INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

FINAL REPORT OF

THE EIGHTH MEETING OF THE SURVEILLANCE IMPLEMENTATION COORDINATION GROUP (SURICG/8)

6 – 9 June 2023
Bangkok, Thailand

The views expressed in this Report should be taken as those of the Meetings and not the Organization.

Approved by the Meeting
and published by the ICAO Asia and Pacific Office, Bangkok

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1. Introduction

1.1 The Workshop on ICAO Aircraft Address and Target Identification in Surveillance Data and Flight Plan and the Eighth Meeting of the Surveillance Implementation Coordination Group (SURICG/8) were held at ICAO APAC Regional Office, Bangkok, Thailand, from 6 – 9 June 2023.

2. Opening of the Meeting

2.1 The meeting was opened by Mr. Hui Man Ho, Assistant Director-General of Civil Aviation (Air Traffic Engineering Services), Civil Aviation Department, Hong Kong China, the Co-Chair of SURICG.

2.2 Mr. Hui, Co-chair of SURICG, welcomed participants and expressed his honour to continue serving as Co-Chair. He informed the meeting that another Co-Chair, Mr. Yeo Cheng Nam, was unavailable to continue his chairmanship. On behalf of the SURICG, Mr. Hui expressed the thankfulness to Mr. Yeo for his efforts and contributions in serving the Meeting as Co-Chair during 2019-2022. Mr. Hui went on to summarize the good work done by the SURICG in last year, including the outcomes of Mode S & DAPs Working Group, ADS-B implementation in the Region, and the planning work for the joint trial/demonstration on surveillance data sharing based on SWIM by the Surveillance Study Group (SURSG) and its SWIM Trial Implementation Group. He also thanked the Chair of ICAO Surveillance Panel, Mr. Doug Arbuckle, for his support and contributions to the work of SURICG as well as sharing of latest discussions from the Panel. Mr. Hui pointed out that the Region was keeping its pace in air traffic recovery even hard hit by the pandemic, and encouraged the SURICG to upkeep the high standards and professionalism, while being pragmatic in setting proper priorities to cater for differences in the Region. He thanked ICAO Regional Office for the organization of the meeting, and the sponsorships from industry partners to this Meeting.

2.3 On behalf of ICAO Regional Director, Mr. Luo Yi, Regional Officer CNS extended warm welcome to the participants. He pointed out that as surveillance elements are playing key roles in safe and efficient ATM systems, States and Administrations are encouraged to share experience with all stakeholders to meet the rapidly emerging challenges. He took the opportunity to mention the great contribution of the ICAO Surveillance Panel (SP) for proactive connection between the Panel's work and regional events to help the Region aligning regional activities with global trend closely and timely and acknowledged the effort and achievements of Mode S and DAPs working group. He also expressed gratitude for the continued support of industry partners and assistance in organising ICAO Regional events, in particular, the sponsorship of the Meeting by CETC Glarun, Chinney, Huawei, Indra and THALES.

3. Attendance

3.1 The Meeting was attended by 79 participants from 18 Member States/Administrations namely Australia, China, Hong Kong China, Macao China, Fiji, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Nepal, New Zealand, Philippines, Republic of Korea, Singapore, Thailand, USA, and Viet Nam, **2** International Organizations namely IATA, and ICAO, and 5 service providers including Airbus, Chinney Alliance Engineering, Huawei, Indra and Thales. The List of participants is provided in **Attachment 1**.

4. Officers and Secretariat

4.1 Mr. Hui Man Ho, Assistant Director-General of Civil Aviation (Air Traffic Engineering Services), Civil Aviation Department, Hong Kong China, and Mr. Ho Wee Sin, Deputy

Director (Info Air Traffic Management) of the Civil Aviation Authority of Singapore, co-chaired the meeting. Mr. Luo Yi, Regional Officer CNS, ICAO Asia and Pacific Regional Office, acted as the Secretary for the meeting with the support of Ms. Soniya Nibhani, Regional Officer ANS (CNS) Implementation, Ms. Zhong Wenhan, Regional Officer CNS, and Ms. Varapan Meefuengsart, the Programme Assistant of the same office.

5. Organization, working arrangements and language

5.1 The meeting met as a single body for the Workshop and the Meeting. The working language was English inclusive of all documentation and this Report. The meeting considered 8 Working Papers, 21 Information Papers, 5 Presentations, and 1 Flimsy. A list of Papers presented at the meeting is provided in **Attachment 2.**

6. Workshop

6.1 A Workshop on ICAO Aircraft Address and Target Identification in Surveillance Data and Flight Plan was organized in conjunction with the SURICG/8 meeting on 6 June 2023. The workshop was attended by 72 participants from 18 Member States/Administrations namely Australia, China, Hong Kong China, Macao China, Fiji, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Nepal, New Zealand, Philippines, Republic of Korea, Singapore, Thailand, USA, and Viet Nam, 2 International Organizations namely IATA, and ICAO, and 2 service providers including Huawei and Indra.

6.2 The objective of Workshop is to promote to stakeholders (ANSPs, airline operators, ground handling agents, etc.) and the aviation community on ensuring proper ICAO Aircraft Address and Target Identification in Surveillance Data and Flight Plan, as well as the exploration of follow-up actions with proper points of contact to rectify incorrect data used in the operational environment. The Workshop received 6 comprehensive presentations from contributors as shown in the Workshop Program in **Attachment 3.** All presentations are uploaded to the SURICG/8 website https://www.icao.int/APAC/Meetings/Pages/2023-SURICG8.aspx

6.3 In his opening remarks, Mr. Luo Yi thanked all presenters for their active support to ICAO regional activities, he expressed appreciation to Mr. MH Hui for his support to ICAO regional activities. He emphasized the importance of bringing together stakeholders in the aviation community to discuss the discrepancies that have been observed in the APAC region and explore follow-up actions with proper points of contact to rectify incorrect data used in the operations environment to mitigate such potential risk.

6.4 Mr. Hui Man Ho, Assistant Director-General of Civil Aviation (Air Traffic Engineering Services), Civil Aviation Department, Hong Kong China facilitated the Workshop as moderator of the Workshop. A number of questions were discussed and clarified. The presentations were well received by the participants.

6.5 The Workshop identified the importance and necessity to develop a regional guidance material to mitigate the discrepancies observed in ICAO Aircraft Address and Target Identification between surveillance data and flight plan by consolidating the outcomes of the workshop, which will be recorded as an **ACTION ITEM** of SURICG/8 taken by an Ad-hoc group led by Hong Kong China, supported by China, New Zealand, Singapore, USA and IATA. The proposed guidance material is planned to be presented to SURICG/9 for review. **ACTION ITEM 8-1**

7. Draft Conclusions, Draft Decisions and Decisions of SURICG – Definition

7.1 SURICG recorded its actions in the form of Draft Conclusions, Draft Decisions and Decisions within the following definitions:

Draft Conclusions deal with matters that, according to APANPIRG terms of reference, require the attention of States, or action by the ICAO in accordance with established procedures;

Draft Decisions deal with the matters of concern only to APANPIRG and its contributory bodies; and

Decisions of SURICG that relate solely to matters dealing with the internal working arrangements of SURICG.

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Agenda Item 1: Adoption of Agenda / Election of new Co-Chair

Adoption of Agenda

1.1 The tentative agenda items provided in WP/01 was adopted by the meeting as the agenda items for the meeting.

Election of new Co-Chair

1.2 The meeting extended sincere gratitude to Mr. Yeo Cheng Nam for his dedication and contributions towards the Surveillance Implementation Coordination Group (SURICG) in the past four years as co-chair. As Mr. Yeo was unavailable to continue his chairmanship, there is a need to elect a new Co-chair to take up the role.

1.3 Nominated by USA and seconded by Hong Kong China, Mr. Ho Wee Sin, Deputy Director (Info Air Traffic Management) of the Civil Aviation Authority of Singapore was unanimously elected as the new co-Chair of the SURICG.

1.4 Mr. Ho Wee Sin appreciated the support of the meeting and committed to continue his effort on facilitating the exchange and sharing of know-how and experience on surveillance in the region.

Agenda Item 2: Review of outcomes of relevant meetings on Surveillance

Review of Relevant Meetings - Sec (WP/02)

2.1 The paper summarized relevant information and updates with the highlight on the reviewed outcomes of SURICG/7, ATMAS TF/3, and relevant discussions of other meetings of CNS SG/26 and APANPIRG/33.

2.2 The CNS SG/26 meeting adopted Five (5) Conclusions and Two (2) Decisions. In addition, based on the outcome of discussions on various agenda items, the CNS SG/26 meeting developed Five (5) Draft Conclusions and One (1) Draft Decision, which were adopted by APANPIRG/33. The meeting noted Conclusions/Decisions adopted by CNS SG/26 and APANPIRG/33 of interest to the group and discussed the follow-up.

Relevant Action Items of 57th Conference of Directors General of Civil Aviation - Sec (WP/08)

2.3 The paper presented the CNS related outcomes of the 57th Conference of Directors General of Civil Aviation Asia and Pacific Regions (DGCA/57), which held at Republic of Korea from 4 to 8 July 2022. The meeting reviewed the Discussion Paper *57-4-3-DP Aeronautical Spectrum Utilization and Protection* and highlighted the Action Item 57/20, which urged States/Administrations to coordinate frequency and SSR IC use with the ICAO APAC Office to ensure the frequency and IC lists are correct and up-to-date, and monitor and report the occupancy of 1090 MHz which is capable to do so. The meeting was invited to review the Action Items related to CNS fields derived from the DGCA Conf/57, and identify CNS related issues if any that need to be brought to the attention of the DGCA Conf/58, which will be hosted by Bangladesh in 2023.

Agenda Item 3: Review Report of Mode S and DAPs WG/6 Meeting

Review Report of Mode S and DAPs WG/6 – Chair of Mode S and DAPs WG (WP/03)

3.1. This paper summarized the main points of the report of the Mode S DAPs WG/6 meeting, which was held in Bangkok, Thailand *from 28 to 30 March 2023*.

3.2. The paper discussed the contents and Draft Conclusions/Decisions proposed by DAPs WG/6 for consideration of SURICG/8. The DAPs WG/6 meeting report, working papers, information papers, and other resources can be accessed by following link: https://www.icao.int/APAC/Meetings/Pages/2023-Mode-S-and-DAPs-WG6.aspx

Sharing of State's implementation on Mode S and related issues in APAC region

A Case Analysis of Manoeuvring Aircraft Track Missing

3.3. China discussed a case of Mode S secondary radar (MSSR) missing a manoeuvring aircraft for a long time due to the error of DAPs data resulting in false extrapolated tracks. Limited by antenna pattern and Mode S scheduling management, short-range aircraft flying along the radial direction of MSSRs might be out of the correlation window when the aircraft making a high-manoeuvre flight turn to a tangential direction. This paper suggested that MSSR manufacturers should verify and reject false DAPs data, with methods described in IP/19 of SURICG/6 and implementation in IP/11 of DAPs WG/5. Besides, MSSR stations should be built far enough from the route turning point and avoid along the route, especially in the terminal area.

Sharing of GPS Interference Investigation Methods

3.4. China introduced the methods and experience of GPS interference investigation based on ADS-B technology for civil aviation flights. Real-time data through ADS-B downlink was used to extract abnormal quality of GPS signal for statistical analysis and then form a "thermal map" of aircraft affected to preliminarily locate interference sources. A case of investigation was also discussed for sharing to the meeting.

Mode S Upgrade by Life Extension

3.5. To accelerate the application of Mode S surveillance, China conducted an evaluation and analysis of the current radars and formulated a life extension plan for upgrading three (3) legacy conventional mode secondary radars. The paper introduced the upgrade procedure including on-site surveys, technical plan preparation, equipment production, equipment factory acceptance test, on-site installation and commissioning, system optimization, on-site acceptance test, etc.

The Progression of Optimization and Improvement of ADS-B Application in China

3.6. China introduced its Nationwide ADS-B Optimization and Adjustment Implementation Scheme. 332 ground stations, 36 level-3 data processing stations, 8 level-2 data processing centres, and 38 sets of ATM automation systems in 22 operation sites were involved in this project. This project allows China to unify ADS-B data output rules and data age maintenance period, filter unqualified ADS-B data in data processing centres, and stable and smoothen fused system tracks.

Progress of CAAC Trials on Surveillance Co-ordination Network of Mode S Secondary Radar

3.7. China introduced the background, updated progress and achievements of Clustering Trials for Mode S Stations to evaluate the feasibility of the technique to solve issues including insufficient II codes, FRUIT due to deteriorating spectrum occupancy and limitations from monopulse radar detection. SCN connects a group of sensors with overlapping coverage sharing the same IC, with sensors in the cluster that can acquire target information and cooperatively maintain tracking. China planned to conduct more trials and share results and experience with the Region.

Mode S monitoring and analysis

The Real Time Mode-S Signal Monitoring with Asterix Cat. 48 data

3.8. ROK presented their example of Mode-S monitoring at Incheon International Airport. The paper discussed different monitoring methods and introduced their implementation of monitoring by in-house software checking the values of Data Item I048/130, Radar Plot Characteristics, to monitor surveillance quality. Republic of Korea was willing to share the research results and relevant software tool with other states to protect the 1030/1090 MHz frequency resource.

Two Cases of False Alarm in A-SMGCS System Caused by the Incorrect Air/Ground Status of Aircraft

3.9. China shared two instances of erroneous warnings in the A-SMGCS system brought on by the wrong Air/Ground status received from avionics which caused A-SMGCS to generate false alarms and affected the accuracy of system output. Since Mode S IGD suggested and DO-260 described that air/ground status to be generated automatically, users should inform the airlines concerned in time for rectification to avoid further safety impact, and controllers should pay close attention and make final judgments referring to the flight's actual situation and the alarm status in the ATM automation system or relevant systems.

The Problem of Low Efficiency of Vertical Intent Flag in DAPs

3.10. China described the low efficiency of flags related to vertical intent of MCP/FCU mode and target altitude source in BDS 4,0 which caused difficulties to determine the target altitude indicating the aircraft's real vertical intent. In the application of pilot-selected altitude and clear flight level mismatch alert, it should be aware that the selected altitude might not represent the real vertical intent of the aircraft, and carefully consider the difference between track prediction based on selected altitude and target altitude, especially for the safety net.

<u>Review on the 1030/1090MHz occupancy in Asia Pacific</u>

Guidance on Management of 1030-1090MHz Utilization

3.11. Singapore presented the work that was being undertaken by the Surveillance Panel (SP) to manage the 1030/1090 MHz utilization. SP established the Surveillance Spectrum Focus Team (SSFT) in September 2019 to look into the overall issue of 1030/1090 MHz utilization, including the impact of evolving systems that would potentially share the 1030/1090 MHz link (e.g. RPAS, new ACAS versions, military IFF, Electronic Conspicuity devices for General Aviation) contributing to the spectrum load. It also covered examining techniques and capabilities that could be considered to reduce 1030/1090 MHz congestion. The SSFT would develop specific solutions, which can be transferred into Proposals for Amendment for Annex 10 Volume IV or change proposals for ICAO Manuals. A list of identified issues related to 1030/1090 MHz spectrum load and possible mitigations was provided in Annex A to the paper. It also contained information on affected ICAO documents and specific aspects like regulations and already available standards. All this material was considered as a basis to formulate appropriate text for ICAO SARPs and guidance material. States were urged to follow the guidance and SARPs and guidance materials produced to keep the frequency utilization healthy.

<u>Interrogator Code (IC) planning and coordination</u>

Guidance Material for Assignment of Interrogator Codes (IC) For MLAT and ADS-B

3.12. During the Mode S DAPs WG/2, it discussed whether interrogators that come with ADS-B need to be assigned with a distinct IC. Current practices suggested that II=0 can be used. However, the existing provision in ICAO documents was not clear to the reader and can be confusing. Singapore shared that the Surveillance Panel (SP) Aeronautical Surveillance Working Group (ASWG) was working on revising the text in the SARPS and guidance material. The paper provided the rationale and relevant updates on the proposed changes across various ICAO documents in Annex A to this paper. The meeting was invited to note the status of the amendments to the SARPS and guidance material for the assignment of IC to interrogators, and discussed the impact on IC usage for ADS-B and MLAT.

Future requirement by ICAO to use II/SI Code Operations

3.13. The paper shared the ongoing proposals within the Surveillance Panel to include a requirement for radars using SI codes to support the II/SI code operations, in which the radar will interrogate the aircraft using SI code and acquire aircraft that reply using the same SI code, as well as those replying with the matching II code. Subsequently, it will only lock out the SI capable transponder and not the non-SI capable transponder to allow the non-SI capable transponder to be acquired by nearby radars using matching SI codes. This paper introduced the text being deliberated for consideration of a provision on the use of II/SI code operations ICAO Annex 10 Vol 4 that would improve the visibility of this requirement and will facilitate its traceability during the procurement, testing of systems and the allocation of SI codes by regional offices that will need to ask whether this mode of operation is supported before allocating an SI code.

