing. The ATMnet will provide a harmonized and common platform to facilitate the sharing of ADS-B data in the Asia and Pacific Regions. This ATMnet would provide a seamless connection where a State can subscribe to this community as and when a State is ready to share or receive data. As long as the receiving State subscribes to this community, it will receive the data from the sending State. Airlines can also subscribe to this community in order to receive ADS-B data that may interest them in support of their flight operations. This ATMnet aims to provide a secure and redundant platform for the States to accelerate cost effective ADS-B implementation. It is a shared community, allowing any States to join the community. The ATMnet will be a managed service that will provide SLA performance reporting with 24 hours helpdesk including professional services e.g. managed firewall service, authentication management and intrusion detection. Based on the inputs provided by the States during the meeting in their implementation plan, SITA was asked to provide some form of ATMnet subscription rates to individual States for their consideration.

Agenda Item 7: Any Other Business

7.1. The meeting noted the information updated by Australia regarding SA awareness as provided in the IP/04 and AMC20-24 requirement developed by Europe – IP/03.

7.2 It was informed that at the recent ASP working group meeting held in Bangkok, member from Australia provided a paper which is a revision of a paper presented to the ADS-B Task Force in Chengdu China in April this year. The meeting noted that GPS systems that are SA aware or assume that SA is off, offer significant availability improvements over SA on avionics. Some avionics manufacturers have upgraded service bulletins to change from SA ON to SA OFF/aware.

EASA AMC20-24

7.3 The meeting noted that The European Aviation Safety Agency (EASA) has published AMC20-24 on 25 April 2008 which defines acceptable means of compliance for the airworthiness and operational approval of the "Enhanced Air Traffic Services in Non-Radar Areas using ADS-B Surveillance" (ADS-B-NRA) application. This will significantly contribute to ADS-B operational deployment. Airbus has already received EASA ADS-B approval for some aircraft. The approval resulted in amendments to the Flight manual. Boeing is planning to certify aircraft in the near future. It was also noted that AMC20-24 does not require GPS SA aware/SA off nor does it require GPS FDE hence AMC20-24 aircraft could be subject to reduced availability of ADS-B signals for ATC separation purposes.

7.3.1 The meeting discussed a proposal presented by Australia for endorsement of AMC20-24 as guidance or fitment requirements within the Asia and Pacific Regions till 2020**.** The document is consistent with the APANPIRG 18 Conclusion and the recent Regional ICAO letter on the topic of ADS-B out mandates. It supports compliance with the avionics requirements of EUROCAE/RTCA ADS-B-NRA standard (ED-126, DO-303). Further, it allows use of DO260 and DO260A although DO260A is clearly preferred. It also allows positional data sources other than GPS provided equivalent performance is demonstrated. It was informed that Boeing and Airbus are currently using this document for aircraft certification in support of the European Pioneer program. It was proposed to amend paragraph 8.4.6.3 to replace wording "highly desired" with "it is required" for FDE capability in the GNSS systems compatible with TSO C-129. It was further proposed to add a new paragraph 8.4.9 in the AMC20-24 as follows：

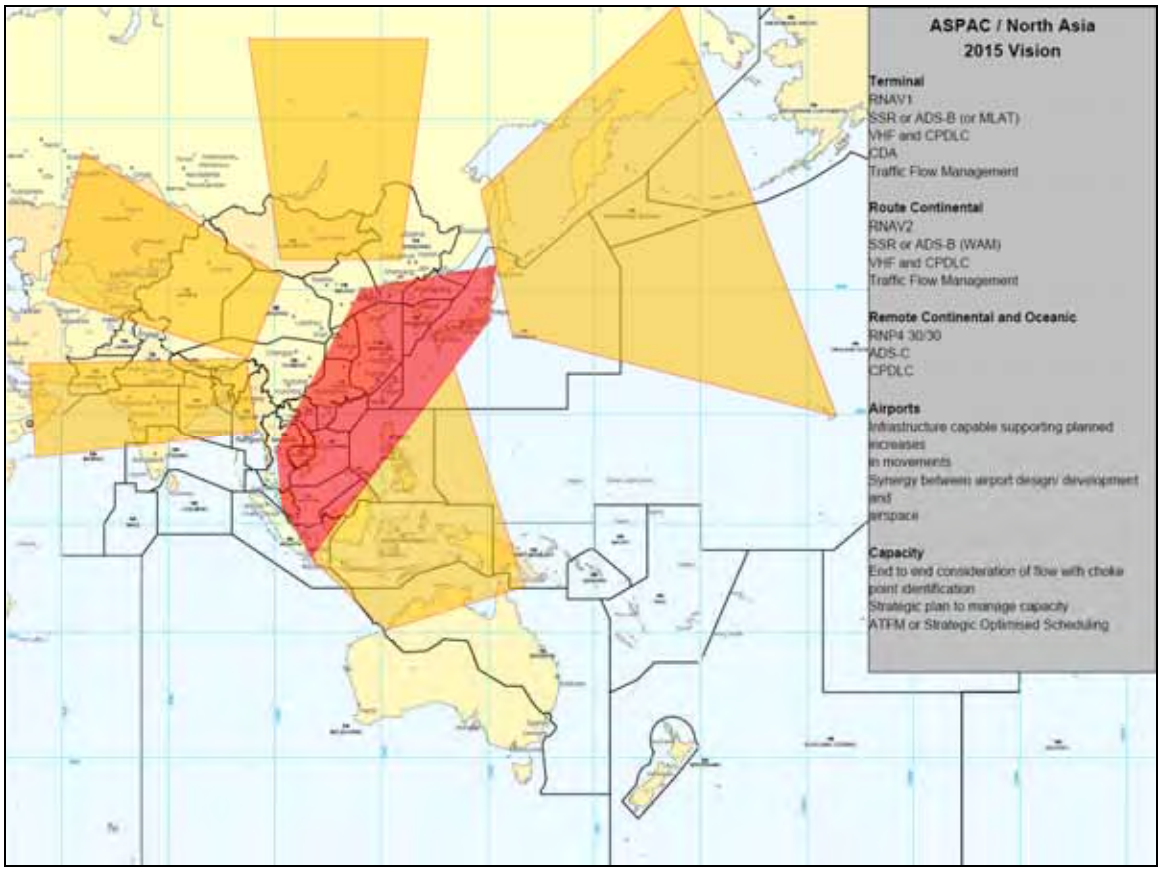
> "For GNSS systems operating in environments where the ANSP requires ADS-B data with (NUC>4 for DO260) or (SIL=2, NIC>5 for DO260A) and an operational availability above 99.95%, the GNSS system shall not assume that Selective Availability (SA) is ON."

7.3.2 The meeting had lengthy discussion on the proposal. The meeting agreed that AMC20-24 with proposed changes serves as baseline document for further consideration. The baseline document with the proposed changes is provided in the **Appendix D** to this report. In view of concerns expressed regarding the AMC20-24 which was just issued by EASA in end of April 2008 and intended application for the Enhanced Air Traffic Services in Non-Radar Areas using ADS-B Surveillance, the meeting recommended to refer the document contained in Appendix D for further consideration by ADS-B SITF and CNS/MET Sub-group of APANAPIRG.

IATA 2015 Vision

7.4 IATA presented a paper on their "2015 Vision". It was developed in accordance with ICAOs Global ATM Operational Concept and Air Navigation Plan as a statement of user expectations for operational improvements in the Asia and Pacific regions.

7.4.1 The work will focus on 6 primary traffic flows in addition to work on PBN and Airport operations. It is in alignment with the Global Plan Initiatives as well as the Performance Based Navigation Manual. The chart below shows the primary traffic flows and is indicative of the broad scope of the project:



7.4.2 IATA indicated its intention to assist ICAO in further developing and advancing the Global Concept and requested the assistance of all stakeholders to work collectively to make the vision a reality.

7.4.3 It was informed that IATA would submit this vision to APANPIRG/19 as a statement of user expectations. In the meantime they will be sharing this vision at ICAO forums, with ANSPs, Regulators and other stakeholders as a means for the ATM community to review.

7.5 The meeting also noted the international implementation snapshot of ADS-B prepared and presented by Australia after the recent 4G meeting. The implementation status of ADS-B and relevant development in Canada, Europe and USA were noted.

7.6 The meeting expressed thanks to DCA Malaysia, for hosting the meeting and for the hospitality and excellent arrangement made for the meeting including the visit to KLIA TWR facilities organized during the meeting.

Agenda Item 8: Time and Venue of Next Meeting

8.1 The meeting identified the need to organize another meeting to progress the sub-regional plan. The meeting discussed the possible date in November 2008 or early 2009. Since no proposal for hosting the meeting was received during the meeting, the exact dates and venue of the next meeting will be further coordinated and the members of the working group will be informed in due course.

– – – – – – – – – – – –

REVISED TERMS OF REFERENCE

SOUTHEAST ASIA SUB-REGIONAL ADS-B IMPLEMENTATION WORKING GROUP

Terms of Reference:

APANPIRG18 Conclusion 18/38 agreed to the establishment of a sub-regional ADS-B implementation Working Group in the South-East Asia area (SEA ADS-B WG) by the end 2007 to develop the ***terms of cooperation*** and an ***implementation plan*** for near-term ADS-B applications in the sub-region.

The outcome of the ADS-B Working Group will report to APANPIRG through the ADS-B Study and Implementation Task Force

The SEA ADS-B WG shall

(a) Develop **Terms of Co-operation** which will include :

- establishing model documents for possible use by States when :
  - Agreeing to share ADS-B data, and DCPC (such as VHF radio voice communication) capability between adjoining States for various ADS-B applications (including a sample letter of agreement); or
  - Establishing ADS-B avionics fitment mandates
- identifying optimum coverage for ADS-B ground stations and associated VHF radio voice communication in the sub-regional FIR boundary areas.

(b) Develop an **implementation plan** for near term ADS-B application which will delivery efficient airspace and increased safety on a regional basis that include :

- schedule and priority dates to bring into effect ADS-B based services taking into account;
  - Timing of any equipage mandates.
  - Timing of any ATC automation upgrades to support ADS-B.
  - Timing of commissioning of any ADS-B data and associated VHF radio voice communication facilities.
- consideration of major traffic flows

(c) Coordination for implementation of the plan

Composition: The Group will be composed of experts nominated by States in the Sub-region including: Australia, Cambodia, Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, IATA and CANSO.

Reporting: The Group will present its report to ADS-B Study and Implementation Task Force.

SEA ADS-B WG Sub Regional Project

Aim

To provide enhanced safety and efficiency in the South East Asia Area using ADS-B

Scope

To provide enhanced surveillance utilizing ADS-B technology to enable radar like separations within the South China Sea region based on traffic requirements. This will include:

- Correlating coverage diagrams with air routes
- Identifying supporting infrastructure required
- Outlining agreements necessary to establish operational benefits
- Provide template cross border Data Sharing agreements to enable greater efficiency, safety and flexibility.

Benefits

Increased ADS-B surveillance has the potential to provide increased airspace capacity, enhanced safety, reduced separations and environmental benefits. It must be implemented in a staged manner considering all aspects of supporting infrastructure to realize these benefits and should be based on user requirements. Any investment must be subject to a robust cost benefit analysis identifying the user requirements and quantifying the benefits that will be delivered.

Considerations

- Potential sites for ADS-B receivers to provide increased surveillance within the South China Sea encompassing the current major traffic routes.

- Required supporting infrastructure to enable radar like separations
  - Communications
  - ATM integration

- Site security and infrastructure (state requirement)
- Data sharing agreements (adapted from with WG template)
- Data integrity
- Equipage requirement including phased implementation plan (states to consider possible legislation as appropriate)
- Transfer of identity and seamless provision of separations

- Testing, maintenance requirements including:
  - Responsibility
  - Reliability, integrity
  - Site Access

- Cost apportionment
- Redundancy
- Staff training and sector manning requirements

Parties

Vietnam
Singapore
Indonesia
Philippines
Malaysia

Other Stakeholders
IATA
Airlines
ICAO
Members SEA ADS-B WG
State Regulatory Authorities

This proposal is not exclusionary and it is expected that other parties will become involved as the project develops.

Current Situation

Vietnam
Ho Chi Minh FIR is mostly covered with Radar surveillance, exception South East Corner. ADS-C/ CPDLC trialed since Mar 2007, fully operational 10 Apr 2008 (FIT SEA/7). Mostly VHF coverage. ATM system software needs to be upgraded to support ADS-B.

Philippines
Limited surveillance (main islands only) with 4 SSR locations. Combination VHF and HF coverage. Evaluation process looking at future requirements, considering short/medium term ADS-B, ADS-C, CPDLC and ATM upgrade. ATM system currently does not support ADS-B, ADS-C or CPDLC.