Amendment of Appendix H and Appendix J of Doc 9924 Aeronautical Surveillance Manual relating to II and SI assignment

3.14. This paper introduced the current proposals for amending the Aeronautical Surveillance Manual (Doc. 9924) Appendices H and J. These amendments in Appendix H will clarify and elaborate on the acquisition and detection of Mode S II-only (non-SI capable) transponders by Mode S II/SI capable interrogators as well as the acquisition and detection of Mode S II/SI capable transponders by Mode S II-only interrogators as currently described in paragraphs 1.2.5 – 1.2.11 of Appendix H, and introduce the planning criteria in Appendix J for co-existence of II and SI codes under the environment where there are non-SI capable transponders still in operations. The proposed amendment was given in full in Annex A to this paper, which was deliberated at the Surveillance Panel. The Meeting noted that Section 8.2.6 *the Mode S II/SI code assignment planning criteria* would be most beneficial for the APAC Region as it lay down the rules for the II/SI code assignment.

SSR Mode S Interrogator Identification (II) Code Re-Allocation

3.15. Indonesia shared information about SSR Mode S II codes 14 and 15 re-assignment and the potential incompatibility with neighbouring countries. The impact of the reassignment of II codes for two MSSRs from II Code 14 to other II Codes was analysed, and proved that there was a significant impact on the radar with the same II code in the same coverage area. The paper also listed the possible incompatibility of II code allocation between Indonesia and neighbouring countries. This showed the need of urgency for coordination of II code in the Region to resolve and move forward for further implementation of Mode S. States were encouraged to report in full to the ICAO APAC Regional Office for their implementation of Mode S II/SI codes, such that meaningful calculation and coordination could be done via Frequency Finder for the Region.

Research on the Mixed Operation of Mode S Radar Codes II and SI

3.16. China shared information about their progress of Mode S radar from II codes operation to II and SI codes mixed operation. China planned to change a part of radars to SI codes, and set an interrogator strategy of roll-call non-lockout or intermittent lockout commands for the Non-SI transponder. To promote the II codes and SI codes mixed operation effectively, China would conduct the tasks including a centralized allocation of IC codes in China; research and test of II codes and SI codes mixed operation; and preparation and issuance of relevant management documents to comprehensively promote the implementation of II codes and SI codes mixed operation.

Capacity for SSR Mode S II or SI Code Assignments in APAC

3.17. This paper presented a preliminary assessment of the future capacity for SSR MODE S II or SI code assignments in the APAC region with the current data in the Frequency Finder Surveillance Module (FFSurvm). The number of possible Mode S II Code assignable was denoted with different colours – white, red, orange, yellow, green and black for 0, 1, 2, 3, 4+ and all 15 assignable II codes respectively. An overview of this raster was given in Fig.1 below, which showed that three main areas in APAC identified to be difficult or impossible to implement new SSR Mode S radar facilities, either operating with Mode S II codes or Mode S SI codes: (a) Afghanistan/Pakistan (b) Malaysia/Singapore/Indonesia, and (c) Republic of Korea/Japan.

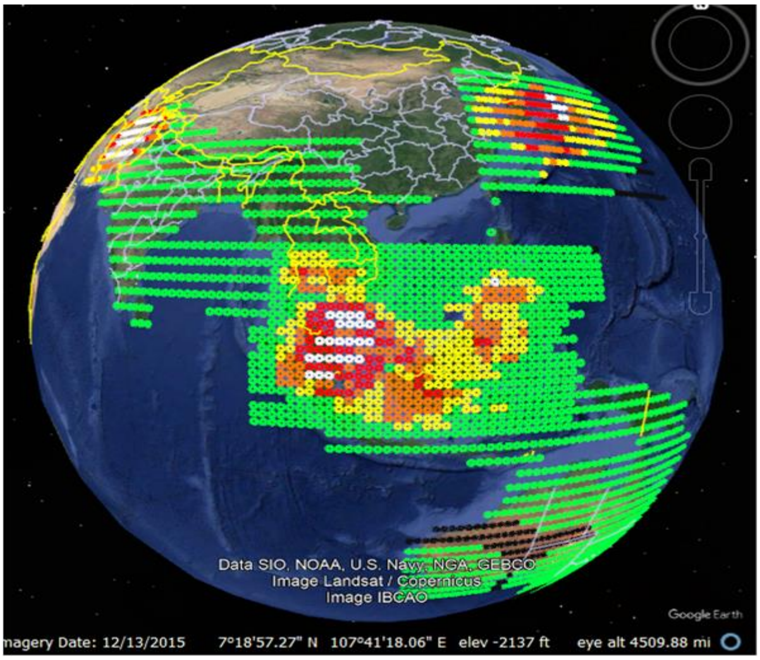

Fig 1. Graphic assessment result of assignable II codes in APAC

Review Roadmap on Mode S Implementation for APAC Region

General Strategy on Migration to SI code

3.18. The paper discussed the general strategy for the assignment of and migration to SI codes. After the meeting deliberated on the proposal, the detailed general strategy for the assignment of and migration to SI codes was summarized as follows:

I. General strategy for the assignment of SI codes

a) The ICAO APAC regional office will assign SSR Mode S II or Mode S SI codes in accordance with the planning criteria in *Appendix A of the paper*, at the same time ensuring support for Mode S II-only transponders.

b) The ICAO APAC regional office will only assign an SI code if the radar can support II/SI code operations.

c) The ICAO APAC regional office will only assign an SI code to radars having overlapping coverage with another radar using “matching” II code when the radar using “matching” II code can support II/SI code operations.

d) The ICAO APAC Regional Office will assume that the designated operating coverage is the same as the lockout coverage. There will be a 5NM buffer between the coverages of two radars using the same II or SI code. States can, as necessary, select a lockout coverage that is smaller than the Designated Operational Coverage.

e) The ICAO APAC regional office will generally avoid assigning II 14 and 15 (and their matching SI codes) to new radars.

II. General strategy for the migration to SI codes

a) States with Mode S radars that can support II/SI code operation are encouraged to coordinate with the ICAO APAC Office to assign or re-assign SI codes to these radars.

b) The ICAO APAC Regional Office may also approach certain States to start migrating to SI codes.

3.19. Subsequently, the following Draft Conclusion endorsed in Mode S and DAPs WG/6 was reviewed and endorsed by SURICG/8 as follows. As the strategy will involve coordination with neighbouring regions and require high-level support from CAAs/ANSPs in the region, the meeting considered it appropriate to seek further endorsement from CNS Sub-Group and/or APANPIRG.

Draft Conclusion SURICG/8/1 *(Mode S and DAPs WG/6/1)*: **General Strategy on Assignment of and Migration to SI Code in the APAC Region**	
What: The General Strategy on Assignment of and Migration to SI Code in the APAC Region provided in **Appendix A** of this Report be adopted.	Expected impact: ☐ Political / Global ☒ Inter-regional ☐ Economic ☐ Environmental ☒ Ops/Technical
Why: To synchronize the APAC region on the general principles applied for assignment of and migration to SI codes.	Follow-up: ☐Required from States
When: 1-Sep-23	Status: Draft to be adopted by PIRG
Who: ☒Sub groups ☒APAC States ☒ICAO APAC RO ☐ICAO HQ ☐Other: -	

<u>Review Guidance Material of implementation of Mode S DAPs</u>

Updates to the Mode S DAPs Implementation and Operations Guidance Document

3.20. China proposed the revised draft of Edition 5.0 of the Mode S DAPs Implementation and Operations Guidance Document, developed based on the adopted Edition 4.0. The revised draft supplemented the guidance material on the following topics:

a) Add a new section 4.1 to illustrate the Mode S downlink format in section 4;
b) Add a new section 7.3.7 to introduce the error protection in section 7.3;
c) Supplement the description of the implementation of Selected Altitude in section 7.5.1;
d) Add a new section 9.6 to give the application of ADS-B DAPs for GPS interference identification in section 9; and
e) Add a newly identified issue in Appendix 2.

3.21. Subsequently, the following Draft Conclusion endorsed in Mode S and DAPs WG/6 was discussed and endorsed by SURICG/8:

Draft Conclusion SURICG/8/2 *(Mode S and DAPs WG/6/2)*: **Mode S DAPs IGD Edition 5.0**	
What: The Mode S DAPs Implementation and Operation Guidance Document Edition 5.0 provided in **Appendix B** of this Report be adopted	Expected impact: ☐ Political / Global ☐ Inter-regional ☐ Economic ☐ Environmental ☒ Ops/Technical
Why: Inclusion of new/supplementary content discussed in Mode S and DAPs WG/6.	Follow-up: ☐Required from States
When: 1-Sep-23	Status: Draft to be adopted by Subgroup
Who: ☒Sub groups ☒APAC States ☒ICAO APAC RO ☐ICAO HQ ☐Other: -	

<u>Review the ToR, future work programme, Action Items and any other business</u>

A GNSS Interference Detection Algorithm Based on Machine Learning

3.22. China presented a novel approach for identifying ADS-B signal interference based on a multi-dimensional evaluation system constructed using multi-variate logistic regression, then by central limit theorem to construct a regional interference index. This work builds upon their previous research in the area and offers a promising approach to detecting and mitigating ADS-B signal interference. The results of their experiments and analyses demonstrate the effectiveness and potential of using machine learning methods to improve the detection of GNSS interference and enhance aviation safety.

Establish Point of Contact List for Mode S and DAPs Matters

3.23. The need for coordination on Mode S and DAPs-related matters between the ICAO APAC Regional Office and APAC States/Administrations was identified in SURICG/7. Secretariat thus proposed the establishment of such point of contact (POC) list for the efficiency and effectiveness of the coordination. The meeting was reminded of Conclusion *APANPIRG/32/8: Interrogator Code (IC) Planning and Coordination* in December 2021 regarding the Coordination Process for SSR Mode S IC. To effectively address such coordination process, States were invited to provide information on POCs. The updated POC List by SURICG/8 is provided in **Appendix C** of this Report.

Achievement and future of Mode S and DAPs WG

3.24. The paper reviewed the background of setting up this Working Group, including the renaming to Mode S *and* DAPs Working Group to better reflect the work done. Besides, this paper summarized the major achievements of this Working Group as follows:

a) Published the Mode S DAPs Implementation and Operations Guidance Document;
b) Published the Mode S Road Map for Asia Pacific;
c) Presented research and development activities;
d) Discussed the need for planning of II/SI code assignment;
e) Encouraged enhanced Mode S forward fit;
f) Shared the experience in radar;
g) Streamlined SAC code monitoring and published SAC in EUROCONTROL website;
h) Conservation of 1090MHz bandwidth including guidance materials on 1030/1090MHz frequency occupancy measurement; and
i) System monitoring and problem reporting.

3.25. The working group has achieved the objective that it was set up for. To conserve resources, the paper suggested the meeting might consider closing this working group, with the outstanding action items be transferred to the SURICG. China supported of continuing the discussion of Mode S and DAPs topics via incorporating ToRs to SURICG. The Secretariat mentioned that the additional scope on for Mode S and DAPs issue might add another day to the SURICG meeting.

Review of Terms of Reference

3.26. With the discussion of achievement of Mode S and DAPs WG provided in WP/06 that to conserve resources, and considering most of the ToR had been completed or already in the process of completion by this Working Group and/or by Surveillance Panel, Co-Chairs of the meeting proposed that the remaining tasks of this WG could be transferred under SURICG and thus of the view that this WG was able to dissolve. In such connection, the following Decision was discussed and endorsed by SURICG/8:

Decision SURICG/8/3 *(Mode S and DAPs WG/6/3)*: **Dissolution of Mode S and DAPs Working Group**	
What:	Expected impact:

Noting that most of the tasks outlined in the ToR have been completed/are in process of completion, the remaining action items will be performed by SURICG. That, the Mode S and DAPs Working Group be dissolved.			☐ Political /Global ☐ Inter-regional ☐ Economic ☐ Environmental ☒ Ops/Technical
Why: From discussion outcome in Mode S and DAPs WG/6 meeting.		Follow-up: ☐Required from States	
When: 9-Jun-23		Status: Adopted by SURICG	
Who: ☐ Sub groups ☐ APAC States ☐ICAO APAC RO ☐ICAO HQ ☐ Other: -			

Review of Action List - Secretariat

3.27. The Secretariat invited the meeting to review the action items. The updated Action Items List is provided in **Appendix D** of this Report, which will be incorporated into the Action Items of SURICG in its 9th meeting in 2023. **ACTION ITEM 8-2**

Review of Mode S Implementation Status in the APAC Region

3.28. The Secretariat invited the meeting to review the Mode S implementation status in APAC. The updated status from SURICG/8 is provided in **Appendix E** of this Report.

Simplified explanation of II/SI code operations - chair of DAPs WG (Presentation/01)

3.29. This presentation illustrated a simplified explanation of II-SI code operations, with an introduction of radar and Mode S working principles, radar identifiers, mechanism of all-call and roll-call in consideration of different II/SI capabilities of transponders, and the general strategy of migrating from using II to SI. For details, the meeting was invited to refer to Doc9924 Appendices H and J.

Agenda Item 4: Review Report of SURSG/3 Meeting

Review of Outcome of the Third Meeting of the Surveillance Study Group (SURSG/3) – Sec (WP/04)

4.1 The Third Meeting of the Surveillance Study Group (SURSG/3) was held in Hong Kong, China, as a hybrid Meeting (In-Person and Virtual Participation) from 22 to 24 March 2023. The meeting report, working papers, information papers, and other resources can be accessed by following link:

https://www.icao.int/APAC/Meetings/Pages/2023-SURSG-3.aspx

Review of Work Plan for Surveillance Study Group

4.2 The paper reviewed and shared recommendations on the Surveillance Study Group Work Plan in view of the progress and development following SURSG/2 held in March 2022. Considering the planned Joint Event for Surveillance Data Sharing in the SWIM Trial and SWIM Over CRV Demonstration (Demo) and the progress of the current Work Plan, the SURSG/3 meeting reviewed the changes proposed to Items 3-2, 4, 4-1 & 4.2 of the Work Plan.

4.3 In accordance with the proposed and agreed changes in WP/11, it was discussed and agreed that description of Task 4 (on Guidance Material) would be elaborated to include the incorporation of a section of technical and operational considerations as reference for the preparation of multilateral agreement for states/parties intending to share surveillance data and the elaborated text is to be discussed at the next SURSG Meeting. The modified SURSG work plan has been further approved by the SURSG/3 meeting.

Outcomes of the Kick-off Meeting of the Surveillance Sharing in SWIM (System Wide Information Management) Trial Implementation Group (S3TIG)

4.4 The paper summarized the outcomes of the Kick-off Meeting of Surveillance Sharing in SWIM (System Wide Information Management) Trial Implementation Group (S3TIG) held on December 6, 2022, via Video Tele Conference (VTC).

Business Models for Joining the S3TIG Trial

4.5 PCCWG presented proposals on how ANSPs can participate in the upcoming S3TIG Trial, including the CRV connectivity requirements, surveillance data sharing demonstration, and scenario-based demonstration. The SURSG/3 meeting was invited to share the number of Member States which will participate in the Trial and discuss the scope of the Trial for the commercial and technical arrangement. The SURSG/3 meeting shared the need to explore other options to join the Trial/demo by States/Administrations having no CRV connectivity. Additionally, further deliberations were required about the cost implication for States having CRV connectivity but no spare bandwidth to share for the Trial/demo. It was agreed that S3TIG will incorporate this discussion into the agenda item while preparing the Survey questionnaire.

A Joint Event for Surveillance Data Sharing in SWIM Trial and SWIM over CRV Demonstration

4.6 Hong Kong China proposed combining the surveillance data sharing in the SWIM Trial under S3TIG ("the Trial") and the SWIM Demonstration over CRV under SWIM TF as a joint event for States' consideration. It was informed that the proposal on combing the two events would save effort in preparing similar network and system infrastructure for the Trial, demonstrate data exchange of different throughput and examine such bandwidth requirements on CRV, and enhance user experience with more types of SWIM services showcased. The SURSG/3 meeting endorsed that *the Trial* and *SWIM over CRV Demonstration* should be conducted as a Joint Event. However, it was discussed that the proposal needs to be agreed by SWIM TF meeting. The Seventh Meeting of System Wide Information Management Task Force (SWIM TF/7) held from 9 to 12 May 2023 agreed to conduct both events as a Joint Event.

Trial of Surveillance Data Sharing Using SWIM

4.7 Hong Kong, China presented the proposal on the items to be demonstrated in the Trial of the surveillance data sharing using SWIM under S3TIG for States' consideration. The Trial was proposed to be conducted as a demonstration event followed by an evaluation period of about three months, subject to discussion in S3TIG. The SURSG/3 meeting noted that with live surveillance data sharing being realized among participating States in the Trial, the practicality and technology in surveillance data sharing using SWIM could be shown to the audience. In addition, a scenario-based demonstration and other SWIM capabilities proposed to be demonstrated in the Event were also shared.