Malaysia
Kota Kinabalu FIR enjoys extensive existing radar and VHF coverage throughout Eastern Malaysia. ADS-C, CPDLC being installed with operational trial commencing Apr 08 (Bay of Bengal area). Data display will be integrated. ATM does not support ADS-B.

Indonesia
ADS-B sited at Natuna. Not supported by ATM infrastructure in Jakarta ACC.

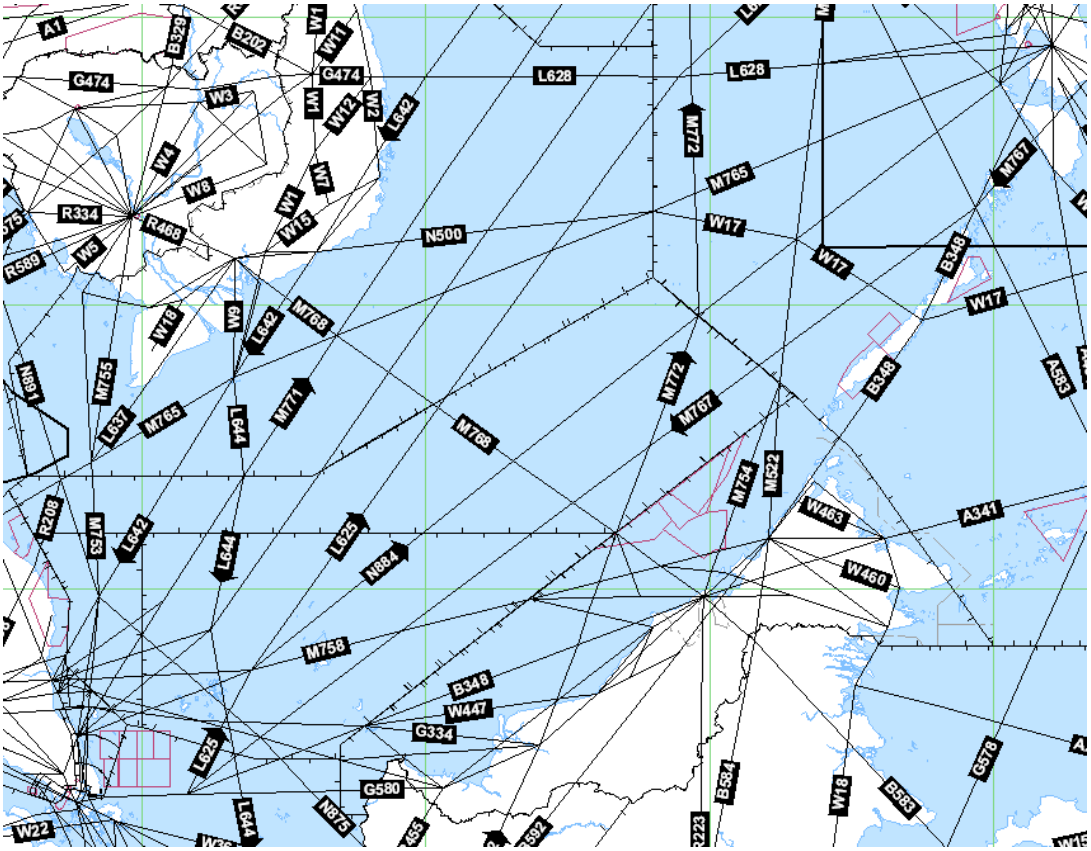
Singapore
Good radar surveillance and VHF coverage within 250nm of Singapore. ADS-C/ CPDLC currently supported. ADS-B being installed with ATM upgrade plan in progress to support, expected operational 2010.

Routes
Parallel routes are laterally spaced 60nm. Longitudinal separation of 10min applied (equivalent to 80nm). Longitudinal separation of 50nm available to suitably equipped aircraft on routes L642 and M771 commencing 3 Jul 08.

Traffic Routes

Traffic Routes

L642 (Southbound)
N892 (Southbound)
M758 (Bi-directional)
M767 (Southbound)
L644 (Southbound)
M753 (Southbound)
M772 (Northbound)
M771 (Northbound)
L625 (Northbound)
M884 (Northbound)
M768 (Bi-directional)
M765 (Bi-directional)
M755 (Southbound)



Locations

Vietnam propose installations supporting Ho Chi Minh FIR in the following locations:

- Truong Sa Island,
- Song Tu Tay Island,
- Con Son Island.

Vietnam also notes that other locations advised as part of ADS-B WG/2 will be considered in the future.

Indonesia already has an installation at Natuna Island used for testing and evaluation purposes although coverage is limited in one direction.
Singapore will have an installation 2009 (Changi Airport)
Philippines has identified potential locations in Palawan Island (Puerto Princesa??)

Requirements

To enable reduced separations, communication systems must provide DCPC. Given the gaps in coverage, the simplest method will be to co-locate VHF transmitter/ receivers with the ADS-B receivers. This will require regional co-operation as the location of the transmitter/ receivers may fall within another states boundaries. Requirements for coverage within the SCS are as detailed below. Service parameters described are as detailed in Report to SEA ADS-B WG/1 Appendix B.

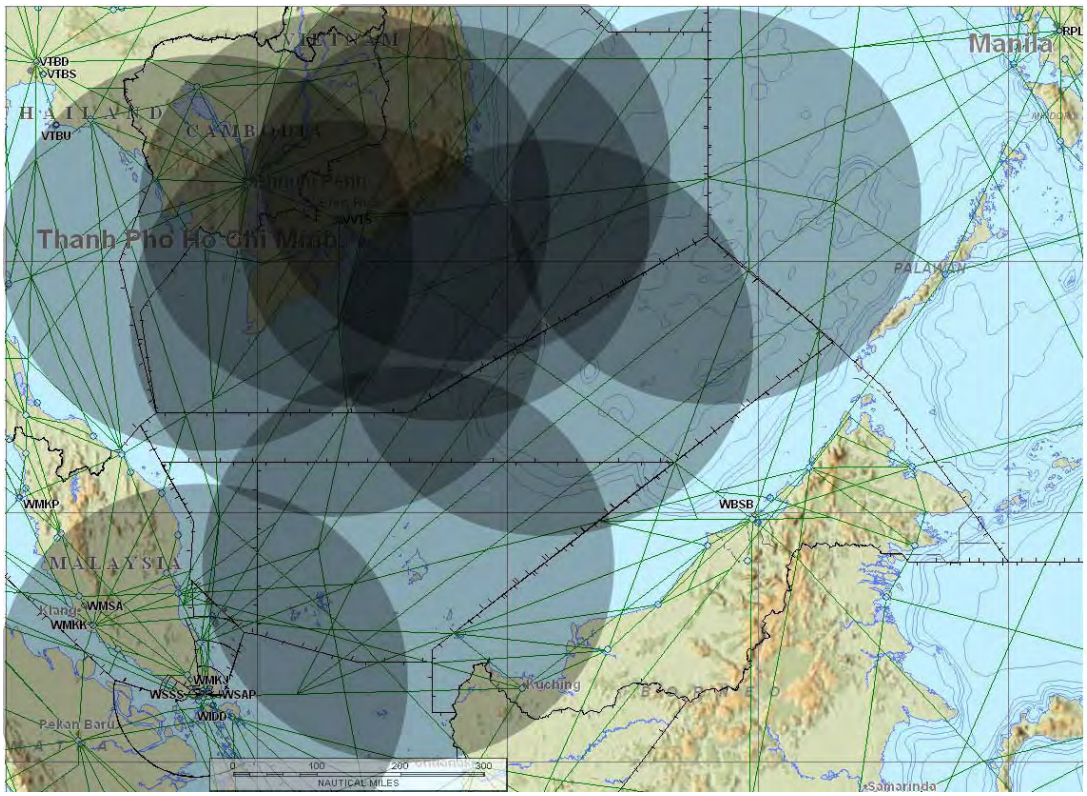
Singapore ADS-B (Singapore)
Tier 1 service to Singapore
Potential to share data with Kuala Lumpur and Jakarta
Tier XXX to Jakarta
Tier XXX to Kuala Lumpur

Natuna ADS-B (Indonesia)
Tier 1 Service to Singapore
Tier XXX to Jakarta
Corresponding VHF Coverage with Singapore
Potential to share data with Kota Kinabalu
Tier XXX to Kota Kinabalu

Truong Sa Island (Vietnam)
Tier 1 service to Ho Chi Minh
Tier 1 service to Singapore
Corresponding VHF coverage with Singapore
Corresponding VHF coverage with Ho Chi Minh??
Potential to share data with Manila and Kota Kinabalu
Tier XXX to Manila
Tier XXX to Kota Kinabalu

Song Tu Tay Island (Vietnam)
Tier 1 service to Ho Chi Minh
Tier 1 to Singapore
Corresponding VHF coverage with Ho Chi Minh??
Corresponding VHF coverage with Singapore
Potential to share data with Manila
Tier XXX to Manila
Corresponding VHF coverage with Manila

Con Son Island (Vietnam)
Tier 1 service to Ho Chi Minh
Tier 1 service to Singapore
Corresponding VHF coverage with Ho Chi Minh (existing)
Corresponding VHF coverage with Singapore
Potential to share data with Bangkok and Kuala Lumpur
Tier XXX to Bangkok
Tier XXX to Kuala Lumpur



(surveillance using planned/ current sites, generic 250nm coverage)

Coverage

The proposed locations will cover all major air routes within the Singapore and Ho Chi Minh FIRs as well as some areas in adjacent FIRs.

While the surveillance coverage has the potential to enable radar like separations, full benefits cannot be realised when effective coverage gaps exist at other points along the air route. For instance, while surveillance and VHF coverage will potentially exist on routes M884/ M767, the inability of the Manila ATM to display ADS-B data means that the controlling authority cannot make use of this enhanced surveillance capability and may need to revert to procedural type separations.

Potential Coverage/ Future Enhancements

The installation at an appropriate site within vicinity of Palawan Island (in addition to the site above Song Tu Tay) and supporting ATM infrastructure will enable Manila full surveillance and VHF coverage to the west/ south west of RPLL in conjunction with their existing radar facilities.

An installation in East Malaysia (vicinity WBSB) provides redundancy in coverage along southern SCS routes. As noted this area is currently well covered by existing radar although that data is not available for other users.

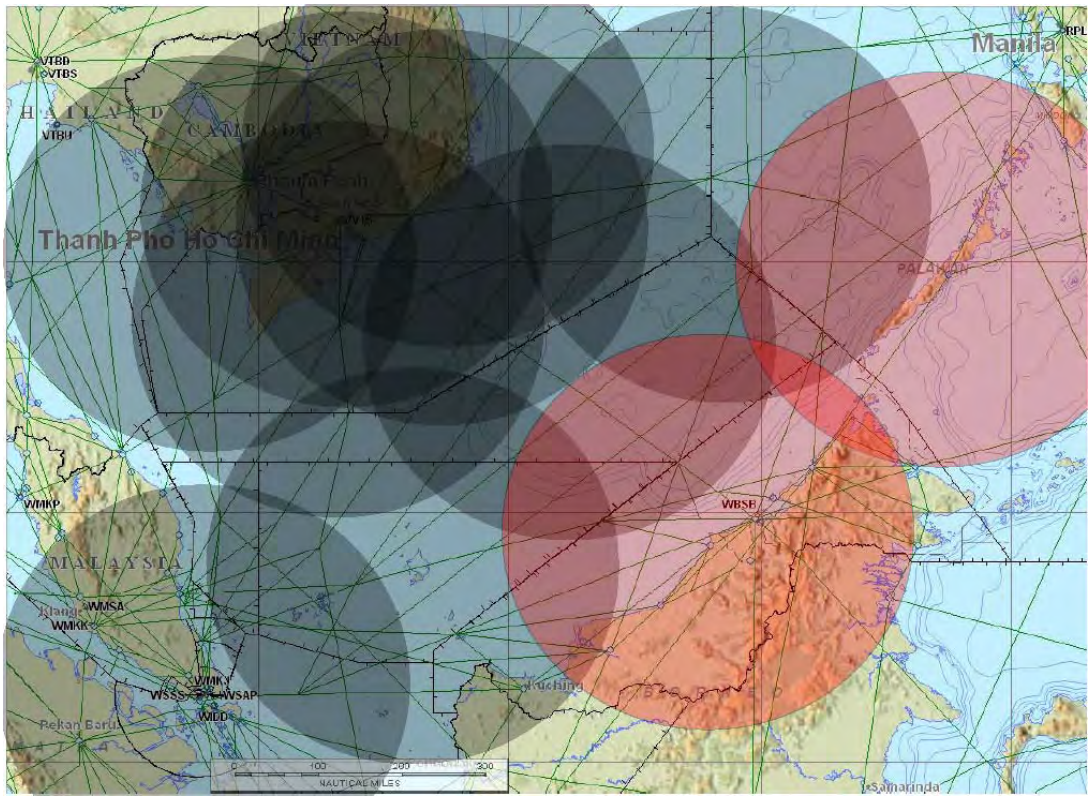
Thailand has announced plans for installation of 22 ADS-B receivers. Their inclusion with appropriate agreements will compliment the proposed SCS project. Coverage diagrams will need to be reviewed but overlapping coverage may incorporate some neighbouring states.

Locations in vicinity of Palawan Island (Philippines)
Tier 1 to Manila
Corresponding VHF coverage with Manila

Potential to share data with Singapore and Kota Kinabalu
Tier XXX to Singapore
Tier XXX to Kota Kinabalu

Locations in vicinity of East Malaysia/ Brunei
(providing overlapping/ complementary coverage)
Tier 1 to Kota Kinabalu???
Potential to share data with Singapore
Tier XXX to Singapore

Thailand
22 ADS-B sites



(potential surveillance coverage)

Supporting Infrastructure

To enable radar like separations, surveillance must be complemented by DCPC (normally VHF communications). Without supporting communication infrastructure, ADS-B surveillance will realise minimal operational benefits to users. Communication requirements for this have already been identified in this paper. In certain circumstances, this may require specific state-to-state agreements where VHF transceivers need to be located within another states borders. These agreements should consider issues such as:

- Location (e.g. site survey)
- Power supply including redundancy
- Security
- Maintenance and Monitoring (responsibility of who and access)
- Integrity
- Costs

New surveillance technologies can require significant investment in ATM infrastructure to enable data integration. This will often require software upgrades or even ATM replacement. It is vital that the HMI is designed to allow seamless display of surveillance data used for separation purposes, irrespective of its source. While separate displays can be used for testing and evaluation purposes, it is unacceptable for operational use and can represent a significant operational risk. It is each states responsibility to ensure ATM systems are appropriate for the requirements

Data Sharing Agreements

Where cross FIR boundary surveillance is available, data sharing agreements will be required. These should be state-to-state agreements developed using the sample document of Agreement of ADS-B data sharing (SEA ADS-B WG/2 Appendix A) as a basis.

Initially agreements will be required between:
- Singapore-Ho Chi Minh FIRs
- Singapore-Indonesia

Agreements involving Manila, Kota Kinabalu and Thailand can be developed as required based on the sample document/

Data Integrity

It is the states requirement to ensure the integrity of data is appropriate for the level of service provided. If a state utilizes data provided by another state, the integrity of the data should be specified in the data sharing agreement. The data integrity utilized should be based on baseline ADS-B service parameters (SEA ADS-B WG/1 Appendix B). The agreement should also specify an action plan to be followed in the event the data integrity is not of the required standard at any time (this should include notification requirements).

Equipage Requirements

To utilize ADS-B for separation purposes relies on aircraft carriage of suitable equipment with specified technical specifications. The basic requirements have been outlined by APANPIRG/18 under conclusion 18/35.

Due to the nature of ADS-B, it will be necessary to mandate the equipage requirements prior to utilizing the technology for separation purposes. These requirements must also be harmonized to ensure compatibility as well as reducing costs for both airlines and ANSPs. This has been recognized although the sample proposal presented at SEA ADS-B WG/2 was not considered mature enough for formal endorsement. With ADS-B still in its infancy, issues such as aircraft certification and carriage requirements are still being developed. It is important that these efforts are harmonized, particularly on a regional basis.

Guidance should be taken from those states further ahead in their implementation plans such as Australia. Their model requires equipage qualification and proof of training. To simplify matters further, if standards are harmonized, when an aircraft is certified to operate in one state, that should be recognized by others. The certification process should be established to ensure minimal administrative burden is placed on operators, ANSPs and regulators beyond what is actually required.

The introduction of these requirements must be in a manner so as to enable airspace users sufficient time to comply without unduly penalizing their operation. This could be a staged approach with airspace becoming exclusionary over a period of several years, allowing capable users short-term benefits but also allowing those without the capability limited access. The body of airspace should be defined both vertically and horizontally. Consideration may be given for some form of incentive/ assistance however this decision must be made only after appropriate consultation with stakeholders.

Transfer of Identification Agreements

To enable the seamless transfer of aircraft between FIRs utilising radar like separations, an agreement is necessary for the transfer of aircraft identity. The absence of an agreement will require procedural separations to be established prior to crossing an FIR boundary. ICAO requirements are detailed within Doc 4444, section 8.6.3.

Site Security and Infrastructure

It is a states responsibility to ensure that each site is appropriate for the requirements of its use. This will include items such as:

- Site survey
- Power supply including redundancy
- Data transfer including redundancy

Testing and Maintenance

With any new system, sufficient testing must be undertaken to ensure all facets are robust and can function with required reliability and accuracy. Each item must be tested both individually as well as collectively with all other pieces of equipment with which it interfaces. The implementation program should consider all aspects of the testing program including a suitable "ghosting" period where real flight data is displayed for a set period of time to ensure integrity, robustness and reliance of all interrelated components. Guidance and lessons may be available from states that have already established programs and developed many of the protocols.

The responsibility of maintenance should be specified in suitable agreements. This should include responsibilities such as:

- Monitoring
- Notification
- Access
- Timing

Cost Apportionment

With ADS-B technology, more opportunity exists for sharing of information between states. As such it is reasonable that costs could be apportioned amongst those utilizing the data. These should be subject to the legal agreement between states and follow the framework detailed in SEA ADS-B WG/1, appendix C.

A similar agreement may be necessary for communications equipment necessary for DCPC. The same framework can be used as a basis for this.

Increases in user charges may be justified with in an increase in service and efficiency. As a general principle, a comprehensive business case that includes cost/benefit analysis for both the provider (ANSP) and users (airlines) should be developed and shared with all key stakeholders as part of due diligence for such initiatives. Any changes in the cost base of the provider (operating expense) or users (aeronautical charges) resulting from such initiatives should be transparent, cost-based, non-discriminatory and determined based on these consultations.

Redundancy

The baseline contained within ADS-B WG/1, appendix A discuss required reliability for provision of services. When states are providing data or equipment for use by another state, they must be able to use that data with sufficient confidence in its reliability. Agreements between the states should ensure integrity (as previously discussed), reliability (including back up systems), system monitoring

requirements and notification/ actions in the event of a failure or degradation. These agreements should include data integrity and system reliability (including power sources).

Staffing and Training

Air Traffic Controllers are limited in their capabilities based on sector capacity. As separations reduce, resectorisation may need to be considered to cope with the increase in capacity. Furthermore ATCO training will need to be planned and extra staff may be required to ensure a seamless transition (requirement for “ghosting”?). Engineering staff will have similar needs with extra training required and involvement in the installation and implementation. These issues will have to be factored into the states implementation plan. Furthermore, for installations involving cross border sharing, this may involve agreements between states.

States must ensure that personnel licensing is also considered as many have traditionally issued “Radar” ratings. In the new multi sensor environment, Annex 1 now makes allowance by referring to “surveillance” ratings. While more of an administrative issue, it will still need to be addressed by states as part of their implementation process.

Future

This project outline is not in itself going to deliver an end solution to enhance safety and efficiency throughout the South East Asia area. It does however represent an outline of considerations that can be used to build on for enhancements as part of the regional ATM roadmap.

– – – – – – – – – – – – –

PHASE 1 OF ADS-B IMPLEMENTATION PLAN IN SOUTH EAST ASIA

Indonesia, Singapore and Viet Nam have agreed to install six ADS-B stations, as shown in the attached drawing, to cover the Southern portion of the South China Sea. The three States agree to share their ADS-B data with their adjacent States in accordance with the implementation plan below.

Scope of collaboration

Indonesia would provide Singapore with:
ADS-B data from their Natuna and Matak (or another location in Natuna)* ADS-B stations;
Indonesia would consider installing VHF radio stations in Natuna and Matak for Singapore's ATC usage.

Note: *Matak was included to complement the coverage of Natuna ADS-B station as the Natuna station is shielded by high mountains in its South-west direction.

Singapore would provide Indonesia with:
ADS-B data from the Singapore ADS-B station.

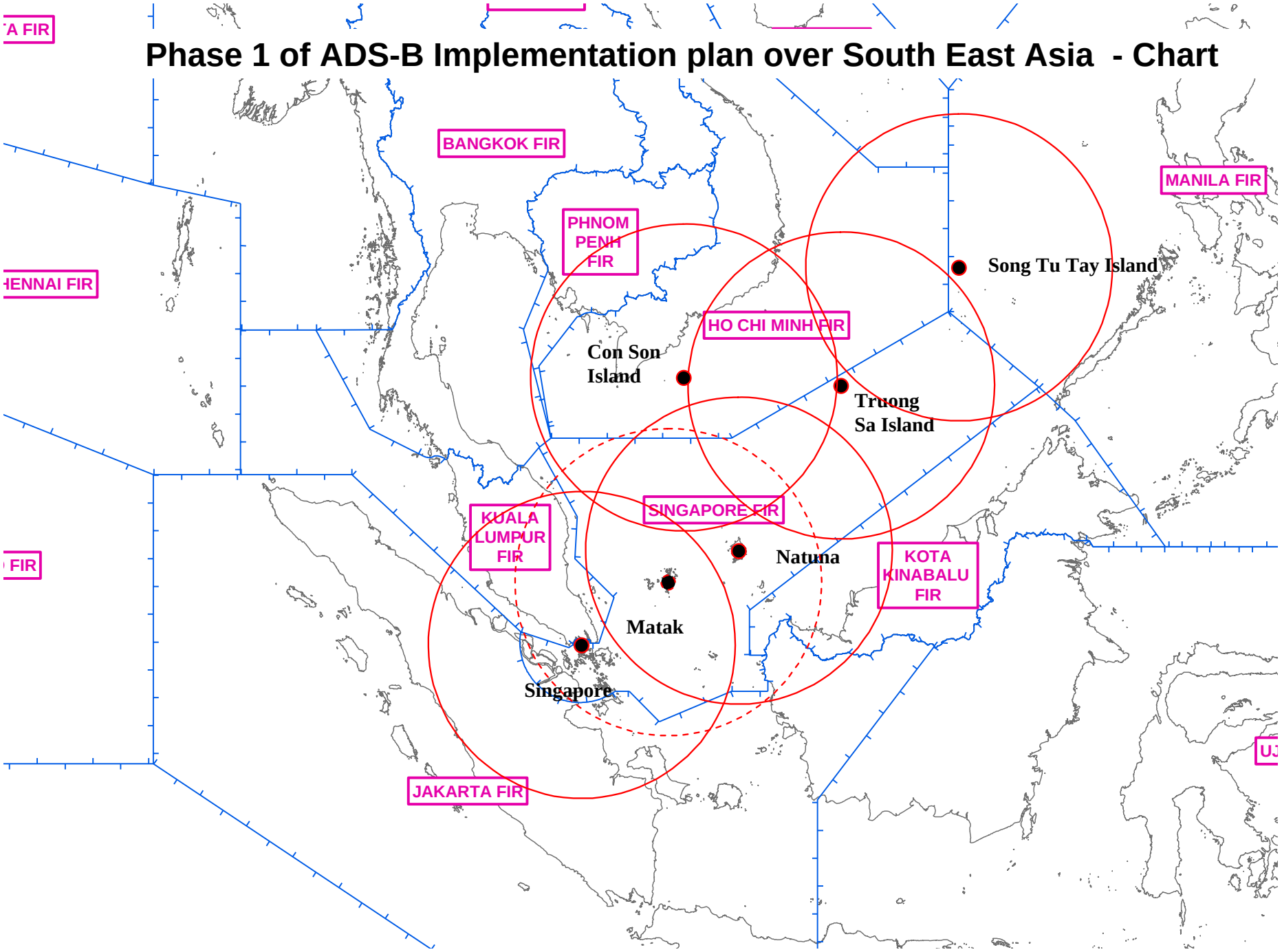
Viet Nam would provide Singapore with:
ADS-B data from their Con Son,Song Tu Tay and Truong Sa ADS-B stations;
.