Survey for Expression of Interest (EOI) in participating in Demo/Trial of S3TIG

4.8 The SURSG/3 meeting deliberated the proposed questions for Expression of Interest (EOI) in participating in the Joint Event of S3TIG and reviewed the S3TIG Joint Event Tentative Timelines. The SURSG/3 meeting agreed that the S3TIG will amend the questionnaire and prepare supporting documents containing useful information such as definitions of various terms used in the questionnaire to clear potential doubts of Member States/Administrations responding to the survey and any other necessary modifications. The questionnaire will be a composite survey with 2 separate sets of questions respective for the Trial and SWIM over CRV Demonstration (Demo). The SURSG/3 meeting also agreed that the Survey will be shared with States/Administrations only, not involving any other parties, after SWIM TF/7 endorsement. The S3TIG will draft a formal package/agreement to participate in the Joint Event by Member States/Administrations to be shared with interested States/Administrations after the outcomes of the Survey are processed, analyzed, and interested Members to participate in the Demo/Trial are identified.

4.9 The tentative timelines to conduct the Trial and/or Demo were as follows:

Task	Responsible Parties	Tentative Timelines/Deadlines
Finalization of Survey Questionnaire	SURSG/3 and S3TIG Participants, Led by HK China, Thailand, and Singapore	28 April 2023
Sharing Survey with APAC Member States	ICAO Secretariat	19 May 2023 (4 weeks will be provided to States to respond)
Submission of response and States and possible extension of Survey	All Interested APAC States	23 June 2023
Compilation of Response to Survey	ICAO Secretariat SURSG/S3TIG Chairs/Leads	30 June 2023
Sharing formal package with agreed Parties to participate in Demo and/or Trial	Agreed Parties and Host State (Hong Kong China)	July 2023 (1 Month will be provided to States to respond)
Working-level preparatory Meetings (online/in-person)	Lead and Deputy Lead, agreed Parties	Mid-August 2023 – October 2023
Trial/Demo	Agreed Parties and Host State (Hong Kong China)	November 2023 (Worst case scenario: Q1 2024)
Report on Demo	Lead and Deputy Lead	SURSG/4

4.10 The abovementioned discussions were performed in the SWIM TF/7 held from 9 to 12 May 2023. The SWIM TF/7 Meeting noted that pseudo CRV will be used as the network infrastructure for the Demo/Trial and the ATFM scenario, based on the ASEAN Demonstration, will be refined and enriched to be used in the Demo, which is considered a suitable use case to demonstrate the operational benefits brought by SWIM. The SWIM TF/7 Meeting also noted that S3TIG is conducting a survey to gauge States' interest in participating in the joint event.

4.11 Reviewed, modified, and agreed by SWIM TF/7, the survey questionnaire has been circulated through ICAO APAC State Letter Ref.: T 8/13.1: AP071/23 (CNS) with Subject – *Survey on a Joint Event of SWIM over CRV Demonstration ("the Demo") and Surveillance Data Sharing in SWIM Trial ("the Trial")* on 16 May 2023, which expected Member States/Administrations to submit the completed Survey preferably not later than 12 June 2023.

Data Format for Surveillance Data Sharing

4.12 Hong Kong China presented the proposal on the data format to be exchanged in the Trial of the surveillance data sharing using SWIM under S3TIG for States' consideration. As a recommendation from the Study Report delivered under SURSG, the Trial to be conducted under S3TIG would adopt the ADS-B CAT 21 Version 2.1 data format to support ATFM operation.

4.13 The paper compared the pros and cons of using FIXM, JSON, and original ASTERIX data and suggested that using the original ASTERIX data format as the payload for SWIM data exchange would be a preferred option. Based on the ASEAN Demonstration, the AMQP headers were proposed for carrying the surveillance data payload.

State of SWIM implementation in Singapore and readiness to share ADS-B data

4.14 Singapore presented the progress of SWIM implementation in Singapore and its impact on the sharing of surveillance information, specifically ADS-B data from the Singapore ADS-B sensor. With introducing its plan for upgrading the SWIM infrastructure, Singapore shared its intention to publish the ADS-B data from the Singapore ADS-B sensor for consumption by approved parties as an ASTERIX-based JSON formatted message similar to the current ADS-B service in the Singapore SWIM is provisioned.

4.15 Considering the format for ADS-B data sharing has not yet been decided, Singapore proposed that the Meeting direct the S3TIG group to deliberate on this matter and consider the appropriate message format to facilitate ADS-B data exchange. It was agreed that S3TIG will discuss the requirements of the question related to the preferred data format to add in the survey questionnaire. S3TIG will further deliberate on this topic of interest and priority and propose data format(s) for the Trial and Demo.

Benefits of Surveillance Data Sharing for MET Information Services in SWIM

4.16 Hong Kong China presented how future MET information services could be enhanced using the surveillance data shared in SWIM. The Meeting noted that MET information to be exchanged in SWIM includes ICAO Meteorological Information Exchange Model (IWXXM) messages, gridded products, and imagery. Additionally, the benefits of surveillance data for MET information services to ANSP and airlines were elaborated. The SURSG/3 meeting agreed to explore the possibility to include the elements and proposed applications in the paper for demonstration in the proposed Joint Event. The S3TIG will consider the feasibility to incorporate the demonstrations proposed in the paper in the planned Joint Event.

Review ToR and Action Items List

4.17 The paper presented the current ToR of SURSG and S3TIG and the Action item list of SURSG Meetings for SURSG/3 Meeting review and update. The SURSG/3 Meeting noted that there was no need to update the ToR of both groups and the Action Items list was discussed and updated by the SURSG/3 Meeting.

Date and Venue for the Next Meeting

4.18 The SURSG/3 Meeting decided that further Meetings of S3TIG would be conducted in Virtual mode until the need for In- Person Meetings arises. The SURSG/3 Meeting agreed that the next Study Group Meeting would be In-Person after the successful completion of the Joint Trial/Demo Event.

4.19 The SURICG/8 meeting was updated that since Hong Kong China may consider hosting other ICAO events at the end of 2023, the exact date of the Joint Trial/Demo Event would be further coordinated with ICAO Secretariat.

Agenda Item 5: Review of regional requirements for Surveillance in the e-ANP, Seamless ANS Plan and the reported implementation status

a) Outcome for survey on APAC Surveillance and DCPC Coverage

ATS Surveillance and Direct Controller and Pilot Communication VHF Coverage Charts for APAC Region – Hong Kong China and Thailand (WP/05)

5.1 The work and progress of updating the coverage charts of ATS Surveillance and Direct Controller and Pilot Communication (DCPC) VHF for APAC Region were discussed and expected to be incorporated in the next update of the APAC Seamless ANS Plan. The ICAO APAC Regional Office issued the State Letter AP027/22 (CNS) in February 2022 for States/Administrations to respond to the survey. With great assistance from Thailand, coverage charts on DCPC VHF and ATS Surveillance have been produced with highlights of changes discussed in the Meeting. The Meeting noted the discussion in CNS SG/26 to include the updated charts in the next update of Seamless ANS Plan. States/Administrations were encouraged to work with appropriate parties and/or other States/Administrations to derive plans in addressing the coverage gaps identified in the coverage charts, and States/Administrations which have not yet responded to the survey were encouraged to contribute relevant information to complete the coverage charts in future updates. It was added that both surveillance and DCPC VHF coverage of the survey are specified to be at FL290.

5.2 The updated charts are provided in Fig.2 and Fig.3 below.

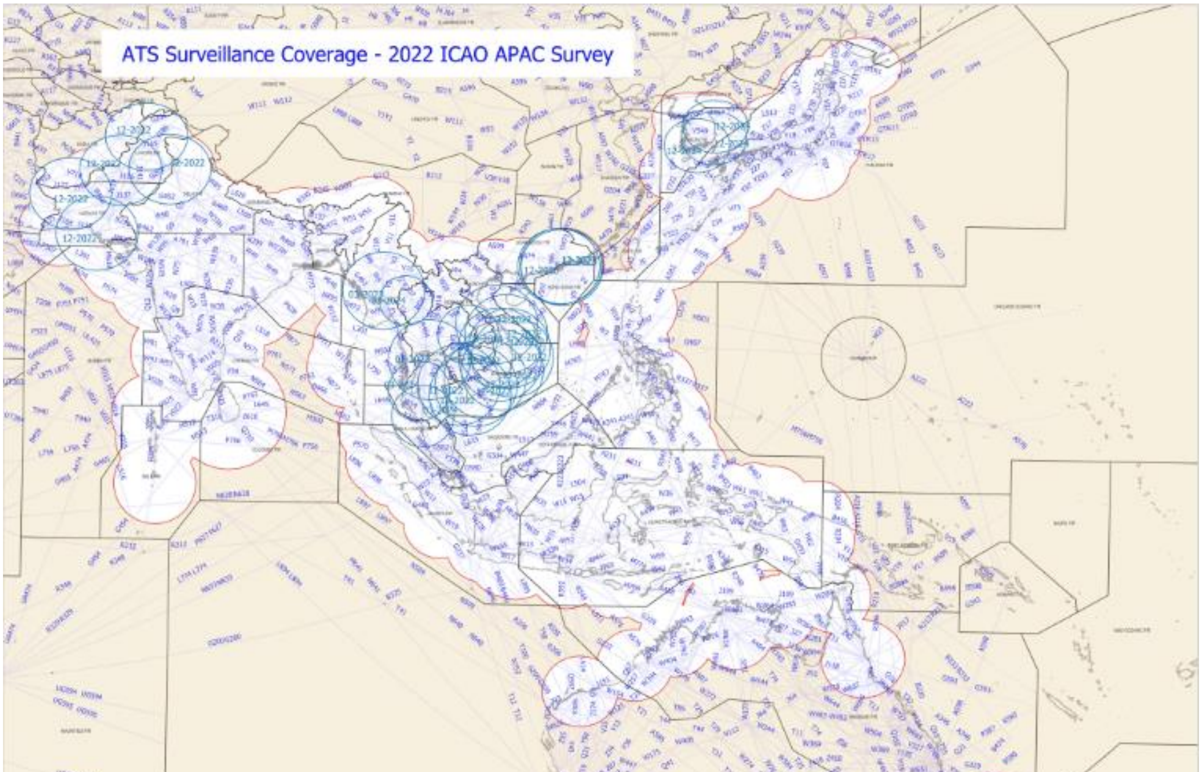

Fig 2. Updated ATS Surveillance Coverage

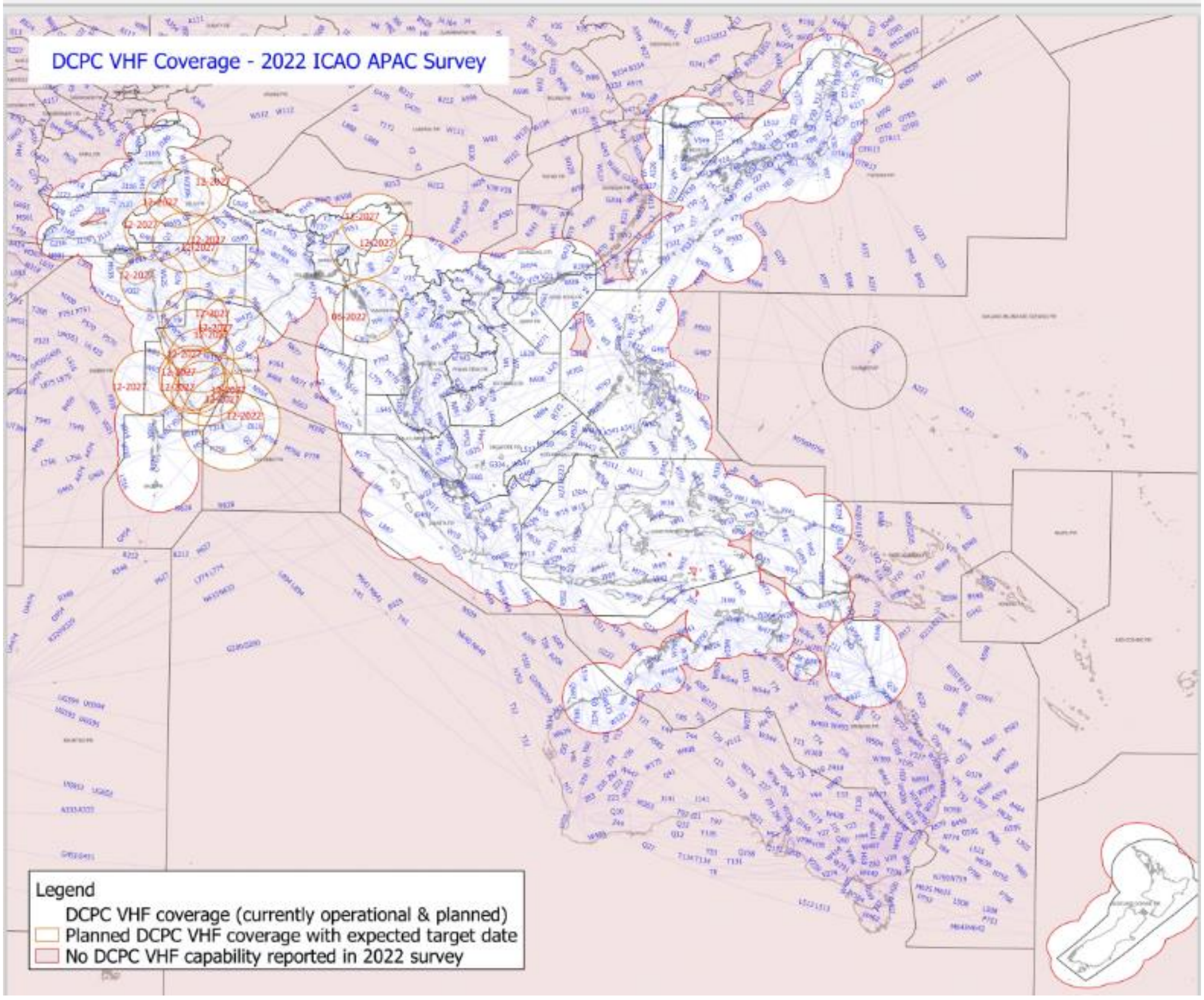

Fig 3. Updated DCPC VHF Coverage

b) Review Table CNS II-APAC-3 in APAC e-ANP Volume II

Review Regional Surveillance Requirements - Sec (WP/06)

5.3 The paper reviewed regional requirements specified in Table CNS II-APAC-3 in APAC e-ANP Volume II. The meeting noted that e-ANP Volume II contains the General Regional Requirements and Specific Regional Requirements related to CNS from Member States. As such, Member States are encouraged to review all facilities listed in Table CNS II-APAC-3 SURVEILLANCE under the Specific Regional Requirements in e-ANP Volume II, and provide update to ICAO APAC Regional Office as necessary through the PfA Process. The proposed changes to e-ANP Volume II Table CNS II-APAC-3 SURVEILLANCE have been incorporated in **Appendix F** to this Report, the Secretariat and the concerned Member States are requested to formally update the e-ANP Volume II Table CNS II-APAC-3 SURVEILLANCE in due course at earliest convenience. **ACTION ITEM 8-3**

Review/update Surveillance Implementation Status - Sec

5.4 The meeting reviewed the ADS-B implementation information consolidated the input from States/Administrations in the Table of ADS-B Implementation Status in the APAC Region, and further updated this table which is provided in **Appendix G** of this Report.

Agenda Item 6: Review implementation and co-ordination activities and sub-regional implementation plans

a) Progress on ADS-B planning and implementation – Bay of Bengal (BOB)
b) Progress on ADS-B planning and implementation – South East Asia (SEA)

6.1. The meeting reviewed the reports on the Sub-regional ADS-B implementation plan/projects presented by BOB and SEA Ad Hoc working groups which were led by Indonesia and Singapore respectively. The reports updated by BOB and SEA Ad Hoc groups are provided in **Appendix H and I** to this Report which could serve as a basis for further development of the sub-regional implementation plans and follow-up actions for coordination by States/Administrations.

6.2. Co-Chair expressed appreciation to all participating States for their efforts paid to the good progress of ADS-B implementation and data sharing projects in States/Administrations. The ICAO Secretariat also thanked Indonesia and Singapore for rapporteuring the ad-hoc working groups.

c) Updates by other States

6.3. There is no paper under this sub-Agenda Item.

d) Discuss progress on data sharing projects among States

6.4. The meeting reviewed the updated table on ADS-B Data Sharing Implementation Status which States and Administrations provided their updates during the ad-hoc working group sessions. The updated table is provided in **Appendix J** of this Report.

Agenda Item 7: Report on surveillance ground system and avionics performance monitoring and improvement in compliance

ADS-B Equipage and Quality Performance Observed in the U.S. (IP/04)

7.1 The paper provided an updated summary of observed NIC/NACp performance for air carrier aircraft compared to the requirements of the U.S. ADS-B mandate, as well as ADS-B equipage trends in the U.S based on the data derived from the ADS-B Performance Monitor (APM) tool which has various capabilities to support the analysis. During the most recent two-month analysis window ending on 9 April 2023 for the full airspace shown in Attachment 1 of the paper, just over 30% (2,895 out of 9,493) of the observed air carrier aircraft were registered outside the U.S.

7.2 In response to the inquiry about the ADS-B In equipage ratio for passenger jets in US, the meeting was informed that it was reported as 10-15%, however, the actual number would be slightly lower (around 10%).

Recent ADS-B Avionics Issues in the United States (IP/05)

7.3 FAA monitors all ADS-B information received in all airspace covered by FAA-contracted ADS-B ground stations via a tool called the ADS-B Performance Monitor (APM).The paper provided a description of recent ADS-B avionics issues observed in the U.S. with DO-260B/ED-102A (1090ES Version 2) systems via the APM, including Collins Aerospace TDR-94/94D issue and Honeywell Primus II RCZ issue, as well as the latest update.

A Method for Assessing RF Interference between PSR Radars in an Airport Area – ROK (IP/08)

7.4 PSR could be a source of RF interference at the airport area because of the highest radiation power with sensitive receiver. The paper presented a case study of PSR interference at the Incheon airport with related technical information and final solution with reference to ITU-R Recommendation M.1464, as there is no ICAO guidance on the optimal location and frequency separation of PSRs in the same airport, and various limitations are observed for radar receiver characteristics and opinions by radar manufacturer. ROK successfully introduced “the simplified M.1464 procedures” to solve this issue at Incheon Airport where the Shinbul A (installed in 2000) and Shinbul B radar (installed in 2017) are 167 meters away, with the new band pass filter designed and adapted to the Shinbul B radar. Now, two PSRs (Shinbul A&B) are fully operational at the same time without affecting another radar. ANSPs are suggested to use “the simplified M.1464 procedures” to determine the potential interference between PSRs before starting the radar project.

7.5 The Secretariat clarified that the ICAO DOC 9718 Vol II mainly looks into the frequency assignment planning criteria for aeronautical spectrum, as such, PSR would not be included in this DOC.

Preliminary Analysis of ADS-B Positional Performance in Japan (IP/10)

7.6 The Japan Civil Aviation Bureau (JCAB) plans to use ADS-B for ATC operations and is evaluating ADS-B performance. ADS-B (version 2) positional performances (NIC and NACp) were analyzed for the data collected every January from 2017 through 2022 in the vicinity of Sendai airport. The percentages of aircraft equipped with ADS-B version 2 increased from 22% in January 2017 to 72% in January 2022. The NIC values of 99.95% of positional data exceeded 6. The NACp values exceeded 7 for 99.90%. JCAB analyzed the positional performance of the surface positional data alone to assess the effect of the airport surface and buildings. Further analyses will be performed to investigate the causes of positional performance degradation.

Factors Affecting Performance of ADS-B Position Verification by TDOA – Japan (IP/12)

7.7 TDOA is an effective approach to detect false ADS-B positions. The paper reported a numerical simulation on average performance via theoretical calculation under various conditions, which revealed that TDOA accuracy and receiver position (sufficient separation between the two receivers) are important for a better performance.

1030/1090MHZ Occupancy Monitoring and Evaluation Project in Japan (IP/15)

7.8 Japan Civil Aviation Bureau (JCAB) established the Network Performance Assessment Center (NPAC) in 2020 for the mission of centralized monitoring, analyzing and assessing the service levels as the core of CNS performance management to support Performance Based Operation (PBO). NPAC surveillance team started 1030/1090MHz Occupancy Monitoring evaluation project in 2023 with the technology transferred by Electronic Navigation Research Institute (ENRI). The measurement procedure for this monitoring is in accordance with Doc9924 Aeronautical Surveillance Manual, which is described in Appendix M 13.3.7.1.1 Method1.

7.9 JCAB used flight inspection aircraft to acquire the data, including positional information and RF data which are analyzed and compiled by NPAC. The analysis tool is developed on LabVIEW software. The actual analysis results in Nagoya area showed that the occupancy rate is about 2%. NPAC is going to coordinate data collection with flight inspection team so as to evaluate congested airspace such as Tokyo for a long period of time and regularly.

7.10 The meeting discussed and was further informed by Japan that the acceptable occupancy rate should be below 8%.

A Radar Data Quality Monitoring Tool – China (IP/17)

7.11 The paper introduced a tool aiming to monitor and analyze radar data quality accessed by ATMAS to ensure that the radar data meets the ATMAS requirement by using quality indicator extracted from radar data, and discussed the difficulty of identifying false information. The meeting noted that metrics used in the tool refer to the minimal set of performance parameters proposed by SURICG/7 WP12 from China, and combine the metrics that must be paid attention to in the equipment operation and maintenance work. The data quality metrics monitored by the system and the difficulty of false information identification were further explained. It was suggested that the RSUR working group will provide the judgment method of the false information and provide the specific calculation method of the relevant metrics.

The Implementation of Optimization and Improvement of ADS-B Application in China (IP/18)

7.12 The paper presented the follow-up implementation progress of 'the Study on Optimization and Improvement of ADS-B Application' submitted by China on SURICG/7, and mainly introduced the nationwide optimization and improvement scheme, effects after adjustment, and the plans for the next stage. In the first half of 2022, ATMB CAAC formulated a national implementation scheme for optimization and adjustment of ADS-B application, which is used to guide and standardize the whole-chain-adjustment including ADS-B ground stations, data processing centers and ATM automation systems. The details of the Scheme, including equipment, contents, sequence, and timeline, together with the summary of effects after adjustment were further introduced. After data quality analysis at the beginning of 2023, it was found that a few ADS-B data items can still be further optimized, and the further optimized ADS-B data will not only meet the operation requirements of ADS-B but also further improve the processing efficiency of the ADS-B ground stations.

Aircraft Parameters Availability in Mode S DAPs and ADS-B ADD – China (IP/20)

7.13 The paper presented aircraft downlink parameters in Mode S DAPs and ADS-B Aircraft Derived Data (ADD), and introduced the study which has been conducted in China to confirm which parameters are available at present. In the study, based on the data collected from 1763 aircraft's in 2018 and 2289 aircraft in 2023, the capable percentage regarding the different parameters in Mode S DAPs and ADS-B ADD were summarized respectively. It was also noted that as the ADS-B V2 installation proportion grows, the available percentage of some ADS-B ADD will grow substantially.

7.14 The meeting appreciated China for sharing the results of the research which would be a good reference for States who would like to utilize the available ADS-B ADD for innovative application.

Agenda Item 8: Update on surveillance activities and explore potential cooperation opportunity

a) States/Administrations

Surveillance Activities in Singapore (IP/02)

8.1 The paper summarized the Surveillance activities in Singapore regarding radars, A-SMGCS, ADS-B, ADS-C/CPDLC, and highlighted the use of Mode S Downlinked Aircraft Parameters (DAPS) in the ATM automation system. Furthermore, the requirements for ADS-B out exclusive airspace and Airport Surface were elaborated, and the results of the study on the equipage status of Singapore registered operators that an increase in the number of DO-260B equipped aircraft were shared.

8.2 In response to a query, the meeting was informed that Space-based ADS-B is used as an additional surveillance source to enhance surveillance coverage and overall situation awareness, which has not been used for separation.

Revisions to FAA Advisory Circular (AC) 90-114, ADS-B Operations – USA (IP/03)

8.3 The requirements for ADS-B in the U.S. are contained in two regulations: Title 14 of the U.S. Code of Federal Regulations §§ 91.225 and 91.227. FAA publishes Advisory Circular (AC) 90-114, Automatic Dependent Surveillance-Broadcast Operations to provide guidance to operators on how to comply with those regulations. The paper summarised the most significant revisions and new guidance included in FAA Advisory Circular (AC) 90-114B Change 1, ADS-B Operations, which covered No Services Aircraft List (NSAL), Non-Performing Emitter (NPE) Notification, Fleet Report Avionics Trend Analysis Tool (ATAT), Pre-flight requirements and an entirely new Appendix F Interval Management (IM). For a complete understanding of new and revised policy, refer to AC 90-114B CHG 1 (faa.gov), which was published on December 15, 2022.

8.4 The meeting was informed that the NSAL is regularly shared to ICAO HQ and EUROCONTROL in the interest of promoting aviation safety, FAA will add ICAO APAC Office to this monthly update of the NSAL for potential use by ANSPs and State regulators in the region.

ADS-B In Retrofit Spacing (AIRS) Evaluation Project Update – USA (IP/06)

8.5 This paper provided an update on the ADS-B In Retrofit Spacing (AIRS) evaluation project, a large-scale operational evaluation of ADS-B In applications that was the subject of SURICG/6-IP/08. The project engages the FAA with ACSS and American Airlines (AAL) in a public-private partnership to equip 288 AAL A321 aircraft with an ADS-B-In retrofit solution that supports Cockpit Display of Traffic Information (CDTI)-Assisted Visual Separation (CAVS) and Interval Management (IM) capabilities. Over 210 Initial Interval Management (I-IM) operations had been conducted in ZAB’s airspace as of 19 April 2023. Over 450 CDTI-Assisted Separation on Approach (CAS-A) operations have been conducted for KDFW arrivals as of 10 May-2023. The paper also shared the avionics certification progress for AAL, as well as the operational approval for CAVS, IM and CAS-A by FAA.

Update on Surveillance Activities in Thailand (IP/09)

8.6 The paper provided a summary update on the surveillance sensors and ATM automation system implementation in Thailand. The implementation statuses and plans for SSR Mode-S, PSR, MLAT, and ADS-B within Thailand have been introduced in detail. The meeting also noted that Thailand has transitioned to the new ATM automation systems nationwide since 2020, and implemented A-SMGCS Level 2 at Suvarnabhumi airport with a plan to implement A-SMGCS at other international airports by 2025.

Update on New Zealand Surveillance Status (IP/11)

8.7 The paper provided an update previous reports, providing information on New Zealand’s Air Traffic Management surveillance activities. The meeting noted that as of Dec 31st, 2022, New Zealand’s surveillance structure is based on ADS-B as the Primary surveillance source, with six MSSRS, and an MLAT system providing cooperative surveillance, and 3 PSRs providing non-cooperative backup where required. The MSSRs and PSR will be replaced by 3 new MSSR/PSR between 2023 and 2025 to provide a NON GNSS contingency to ADSB.

8.8 It was clarified that for safety and regulatory considerations New Zealand will continue to use PSR for those airport with “dense-complex airspace” (i.e. airspace with over 100,000 RPT movements a year).

ADS-B Implementation for Low-flying Traffic – Hong Kong, China (IP/13)

8.9 This paper outlined the status of ADS-B implementation for low-flying traffic within the territories of Hong Kong China after the mandate of ADS-B avionics was effective for locally registered low-flying aircraft on 31 January 2023. As some General Aviation (GA) and helicopters flying at low altitudes could not be covered by SSRs due to the mountainous terrain in the territories of Hong Kong China, ADS-B ground station network was introduced in 2013 and designed for air traffic surveillance of both en-route and low-flying aircraft. To verify the ADS-B low-level surveillance coverage, flight trials were conducted by a helicopter equipped with ADS-B test transponder flying at low altitude, and descending at some pre-selected locations by landing at helipads/aircraft bases, or performing low-level hovering over waters. Results showed that the low-level coverage of ADS-B is far better than that of SSRs with almost no target drops observed with a comparison of flight tracks between SSR and ADS-B provided in the paper. The implementation enhanced surveillance capabilities and situation awareness for both air traffic controllers and pilots of low-flying GA/helicopters, with high update rate and high positional accuracy for effective monitoring of low-flying GA/helicopters with frequent turning and altitude change, thus facilitating search and rescue operations of GA/helicopters and support subsequent aircraft incident/accident investigation.

Long-range Air Traffic Surveillance for Air Traffic Flow Management – Hong Kong, China (IP/14)

8.10 This paper presented the implementation of an in-house developed long-range air traffic surveillance display system using Space-based ADS-B to facilitate Air Traffic Flow Management (ATFM) operation in Hong Kong China by providing an air traffic overview to flow managers, thus enhancing their situational awareness and assisting them to assess the overall impacts of certain flow restriction imposed by other airspaces and assist in flow control decision making. While the display system was initially relying on terrestrial ADS-B data service for monitoring air traffic from "departure to destination". the long-range surveillance source was recently moved to a tailored Space-based ADS-B data service for allowing continuous surveillance coverage and removing limitations from terrestrial ADS-B data sources. Due to nearby airspaces being very busy, the original Space-based ADS-B data stream would be huge while only some portion of in-bound and overflight air traffic was related to the ATFM operation of Hong Kong China, the Space-based ADS-B data stream was customized to filter out flight movements not relevant to the ATFM operation of Hong Kong China. To allow such customization, Hong Kong China shared its flight plan data with the Space-based ADS-B provider via Aeronautical Fixed Telecommunication Network (AFTN), with Air Traffic Services Message Handling System (AMHS) forwarding a duplicated copy of the relevant AFTN messages to the address of the Space-based ADS-B provider. The long-range air traffic surveillance display system could be extended to assist in a more accurate estimation of FIR entry time of flights and integrate with the ATFM system.

ATC Surveillance Activities Update in Malaysia (IP/16)

8.11 The paper provided information on Air Traffic Surveillance activities in Malaysia, especially in Kuala Lumpur Flight Information Region (KL-FIR) and Kota Kinabalu Flight Information Region (KK-FIR), and also summarized the progress of the on-going and future projects related to ATC Surveillance activities.

Update the Action Plan for Surveillance in China (IP/19)

8.12 The paper presented the current status of the civil ATC surveillance business in China and the latest development, including the progress of ADS-B Application for ATC Operation, Mode S DAPs Implementation, II conflict Analysis and II/SI Mixed Operation, Radar Clustering, and A-SMGCS. The meeting noted CAAC has completed the Phase 2 of ADS-B ATC Operation to implement ADS-B control operation in the APP and ACC area without radar control ability, and implement Radar/ADS-B mixed control operation in the APP and ACC areas with Radar control ability. The integration and application of ADS-B data in China's ATM Automation System has increased from 65% at the end of 2019 to 92% at present. Additionally, CAAC will actively follow the ICAO APAC procedure to coordinate the allocation of II/SI codes with neighboring countries and regions.

8.13 The meeting appreciated China's and Singapore's contributions to the work of the Mode S and DAPs Working Group and regional Mode S DAPs implementation, and looked forward to continuing support from them to this SURICG in future.

Challenges Faced by Nepal in Implementing ADS-B Based Surveillance – Nepal (IP/21)

8.14 The paper presented challenges faced by Nepal in implementing ADS-B based surveillance in the VNSM FIR. Nepal has completed the installation of four ADS-B ground stations, which is intended not only to supplement the MSSR-based surveillance but also to extend the coverage in the far western region with NRA operations in the near future. However, to ensure compliance with the PANS-ATM procedures in 8.1.10 and 8.6.1.1, and 8.6.1.2 while implementing ADS-B based surveillance services is proving difficult as the onus of specifying the quality of information has been rested on the States (or appropriate ATS authority) without any accompanying technical guidance. Therefore, despite induction of ADS-B, Nepal has been unable to use it operationally for the provision of air traffic services- vectoring, separation- in order to realize efficient use of airspace. Nepal is willing to learn from the experience of other Member States who have successfully implemented ADS-B based surveillance in non-radar airspace (NRA).

8.15 The meeting suggested Nepal to make reference to the ADS-B Implementation and Operations Guidance Document (AIGD), which provides the guidance material for the planning, implementation and operational application of ADS-B technology in the Asia and Pacific Regions. If any further guidance/assistance is needed, Nepal can email ICAO Secretariat, and the Secretariat will coordinate/link with capable States/Administrations, such as Hong Kong China, Singapore, and New Zealand to share experiences with Nepal, and help to resolve the difficulties encountered. The meeting was informed that CNS SG/27 will also discuss the challenges faced by States/Administrations and provide a platform to whom have difficulties on implementing any technologies under its Agenda Item 11: Capacity Building.

b) Updates from ICAO Surveillance Panel, Standards Making Organization

ICAO Surveillance Panel Activities – Chair of ICAO SP (IP/07)

8.16 The paper described recent and planned activities of the ICAO Surveillance Panel, including the development of new guidance material containing performance-based surveillance requirements by Performance-Based Surveillance Sub-Group (PBSSG), the relevant outcomes of the Fourteenth Meeting of the Airborne Surveillance Working Group (AIRBWG) and the Sixteenth Meeting of the Aeronautical Surveillance Working Group (ASWG) held in Montreal at ICAO Headquarters, and the Fifteenth Meeting of the Airborne Surveillance Working Group (AIRBWG) and the Seventeenth Meeting of the Aeronautical Surveillance Working Group (ASWG) hosted by the Civil Aviation Authority of Singapore. The ongoing works by SP covered the Change Proposals (CPs) to the Manual on Airborne Surveillance Applications (Doc 9994), the PfA of Annex 10 Volume IV, the proposed Change Proposal for Doc 9871 Technical Provisions for Mode S Services and Extended Squitter, the Change Proposals for Doc 9924 Aeronautical Surveillance Manual, the PfA to Annex 10 Volume III, compatibility testing with LDACS (L-band Digital Aeronautical Communications System), surveillance material in Doc 9830 (A-SMGCS Manual).