Implementation Schedule

Time period	Planned activities
Year 2008	• Natuna ADS-B station ready • Matak ADS-B station ready (Dec 2008) • Indonesia and Singapore signs collaboration agreement. • Viet Nam and Singapore signs collaboration agreement.
Year 2009	• Singapore ADS-B station ready (Sep 2009). • Matak and Natuna VHF radio stations ready for Singapore ATC usage** (Nov 2009). • Technical trial by Singapore using Matak and Natuna ADS-B stations (Sep – Dec 2009)
Year 2010	• Con Son ADS-B station ready. • Technical trial by Singapore using Con Son ADS-B station. • Technical trial by Ho Chi Minh using Con Son ADS-B station. • Operational trial by Singapore using Matak, Natuna and Con Son ADS-B stations. • Operational trial by Ho Chi Minh using Con Son ADS-B station.
Year 2011	• Song Tu Tay and Truong Sa ADS-B stations ready. • Technical trial by Singapore using Song Tu Tay and Truong Sa ADS-B stations. • Technical trial by Ho Chi Minh with Song Tu Tay and Truong Sa ADS-B stations. • Operational trial by Singapore with Song Tu Tay and Truong Sa ADS-B stations. • Operational trial by Ho Chi Minh using Song Tu Tay and Truong Sa ADS-B stations.

Note: **Subject to mutual agreement between the relevant parties.

Phase 1 of ADS-B Implementation plan over South East Asia - Chart



AMC 20-24
Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHZ Extended Squitter.

1 PREAMBLE

1.1 The scope of this Acceptable Means of Compliance (AMC) is the airworthiness and operational approval of the "Enhanced Air Traffic Services in Non-Radar Areas using ADS-B Surveillance" (ADS-B-NRA) application.

1.2 Operational benefits of the ADS-B-NRA application include the enhancement of the Air Traffic Control Service in current non-radar airspace. ADS-B-NRA would provide controllers with improved situational awareness of aircraft positions, and in consequence appropriate separation minima could be applied depending on the environment and the approval of the competent authority. Current non-radar airspace is controlled using procedural methods which demand large separations. ADS-B-NRA separation minima would be smaller than that used in current non-radar airspace. Alerting Services in non-radar airspace will be enhanced by more accurate information on the latest position of aircraft.

Hence, it is expected that in areas where radar coverage is not feasible or not economically justified this application will provide benefits to capacity, efficiency and safety in a way similar to what would be achieved by use of SSR radar.

1.3 The European CASCADE programme is the mechanism for co-ordination of the European implementation of ADS-B (ADS-B-NRA and other ADS-B based ground and airborne surveillance applications). One of the programme's aims is to ensure harmonisation and efficiency of implementation.

1.4 CASCADE uses the globally interoperable 1090 MHz Extended Squitter (ES) data link technology, compliant with ICAO SARPS in Annex 10 and in line with the recommendations of the Conference ICAO ANC-11.

1.5 In parallel, the FAA Airservices Australia and Nav Canada plan to deploy ADS-B using the same data link technology. It is assumed that aircraft will be interoperable with all implementation programmes using the EUROCAE/RTCA ADS-B-NRA standard (ED-126, DO-303).

1.6 The meaning of abbreviations may be found in Appendix 1.

2 PURPOSE

2.1 This AMC is for operators seeking to operate in airspace classifications A to E where ADS-B-NRA services have been implemented by the Air Navigation Service Provider. It provides the basis for approval of aircraft systems and identifies operational considerations.

It may also assist other stakeholders by alerting them to aircraft requirements, operator procedures and related assumptions. These other stakeholders could include airspace planners, air traffic service providers, ATS system manufacturers, surveillance data processing system manufacturers, communication service providers, aircraft and avionics equipment manufacturers and ATS regulatory authorities.

2.2 Acceptable Means of Compliance (AMC) illustrate a means, but not the only means, by which a requirement contained in an EASA airworthiness code or an implementing rule of the Basic Regulation, can be met.

An applicant correctly implementing this AMC in its entirety is assured of acceptance of compliance with the airworthiness considerations prior to use of the automatic dependent surveillance broadcast equipment. The operational considerations in this AMC are consistent with the operational considerations in the position paper 039 revision 8, that is endorsed by the JAA Operations Sectorial Team (OST). An Operator that, in conjunction with the airworthiness considerations, has correctly implemented this AMC

should be ensured of acceptance of compliance with the operations rules applicable in JAA Member States.

3 SCOPE

3.1 This AMC is applicable to the various ATS services contained in the ADS-B-NRA application, including separation services. This AMC fulfils the ADS-B-NRA Safety, Performance Requirements and Interoperability Requirements as established in EUROCAE ED-126[1], using the methodology described in EUROCAE document ED-78A[2].

AMC requirements are driven by the ED-126 requirements for a 5NM separation service (applicable to both en-route and TMA airspace).

Note: the actual choice of ADS-B-NRA ATC service provision, including of the applicable separation minima, is at the discretion of the implementing Air Traffic Service Provider, and should be based on local safety cases.

3.2 The AMC addresses the 1090 MHz Extended Squitter (ES) data link technology as the ADS-B transmit technology.[3]

4 REFERENCE DOCUMENTS

4.1 Related Regulatory Requirements

- CS/FAR 25.1301, 25.1307, 25.1309, 25.1322, 25.1431, 25.1581, or equivalent requirements of CS 23, 27 and 29, if applicable.
- EU-OPS 1.230, 1.420, 1.845, 1.865, 1040, 1.1045 and 1.1060, as amended, or, if applicable, equivalent requirements of JAR-OPS 3.
- National operating regulations.

4.2 Related EASA/JAA TGL/NPA/AMC (and FAA TSO) Material

- ETSO-2C112b: Minimum Operational Performance Specification for SSR Mode S Transponders (adopts ED-73B)
- ETSO-129A (TSO-129/TSO-129A): Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)
- ETSO-145/ETSO-146 (TSO-145/TSO-146; TSO-145A/TSO-146A): Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)
- AMC 20-13 Certification of Mode S Transponder Systems for Enhanced Surveillance
- JAA Temporary Guidance leaflet (TGL) 13, Revision 1: Certification of Mode S Transponder Systems for Elementary Surveillance

4.3 Related FAA Advisory Circular Material

- FAA AC20-138A: Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment

4.4 Related EUROCAE/RTCA Standards

- ED-126 (DO-303): Safety, Performance and Interoperability Requirements Document for ADS-B-NRA Application (December 2006)

---

[1] ED-126: "Safety, Performance and Interoperability Requirements Document for ADS-B-NRA" Application

[2] ED-78A: Guidelines for approval of the provision and use of Air Traffic Services supported by Data communications

[3] Other, requirements compliant, ADS-B transmit systems (e.g. VDL Mode 4) are expected to be covered through separate regulatory material, as appropriate.

- ED78A (DO-264): Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by data communications;
- ED-102 (DO-260): MOPS for 1090MHz for ADS-B
- DO-260A: MOPS for 1090MHz for ADS-B
- ED-73B (DO-181C): Minimum Operational Performance Specification for Secondary Surveillance Radar Mode S Transponders
- ED-26: MPS for airborne altitude measurements and coding systems

4.5 Related ICAO Standards and Manuals

- PANS-ATM, Doc 4444, Amendment 4: Procedures for Air Navigation Services – Air Traffic Management
- Annex 10 (Volume III & IV): Aeronautical Telecommunications

5 ASSUMPTIONS

Applicants should note that this AMC is based on the following assumptions.

5.1 Air Traffic Service Provider (ATSP)

ATSP implements the ADS-B-NRA application compliant with relevant requirements of the safety, performance and interoperability requirements of EUROCAE standard ED-126. Deviations from, or supplements to the established standards are assessed by the ATSP. Deviations that potentially impact the airborne domain should be assessed in coordination with relevant stakeholders as per ED78A.

Section 8 of this document, “Airworthiness Considerations”, lists permissible deviations from the target requirements related to the use of existing aircraft installations in support of initial implementations[4]. These deviations are currently considered operationally acceptable under the assumption that ground mitigation means as discussed in the following subsections, are implemented, at the descretion of the ATSP.

5.1.1 Consistency of position quality indicators with associated position information at time of transmission

In cases where position quality indicators are not consistent with actual position quality (e.g., due to uncompensated latency in position transmissions), the implementing ATSP might:

- treat the higher quality indicator encodings as an advised lower one (e.g. NUC=7 may be treated as NUC=5) or,
- consider, for separation purpose, a quality indicator more stringent than the one stated in ED-126 (e.g. NUC =5 rather than NUC=4).

5.1.2 Encoding of NUC Quality Indicator (DO-260 compliant transponders)

In order to mitigate the encoding of the NUC quality indicator based on accuracy quality information (HFOM) in the case of the unavailability of the GPS RAIM function (i.e. unavailability of HPL information), the implementing ATSP may, for instance, rely on the analysis of the frequency and duration of the unavailability of the RAIM function (as part of the local safety assessment).

5.1.3 Transmission of generic emergency indicator only

In order to mitigate the transmission of only the generic emergency indicator (and not also the discrete codes selected by the flight crew), It is assumed that appropriate operational procedures have been established by the implementing ATSP and that pilots and controllers have been trained in their use.

[4] Refer to sections 8.3.3, 8.3.5 and 8.8.2.

5.1.4 Communications Service Provider (CSP)

In case of CSPs providing (part of) the ground surveillance data communication services (operation of ADS-B ground stations and/or surveillance data networks), the CSP is committed to provide communication services to ATSPs with the expected Quality of Service as defined in a specific Service Level Agreement.

The Service Level Agreement is bilaterally agreed between the CSP and an ATSP. The terms of reference of the Service Level Agreement are consistent with the performance requirements of the ED-126 document.

5.2 Aeronautical Information Service

Each State publishes in its AIP/NOTAM, or equivalent notification, information related to the surveillance provisions, schedule, relevant procedures and confirmation of compliance with ED-126.

6 SYSTEM DESCRIPTION

The basic concept of ADS-B involves the broadcasting of surveillance information from aircraft via a data link.

To support the ADS-B-NRA application, the overall ADS-B avionics system (in the following referred to as "**ADS-B System**") would need to provide the following functions:

- Adequate surveillance data provision capability;
- ADS-B message processing (encoding and generation);
- ADS-B message transmission (1090 MHz ES airborne surveillance data-link);

Whereas the latter two functions are incorporated in the 1090 MHz ES ADS-B transmit system, the surveillance data provision is realised through various on-board surveillance data sources (e.g. horizontal position source, barometric altimetry, ATC transponder control panel).

The horizontal position accuracy and integrity requirements of the ADS-B-NRA application are associated with quality indicators which form part of the air-to-ground ADS-B message exchange. The interconnecting avionics architecture is part of the ADS-B System.

7 FUNCTIONAL CRITERIA

Note: ICAO and EUROCAE/RTCA interoperability references, including aspects of range and resolution of the various data items listed hereafter, for both ED-102/DO-260 and DO-260A equipment-based ADS-B transmit systems, are presented in Appendix 4.

7.1 In line with ED-126 (section 4), the ADS-B System needs to meet the following surveillance data transmission requirements, as a minimum:

- A unique ICAO 24 bit aircraft address (contained within each ADS-B message transmission);
- Horizontal Position (latitude and longitude);
- Horizontal Position Quality Indicator(s) (position integrity for both ED-102/DO-260 and DO-260A based ADS-B transmit systems, as well as accuracy for DO-260A based ADS-B transmit systems);
- Barometric Altitude;
- Aircraft Identification;
- Special Position Identification (SPI);
- Emergency Status and Emergency Indicator;

- Version Number (in aircraft operational status message, if avionics are DO-260A compliant).

7.2 In line with ED-126 (section 4), it is recommended that the ADS-B System meets the following optional surveillance data transmission requirement:

- Ground Velocity.

8 AIRWORTHINESS CONSIDERATIONS

8.1 Airworthiness Certification Objectives

For the purposes of the ADS-B-NRA application, the ADS-B System installed in the aircraft needs to be designed to deliver data that satisfy the airborne domain requirements in line with ED-126 Section 3.4, (Appendix 3 provides a summary for information purposes).

8.2 ADS-B System

8.2.1 The (overall) ADS-B System integrity level with respect to the processing of horizontal position data and horizontal position quality indicators, covering the processing (and data exchange) chain from horizontal position data source(s) to ADS-B transmit data string encoding) needs to be 10^{-5}/fh (refer also to Table 1 in Appendix 3).

Note 1: this integrity level is required to adequately protect against the corruption of horizontal position data and horizontal position quality indicators when applying separation.

Note 2: These performance figures have been set for the "ADS-B out" function, to be used in ADS-B NRA operations as laid down by the Operational Safety Assessment in Annex C of ED 126.

Note 3: Compliance with these performance figures do not constitute per se a demonstration that the safety objectives of ADS-B NRA operations allocated to avionics are achieved.

Note 4: Also refer to § 3.1.

8.2.2 The (overall) ADS-B System continuity level needs to be $2*10^{-4}$/fh (refer also to Table 1 in Appendix 3).

Note 1: These performance figures have been set for the "ADS-B out" function, to be used in ADS-B NRA operations as laid down by the Operational Safety Assessment in Annex C of ED 126;

Note 2: Compliance with these performance figures do not constitute per se a demonstration that the safety objectives of ADS-B NRA operations allocated to avionics are achieved;

Note 3: Also refer to § 3.1.