8.17 The meeting was further informed that the new guidance material containing performance-based surveillance requirements with examples from States will be circulated to Member States for comments and released as ICAO documents. The meeting also encouraged States who are interested in aviation surveillance to nominate members to join and contribute to the Surveillance Panel consistently.

c) Aircraft Manufacturers and Avionics Suppliers

Creating Skies Together – Indra (Presentation/02)

8.18 Indra provided a brief introduction on the topic of creating skies together. The relevant technologies in Automation, Surveillance, Communications, Navigation, Drones, Information services were further presented.

Enhancing surveillance capability for a seamless sky through advanced surveillance solution - THALES (Presentation/03)

8.19 Thales shared the advance solutions regarding automation, traffic flow management, the deployment of UAS operations into the airspace, non radar surveillance, navigation aids, and civil radars.

Full situational awareness and accurate data to ensure aviation safety and operational readiness – Huawei (Presentation/04)

8.20 Huawei presented the full situational awareness and accurate data to ensure aviation safety and operational readiness. Noting that digital transformation in the Civil Aviation Industry has started, the technologies including the Cloud, 5G, optical, microwave, and digital platforms, which could build a solid foundation to support civil aviation digital transformation with full situational awareness for Safety & Operational Efficiency for Civil Aviation/ANSP, Airports and other Stakeholders, were shared.

Airbus Presentation – Laurent VIDAL (Presentation/05)

8.21 Airbus introduced the technologies equipped in the different models of Airbus aircrafts, including ADS-B OUT, ATSAW, CAVS, SURF-A, ACAS Xa.

Agenda Item 9: Review of the Terms of Reference (ToR) and the Action Items

ToR of SURICG and Action Items – Sec (WP/07)

9.1 The paper presented the Terms of Reference of the SURICG and its action items for review and update. Noting that Mode S and DAPs WG will be dissolved and its remaining tasks would be transferred to SURICG to follow up, the meeting was invited to review and update the ToR and actions items of SURICG to incorporate those remaining tasks and identify ways for SURICG to follow up.

9.2 The updated action items of SURICG which are provided in **Appendix K** to this Report.

Proposed Revision to ToR – Hong Kong China & Singapore (Flimsy01)

9.3 Hong Kong China and Singapore analyzed the ToR of Mode S and DAPs WG, and suggested a revised version of ToR of SURICG.

9.4 The meeting reviewed and adopted the revised ToR of SURICG which is provided in **Appendix L** to this Report, and formulated the following **Draft Decision** for CNS SG/27 consideration.

Draft Decision SURICG/8/4: Revised ToR of Surveillance Implementation Coordination Group (SURICG)

<table>
<tr><td colspan="2">What: That, the Revised Terms of Reference of the Surveillance Implementation Coordination Group (SURICG) provided in Appendix L to this Report be adopted.</td><td>Expected impact:
☐ Political /Global
☐ Inter-regional
☐ Economic
☐ Environmental
☒ Ops/Technical</td></tr>
<tr><td>Why: The ToR from dissolved Mode S and DAPs WG was reviewed and necessary updates were identified.</td><td colspan="2">Follow-up: ☐Required from States</td></tr>
<tr><td>When: 1-Sep-2023</td><td colspan="2">Status: Draft to be adopted by Subgroup</td></tr>
<tr><td colspan="3">Who:☒Sub groups ☐ APAC States ☐ICAO APAC RO ☐ICAO HQ ☐APANPIRG ☒ Other: SURICG</td></tr>
</table>

Agenda Item 10: Review ADS-B Implementation and Operations Guidance Document (AIGD)

10.1 Under this agenda, the meeting appreciated Hong Kong China for continuous support in updating the AIGD and agreed there are no additional updates from this meeting.

Agenda Item 11: Next Meeting and Any Other Business

Date and Venue for the Next Meeting

11.1 The meeting considered that the next SURICG meeting would be held for 4 days tentatively planned for April 2024. Exact dates and venue will be coordinated with States concerned and inform Member States in due course.

Note of appreciation

11.2 On behalf of the Group, Mr. Ho Wee Sin, Deputy Director (Info Air Traffic Management) of the Civil Aviation Authority of Singapore, Co-Chair of SURICG, expressed thankfulness to the ICAO APAC Regional Office, Chair and APAC Members of ICAO Surveillance Panel, Chairs of DAPs WG and SURSG, all participants from Member States/Administrations and international organizations for their significant progress in the Region and contributions in making the meeting a successful and fruitful one. The ICAO Secretariat expressed his gratitude for the continued support of experts in surveillance and industry partners for their assistance in organising ICAO Regional events, in particular, the sponsorship of the Meeting by CETC Glarun, Chinney, Huawei, Indra and THALES.

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List of Participants

		STATE/NAME	TITLE/ORGANIZATION	E-MAIL	ATTENDANCE	
1.		**AUSTRALIA (1)**			Workshop	Meeting
	1.	Mr. Adrian Shalley*	Senior Asset Engineer (Surveillance), Airservices	adrian.shalley@airservicesaustralia.com;	✓	✓
2.		**CHINA* (9)**				
	2.	Ms. Cao Susu	Senior Engineer, CNS Division, ATMB, CAAC	Caosusu_atmb@qq.com;	✓	✓
	3.	Mr. Zhao Xin	Engineer, Technical Centre of Air Traffic Management Bureau, CAAC	zhaox@atmb.net.cn;	✓	✓
	4.	Mr. Jiang Siwei	Assistant of CNS Division, North China Regional ATMB, CAAC	455211329@qq.com;	✓	✓
	5.	Mr. Chen Weiqing	Engineer, East China Regional, ATMB, CAAC	Cwq3545@163.com;	✓	✓
	6.	Mr. Zhang Jinwei	Engineer, East China Regional, ATMB, CAAC	Feman5656@126.com;	✓	✓
	7.	Mr. Yao Yuan	Assistant of CNS Division, Middle South ATMB, CAAC	yaoyuan@atmb.org;	✓	✓
	8.	Ms. Xu Jian	Assistant of CNS Division, Southwest China Regional ATMB, CAAC	390703257@qq.com;	✓	✓
	9.	Mr. Yang Bin	Assistant of CNS Division, Northwest China Regional ATMB, CAAC	674359088@qq.com;	✓	✓
	10.	Mr. Jin Kaiyan	Senior Engineer / Aviation Data Communication Corp. of ATMB CAAC	jinky@adcc.com.cn;	✓	✓
3.		**HONG KONG, CHINA (3)**				

	STATE/NAME		TITLE/ORGANIZATION	E-MAIL	ATTENDANCE	
	11.	Mr. MH HUI	Assistant Director-General of Civil Aviation (Air Traffic Engineering Services)	mhhui@cad.gov.hk;	✓	✓
	12.	Mr. Sze Lung How	Electronics Engineer, Civil Aviation Department of Hong Kong, China	dslhow@cad.gov.hk;	✓	✓
	13.	Mr. Anthony TSUI*	Senior Operations Officer, Civil Aviation Department of Hong Kong, China	ahktsui@cad.gov.hk;	✓	✓
4.		**MACAO, CHINA (1)**				
	14.	Mr. Veng Tong Lo	Senior Safety Officer (CNS), Civil Aviation Authority of Macao SAR	freemanlo@aacm.gov.mo;	✓	✓
5.		**FIJI (1)**				
	15.	Mr. ILIMELEKI NAVULA*	CONTROLLER STANDARDS/SAR - ATM, Fiji Airports	IlimelekiN@fijiairports.com.fj;	✓	✓
6.		**INDONESIA (6)**				
	16.	Ms. Mardiana	Air Navigation Inspector, DGCA INDONESIA	dhy_en@yahoo.com;	✓	✓
	17.	Mr. BUDI FATHONI	Air Navigation Inspector, DGCA INDONESIA, DIRECTORATE OF AIR NAVIGATION	bfathoni@yahoo.com;	✓	✓
	18.	Ms. Efryanti Efryanti	Inspector, Ministry of Transportation of Indonesia	efryantiyanti@yahoo.com;	✓	✓
	19.	Mr. MOHAMAD ALI SAID	Junior Manager Design of Surveillance and ATC Automation Facilities AirNAV Indonesia	mohamad.ali@airnavindonesia.co.id;	✓	✓

		STATE/NAME	TITLE/ORGANIZATION	E-MAIL	ATTENDANCE	
	20.	Mr. Bayu Dewangga*	Repair Specialist, AirNAV Indonesia Head Office	bayudewangga@gmail.com;	✓	✓
	21.	Mr. Dedy Iskandar*	ATM Facility Readiness, AirNAV Indonesia Head Office	Dedy.nav7@gmail.com;	✓	✓
7.		**JAPAN (10)***				
	22.	Mr. Junichi Honda	Researcher, ELECTRONIC NAVIGATION RESEARCH INSTITUTE	j-honda@enri.go.jp;	✓	✓
	23.	Mr. Kenji Uehara	Chief, CNS Planning Office, Japan Civil Aviation Bureau (JCAB)	uehara-k46qj@mlit.go.jp;	✓	✓
	24.	Mr. Nobutaka Kishi	Deputy Chief Air Nabigation Service Engineer, JCAB	kishi-n97vq@mlit.go.jp;	✓	✓
	25.	Mr. Fuchinoue Satoshi	Special Assistant to the Director, JCAB/JAPAN	futinoue-s46pu@mlit.go.jp;	✓	✓
	26.	Mr. OZEKI Shigeru	Technical Advisor, JRANSA	ozeki-s200@jransa.or.jp;	✓	✓
	27.	Mr. Takeo Fujimori	Chief Engineering Analyst, JRANSA	fujimori-t183@jransa.or.jp;	✓	✓
	28.	Mr. MASAHIRO SUZUKI	Air Navigation Services Engineer, Ministry of Land, Infrastructure, Transport and Tourism / Japan Civil Aviation Bureau	suzuki-m02sf@mlit.go.jp;		✓
	29.	Mr. Muneyuki Takegawa	Japan Civil Aviation Bureau	takegawa-m01nr@mlit.go.jp;	✓	✓
	30.	Mr. Kanta Kuwahara	Engineer, Japan Civil Aviation Bureau	kuwahara-k97j8@mlit.go.jp	✓	✓

	STATE/NAME		TITLE/ORGANIZATION	E-MAIL	ATTENDANCE	
	31.	Mr. Junichi Naganawa	Researcher, Electronic Navigation Research Institute	naganawa@mpat.go.jp;		✓
8.		**LAO PEOPLE'S DEMOCRATIC REPUBLIC (3)**				
	32.	Mr. Soudalath Khamsitthisack	Officer, Department of Civil Aviation of Lao PDR	s.khamsouy@gmail.com;	✓	✓
	33.	Ms. Lucky SAYASITH	Air Traffic Controller, Lao Air Navigations Services	keeatc@gmail.com;	✓	✓
	34.	Ms. Kongla Phommahane	Radar Engineer, Lao Air Navigations Services	phommahane.k@gmail.com;	✓	✓
9.		**MALAYSIA (5)**				
	35.	Mr. Sharudin Hashim	Principal Assistant Director, Civil Aviation Authority of Malaysia (CAAM)	sharudin@caam.gov.my;	✓	✓
	36.	Mr. Mohammad Syahir Abd Manap	Surveillance Engineer, Civil Aviation Authority of Malaysia (CAAM)	syahir@novatis.com.my;	✓	✓
	37.	Mr. Shairyzal Mohamad @ Azizan	Assistant Director, Civil Aviation Authority of Malaysia (CAAM)	shairyzal.azizan@caam.gov.my;	✓	✓
	38.	Mr. Abrar Kamil Sauid	Engineer, Department of Civil Aviation of Malaysia	kamil@aat.my;	✓	✓
	39.	Mr. ISTAS FAHRURRAZI NUSYIRWAN	RESEARCHER, Universiti Teknologi Malaysia	istaz@utm.my;	✓	✓
10.		**MALDIVES (1)**				

		STATE/NAME	TITLE/ORGANIZATION	E-MAIL	ATTENDANCE	
	40.	Mr. Ishag Abdulla	General Manager, Air Traffic Engineering Maldives Airports Company Limited	ishag@macl.aero	✓	✓
11.		**NEPAL (2)**				
	41.	Mr. Dinesh Ram Baidya	Dy. Director, Civil Aviation Authority of Nepal (CAAN)	drbaidya@hotmail.com;	✓	✓
	42.	Mr. Lekh Nath Subedi	Manager, Civil Aviation Authority of Nepal (CAAN)	subedilekh@yahoo.com;	✓	✓
12.		**NEW ZEALAND (1)**				
	43.	Mr. Andy Alford	Senior ANS Operations (Surveillance) Specialist, Airways Corporation Of New Zealand Limited, Airways International Training Facilities	andy.alford@airways.co.nz;	✓	✓
13.		**PHILIPPINES (1)**				
	44.	Mr. Joselito Mamuad	Air Traffic Management Officer V, Civil Aviation Authority of the Philippines	ym_atcradar@yahoo.com;	✓	✓
14.		**REPUBLIC OF KOREA (3)**				
	45.	Mr. Pak Seongjoon*	Engineer, Republic Of Korea/Incheon Airport	sjpak@airport.kr;	✓	✓
	46.	Ms. Yujin Cha	Assistant Manager, Incheon Air Traffic Control Regional Office, Ministry of Land, Infrastructure and Transport(MOLIT)	Yjcha8@korea.kr;	✓	✓
	47.	Ms. Min Ji Park	Manager, Korea Airports Corporation	Minji91@airport.co.kr;	✓	✓
15.		**SINGAPORE (4)**				

		STATE/NAME	TITLE/ORGANIZATION	E-MAIL	ATTENDANCE	
	48.	Mr. Ho Wee Sin	Deputy Director (Info Air Traffic Management)	HO_Wee_Sin@caas.gov.sg;	✓	✓
	49.	Ms. Suk Leng Lee*	Head(Surveillance), Civil Aviation Authority Singapore	lee_suk_leng@caas.gov.sg;	✓	✓
	50.	Mr. Chua Eng Leong	Senior Engineer (Surveillance)	CHUA_Eng_Leong@caas.gov.sg;	✓	✓
	51.	Mr. Wilson Wee Wei Sheng	Senior Air Traffic Control Manager (Operations Technology Planning)	Wilson_WEE@caas.gov.sg;	✓	✓
16.		**THAILAND (10)**				
	52.	Mr. Phichpawis Plengsiriwat	CNS Officer, The Civil Aviation Authority of Thailand	phichpawis.p@caat.or.th;	✓	✓
	53.	Mr. Thamawoot Pocathikorn	CNS Standards Officer, CAAT	Thamawoot.o@caat.or.th;	✓	✓
	54.	Mr. Chavalit Ithiapa*	Senior CNS Standards Officer, The Civil Aviation Authority of Thailand	chavalit.i@caat.or.th;	✓	✓
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	56.	Ms. Achiraya Dechanuntasin*	Air Traffic Management Standard Officer, CAAT	Achiraya.d@caat.or.th;	✓	✓
	57.	Mr. Ponlawat Wattayatin	Air Traffic Systems Engineer Aeronautical Radio of Thailand Co, Ltd. (AEROTHAI)	ponlawat.wa@aerothai.co.th;	✓	✓

		STATE/NAME	TITLE/ORGANIZATION	E-MAIL	ATTENDANCE	
	58.	Mr. Sutham Sujaritthammakun	Executive Air Traffic Systems Engineering Aeronautical Radio of Thailand Ltd. (AEROTHAI)	Sutham.su@aerothai.co.th;	✓	✓
	59.	Mr. Maethee Riwsawai*	Senior Air Traffic Systems Engineering Aeronautical Radio of Thailand Ltd. (AEROTHAI)	Maethee.ri@aerothai.co.th;	✓	✓
	60.	Mr. Popporn Kosaikanont*	Air Traffic Systems Engineering Aeronautical Radio of Thailand Ltd. (AEROTHAI)	Popporn.ko@aerothai.co.th;	✓	✓
	61.	Mr. Nontawat Limprasert*	Air Traffic Systems Engineering Aeronautical Radio of Thailand Ltd. (AEROTHAI)	Nontawat.li@aerothai.co.th;	✓	✓
17.		**USA (4)**				
	62.	Mr. Doug Arbuckle	Technical Advisor, Air Traffic Systems, Chief Scientist and Int'l Lead, FAA	doug.arbuckle@faa.gov;	✓	✓
	63.	Mr. Alejandro Rodriguez	Technical Advisor, Federal Aviation Administration	alejandro.Rodriguez@faa.gov;	✓	✓
	64.	Mr. Paul Von Hoene*	Aviation Safety Inspector, United States Federal Aviation Administration (FAA)	paul.vonhoene@faa.gov;	✓	✓
	65.	Mr. Shayne A. Campbell	Senior Air Traffic Representative, Air Traffic Organization, FAA	Shayne.a.campbell@faa.gov;	✓	✓
18.		**VIETNAM (2)**				
	66.	Mr. CUONG Nguyen Viet	CNS Leader, CNS Department, Vietnam Air Traffic Management Corporation (VATM)	cuongnv_bkt@vatm.vn;	✓	✓

		STATE/NAME	TITLE/ORGANIZATION	E-MAIL	ATTENDANCE	
	67.	Mr. DO HO TRUNG	Chief of Technical Operation Center, Vietnam Air Traffic Management Corporation (VATM)	trungdoho@vatm.vn;	✓	✓
19.		**IATA (1)**				
	68.	Mr. Diego Albert	Regional Assistant Director Operations, Safety and Security, International Air Transport Association (IATA)	albertd@iata.org;	✓	✓
20.		**AIRBUS (1)**				
	69.	Mr. Laurent Vidal	Engineering - Support to sales & marketing, Airbus	laurent.vidal@airbus.com;		✓
21.		**CHINNEY ALLIANCE ENGINEERING (1)**				
	70.	Ms. Monica Yang	Director of Marketing, Chinney Alliance Engineering Limited	Monica.yang@chinney-eng.com;		✓
22.		**HUAWEI (1)**				
	71.	Mr. Adrien Tay	Aviation Industry Solutions Director, Asia Pacific, Huawei	Adrien.Tay@huawei.com;	✓	✓
23.		**INDRA (3)**				
	72.	Mr. Beiya Lu	Senior Sales Manager, INDRA SISTEMAS S.A.	blu@indracompany.com;	✓	✓
	73.	Mr. CHI ZHANG	Senior Expert, INDRA SISTEMAS S.A.	chzhang@indracompany.com;	✓	✓
	74.	Ms. Titapa Sarikha	Office Manager, Thailand	tsarikha@indracompany.com;		✓
24.		**THALES (1)**				
	75.	Mr. Thomas Delalande	Strategy and Business Development Manager, Thales	thomas.delalande@thalesgroup.com;		✓

		STATE/NAME	TITLE/ORGANIZATION	E-MAIL	ATTENDANCE	
25.		**ICAO (5)**				
	76.	Mr. Yi Luo	Regional Officer CNS International Civil Aviation Organization Asia and Pacific Office	yluo@icao.int;	✓	✓
	77.	Ms. Soniya Nibhani	Regional Officer ANS (CNS) Implementation International Civil Aviation Organization Asia and Pacific Office	snibhani@icao.int;		✓
	78.	Mr. Shane Sumner	Regional Officer Air Traffic Management/Aeronautical Information Management, ICAO APAC	ssumner@icao.int;	✓	
	79.	Ms. Zhong Wenhan, Nancy	Regional Officer CNS International Civil Aviation Organization Asia and Pacific Office	wzhong@icao.int;	✓	✓
	80.	Ms. Varapan Meefuengsart	Program Assistant International Civil Aviation Organization Asia and Pacific Office	vmeefuengsart@icao.int;	✓	✓

* Online Attendance

Total 73 79

LIST OF WORKING/INFORMATION PAPERS AND PRESENTATIONS

WP/IP/SP No.	Agenda Item	Subject	Presented by
		LIST OF WORKING PAPERS	
WP/01	1	Provisional Agenda	Secretariat
WP/02	2	Review of Relevant ICAO Meetings	Secretariat
WP/03	3	Review Report of Mode S and DAPs WG/6 Meeting	Secretariat
WP/04	4	Review Outcomes of the Third Meeting of the Surveillance Study Group (SURSG/3)	Secretariat
WP/05	5	Outcome for Survey on ATS Surveillance and Direct Controller and Pilot Communication (DCPC) VHF Coverage Charts for APAC Region	Secretariat, Hong Kong China and Thailand
WP/06	5	Review Regional Surveillance Requirements	Secretariat
WP/07	9	Terms of Reference of SURICG and Action Items	Secretariat
WP/08	2	Relevant Action Items of 57th Conference of Directors General of Civil Aviation	Secretariat
		LIST OF INFORMATION PAPERS	
IP/01	-	Meeting Bulletin	Secretariat
IP/02	8	Surveillance Activities in Singapore	Singapore
IP/03	8 (a)	Revisions to FAA Advisory Circular (AC) 90-114, ADS-B Operations	United States
IP/04	7	ADS-B Equipage and Quality Performance Observed in the U.S.	United States
IP/05	7	Recent ADS-B Avionics Issues in the United States	United States
IP/06	8 (a)	Ads-B In Retrofit Spacing (Airs) Evaluation Project Update	United States
IP/07	8 (b)	ICAO Surveillance Panel Activities	ICAO Surveillance Panel
IP/08	7	A Method for Assessing RF Interference between PSR Radars in an Airport Area	Republic of Korea
IP/09	8	Update on Surveillance Activities in Thailand	Thailand

WP/IP/SP No.	Agenda Item	Subject	Presented by
IP/10	7	Preliminary Analysis of ADS-B Positional Performance in Japan	Japan
IP/12	7	Factors Affecting Performance of ADS-B Position Verification by TDOA	Japan
IP/13	8	Automatic Dependent Surveillance-Broadcast (ADS-B) Implementation for Low-Flying Traffic	Hong Kong, China
IP/14	8	Long-Range Air Traffic Surveillance for Air Traffic Flow Management	Hong Kong, China
IP/15	7	1030/1090MHz Occupancy Monitoring and Evaluation Project in Japan	Japan
IP/16	8 (a)	ATC Surveillance Activities Update in Malaysia	Malaysia
IP/17	7	A Radar Data Quality Monitoring Tool	China
IP/18	7	The Implementation of Optimization and Improvement of ADS-B Application in China	China
IP/19	8	Update the Action Plan for Surveillance in China	China
IP/20	7	Aircraft Parameters Availability in Mode S DAPs and ADS-B ADD	China
IP/21	8	Challenges Faced by Nepal in Implementing ADS-B Based Surveillance	Nepal
LIST OF PRESENTATION			
01		Simplified explanation of II/SI code operations	Singapore
02		Creating Skies Together	Indra
03		Enhancing Surveillance Capability for a Seamless Sky Through Advanced Surveillance Solution	Thales
04		Full Situational Awareness and Accurate Data to Ensure Aviation Safety and Operational Readiness	Huawei
05		Airbus Briefing to SURICG/8	Airbus
LIST OF FLIMSY			
Flimsy/01	9	Revision to Terms of Reference of SURICG	Hong Kong China and Singapore

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International Civil Aviation Organization

Workshop on ICAO Aircraft Address and Target Identification in Surveillance Data and Flight Plan

Bangkok, Thailand, 6 June 2023

Tentative Programme

Moderator: *MH Hui, co-chair of SURICG*

Opening	
09:00 – 09:10	**Opening Remarks** *Regional Officer, CNS of ICAO APAC Office* **Administrative information**
Presentations	
Session 1 **09:10 – 10:10**	**Presentation 1: ADS-B Call Sign Mismatch, Analysis and Mitigation** *Paul Von Hoene,* *Aviation Safety Inspector (AC/OPS),Federal Aviation Administration* **Presentation 2:[Sharing on Follow-up Actions taken by Airlines]** *Diego Albert,* *Assistant Director, Operations, Safety and Security, IATA Asia Pacific* **Presentation 3: ICAO Aircraft Address in Search and Rescue Applications** *Shane Sumner* *Regional Officer, ATM/AIM , ICAO APAC Office*
10:10-10:30	**Coffee Break**
Session 2 **10:30-11:30**	**Presentation 4: Effort in addressing Inconsistent ICAO Aircraft Address and Target Identification between Surveillance Data and Flight Plan** *Mr. Derek How,* *Civil Aviation Department of Hong Kong, China* **Presentation 5:[Sharing on the Observation, Analysis and Mitigation Measures]** *Mr. Andy Alford,* *Senior ANS Operations (Surveillance) Specialist, Airways New Zealand* **Presentation 6:[Sharing on the Observation, Analysis and Mitigation Measures]** *Mr. Kaiyan Jin,* *Air Traffic Management Bureau, China*
Closing	
11:20-11:30	**Remarks**
11:30-13:00	**Lunch at cafeteria**

GENERAL STRATEGY ON ASSIGNMENT OF AND MIGRATION TO SI CODE

Consider that when formulating the general strategy:

a) It was previously shared that radars using SI code cannot detect II-only transponders unless a work-around known as the II/SI code operation is used;

b) Even if a radar using SI code supports the II/SI code operation, it will not be able to detect an II-only transponder if that transponder is already locked to a matching II code by a radar using that matching II code. A way to overcome this is for II radars to also use the II/SI code operations whereby it will only lock out SI-capable transponders and not II-only transponders. However, it is difficult to ensure that all radars (including old radars) can support the II/SI code operations;

c) Transponders that support only II codes are unlikely to disappear totally. Even with strict enforcement by ICAO, there will still be aircraft not subjected to ICAO's provision;

d) While it is possible to configure the lock-out coverage to be smaller than the designated operating coverage, such configuration may not be intuitive and may be subjected to error;

e) The European region is reserving II 14 and 15 (and their matching SI codes) for special use (i.e. research/test and military purposes);

f) The Surveillance Panel is deliberating on a proposal to include a **requirement** for use of II/SI code operations for radars using SI code and a **recommendation** for the use of II/SI code operations for radars using II code; and

g) The strategy is to be kept simple,

The following general strategy is thus proposed for the assignment of SI codes:

a) ICAO APAC regional office will assign SSR Mode S II or Mode S SI codes in accordance with the planning criteria in *Appendix A-1*, at the same time ensuring support for Mode S II-only transponders;

b) ICAO APAC regional office will only assign an SI code if the radar can support II/SI code operations;

c) ICAO APAC regional office will only assign an SI code to radars having overlapping coverage with another radar using "matching" II code when the radar using "matching" II code can support II/SI code operations;

d) The ICAO APAC Regional Office will assume that the designated operating coverage is the same as the lockout coverage. There will be a 5NM buffer between the coverages of two radars using the same II or SI code. States can, as necessary, select a lockout coverage that is smaller than the Designated Operational Coverage; and

e) The ICAO APAC regional office will generally avoid assigning II 14 and 15 (and their matching SI codes) to new radars.

The following general strategy for migration is proposed:

a) States with Mode S radars that can support II/SI code operation are encouraged to coordinate with the ICAO APAC Office to assign or re-assign SI codes to these radars.

b) The ICAO APAC Regional Office may also approach certain States to start migrating to SI codes.

Appendix A-1

The following planning criteria for assigning SSR Mode S II or SSR Mode S SI codes have been agreed by the Surveillance Panel and will be incorporated in the ICAO Aeronautical Surveillance Manual (DOC 9924)

(Editorial Note: Some of the texts below are edited from the original material in DOC. 9924)

Table 1: Considered interrogator (interrogator for which an Interrogator Code is demanded)
Mode S II-only interrogator
Operating on II code
Can operate with Mode S II-only and Mode S II/SI transponders

Case	**Capability of the overlapping interrogator**	**Operating code**	**Condition**	**Transponder Type**
A	A Mode S II only	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
B	Mode S SI operating with II code (1)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
C	Mode S SI operating with SI code (1)	Any SI code, including a “matching” SI code	Overlap OK	II/SI
D	Mode S II/SI+ operating with II code (2)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
E	Mode S II/SI+ operating with SI code (2)	Non-matching SI code	Overlap OK	II-only and II/SI
		Matching SI code	No overlap	

Note 1: Mode S SI means Mode S II/SI capable interrogator which does not support the II/SI code operation
Note 2: Mode S II/SI+ means Mode S II/SI capable interrogator which does support the II/SI code operation

Table 2: Considered interrogator (interrogator for which an Interrogator Code is demanded)
Mode S II/SI interrogator that does not support the use of II/SI code operation.
Operating on II code
Can operate with Mode S II-only and Mode S II/SI transponders

Case	**Capability of the overlapping interrogator**	**Operating code**	**Condition**	**Transponder Type**
A	A Mode S II only	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
B	Mode S SI operating with II code (1)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
C	Mode S SI operating with SI code (1)	Any SI code, including a “matching” SI code	Overlap OK	II/SI
D	Mode S II/SI+ operating with II code (2)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
E	Mode S II/SI+ operating with SI code (2)	Non-matching SI code	Overlap OK	II-only and II/SI
		Matching SI code	No overlap	

Note 1: Mode S SI means Mode S II/SI capable interrogator which does not support the II/SI code operation
Note 2: Mode S II/S+I means Mode S II/SI capable interrogator which does support the II/SI code operation

Table 3: Considered interrogator (interrogator for which an Interrogator Code is demanded)
Mode S II/SI interrogator that does not support the use of II/SI code operation.
Operating on SI code
Can only operate with Mode S II/SI transponders

Case	Capability of the overlapping interrogator	Operating code	Condition	Transponder Type
A	A Mode S II only	Any II code including the matching II code	Overlap OK	II/SI
B	Mode S SI operating with II code (1)	Any II code including the matching II code	Overlap OK	II/SI
C	Mode S SI operating with SI code (1)	Different SI code	Overlap OK	II/SI
		Same SI code	No overlap	
D	Mode S II/SI+ operating with II code (2)	Any II code including the matching II Code	Overlap OK	II/SI
E	Mode S II/SI+ operating with SI code (2)	Different SI code	Overlap OK	II/SI
		Same SI code	No overlap	

Note 1: Mode S SI means Mode S II/SI capable interrogator which does not support the II/SI code operation
Note 2: Mode S II/SI+ means Mode S II/SI capable interrogator which does support the II/SI code operation

Table 4: Considered interrogator (interrogator for which an Interrogator Code is demanded)
Mode S II/SI+ interrogator that supports the use of II/SI code operation.
Operating on II code
Can operate with Mode S II-only and Mode S II/SI transponders

Case	Capability of the overlapping interrogator	Operating code	Condition	Transponder Type
A	A Mode S II only	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
B	Mode S SI operating with II code (1)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
C	Mode S SI operating with SI code (1)	Any SI code including a matching SI code	Overlap OK	II/SI
D	Mode S II/SI+ operating with II code (2)	Different II code	Overlap OK	II-only and II/SI
		Same II code	No overlap	
E	Mode S II/SI+ operating with SI code (2)	Any SI code including a matching SI code	Overlap OK	II-only and II/SI

Note 1: Mode S SI means Mode S II/SI capable interrogator which does not support the II/SI code operation
Note 2: Mode S II/SI+ means Mode S II/SI capable interrogator which does support the II/SI code operation

Table 5: Considered interrogator (interrogator for which an Interrogator Code is demanded) Mode S II/SI+ interrogator that supports the use of II/SI code operation. Operating on SI code Can operate with Mode S II-only and Mode S II/SI transponders				
Case	**Capability of the overlapping interrogator**	**Operating code**	**Condition**	**Transponder Type**
A	A Mode S II only	Non-matching II code	Overlap OK	II-only and II/SI
		Matching II code	No overlap	
B	Mode S SI operating with II code (1)	Non-matching II code	Overlap OK	II-only and II/SI
		Matching II code	No overlap	
C	Mode S SI operating with SI code (1)	Different SI code	Overlap OK	II/SI
		Same SI code	No overlap	
D	Mode S II/SI+ operating with II code (2)	Any II code including a matching II code	Overlap OK	II-only and II/SI
E	Mode S II/SI+ operating with SI code (2)	Different SI code	Overlap OK	II-only and II/SI
		Same SI code	No overlap	

Note 1: Mode S SI means Mode S II/SI capable interrogator which does not support the II/SI code operation

Note 2: Mode S II/SI+ means Mode S II/SI capable interrogator which does support the II/SI code operation

SURICG/8
Appendix B to the Report

INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

MODE S DOWNLINK AIRCRAFT PARAMETERS IMPLEMENTATION AND OPERATIONS GUIDANCE DOCUMENT

Edition 5.0 - March 2023

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PREFACE

This publication is one of the deliverables of the Mode S DAPs WG according to the Terms of Reference (TOR). It aims at providing guidance materials to States and airspace users on the use of Mode S DAPs in the Asia and Pacific Regions from both operational and technical perspectives. A working team was established to develop the contents, and China has volunteered to take lead on coordinating and consolidating inputs from members of the working team.