8.2.3 The latency of the horizontal position data, including any uncompensated latency, introduced by the (overall) ADS-B System does not exceed 1.5 second in 95% and 3 seconds in 99.9% of all ADS-B message transmission cases (refer also to Table 1 in Appendix 3).

8.3 ADS-B Transmit System

8.3.1 Compliance with the air-ground interoperability requirements, as specified in ED-126 and presented in Section 7.1 and Appendix 4, needs to be demonstrated.

8.3.2. For 1090 MHz Extended Squitter ADS-B transmit systems, this should be demonstrated by the relevant tests documented in:

- ED-73B/ETSO-2C112b (or DO-181C);

- ED-102, as a minimum, or an equivalent standard which is acceptable to the Agency (e.g. DO-260 or DO-260A).

8.3.3 ADS-B transmit systems need to transmit horizontal position quality indicators consistent with the associated position information at the time of transmission.

For the expression of the position accuracy quality, the related indicator should therefore reflect:

- The quality (in terms of both integrity and accuracy) of the position measurement itself; and
- Any (uncompensated) latency incurring prior to transmission.

Note: guidance on the quality indicators is provided in Appendix 4.

The applicant needs to demonstrate the correctness of consistent quality indicator encodings in line with (minimum) position source quality and any (uncompensated) maximum latency as expressed in 8.2.3.

Permissible deviation for initial implementations:

For initial implementations, some aircraft installations may not take into account any (uncompensated) latency in the encoding of the position accuracy quality indicator as applicable at the time of transmission. Hence, such installations might transmit horizontal position quality indicators that are consistent with the associated position information only for lower quality indicator encodings[5] (e.g. NUC=5 or NAC=5) but not higher ones (e.g. NUC=7 or NAC=7). Such deviation from the above target requirement need to be listed in the Aircraft Flight Manual (refer to Section 9.3).

8.3.4 The value of the horizontal position quality indicators need to be based on the integrity information for the encoding of the ED-102/DO-260 related NUC and the DO-260A related NIC quality indicator, as related to the horizontal position sources.

In addition, the encoding of the DO-260A NAC quality indicator needs to be based on the accuracy information of the horizontal position sources.

8.3.5 In case of ED-102/DO-260 based ADS-B transmit systems, the NUC Quality Indicator value need to be encoded based on the integrity containment radius[6] only.

Permissible deviation for initial implementations:

For initial implementations, some GNSS position source based aircraft installations may encode the NUC Quality Indicator on accuracy quality information (HFOM) under rare satellite constellation circumstances leading to the temporary unavailability of the integrity monitoring (RAIM) function (i.e. unavailability of integrity containment radius calculation). Such deviation from the above target requirement need to be listed in the Aircraft Flight Manual (refer to Section 9.3).

8.3.6 If the ADS-B transmit system does not have a means to determine an appropriate integrity containment radius and a valid position is reported, then the Quality Indicator (i.e. NUC or NIC) need to be encoded to indicate that the integrity containment radius is unknown (i.e. NUC/NIC should be set to 'zero').

8.3.7 Transmitter antenna installation needs to comply with guidance for installation of ATC transponders to ensure satisfactory functioning. (Also refer to ED-73B)

---

[5] This is a consequence of the definition of the quality indicator encoding describing an interval of values between a lower and an upper bound (refer also to Appendix 4.2). For instance, a NUC=5 encoding expresses an upper bound of position accuracy quality indication of 0.3NM whilst a NUC=7 encoding expresses an upper bound of 0.05NM. Therefore, in case of e.g. the actual GNSS position source performance, a NUC=5 encoding provides sufficient margin to also correctly express the effects of on-board uncompensated latency whilst this is not the case for a NUC=7 encoding any more.

[6] I.e. GNSS conformant HPL/HIL information.

8.3.8 If more than one ADS-B transmit system is installed, simultaneous operation of both transmit systems needs to be prevented.

8.4 Horizontal Position Data Sources

8.4.1 The requirements on horizontal position data sources are based on the ED-126 safety and performance assessments.

8.4.2 Components of horizontal position data sources external to the aircraft ADS-B system (such as the GNSS space segment) fall outside these airworthiness considerations. Such external components are assumed to operate in accordance with their specified nominal performance[7].

Nevertheless, failures of the external data source components are required to be detected through on-board monitoring (as expressed in section 8.4.3).

8.4.3 Any eligible horizontal position data source needs to meet the following minimum requirements (refer also to Table 2 in Appendix 3):

- Correct encoding of quality indicator information in line with the actual performance of the selected horizontal position data source(s), i.e. in relation to position integrity containment bound (ED-102/DO-260 and DO-260A ADS-B transmit systems) and position accuracy (DO-260A ADS-B transmit systems);
- Position source failure probability: 10^{-4} per hour[8];
- Position integrity alert failure probability, commensurate with the performance characteristics of GNSS integrity monitoring[9]: 10^{-3} (per position source failure event);
- Position integrity time to alert: 10 seconds.

8.4.4 If available and valid, integrity containment radius information should be provided to the ADS-B transmit system from the position data source, or equivalent, on the same interface as and together with each positional data.

8.4.5 If the integrity containment radius is not provided by the horizontal position data source, the ADS-B transmit system may use other means to establish an appropriate integrity containment radius[10], provided a requirements compliant integrity alert mechanism is available.

8.4.6 Use of GNSS Systems as Primary Position Data Source

8.4.6.1 GNSS is considered as primary horizontal position data source for the provision of an acceptable accuracy and integrity performance in support of the ATC separation services contained within the ADS-B-NRA application.

The ED-126 safety and performance assessments are based on the specified performance and characteristics of GNSS systems, including receiver autonomous integrity monitoring. Therefore, for GNSS systems as specified in section 8.4.6.2, a safety and performance demonstration is not required.

8.4.6.2 If GNSS is used as a positional source, the GNSS system should be either compatible with:

---

[7] For GNSS based systems, this includes satellite constellation aspects.

[8] For GNSS based position sources, the failure occurs outside the aircraft system and is therefore expressed as per ATSU-hour. Proof of compliance of alternative solely aircraft based sources should take this into account and might have to express the requirement as 10^{-5} per flight hour (i.e. for the en-route environment).

[9] As realised through receiver autonomous integrity monitoring (RAIM), including its characteristics of increasingly less likely to fail for position errors beyond the horizontal protection limit. Within ED-126, the position source failure is modelled as a bias error that equals the integrity containment radius.

[10] E.g. HPL/HIL based upon known RAIM protection threshold.

- ETSO C-129A, TSO C-129 or TSO C-129A; or
- ETSO C-145/C-146 or TSO C-145A/C-146A,

capable of delivering position data with a periodic interval of at least 1.2 s [11].

8.4.6.3 For GNSS systems compatible with (E)TSO C-129 (any revision), it is highly desired that the system incorporates Fault Detection and Exclusion capability as defined in AC 20-138A, Appendix 1, "GPS as a Primary Means of Navigation for Oceanic/Remote Operations".

8.4.7 Use of Alternative Compliant Position Data Sources

As the ED-126 safety and performance assessments are based on the performance and characteristics of GNSS systems, for alternative position sources a dedicated safety and performance assessment is required to demonstrate compliance with the ED-126 requirements.

8.4.8 Use of Temporary Back-up Position Data Sources

Back-up position data sources not complying with the requirements referred to in section 8.4.3 may prove very useful in enhancing the continuity of ADS-B surveillance provision during temporary outages of the primary (or equivalent alternative) position data sources.

Any such back-up position data source needs to report its accuracy and integrity performance to the ADS-B transmit system, in a format compliant with ED-102/DO-260 or DO-260A, as appropriate.

8.5 Barometric Altitude Data Sources

8.5.1 Pressure altitude provided to the ADS-B transmit system needs to be in accordance with existing requirements for ATC transponders.

8.5.2 The digitizer code selected needs to correspond to within plus or minus 38.1 m (125 ft), on a 95% probability basis, with the pressure-altitude information (referenced to the standard pressure setting of 1013.25 hectopascals), used on board the aircraft to adhere to the assigned flight profile. (ICAO Annex 10, Vol IV, 3.1.1.7.12.2.4. See also EUROCAE ED-26).

The performance of the encoders and of the sensors needs to be independent from the pressure setting selected.

8.5.3 The transponder should indicate correctly the altitude resolution (quantisation) used, i.e. 25ft (from an appropriate source, default resolution) or 100ft (Gillham's coded source, permissible alternative resolution).

The conversion of Gillham's coded data to another format before inputting to the transponder is not permitted unless failure detection[12] can be provided and the resolution (quantisation) is set in the transmitted data to indicate 100ft.

8.5.4 In case more stringent barometric altimetry requirements are applicable in line with e.g. airspace requirements (e.g. RVSM) or other function requirements (e.g. ACAS II), then these requirements and their related regulation take precedence.

[11] ETSO C-145/C146 provides additional capabilities compared with ETSO C129A such as: processing of GPS without Selective Availability, processing of SBAS signals when available and Fault Detection Exclusion as a basic function. Therefore ETSO C145/146 usually provides higher quality integrity values than ETSO C-129A equipment.

[12] For instance, this need can be satisfied by means of dual independent altitude corrected sensors together with an altitude data comparator (which may be incorporated and enabled in the ADS-B transmit system).

8.6 Aircraft Identification

8.6.1 Identification needs to be provided to the ADS-B transmit system so that the information is identical to the filed ICAO flight plan. This information may be provided from:

- A flight management system; or
- A pilot control panel; or
- For aircraft, which always operate with the same flight identification (e.g. using registration as the flight identification) it may be programmed into equipment at installation.

8.6.2 In case no ICAO flight plan is filed, the Aircraft Registration needs to be provided to the ADS-B transmit system.

8.7 Special Position Identification (SPI)

For ATC transponder-based ADS-B transmit systems, the SPI capability needs to be provided. The SPI capability should be integrated into the transponder functionality and should be controlled from the transponder control panel.

8.8 Emergency Status/Emergency Indicator

8.8.1 When an emergency status (i.e. discrete emergency code) has been selected by the flight crew, the emergency indicator needs to be set by the ADS-B transmit system.

8.8.2 For ATC transponder-based ADS-B transmit systems, the discrete emergency code declaration capability should be integrated into the transponder functionality and should be controlled from the transponder control panel.

Permissible deviation for initial implementations:

For initial implementations, instead of the required transmission of the discrete emergency codes 7500, 7600 and 7700 when selected by the flight crew, the transmission of only the generic emergency indicator can satisfy this requirement. Such deviation from the above target requirement needs to be listed in the Aircraft Flight Manual (refer to Section 9.3).

8.9 Airworthiness Considerations regarding Optional Provisions

8.9.1 Ground Velocity (OPTIONAL)

Ground velocity, e.g. from an approved GNSS receiver, in the form of East/West and North/South Velocity (including a velocity quality indicator) is recommended to be provided.

8.9.2 Special Position Identification (SPI) (OPTIONAL)

For non-ATC transponder-based ADS-B transmit systems (i.e. installations based on dedicated ADS-B transmitters), a discrete input or a control panel should be provided to trigger the SPI indication.

8.9.3 Emergency Status/Emergency Indicator (OPTIONAL)

For non-ATC transponder-based ADS-B transmit systems (i.e. installations based on dedicated ADS-B transmitters), a discrete input or a control panel should be provided to indicate the emergency status (discrete emergency code).

8.9.4 Flight Deck Control Capabilities (OPTIONAL)

8.9.4.1 Means should be provided to the flight crew to modify the Aircraft Identification information when airborne.

8.9.4.2 Means should be provided to the flight crew to disable the ADS-B function on instruction from ATC without disabling the operation of the ATC transponder function.

Note: It is recommended to implement an independent ADS-B disabling function. For future ADS B application such flight deck capability may become mandatory. It should be recalled that disabling the operation of the transponder will disable also the ACAS function.

8.9.4.3 Means should be provided to the flight crew to disable the transmission of the barometric altitude.

9 COMPLIANCE WITH THIS AMC

9.1 Airworthiness

9.1.1 When showing compliance with this AMC, the following points should be noted:

a) The applicant will need to submit, to the Agency, a certification plan and a compliance statement that shows how the criteria of this AMC have been satisfied, together with evidence resulting from the activities described in the following paragraphs.

b) Compliance with the airworthiness requirements (e.g. CS-25) for intended function and safety may be demonstrated by equipment qualification, safety analysis of the interface between the ADS-B equipment and data sources, structural analyses of new antenna installations, equipment cooling verification, evidence of a human to machine interface, suitable for ADS-B-NRA.

c) The safety analysis of the interface between the ADS-B transmit system and its data sources should show no unwanted interaction under normal or fault conditions.

d) The functionality for ADS-B-NRA application may be demonstrated by testing that verifies nominal system operation, the aircraft derived surveillance data contained in the ADS-B messages, and the functioning of system monitoring tools/fault detectors (if any).