During Mode S DAPs WG/1 held in March 2018, the meeting considered that further development work is required before the initial draft (Edition 0.1) proposed by China and Hong Kong China becomes ready for approval. Then the working team began to develop the contents of the guidance document, China organized two internal conferences and ICAO APAC office organized a web conference for reviewing the contents. Based on numerous rounds of review and comments with joint efforts from the working team, China has revised the draft into five previous versions. Finally, Edition 1.0 was submitted for endorsement after Mode S DAPs WG/2, and published in the CNS SG/23. China revised the document and circulated it to the members of the Working Group for comments. Then Edition 2.0 was released in 2020, during CNS SG/24. Edition 3.0 was adopted by CNS SG/25 in 2021. Edition 4.0 includes information related to ADS-B DAPs, and was released in 2022, during CNS SG/26. The revised draft is prepared and proposed to be endorsed by Mode S DAPs WG/6.

The support from ICAO APAC Office and contributions from the following volunteer State/Administration and industry partner in preparing the guidance material is acknowledged and highly appreciated:

- Air Traffic Management Bureau of CAAC, China
- The Second Research Institute of CAAC, China
- Hong Kong Civil Aviation Department, China
- Civil Aviation Authority of Singapore
- Japan Civil Aviation Bureau
- Electronic Navigation Research Institute, Japan
- Airways, New Zealand
- Airservices, Australia

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Purpose

This Mode S Downlink Aircraft Parameters Implementation and Operations Guidance Document (DAPs IGD) provides guidance for the planning, implementation and operational application of Mode S DAPs technology in the Asia and Pacific Regions.

The procedures and requirements for Mode S DAPs operations are detailed in the relevant States' AIP. This IGD is intended to provide key information on Mode S DAPs performance, integration, principles, procedures and collaboration mechanisms.

The content is based upon the work to date of the Mode S DAPs Working Group and various ANC Panels for the operational use of Mode S DAPs.

1.2 Background

1.2.1 Mode S and DAPs

Mode S (Select) is an extension of conventional SSR which permits selective addressing of individual aircraft equipped with Mode S transponders. Additional data known as Downlink Aircraft Parameters (DAPs) may also be extracted from the aircraft, including aircraft identification which should correspond to the ACID entered in the flight plan.

Mode S operates on the same radio frequencies (1030 and 1090 MHz) as conventional SSR systems, allowing for interrogation of Mode A/C only transponders and Mode S transponders.

Each Mode S equipped aircraft is assigned a unique ICAO 24-bit aircraft address. Using the selective interrogation capability of the Mode S SSR, Mode S Sensors are able to first acquire and then selectively interrogate a specific aircraft via its unique ICAO 24-bit aircraft address. This significantly improves the radar's detection and tracking performance, and therefore improving the ability of ATC to monitor and control the aircraft, as well as the others around it.

The innovation of Mode S resides in the use of selective addressing of aircraft which offers technical advantages over conventional SSR, such as reducing "fruit" and "garbling", providing higher integrity radar tracks.

Mode S technology has the following characteristics:

a) selective interrogation,

b) individual aircraft address and

c) datalink capability.

The Mode S application includes Mode S radar system, datalink Systems, MLAT Systems, etc.

Various avionics systems onboard an aircraft receive data from sensors to provide the DAPs output. The data mainly comes from several sets of sensors, such as air data sensors (including pitot probe, static port, temperature sensor, and angle of attack sensor), inertial sensors (including position gyroscopes, rate gyroscopes and accelerometers) and magnetic sensor(s). Part of the parameters produced by other avionics systems (such as MCP/FCU, FMS, TCAS, etc.) are also defined as downlink aircraft parameters. These parameters are then sent to the transponder through standard data buses, and stored inside the relevant transponder's 256 different 56-bit wide Binary Data Store. Ground-based surveillance systems (such as MSSR or MLAT) can downlink the desired parameters using specific Mode S protocols.

For detailed information about DAPs data source, please refer to Appendix 3.

Mode S DAPs is an application of the Mode S Datalink System. The downlink standard length transaction interface shall deliver DAPs to the transponder which then makes data available to the ground surveillance systems. Each DAP shall be packed and then transmitted by the downlink SLM, ground-initiated and broadcast protocols.

There are 255 Comm-B registers within the Mode S transponder, some of them are assigned for Mode S SSR DAPs and some are assigned for ADS-B DAPs. The Mode S transponder transmits extended squitter to support the ADS-B message transmitted on 1090 MHz which is called ADS-B DAPs. And the SSR DAPs can be extracted using either the ground-initiated Comm-B (GICB) protocol, or using MSP downlink channel 3 via the data flash application.

There are four 1090 MHz Extended Squitter ADS-B MOPS versions with the latest, Version 3 published in December 2020. With each new version, some messages have different formats and contain additional or eliminated message subfields. As version 3 is so new there are few if any avionics which meet the standards, therefore the related information of ADS-B DAPs in this document is based on the version 2 and earlier versions.

1.2.2 Benefit of Mode S and Use of DAPs

The Mode S application reduces the weakness of Mode A/C, because of the selective interrogation reducing synchronous garble and asynchronous interference. The parity check technique improves the reliability and integrity of surveillance data. The availability of almost 17 million unique aircraft addresses, in conjunction with the automatic reporting of flight identity, alleviates Mode 3/A code shortages and enables unambiguous aircraft identification, if the correct aircraft address and/or Aircraft Identification are entered in both the flight plan and aircraft systems. The datalink technique assists the acquisition of downlink aircraft parameters, and the additional track label information improves the air situational awareness. The controller and pilot are presented with improved situation awareness, which reduces the R/T workload.

Another benefit is to maximize SSR Mode 3/A code savings. By introducing the Mode S Conspicuity Code, all aircraft identified by Mode S via DAPs (ACID) can use the same SSR Mode 3/A code. During the 6th meeting of ATM SG, the following Conclusion is adopted:

Conclusion ATM/SG/6-3: Proposed Air Navigation Plan Volume II Amendment

'A1000' was reserved for the Mode S Conspicuity Code for the ICAO APAC region.

The ADS-B DAPs also provide benefits such as economical, enhanced safety and efficiency. The position report in ADS-B message is transmitted with an indication of the integrity associated with the data. And the ADS-B ground station is simpler than the stations of primary radar, secondary radar and multilateration, and acquisition and installation costs are significantly lower. Since ADS-B messages are broadcast, it supports both ground-based and airborne surveillance applications.

1.3 Arrangement of DAPs IGD

The Mode S DAPs Implementation and Operations Guidance Document consists of the following parts:

Section 1	Introduction
Section 2	Acronym Lists
Section 3	Reference Documents
Section 4	Description of Mode S DAPs Data
Section 5	Implementation Principles and Phase
Section 6	System Integrity and Monitoring
Section 7	Regulations and Procedures
Section 8	Training and Competence
Section 9	Specific Examples on Mode S DAPs Applications

1.4 Document History and Management

The framework of this document was introduced in the first Working Group Meeting of Mode S Downlink Aircraft Parameters in March 2018. The Meeting agreed to further develop based on the proposed framework to a complete document for approval as a regional guidance document. A working team, consisting of volunteers from China, Hong Kong-China, Japan, Malaysia, Singapore, Thailand and New Zealand was established by the Meeting to contribute to the content of the document. In July 2018, the completed draft of this document was ready for circulation among States for review and comment.

The aim of this document to supplement SARPs, PANS and relevant provisions contained in ICAO documentation, and it will be regularly updated to reflect evolving provisions.

1.5 Copies

Paper copies of this DAPs IGD are not distributed. Controlled and endorsed copies can be found at the following website: http://www.icao.int/APAC/Pages/edocs.aspx and may be freely downloaded from the website, or by emailing APANPIRG through the ICAO Asia and Pacific Regional Office who will send a copy by return email.

1.6 Changes to DAPs IGD

Whenever a user identifies a need for a change to this document, a Request for Change (RFC) Form (see Section 1.8 below) should be completed and submitted to the ICAO Asia and Pacific Regional Office. The Regional Office will collate RFCs for consideration by the Surveillance Implementation Coordination Group.

When an amendment has been adopted by the meeting of the Surveillance Implementation Coordination Group, then a new version of the DAPs IGD will be prepared, with the changes marked by an "|" in the margin, and an endnote indicating the relevant RFC, so a reader can see the origin of the change. If the change is in a table cell, the outside edges of the table will be highlighted, e.g.:

Final approval for publication of an amendment to the DAPs IGD will be the responsibility of APANPIRG.

1.7 Editing Conventions

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1.8 DAPs IGD Request for Change Form

RFC Nr:	

Please use this form when requesting a change to any part of this DAPs IGD. This form may be photocopied as required, emailed, faxed or e-mailed to ICAO Asia and Pacific Regional Office +66 (2) 537-8199 or APAC@icao.int

1. SUBJECT:				
2. REASON FOR CHANGE:				
3. DESCRIPTION OF PROPOSAL: [expand / attach additional pages if necessary]				
4. REFERENCE(S):				
5. PERSON INITIATING:			**DATE:**	
ORGANISATION:				
TEL/FAX/E-MAIL:				
6. CONSULTATION	**RESPONSE DUE BY DATE:**			
	Organization	**Name**	**Agree/Disagree**	**Date**
7. ACTION REQUIRED :				
8. DAPs IGD EDITOR			**DATE REC'D :**	
9. FEEDBACK PASSED			**DATE :**	

1.9 Amendment Record

Amendment Number	Date	Amended by	Comments
0.1	20 March 2018	China Hong Kong, China	Initial draft for consideration by Mode S DAPs WG/1
0.2	1 August 2018	China Hong Kong, China Japan Singapore Malaysia	First completed draft based on the agreed document framework in Mode S DAPs WG/1 for review and comment by States
0.3	23 August 2018	China	Based on Version 0.2 draft, China hold a meeting to discuss problems respecting the first completed draft. This is a revised document according to content of this meeting.
0.3.1	26 September 2018	China Hong Kong, China Singapore New Zealand	Based on Version 0.3 draft, States make a full comment on the content of IGD. This is a revised document according to those comments.
0.3.2	6 November 2018	China New Zealand Hong Kong, China Singapore Malaysia	Based on Version 0.3.1 draft, States discussed all comments of IGD in the Mode S DAPs WG 1st Web Conference. This is revised by the meeting decisions.
0.4	27 December 2018	China New Zealand Singapore Australia	Based on Version 0.3.2, States review and comment on the IGD. This is a revised document according to those comments.
1.0	14 March 2019	China Japan Singapore Malaysia	Consideration by Mode S DAPs WG/2
1.1	17 February 2020	China New Zealand Singapore	Modify based on Version 1.0, States review and comment on the IGD.
2.0	13 May 2020	China	Consideration by Mode S DAPs WG/3
3.0	March 2021	China	Consideration by Mode S DAPs WG/4
4.0	March 2022	China	Add information related to ADS-B DAPs and guidance on measurement of 1030/1090 MHz usage

5.0	March 2023	China	

2. ACRONYMS LIST

AA	Aircraft Address
AAD	Assigned Altitude Deviation
AC	Altitude Code
ACAS	Airborne Collision Avoidance System
ACID	Aircraft Identification
ADS-B	Automatic Dependent Surveillance-Broadcast
AICB	Air-Initiated Comm-B
AIGD	ADS-B Implementation and Operations Guidance Document
AIP	Aeronautical Information Publication
AMC	Acceptable Means of Compliance
ANC	Air Navigation Conference
ANSP	Air Navigation Service Provider
APAC	Asia Pacific
ASE	Altimetry System Error
ASTERIX	All Purpose Structured EUROCONTROL Surveillance Information Exchange
ATC	Air Traffic Control
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Service
ATSEP	Air Traffic Safety Electronic Personnel
BDS	Comm-B Data Selector
CA	Capability
CDTI	Cockpit Display Traffic Information
CFL	Cleared Flight Level
CLAM	Cleared Level Adherence Monitoring
CNS	Communications, Navigation and Surveillance
DAPs	Downlink Aircraft Parameters
DF	Downlink Format
EASA	European Aviation Safety Agency
EHS	Mode S Enhanced Surveillance
ELM	Extended Length Message
ELS	Mode S Elementary Surveillance
ES	Extended Squitter
EUROCAE	European Organization for Civil Aviation Equipment
EUROCONTORL	European Organization for the Safety of Air Navigation
FCU	Flight Control Unit
FIR	Flight Information Region
FLTID	Flight Identification (transmitted by aircraft)
FMS	Flight Management System
FRUIT	False Relies Unsynchronized In Time
FS	Flight Statud
FTE	Flight Technical Error
HDG	Heading
HRD	Horizontal Reference Direction
GICB	Ground-Initiated Comm-B
GNSS	Global Navigation Staellite System
GVA	Geometric Vertical Accuracy
HMI	Human Machine Interface
IC	Interrogator Code
ICAO	International Civil Aviation Organization

ID	Identity
IFR	Instrument Flight Rules
II	Interrogator Identifier
IRF	Interrogation Repetition Frequency
MCP	Mode Control Panel
MET	Meteorological
MHz	Megahertz
MIP	Mode Interlace Patterns
MIT	Massachusetts Institute of Technology
MLAT	Multilateration
MOPS	Minimum Operational Performance Standard
MSAW	Minimum Safe Altitude Warning
MSP	Mode S Specific Protocol
MTCD	Medium Term Conflict Detection
NAC	Navigation Accuracy Category
NIC	Navigation Integrity Category
NUC	Navigation Uncertainty Category
RA	Resolution Advisory
RVSM	Reduced Vertical Separation Minimum
SARPs	(ICAO) Standards and Recommended Practices
SFL	Selected Flight Level
SI	Surveillance Identifier
SIL	Surveillance Integrity Level
SSR	Secondary Surveillance Radar
STCA	Short-Term Conflict Alert
TCAS	Traffic Alert and Collision Avoidance System
TRK	Track Angle
TVE	Total Vertical Error
UTC	Universal Time Coordinated
WAM	Wide Area Multilateration
WG	Working Group

3. REFERENCE DOCUMENTS

Id	Name of the document	Edition	Date	Origin	Domain
1	Aeronautical Telecommunications, Annex 10 - Vol. III - Communication Systems	Edition 2	2007	ICAO	
2	Aeronautical Telecommunications, Annex 10 - Vol. IV - Surveillance Radar and Collision Avoidance Systems	Edition 5	2014	ICAO	
3	Doc 9871, Technical Provisions for Mode S Services and Extended Squitter.	Edition 2	2012	ICAO	
4	Doc 9688 Manual on Mode S specific service.	Edition 2	2004	ICAO	
5	ED-73E, Minimum Operational Performance Standards for Secondary Surveillance Radar Mode S Transponders.	Edition 1	May 2011	EUROCAE	
6	ADS-B Implementation and Operations Guidance Document (AIGD)	Edition 13	April 2021	ICAO APAC	
7	Concept of Operations Mode S in Europe (Mode S CONOPS)	Edition 2	November 2013	Eurocontrol	
8	Mode S Elementary Surveillance (ELS) Operations Manual	Edition 1	January 2011	Eurocontrol	
9	Asia/Pacific Seamless ATM Plan		May 2015	ICAO APAC	
10	Doc 9924 Aeronautical Surveillance Manual	Third Edition	2020	ICAO	
11	Preliminary System Safety Analysis for the Mode S Elementary Surveillance	Edition 1.8	April 2004	Eurocontrol	EATMP
12	Elementary Surveillance (ELS) and Enhanced Surveillance (EHS) validation via Mode S Secondary Radar		April 2008	MIT Lincoln Laboratory	ATC Project
13	Aircraft Derived Data Validation Algorithms		August 2012	MIT Lincoln Laboratory	ATC Project
14	Doc.4444 Procedures For Air Navigation Services Air Traffic Management	Sixteenth Edition	November 2016	ICAO	
15	Clarification Mode S Transponder in an Airport/A-SMGCS Environment	Edition 1.1	3 May 2005	Eurocontrol	

16	Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System /Mode Select (ATCRBS / Mode S) Airborne Equipment	Edition E	17 March 2011	RTCA	
17	MARK 4 AIR TRAFFIC CONTROL TRANSPONDER (ATCRBS/MODE S)	Edition 4	15 November 2011	ARINC	
18	DO-260 Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B)		13 September 2000	RTCA	
19	DO-260A Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)		2003	RTCA	
20	DO-260B Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)		2 December 2009	RTCA	
21	Doc9574 Manual on a 300 m(1 000 ft) Vertical Separation Minimum Between FL 290 and FL410 Inclusive	Edition 3	2012	ICAO	

4. DESCRIPTION OF MODE S DAPs DATA

Inside the aircraft transponder, DAPs are stored in different BDS Registers for responding to interrogation requests by a Mode S ground system. Aircraft parameters are periodically delivered from aircraft sensors, flight management system, etc., to these registers via the downlink standard length transaction interface. BDS Registers, which have not been updated within the specified maximum update interval, are cleared or indicated as invalid and such aircraft parameters would be unavailable for ground interrogations. When a Mode S SSR sends an interrogation requesting the downlink of registers, Mode S SSR DAPs are packed into Comm-B format (known as "MB" field) and are extracted using either the GICB protocol or Mode S specific protocols (MSPs) channel 3. Mode S transponder transmit extended squitter to broadcast ADS-B DAPs.