9.1.2 The functionality for ADS-B-NRA application may be further demonstrated by ground testing, using ramp test equipment where appropriate, that verifies nominal system operation, the aircraft derived surveillance data contained in the ADS-B messages, and the functioning of system monitoring tools/fault detectors (if any).

Note: this limited testing assumes that the air-ground surveillance systems have been shown to satisfactorily perform their intended functions in the flight environment in accordance with applicable requirements.

To minimise the certification effort for follow-on installations, the applicant may claim credit, from the Agency, for applicable certification and test data obtained from equivalent aircraft installations.

9.2 Performance

Where compliance with a performance requirement cannot readily be demonstrated by a test, then the performance may be verified by an alternative method such as analysis, including statistical analysis of measurements under operational conditions.

9.3 Aircraft Flight Manual

9.3.1 The Aircraft Flight Manual (AFM) or the Pilot's Operating Handbook (POH), whichever is applicable, needs to provide at least a statement of compliance that the ADS-B System complies with this AMC20-24 and if deviations are applicable. Deviations, including those stated in this document[13], as appropriate may be included or referred to.

9.4 Existing installations

9.4.1 The applicant will need to submit, to the Agency, a compliance statement, which shows how the criteria of this AMC have been satisfied for existing installations. Compliance may be supported by design review and inspection of the installed system to

[13] Refer to sections 8.3.3, 8.3.5 and 8.8.2.

confirm the availability of required features, functionality and acceptable human-machine interface.

9.4.2 Where this design review finds items of non-compliance, the applicant may offer mitigation that demonstrates an equivalent level of safety and performance. Items presented by the applicant which impact safety, performance and interoperability requirements allocation will need to be coordinated in accordance with ED-78A.

10 OPERATIONAL CONSIDERATIONS

10.1 General

10.1.1 The installation should be certified according to airworthiness considerations in section 8 prior to operational approval.

10.1.2 The assumptions in section 5, concerning Air Traffic and Communications Services Providers, and Aeronautical Information Services, should have been satisfied.

10.1.3 A unique ICAO 24 bit aircraft address should be assigned by the responsible authority to each airframe.

10.2 Operational Safety Aspects

10.2.1 In all cases, flight crews should comply with the surveillance provisions, schedules and relevant procedures contained in the Aeronautical Information Publications (AIP) published by the appropriate authorities.

10.2.2 Direct controller-pilot VHF voice communications should be available at all times.

10.2.3 If flight crew receive equipment indications showing that position being broadcast by the ADS-B system is in error (e.g. GPS anomaly), they should inform the ATSP, as appropriate, using any published contingency procedures.

10.2.4 When there is not an independent Flight Deck Control selection between the ADS-B function (ADS-B on/off) and the ATC transponder function, the crew must be fully aware that disabling the ADS B function will also lead to disable the ACAS function.

10.3 Operations Manual and Training

10.3.1 Operations Manual

10.3.1.1 The Operations Manual should include a system description, operational and contingency procedures and training elements for use of the ADS-B-NRA application.

10.3.1.2 The Operations Manual, preferably section B, should contain the operational aspects described in this guidance material.

10.3.1.3 Operators operating under the provisions of ICAO Annex 6 Part II “International General Aviation – Aeroplanes” are not required to have an operations manual.

However, in order to use ADS-B applications, the operator should develop similar training and operational procedures to the ones described in this guidance material. This material may need to be approved by the State of Registry of the operator in accordance with national practice and sight of this approval may be required by the ADS-B navigation service provider.

10.3.2 Flight Crew Training

10.3.2.1 Aircraft operators should ensure that flight crew are thoroughly familiar with all relevant aspects of ADS-B applications.

10.3.2.2 Flight crew training should address the:

a) General understanding of ADS-B-NRA operating procedures;

b) Specific ADS-B associated phraseology;

c) General understanding of the ADS-B technique and technology;

d) Characteristics and limitations of the flight deck human-machine interface, including an overview of ADS-B environment and system descriptions;

e) Need to use the ICAO defined format for entry of the Aircraft Identification or Aircraft Registration marking as applicable to the flight;

Note 1: ICAO Document 8168-OPS/611 Volume I (Procedures for Air Navigation Services) requires that flight crew of aircraft equipped with Mode "S" having an aircraft identification feature should set the aircraft identification into the transponder. This setting is required to correspond to the aircraft identification that has been specified at Item 7 of the ICAO flight plan and consists of no more than seven characters. If the aircraft identification consists of less than seven characters, no zeros, dashes or spaces should be added. If no flight plan has been filed, the setting needs to be the same as the aircraft's registration, again, up to a maximum of seven characters.

Note 2: The shortened format commonly used by airlines (a format used by International Airlines Transport Association (IATA)) is not compatible with ICAO provisions for the flight planning and ATC services used by ATC ground systems.

f) Operational procedures regarding the transmission of solely the generic emergency flag in cases when the flight crew actually selected a discrete emergency code (if implemented, refer to section 8.8) and SPI;

g) Indication of ADS-B transmit capability within the ICAO flight plan but only when the aircraft is certified according to this AMC;

h) Handling of data source errors (e.g. discrepancies between navigation data sources) (refer to 10.2.3);

i) Incident reporting procedures;

j) Crew Resources Management and associated human factors issues.

10.4 Incident reporting

Significant incidents associated with ATC surveillance information transmitted by the ADS-B data link that affects or could affect the safe operation of the aircraft will need to be reported in accordance with EU-OPS 1.420 (or national regulations, as applicable).

10.5 Minimum Equipment List

The MEL will need to be revised to indicate the possibility of despatch of aircraft with the ADS-B system unserviceable or partially unserviceable.

11 MAINTENANCE

11.1 Maintenance tests should include a periodic verification check of aircraft derived data including the ICAO 24 bit aircraft address using suitable ramp test equipment. The check of the 24 bit aircraft address should be made also in the event of a change of state of registration of the aircraft.

11.2 Maintenance tests should check the correct functioning of system fault detectors (if any).

11.3 Maintenance tests at ADS-B transmit system level for encoding altitude sensors with Gillham's code output should be based on the transition points defined in EUROCAE ED-26, Table 13.

11.4 Periodicity for the check of the ADS-B transmitter should be established.

12 AVAILABILITY OF DOCUMENTS

EASA documents are available from http://www.easa.europa.eu.

JAA documents are available from the JAA publisher Information Handling Services (IHS). Information on prices, where and how to order is available on both the JAA web site www.jaa.nl and the IHS web site www.avdataworks.com.

ICAO documents may be purchased from Document Sales Unit, International Civil Aviation Organisation, 999 University Street, Montreal, Quebec, Canada H3C 5H7, (Fax: 1 514 954 6769, e-mail: sales_unit@icao.org) or through national agencies.

EUROCAE documents may be purchased from EUROCAE, 102 rue Etienne Dolet, 92240 MALAKOFF, France, (Fax: 33 1 46556265). Web site: www.eurocae.org.

RTCA documents may be purchased from RTCA, Incorporated, 1828 L Street, Northwest, Suite 820, Washington, D.C. 20036-4001 U.S.A. Web site: www.rtca.org.

EUROCONTROL documents may be requested from EUROCONTROL, Documentation Centre, GS4, Rue de la Fusee, 96, B-1130 Brussels, Belgium; (Fax: 32 2 729 9109 or web site www.eurocontrol.int).

FAA documents may be obtained from Department of Transportation, Subsequent Distribution Office SVC-121.23, Ardmore East Business Centre, 3341 Q 75th Avenue, Landover, MD 20785, USA.

Australia CASA documents are available from http://www.casa.gov.au/.

Appendix 1.1: Common Terms

Reference should be made to EUROCAE document ED-126 for the definitions of terms.

Appendix 1.2: Abbreviations

ADS-B	Automatic Dependent Surveillance- Broadcast
ADS-B-NRA	Enhanced ATS in Non-Radar Areas using ADS-B Surveillance
AFM	Aircraft Flight Manual
ANC	Air Navigation Commission (ICAO)
ATSP	Air Traffic Service Provider
ATC	Air Traffic Control
ATS	Air Traffic Services
ATSU	Air Traffic Service Unit
ATM	Air Traffic Management
CASCADE	Co-operative ATS through Surveillance and Communication Applications Deployed in ECAC
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration
GNSS	Global Navigation Satellite System
HPL	Horizontal Protection Limit
HIL	Horizontal Integrity Limit
ICAO	International Civil Aviation Organisation
INTEROP	Interoperability Requirements
MEL	Minimum Equipment List
NIC	Navigation Integrity Category
NACp	Navigation Accuracy Category
NUC	Navigation Uncertainty Category
POH	Pilots Operating Handbook
RFG	Requirement Focus Group
SIL	Surveillance Integrity Level
SPI	Special Position Identifier
SPR	Safety and Performance Requirements
SSR	Secondary Surveillance Radar
OSED	Operational Services and Environment Definition
Rc	Horizontal Position Integrity Containment Radius
TMA	Terminal Manoeuvring Area

Appendix 2.1: Summary of core ADS-B-NRA Operational Assumptions

- The ADS-B-NRA application assumes implementation of the procedures contained in the PANS-ATM ADS-B amendment. Fallback procedures from the radar environment apply to ADS-B-NRA when necessary. For example, ATC could apply alternate procedural separation (e.g., a vertical standard) during degraded modes.
- En route traffic density is assumed to be the same as in the current environment in which single radar coverage would enable the provision of a 5NM separation service for en route regions. This corresponds to low or medium density.
- Direct Controller-Pilot Communication (VHF) is assumed to be available at all times.
- It is assumed that the ADS-B coverage is known to the Controller in the controlled airspace.

Appendix 2.2: Summary of core ADS-B-NRA Ground Domain Assumptions

- Controller operating procedures are assumed to be unaffected by the selection of an ADS-B data link, i.e., the ADS-B data link is assumed to be transparent to the controller.
- Air Traffic Controllers are assumed to follow existing procedures for coordination and transfer of aircraft. This applies to coordinating appropriate information with downstream units and complying with local agreements established between ATC units regarding separation standards to be established prior to entry into a bordering ATC unit.
- Appropriate ATS authorities are assumed to provide controllers with adequate contingency procedures in the event of ADS-B failures or degradation.
- It is assumed that there is a monitoring capability in the ADS-B Receive Subsystem that monitors the health and operation of the equipment and sends alerts and status messages to the Air Traffic Processing Subsystem.

Appendix 3: Summary of ADS-B-NRA Airborne Safety and Performance Requirements

Parameter	Requirement
Horizontal Position and Horizontal Position Quality Indicator(s)	10^{-5}/fh
ADS-B System Continuity	$2*10^{-4}$/fh
Horizontal Position Latency[1]	1.5 sec/95%

Table 1: Overall Minimum Airborne ADS-B System[2] Requirements

Parameter	Requirement
Horizontal Position Source	
• Accuracy (95%)	• 5 NM Sep: 926 m
• Integrity	
• Containment Radius (Rc)	• 5 NM Sep: Rc=2 NM
• Source Failure Probability	10^{-4}/h[3]
• Alert Failure Probability	10^{-3} (per position source failure event)
• Time to Alert	• 5 NM Sep: 10 sec

Table 2: Minimum Horizontal Position Source Requirements

Note: *for DO-260 based ADS-B transmit systems, the related encoding of the horizontal position quality indicator through the Navigation Uncertainty Category (NUC) effectively leads to a containment radius requirement of 1NM for a 5 NM separation service.*

Note: *accuracy and integrity containment radius requirements are expressed here as guidance to related horizontal position source regulation (refer to section 8.4).*

Note: *the containment bound requirements reflect the outcomes of both the collision risk assessment (CAP) and time-to-alert assessment.*

Note: *the accuracy and integrity containment radius requirements have to be met by the horizontal position source, taking into account the effects of on-board latency (if not compensated for).*

An uncompensated latency of 1.5 seconds translates into a dilution in the order of 450 metres (assuming an aircraft speed of 600 knots in en-route airspace). This value of 450 metres has to be added to the actual performance of the horizontal position source(s), the sum of which has to be within the required bounds.

The GNSS equipment specified in 8.4.6 meets the overall accuracy and integrity requirements, including the effects of an uncompensated latency of maximum 1.5 second accumulated up to the time of transmission.

[1] Uncompensated delay measured from to the time of validity of position measurement until ADS-B transmission (i.e. at RF level).
[2] As defined in section 6.
[3] For GNSS based functions, expressed as an assumption of GNSS performance.

Parameter	Requirement
Barometric Altitude	• Accuracy: as per the installed sensors (refer to section 8.5.2) • Maximum Latency: 1 sec (as for SSR)
Aircraft Identification, SPI, Emergency Status	As for SSR [AMC20-13].

Table 3: Other Minimum ADS-B Surveillance Data Requirements

Parameter	Loss	Corruption	Note
Barometric Altitude	Minor	Minor	As for SSR [AMC20-13].
Aircraft Identification	Minor	Minor	As for SSR.[AMC20-13]

Table 4: Failure Condition Categories

Appendix 4.1: Summary of ADS-B-NRA Air-to-ground Interoperability Requirements

The minimum set of parameters that **should** be provided to support the ADS-B-NRA application are summarised in the following table extracted from ED-126:[1]

Parameter		BDS register	Version 0		Version 1
			ICAO Annex 10 Amendment 79, VOL III, App to chap 5	DO-260/ED-102	DO-260A
Aircraft identification		0.8	§2.3.4	§2.2.3.2.5	§2.2.3.2.5
SPI [2]		0.5	§2.3.2.6	§2.2.3.2.3.2	§2.2.3.2.3.2
Emergency indicator		0.5	§2.3.2.6	§2.2.3.2.3.2	§2.2.3.2.3.2
Barometric altitude		0.5	§2.3.2.4	§2.2.3.2.3.4	§2.2.3.2.3.4
Quality indicator (NUC/NIC)		0.5	§2.3.1	§2.2.3.2.3.1	§2.2.3.2.3.1
Airborne Position	Latitude	0.5	§2.3.2.3	§2.2.3.2.3.7	§2.2.3.2.3.7
	Longitude	0.5	§2.3.2.3	§2.2.3.2.3.8	§2.2.3.2.3.8
Emergency status [3] [4]		6.1	Table 2-97	§2.2.3.2.7.9	§2.2.3.2.7.8
Quality indicator (NACp)		6.5	No definition	No definition	§2.2.3.2.7.2.7
Quality indicator (SIL)		6.5	No definition	No definition	§2.2.3.2.3.1.1
Version Indicator[5]		6.5	No definition	No definition	§A.1.4.10.5

Table 5: Mandatory ADS-B-NRA Parameters

[1] The notion of version "0" and "1" differentiates between DO-260/ED-102 and DO-260A transponders.
[2] If provided by flight deck controls.
[3] If provided by flight deck controls.
[4] For special conditions under which the non-transmission of selected discrete emergency codes is allowed, refer to Section 8.8.2.
[5] Only for D0-260A based ADS-B transmit systems.

The minimum set of parameters that **should** be provided to support the ADS-B-NRA application are summarised in the following table extracted from ED-126:

Parameter	BDS register	Version 0		Version 1
		ICAO Annex 10 Amendment 79, VOL III, App to chap 5	DO-260/ED-102	DO-260A
Airborne Ground Velocity	0.9	§2.3.5	§2.2.3.2.6	§2.2.3.2.6

Table 6: Optional ADS-B-NRA Parameters

Appendix 4.2: Guidance on Encoding of Positional Quality Indicators

In order to be able to check the compliance of the actually transmitted ADS-B data with the required quality on the recipient side, ADS-B message transmissions contain “Quality Indicators”. These are expressed for ED-102/DO-260 and DO-260A compliant ADS-B transmit systems as follows:

- ED-102/DO-260: Navigation Uncertainty Category (NUC), a combined expression of (accuracy and) integrity requirements through a single parameter;
- DO-260A: Navigation Accuracy Category (NACp) to express the position accuracy (as a 95 percentile), Navigation Integrity Category (NIC) to express the integrity containment radius and Surveillance Integrity Level (SIL) to specify the probability of the true position lying outside that containment radius without alerting.

Minimum acceptable NUC and NIC/NACp values in support of 5 NM ADS-B-NRA separation services, based on the requirements summarised in Table 2 of Appendix 4, are as follows in line with the “NIC/NACp to NUC” conversion table below.

NUC values (encoding based on HPL, with the accuracy requirements met by GNSS systems by design and in line with the related NACp values in below conversion table):

- 5 NM separation: NUC = 4;

The corresponding NIC/NACp values are as follows.

- 5 NM separation: NIC = 4, NACp = 5,

The SIL value is established to SIL≥2 in line with the combination of the position source failure and position integrity alert failure requirements, as summarised in Table 2 of Appendix 4.

Note 1: In case the SIL value is not output by the position data sources, it is recommended that the ADS-B transmit system provides for the static setting of SIL as part of the installation procedure and as demonstrated for the applicable position data source configuration.

Note 2: ED-126 provides, based on its reference collision risk analysis only, arguments for an equally appropriate encoding of a SIL=2 as a matter of expressing the system integrity as well. As for the presentation of the values presented in this document, it is at the discretion of the ATSP to decide upon the appropriate threshold values required in support of the separation services in its airspace.

NUC (max Rc NM)		NIC (max Rc NM)		NACp (95% bound)	
9	(0.003)	**11**	(0.004)	**11**	(3 m)
8	(0.01)	**10**	(0.013)	**10**	(10 m)
	-	**9**	(0.04)	**9**	(30 m)
7	(0.1)	**8**	(0.1)	**8**	(0.05 NM)
6	(0.2)	**7**	(0.2)	**7**	(0.1 NM)
5	(0.5)	**6**	(0.6)	**6**	(0.3 NM)
4	(1.0)	**5**	(1.0)	**5**	(0.5 NM)
3	(2.0)	**4**	(2.0)	**4**	(1 NM)
	-	**3**	(4.0)	**3**	(2 NM)
	-	**2**	(8.0)	**2**	(4 NM)
2	(10)	**1**	(20)	**1**	(10 NM)
1	(20)	**1**	(20)	**1**	(10 NM)
0	(no integrity)	**0**	(> 20)	**0**	(unknown)

Table 7: NUC conversion to NIC and NACp

ADS-B Approved Means of Compliance in Asia Pacific

ADS-B out certification shall comply with EASA AMC20-24 with the following exceptions:

1. At para 8.4.6.3 revise from

   For GNSS systems compatible with (E) TSO C-129 (any revision), it is highly desired that the system incorporates Fault Detection and Exclusion capability as defined in AC20-138A, Appendix 1, "GPS as a Primary Means of Navigation for Oceanic/Remote Operations".

   to

   For GNSS systems compatible with (E)TSO C-129 (any revision), **it is required** that the system incorporates Fault Detection and Exclusion capability as defined in AC20-138A, Appendix 1, "GPS as a Primary Means of Navigation for Oceanic/Remote Operations".

2. Add a new paragraph 8.4.9

   For GNSS systems operating in environments where the ANSP requires ADS-B data with (NUC>4 for DO260) or (SIL=2, NIC>5 for DO260A) and an operational availability above 99.95%, the GNSS system shall not assume that Selective Availability (SA) is ON.

– – – – – – – – – – – – –

Attachment 1

THIRD MEETING OF THE SOUTHEAST ASIA SUB-REGIONAL ADS-B IMPLEMENTATION WORKING GROUP (SEA ADS-B WG/3)

Putrajaya, Malaysia, 2-3 July 2008

LIST OF PARTICIPANTS

STATE / INTERNATIONAL ORGANIZATION / NAME	DESIGNATION / ADDRESS	TELEPHON / FAX / EMAIL
AUSTRALIA (1)		
Mr. Greg Dunstone	Airservice Australia GPO Box 367, Canberra ACT 2601, 25 Constitution A venue Canberra, ACT 2601 **AUSTRALIA**	Tel : +61(2) 6268 4286 Fax : +61(2) 6268 5709 Email : greg.dunstone@airservicesaustralia.com
CAMBODIA (2)		
Mr. Kritsanat Chumsri	State Secretariat of Civil Aviation No.62 Preah Norodom Blvd. Phnom Penh **CAMBODIA**	Tel : + 855 (16) 771 121 Fax : - Email : kritsanat@cats.com.kh
Mr. Sary Peang	Director of Engineering State Secretariat of Civil Aviation No. 62 Preah Norodom Blvd. Phnom Penh **CAMBODIA**	Tel : + 855 (16) 771 131 Fax : + 855 (23) 725 938 Email : sary@cats.com.kh
INDONESIA (3)		
Mrs. Yudhi Sari S.	Directorate of Aviation Electronic and Electricity Facilities Deputy Director of Navigation and Surveillance Medan Merdeka Barat No.8 Karya Building 23 Fl. Jakarta – 10110 **INDONESIA**	Tel : +62 (21) 350 5006 ext 5168 Fax : +62 (21) 3483 2663 Email : yudhi@attglobal.net
Mr. Edison Saragih	Directorate of Aviation Electronic and Electricity Facilities Medan Merdeka Barat No.8 Karya Building 23 Fl. Jakarta – 10110 **INDONESIA**	Tel : +62 21 350 5006 ext 5147 Fax : +62 21 3483 2663 Email : edisonsaragih@yahoo.com
Mr. Taruna Jaya	Directorate of General Aviation Staff of Navigation and Surveillance Facility Medan Merdeka Barat No.8 Karya Building 23 Fl. Jakarta – 10110 **INDONESIA**	Tel : +62 21 350 5006 ext 5147 Fax : +62 21 3483 2663 Email : taruna_jaya@yahoo.com

Attachment 1

STATE / INTERNATIONAL ORGANIZATION / NAME	DESIGNATION / ADDRESS	TELEPHON / FAX / EMAIL
MALAYSIA (12)		
Mr. Ahmad Nizar bin Zolfakar	Director Air Traffic Management Sector Department of Civil Aviation Malaysia No. 27, Persiaran Perdana, Level 4, Block Podium, Precinct 4, 62618 Putrajaya, **MALAYSIA**	Tel : +603 8871 4227 Fax : +603 8881 0510 Email : ahmad_nizar@dca.gov.my
Mr. Balasubramaniam a/l Muttaya	Director KL ATCC Department of Civil Aviation Malaysia Block A, Air Traffic Control Center Complex, LTSAAS, 47200 Subang, Selangor **MALAYSIA**	Tel : +603 7846 5233 Fax : +603 7845 6590 Email : m_bala@dca.gov.my
Hj. Ghazali bin Said	Director Regional I Department of Civil Aviation Malaysia Block A, Air Traffic Control Center Complex, LTSAAS, 47200 Subang, Selangor **MALAYSIA**	Tel : +603 7846 5233 Fax : +603 7846 4376 Email : ghazali@dca.gov.my
Mr. Jamil Khir Bin Mohamed	Deputy Director Air Traffic Management Sector Department of Civil Aviation Malaysia No. 27, Persiaran Perdana, Level 1-4, Block Podium, Precinct 4, 62618 Putrajaya, **MALAYSIA**	Tel : +603 8871 4228 Fax : +603 8881 0510 Email : jamilkhir@dca.gov.my
Dr. Manjit Singh a/l Seva Singh	Deputy Director Malaysia Aviation Academy Department of Civil Aviation Malaysia Block A, Air Traffic Control Center Complex, LTSAAS, 47200 Subang, Selangor **MALAYSIA**	Tel : +603 7845 7724 Fax : +603 7845 6354 Email : manjit@dca.gov.my
Capt. Norhalim Md Yunus	Capt. / Snr Deputy Director Flight Operation Sector Department of Civil Aviation Malaysia No. 27, Persiaran Perdana, Level 1-4, Block Podium, Precinct 4, 62618 Putrajaya, **MALAYSIA**	Tel : +603 8871 4201 Fax : +603 8871 4334 Email : norhalim@dca.gov.my

STATE / INTERNATIONAL ORGANIZATION / NAME	DESIGNATION / ADDRESS	TELEPHON / FAX / EMAIL
Mr. Azli @ Azmin bin Faizul	Senior Asst. Director Air Traffic Management Sector Department of Civil Aviation Malaysia No. 27, Persiaran Perdana, Level 1-4, Block Podium, Precinct 4, 62618 Putrajaya, **MALAYSIA**	Tel : +603 8871 4276 Fax : +603 8881 0510 Email : azmin@dca.gov.my
Mr. Khairul A'amali bin Ismail	Senior Asst. Director Air Traffic Management Sector Department of Civil Aviation Malaysia No. 27, Persiaran Perdana, Level 1-4, Block Podium, Precinct 4, 62618 Putrajaya, **MALAYSIA**	Tel : +603 8871 4272 Fax : +603 8881 0510 Email : khairulamali@dca.gov.my
Hj Tajul Annwar Bin Ismail	Senior Asst Director Malaysia Aviation Academy Department of Civil Aviation Malaysia Block A, Air Traffic Control Center Complex, LTSAAS, 47200 Subang, Selangor **MALAYSIA**	Tel : +603 7845 2161 Fax : +603 7845 6354 Email : tajul@dca.gov.my
Mr. Ngai Chee Heng	Senior Asst. Director KL ATCC Department of Civil Aviation Malaysia Block A, Air Traffic Control Center Complex, LTSAAS, 47200 Subang, Selangor **MALAYSIA**	Tel : +603 7846 5233 Fax : +603 7845 6590 Email : chngai@dca.gov.my
Mr. Syed Syahrill bin Syed Salim	Air Traffic Controller KL ATCC Department of Civil Aviation Malaysia Block B, Air Traffic Control Center Complex, LTSAAS, 47200 Subang, Selangor **MALAYSIA**	Tel : +603 7847 3573 Fax : +603 7847 3572 Email : syahrill@dca.gov.my
Mr. A. Theodore Rayan	Secretary Civil Aviation Air Traffic Control Services Union (CAATCSU) Department of Civil Aviation Malaysia Air Traffic Control Complex KL International Airport 64000 KLIA Selangor Darul Ehsan **MALAYSIA**	Tel : - Fax : - Mobile : +6012 391 5831 Email : theodore@pd.jaring.my

Attachment 1

STATE / INTERNATIONAL ORGANIZATION / NAME	DESIGNATION / ADDRESS	TELEPHON / FAX / EMAIL
PHILIPPINES (1)		
Mrs. Ma. Theresa Lee Olpindo	Chief ATC, Manila Radar Approach Control Air Traffic Service Air Transportation Office Naia Rd, Pasay City 1300 Metro Manila, **PHILIPPINES**	Tel : +632 879 9298 Fax : +632 879 9298 Email : limavic2000@yahoo.com
SINGAPORE (3)		
Mr. Yeo Cheng Nam	Head (Aeronautical Telecommunications) Civil Aviation Authority of Singapore Singapore Changi Airport PO Box 1 **SINGAPORE** 918141	Tel : +65 6541 2442 Fax : +65 6542 2447 Email : yeo_cheng_nam@caas.gov.sg
Mr. Ho Wee Sin	Engineer (Surveillance) Civil Aviation Authority of Singapore Singapore Changi Airport PO Box 1 **SINGAPORE** 918141	Tel : +65 6541 1930 Fax : +65 6542 2447 Email : ho_wee_sin@caas.gov.sg
Mr. Hermizan Jumari	Project Officer (Air Traffic Management) Civil Aviation Authority of Singapore Singapore Changi Airport PO Box 1 **SINGAPORE** 918141	Tel : +65 6541 2464 Fax : +65 6545 6516 Email : hermizan_jumari@caas.gov.sg
THAILAND (2)		
Mr. Chainan Chaisompong	Executive Officer, Systems Engineering Air Traffic Services Engineering Planning and Standards Department Aeronautical Radio of Thailand Ltd. 102 Ngamduplee, Tungmahamek Sathorn, Bangkok 10120 **THAILAND**	Tel : +66 (2) 287 8391 Fax : +66 (2) 287 8620 Email : chainan.ch@aerothai.co.th
Mr. Chutintorn Pongpairoj	Director Air Traffic Surveillance Systems Engineering Dept Aeronautical Radio of Thailand Ltd. 102 Ngamduplee, Tungmahamek Sathorn, Bangkok 10120 **THAILAND**	Tel : +66 (2) 285 9448 Fax : +66 (2) 285 9145 Email : chutin@aerothai.co.th
VIETNAM (2)		
Mr. Hoang Huu Lich	Manager of CNS Division Air Navigation Department Civil Aviation Administration of Vietnam 119 Nguyen Son Street Long Bien District, Hanoi **VIETNAM**	Tel : +84-4-827 4191 Fax : +84-4-827 4194 Email : hhlich@caa.gov.vn

STATE / INTERNATIONAL ORGANIZATION / NAME	DESIGNATION / ADDRESS	TELEPHON / FAX / EMAIL
Mr. Nguyen Xuan Nhu	Technical Officer CNS Division Vietnam Air Traffic Management 200/6 Nguyen Son Street, Long Bien District, Hanoi **VIETNAM**	Tel : +84-4-872 5969 Fax : +84-4-827 2597 Email : vatmtech@hn.vnn.vn
CANSO (1)		
Mr. Chiang Hai Eng	Director Asia Pacific Affairs CANSO Asia Pacific Office Singapore Aviation Academy 1 Aviation Drive **SINGAPORE** 499867	Tel : +65 6541 2006 Fax : +65 6543 4995 Email : hai.eng.chiang@canso.org
IATA (2)		
Mr. Geoff Hounsell	Asst Director ATM, SO & I International Air Transport Association 111 Somerset Road, #14-05 **SINGAPORE** 238164	Tel : +65 6499 2253 Fax : +65 6233 9286 Email : hounsellg@iata.org
Mr. Owen Dell	Manager International Operations Cathay Pacific 9F, Central Tower, Cathay Pacific City, 8, Scenic Road, Hong Kong International Airport Lantan Island, **HONG KONG**	Tel : +852 2747 8829 Fax : +852 2141 8829 Email : owen_dell@cathaypacific.com
ICAO (1)		
Mr. Li Peng	Regional Officer CNS International Civil Aviation Organization 252/1, Vibhavadee Ramgsit Road Ladyao, Chatuchak Bangkok 10900 **THAILAND**	Tel : +62 (2) 537 8189 Ext. 158 Fax : +62 (2) 537 8199 Email : pli@bangkok.icao.int
SITA (1)		
Mr. Philip Koh	ATM Business Development Manager Asia Pacific	Tel : +65 6347 8220 Fax : +65 6548 2606 Mobile : +65 8163 3696 Email : philip.koh@sita.aero
ADVANCE AIR TRAFFIC SYSTEM (AAT) (4)		
Ms. Maria Mazni binti Ghazali	Advance Air Traffic Sdn. Bhd. Jalan Pengacara U 1/48 Temasya Industrial Park 40150 Shah Alam Selangor Darul Ehsan **MALAYSIA**	Tel : +603 5569 1515 Fax : +603 7846 5659 Mobile : +6019 228 8427 Email : maria@aat.com.my
Mr. Mohamad Azli bin Kongit	Advance Air Traffic Sdn. Bhd. Jalan Pengacara U 1/48 Temasya Industrial Park 40150 Shah Alam Selangor Darul Ehsan **MALAYSIA**	Tel : +603 5569 1515 Fax : +603 7846 5659 Mobile : +6019 221 3899 Email : azli@aat.com.my

Attachment 1

STATE / INTERNATIONAL ORGANIZATION / NAME	DESIGNATION / ADDRESS	TELEPHON / FAX / EMAIL
Mr. Mohd Firdaus bin Mohd Yunus	Advance Air Traffic Sdn. Bhd. Jalan Pengacara U 1/48 Temasya Industrial Park 40150 Shah Alam Selangor Darul Ehsan **MALAYSIA**	Tel : +603 5569 1515 Fax : +603 7846 5659 Mobile : +6012 360 2032 Email : firdaus@aat.com.my
Mr. Mohd. Shahlan Fitri bin Noor Rahin	Advance Air Traffic Sdn. Bhd. Jalan Pengacara U 1/48 Temasya Industrial Park 40150 Shah Alam Selangor Darul Ehsan **MALAYSIA**	Tel : +603 5569 1515 Fax : +603 7846 5659 Mobile : +6019 380 3995 Email : shahlanfitry@aat.com
AMP CORPORATION (M) SDN. BHD (2)		
Mr. Tanapaal Balakrihsnan	Business Manager – Asia Pacific Blk #09-1 Tamarind at Sentul East No. 2 Jln Sentul Indah, Sentul 51100 Kuala Lumpur **MALAYSIA**	Tel : - Fax : +603 4044 5159 Mobile : +6019 288 7215 Email : tbalakrishnan@arabeyondradar.com
Mr. Rahiman	Lot 31, Jalan U1/35 HICOM-Glenmarie Industrial Park 40150 Shah Alam Selangor Darul Ehsan **MALAYSIA**	Tel : +603 5569 2020 Fax : +603 5569 2025 Mobile : +6019 274 0734 Email : rahiman@amcop.com
PUBLIC WORKS DEPARTMENT (1)		
Mr. Mat Rosly Mat Daud	Principal Assistant Director 8th Floor Block F, Public Works Department Head Office Jalan Sultan Salahuddin 50582 Kuala Lumpur **MALAYSIA**	Tel : +603 2696 7224 Fax : +603 2697 5273 Email : mrosly@jkr.gov.my
ROYAL MALAYSIA AIR FORCE (2)		
Major Tarlochan Singh A/L Kernal Singh	Air Operation Head Quarters Ministry Of Defence, Jalan Padang Tembak 50634 Kuala Lumpur **MALAYSIA**	Tel : +603 2071 2812 Fax : +603 2698 6403 Email : tarlochan1867@yahoo.com
Major Zahidi bin Amad	PS2 ATC, MTU RMAF Ministry Of Defence, Jalan Padang Tembak 50634 Kuala Lumpur **MALAYSIA**	Tel : +6019 281 9614 Fax : +603 2698 6403 Email : zahidi_ahmad@yahoo.com
TELEKOM MALAYSIA BERHAD (2)		
Mr. Anuar Bin Mat Alim	Manager, Aviation Product Marketing Telekom Malaysia Berhad 6th Floor, TM Bukit Mahkamah Jalan Raja Chulan 50200 Kuala Lumpur **MALAYSIA**	Tel : +603 2020 6086 Fax : +603 2034 1619 Email : anuarma@tm.com.my

STATE / INTERNATIONAL ORGANIZATION / NAME	DESIGNATION / ADDRESS	TELEPHON / FAX / EMAIL
Mr. Norhisyam Mohd Nor	Assistant Manager, Telekom Malaysia Berhad SNS, 6th Floor, TM Bukit Mahkamah Jalan Raja Chulan 50200 Kuala Lumpur **MALAYSIA**	Tel : +603 2020 6076 Fax : +603 2034 1619 Email : hisyam@tm.com.my
AIR ASIA (1)		
Lt. Col. (Rtd) Tony Quek	AirAsia Berhad LCC Terminal, Jalan KLIA S3, Southern Support Zone, KLIA 6400 Sepang Selangor Darul Ehsan **MALAYSIA**	Tel : +603 8860 4333 Fax : +603 8660 4133 Mobile : +6012 223 1737 Email : tonyquek@airasia.com
MALAYSIA AIRLINES (3)		
Capt. Mr. Wee Yeng Chor	Manager (Technical) Flight Operations (B744/B777) Malaysia Airline System Berhad	Tel : +603 8777 9666 Fax : +603 8787 3752 Email : weeyc@mas.com.my
Capt. Shahrom Basri	Manager Flight Operations (B744 Training) Malaysia Airline System Berhad	Tel : +603 8777 2983 Fax : +603 8787 3752 Email : sbasri@mas.com.my
Capt. Joseph Emuang	Manager Flight Operations (B777 Training) Malaysia Airline System Berhad	Tel : - Fax : - Email : junior@mas.com.my
SINGAPORE AIRLINES (1)		
Capt. R. Saravanam	Pilot Singapore Airliners / IATA Blk 579 Hougang Ave 4 # 15-632 **SINGAPORE** 530579	Tel : +65 93691656 Fax : - Email : R_saravanan@sinagporeair.com.sg

Attachment 2

International Civil Aviation Organization

THIRD MEETING OF THE SOUTHEAST ASIA SUB-REGIONAL ADS-B IMPLEMENTATION WORKING GROUP (SEA ADS-B WG/3)

Putrajaya, Malaysia, 2-3 July 2008

LIST OF WORKING PAPERS

WP/IP No.	Agenda Item	Subject	Presented by
1	1	Provisional Agenda	Secretariat
2	2	Outcome of ADS-B SITF/7	Secretariat
3	3	Review of TOR of SEA ADS-B Working Group	Secretariat
4	5	Project proposal for the enhancement of the safety and efficiency using ADS-B	IATA
5	6	Collaboration project for using ADS-B in the South East Asia	Indonesia, Singapore and Viet Nam
6	6	Consideration of Provision of VHF Radio Communication to Neighboring FIR	Australia
7	3	ADS-B Avionics Certification Requirements	Australia

LIST OF INFORMATION PAPERS

1	4	Implementation status of ADS-B Programme in Indonesia	Indonesia
2	7	IATA Vision 2015	IATA
3	7	EASA AMC20-24	Greg-Australia
4	7	Updates on SA Aware avionics : ASP WG Paper	Greg-Australia
5	6	Introduction of ATMnet	SITA
6	4	ADS-B Programme updates (presentation)	Australia


KEMENTERIA