BDS Registers are identified by a two-digit hex number. For example, BDS Register for selected vertical intention, which is identified by hex number 40_{16}, is commonly written as BDS code 4, 0 in publications. Depending on the stage of Mode S implementation, i.e., Mode S ELS and Mode S EHS, the scope of Mode S SSR DAPs data involved would be different as illustrated in the following subsections. These subsections also describe ADS-B DAPs data and the differences between Mode S SSR DAPs and ADS-B DAPs.

Detailed data format and maximum update interval of each BDS register are given in "ICAO Doc 9871 - Technical Provisions for Mode S Services and Extended Squitter".

4.1 Mode S Downlink Format

There are 25 downlink formats, of which a number are reserved. DF0/16 are used for air-air surveillance, while DF18 is used for Extended squitter non transponder. The list below is only for DF4/5/11/17/20/21.

<table>
<tr><td>00100</td><td colspan="2">FS:3</td><td>DR:5</td><td>UM:6</td><td>AC:13</td><td>AP:24</td></tr>
<tr><td>00101</td><td colspan="2">FS:3</td><td>DR:5</td><td>UM:6</td><td>ID:13</td><td>AP:24</td></tr>
<tr><td>01011</td><td colspan="2">CA:3</td><td colspan="3">AA:24</td><td>PI:24</td></tr>
<tr><td>10001</td><td>CA:3</td><td colspan="3">AA:24</td><td>ME:56</td><td>PI:24</td></tr>
<tr><td>10100</td><td>FS:3</td><td>DR:5</td><td>UM:6</td><td>AC:13</td><td>MB:56</td><td>AP:24</td></tr>
<tr><td>10101</td><td>FS:3</td><td>DR:5</td><td>UM:6</td><td>ID:13</td><td>MB:56</td><td>AP:24</td></tr>
</table>

FS: Flight status, contains information about alert(s), SPI and whether the aircraft is airborne or on the ground.

DR: Downlink request, contains a request to downlink information.

UM: Utility message, contains transponder communications status information.

AC: Altitude code, contains the altitude coded as special method.

AP: Address/parity, contains parity overlaid on the aircraft address.

ID: Identity, contains the aircraft identity code in accordance with the pattern for Mode A replies.

CA: Capability, contains information on the transponder level and some additional information.

AA: Aircraft Address.

PI: Parity/interrogator identifier, the parity overlaid on the interrogator's identity.

ME: Message, extended squitter.
MB: Message, Comm-B,

#Note: For more detailed information, please refer to Aeronautical Telecommunications, Annex 10 - Vol. IV - Surveillance Radar and Collision Avoidance Systems.

4.2 Mode S ELS

In Mode S ELS implementation, aircraft and ground Mode S system should be compliant with providing the following functionalities over conventional Mode A/C systems:

a) Selective interrogation.
b) Use of ICAO Aircraft Address.
c) Automatic reporting of ACID.
d) Report of transponder capability;.
e) Altitude reporting with a resolution of 25ft (subject to aircraft capability).
f) Provision of flight status to indicate airborne or on-the-ground (subject to aircraft capability).
g) Report of SI Code capability; and
h) ACAS active resolution advisory report (when equipped with TCAS).

DAPs associated with Mode S ELS are stored in BDS code 1,0, BDS code 1,7, BDS code 2,0 and BDS code 3,0 registers of the aircraft's transponder.

Table 4-1 DAPs in Mode S ELS

Register	**Name**	**Usage**
BDS code 1,0	Datalink Capability Report	To report the data link capability of the Mode S transponder/data link installation.
BDS code 1,7	Common Usage GICB Capability Report	To indicate common usage GICB services currently supported.
BDS code 2,0	Aircraft Identification	To report aircraft identification to the ground.
BDS code 3,0	ACAS Resolution Advisory Report	To report ACAS active resolution advisory

With the above functionalities properly configured, Mode S ELS could bring the following benefits to ATC operations:

a) Provide unambiguous aircraft identification using the unique aircraft address and aircraft identification.
b) Help to solve Mode 3/A code shortage in congested airspace, using the Mode S conspicuity code (A1000) instead of discrete Mode 3/A codes.
c) Improve surveillance data integrity by;
   1) reducing synchronous garble*,
   2) lessening over-interrogations, and
   3) simplifying aircraft identification in case of false targets.

d) Improve the accuracy of multi-surveillance tracking and safety nets with more accurate target detection from Mode S radars and high resolution in altitude reporting; and

e) Able to process more aircraft tracks than conventional Mode A/C radars; and

f) Able to provide ACAS active resolution advisory from suitably equipped aircraft.

*Note, while Mode S will help to reduce data garble it will not resolve the issue. Issues around multi-path and different transponder types in close proximity (e.g., Mode A/C near a Mode S transponder) can mean that the return received by the radar may not be correct. In the case of a Mode A/C transponder close to a Mode S transponder, instances have been recorded where the Mode S address has been transposed into the reply from the Mode A transponder.

4.3 Mode S EHS

Mode S EHS implementation includes all the features of Mode S ELS with the addition of DAPs stored in BDS code 4,0, BDS code 5,0 and BDS code 6,0 registers of the aircraft's transponder. The following table summarizes the details of DAPs of these three registers:

Table 4-2 DAPs in Mode S EHS

<table>
<tr><th>Register</th><th colspan="2">Name/Downlink Aircraft Parameters</th><th>Usage</th></tr>
<tr><td rowspan="5">BDS code 4,0</td><td rowspan="5">Selected Vertical Intention</td><td>MCP/FCU Selected Altitude</td><td rowspan="5">To provide information about the aircraft's current vertical intentions</td></tr>
<tr><td>FMS Selected Altitude</td></tr>
<tr><td>Barometric Pressure Setting</td></tr>
<tr><td>MCP/FCU Mode</td></tr>
<tr><td>Target Altitude Source</td></tr>
<tr><td rowspan="5">BDS code 5,0</td><td rowspan="5">Track and Turn Report</td><td>Roll Angle</td><td rowspan="5">To provide track and turn data to the ground systems.</td></tr>
<tr><td>True Track Angle</td></tr>
<tr><td>Ground Speed</td></tr>
<tr><td>Track Angle Rate</td></tr>
<tr><td>True Air Speed</td></tr>
<tr><td rowspan="5">BDS code 6,0</td><td rowspan="5">Heading and Speed Report</td><td>Magnetic Heading</td><td rowspan="5">To provide heading and speed data to ground systems.</td></tr>
<tr><td>Indicated Air Speed</td></tr>
<tr><td>Mach Number</td></tr>
<tr><td>Barometric Altitude Rate</td></tr>
<tr><td>Inertial Vertical Velocity</td></tr>
</table>

In addition to those improvements contributed by Mode S ELS in Section 4.1, Mode S EHS implementation provides the following benefits to ATC operation:

a) Further improve multi-surveillance tracking accuracy and performance through the use of DAPs on track, turn, speed and heading of the aircraft in the track calculation.

b) Further improve the accuracy of safety nets, e.g., Short-Term Conflict Alert (STCA), through the provision of more accurate aircraft tracks, and Medium-Term Conflict Detection (MTCD), Minimum Safe Altitude Warning (MSAW), through the provision of the earlier judgment of vertical movement.

c) Allow the implementation of new safety nets in ATM automation system for cross-checking selected aircraft vertical intention (i.e., Selected Altitude) with ATC controllers' instruction as well as verifying the barometric pressure setting applied in the aircraft with QNH setting in ATM automation system; and

d) Improve situational awareness of ATC controllers by enabling the direct access of aircraft parameters in ATM automation system, e.g., Indicated Air Speed, Mach speed, Selected Altitude, Barometric Pressure Setting, etc.

e) Progressive reduction of R/T workload per aircraft.

4.4 ADS-B DAPs

According to the current situation and operation requirements of airborne ADS-B transponder, only the aircraft downlink parameters corresponding to ADS-B 1090ES Version 2 are considered. DAPs associated with ADS-B are stored in BDS Code 0,5, BDS Code 0,6, BDS Code 0,8, BDS Code 0,9, BDS Code 6,1, BDS Code 6,2 and BDS Code 6,5.

The following table summarizes the details of these parameters:

Table 4-3 ADS-B DAPs

Register	Name/Downlink Aircraft Parameters		Usage
BDS code 0,5	Airborne Position	Airborne Position	To provide accurate airborne position information
		NIC Supplement-B	
		Pressure Altitude GNSS Height	
		Surveillance Status	
BDS code 0,6	Surface Position	Surface Position	To provide accurate surface position information.
		Ground Speed Vector	
BDS code 0,8	Aircraft Identification and Category	Aircraft Identification	To provide aircraft identification and category
		Emitter Category	
BDS code 0,9 Subtype 1/2	Velocity Over Ground	Ground Speed Vector	To provide additional state information for both normal and supersonic flight
		NACv	
		Vertical Rate	
		Intent Change Flag	
		Difference from Baro Altitude	
BDS code 0,9 Subtype 3/4	Airspeed and Heading	Air Speed	To provide additional state information for both normal and supersonic flight based on airspeed and heading
		Heading	
		NACv	
		Vertical Rate	
		Intent Change Flag	
		Difference from Baro Altitude	
BDS code 6,1 Subtype 1	Emergency/Priority Status	Emergency/Priority Status	To provide additional information on aircraft status
		Mode A Code	
BDS code 6,1 Subtype 2	ACAS RA Broadcast	ACAS RA Report	To report RAs generated by TCAS/ACAS equipment.
BDS code 6,2 Subtype 1	Target State and Status Message	Selected Altitude	To provide aircraft state and status information
		Barometric Pressure Setting	
		Selected Heading	
		NAC_P, SIL, NIC_{BARO},	
		SIL Supplement	
		MCP/FCU Mode	
		TCAS/ACAS Operational	
BDS code 6,5		Airborne Capability Class	

Subtype 0	Aircraft Operational Status- While Airborne	Airborne Operational Mode	To provide the capability class and current operational mode of ATC-related applications and other operational information.
		MOPS Version	
		NIC Supplement-A	
		NAC_P, GVA, SIL, NIC_{BARO}	
		HRD	
		SIL Supplement	
BDS code 6,5 Subtype 1	Aircraft Operational Status-On the Surface	Surface Capability Class	
		Length/Width	
		Surface Operational Mode	
		MOPS Version	
		NIC Supplement-A	
		NAC_P, SIL	
		TRK/HDG	
		HRD	
		SIL Supplement	

4.5 The Data Item in SSR DAPs and ADS-B DAPs

The airborne Mode S transponder may transmit the same data item to radar and ADS-B via different routes. The following table summarizes some of the parameters in use.

Table 4-4 The Data Item in SSR DAPs and ADS-B DAPs

Data Items	**SSR DAPs**		**ADS-B DAPs**	
	BDS/DF	**ASTERIX**	**BDS/DF**	**ASTERIX**
Aircraft Address	DF4/5/20/21 AP DF11 AA	I048/220	DF17 AA	I021/080
Mode A Code	DF5/21_ID	I048/070	BDS Code 6,1	I021/070
Pressure Altitude	DF4/20_AC	I048/090	BDS Code 0,5	I021/145
Airborne/On-the-ground	DF4/5/20/21_FS	I048/230	Determine by position message type (BDS Code 0,5 or 0,6)	I021/040
Aircraft Identification	BDS Code 2,0	I048/240	BDS Code 0,8	I021/170
Aircraft Emitter Category	-	-	BDS Code 0,8	I021/020
Special Position Indication/SPI	DF4/5/20/21_FS	I048/020 I048/230	BDS Code 0,5	I021/200
Emergency Status	DF5/21_ID	I048/230 I048/070	BDS Code 6,1	I021/200
ACAS RA Report	BDS Code 3,0	I048/260	BDS Code 6,1	I021/260
MCP/FCU Selected Altitude	BDS Code 4,0	I048/250	BDS Code 6,2	I021/146 I021/148
FMS Selected Altitude	BDS Code 4,0		BDS Code 6,2	I021/146
Barometric Pressure Setting	BDS Code 4,0		BDS Code 6,2	I021/REF
MCP/FCU Mode	BDS Code 4,0		BDS Code 6,2	I021/148 I021/REF
Roll Angle	BDS Code 5,0		-	I021/230
True Track Angle	BDS Code 5,0		BDS Code 0,9+6,5 BDS Code 0,6+6,5	I021/160
Ground Speed	BDS Code 5,0		BDS Code 0,9 BDS Code 0,6	I021/160

Track Angle Rate	BDS Code 5,0		-	I021/165
True Air Speed	BDS Code 6,0		BDS Code 0,9	I021/151
Magnetic Heading	BDS Code 6,0		BDS Code 0,9+6,5 BDS Code 0,6+6,5	I021/152
Indicated Air Speed	BDS Code 6,0		BDS Code 0,9	I021/150
Mach Number	BDS Code 6,0		-	-
Barometric Altitude Rate	BDS Code 6,0		BDS Code 0,9	I021/155
Inertial Vertical Velocity	BDS Code 6,0			-
Position in WGS-84 Co-ordinates	-	-	BDS Code 0,5 BDS Code 0.6	I021/130 I021/131
GNSS Height	-	-	BDS Code 0,5 + 0,9 BDS Code 0,5	I021/140
Geometric Vertical Rate	-	-	BDS Code 0,9	I021/157
Quality Indicator	-	-	BDS Code 0,5 BDS Code 0,9 BDS Code 6,2 BDS Code 6,5	I021/090
Aircraft Length and Width	-	-	BDS Code 6,5	I021/271
GNSS Antenna Offset	-	-	BDS Code 6,5	I021/REF

Note: The airspeed and magnetic heading values are only available from airborne participants that are not providing information about their velocities over the ground in ADS-B DAPs.

4.6 DAPs Data Exchange Protocol Between Surveillance and ATM Automation System

The decoding of DAPs data from downlink messages is handled by ground surveillance equipment such as radars, ADS-B, MLAT and WAM ground stations. The Surveillance Data Processor (SDP) within the ATM automation system can combine multiple downlink messages into a single target report for display to controllers. All Purpose Structured EUROCONTROL Surveillance Information Exchange (ASTERIX) formats are commonly used as the protocol for target report transmission from surveillance systems to the ATM automation system.

For detailed information about ASTERIX formats please refer to the following link of EUROCONTROL web site:

https://www.eurocontrol.int/asterix

ASTERIX formats are categorized based on the types of surveillance data involved. ASTERIX Category 20, ASTERIX Category 21 and ASTERIX Category 48 are responsible for the DAPs data transmission from MLAT systems, ADS-B systems and radars respectively. For each ASTERIX category, the protocol format is further divided into different editions with variations on the supported DAPs data. ANSP's should carry out appropriate studies on the available protocol editions during the design stage to ensure the chosen format can cater to the scope of DAPs proposed to be implemented and that the Surveillance and ATM automation systems can correctly process the protocol selected.

For details, previous and current versions of ASTERIX Category 20, Category 21 and Category 48 specification documents can be downloaded from the following link of EUROCONTROL web sites:

https://www.eurocontrol.int/publication/cat020-eurocontrol-specification-surveillance-data-exchange-asterix-part-14-category-20

https://www.eurocontrol.int/publication/cat021-eurocontrol-specification-surveillance-data-exchange-asterix-part-12-category-21 https://www.eurocontrol.int/publication/cat021-eurocontrol-specification-surveillance-data-exchange-asterix-part-12-category-0

https://www.eurocontrol.int/publication/cat048-eurocontrol-specification-surveillance-data-exchange-asterix-part4

5. IMPLEMENTATION PRINCIPLES AND PHASES

Implementation guidance is developed to progress the DAPs implementation from concept to operational use in the ICAO APAC region. In this chapter, section one addresses the implementation principles, which describes the issues of international coordination, system compatibility, data integrity and system integration, while section two addresses the implementation phase, to assist States with the management of DAPs implementation activities.

5.1 Implementation Principles

5.1.1 Stakeholders Coordination

DAPs provide useful information from aircraft which can benefit ANSP and airspace users. Improvements in efficiency and safety can be achieved, however the resultant changes in operational procedures to provide the improvements, will affect ANSPs, Regulators, Airlines, and other related airspace users. Before implementation by any State, a coordination team should be formed to study, coordinate, support and consult the implementation plans and related activities. The coordination team should include field experts on avionics, data link, surveillance infrastructures and end users.

Changes in the ATM operational procedures as the result of the use of DAPs require coordination among ATS providers, Regulators, Airlines, and where applicable, coordination among neighboring States to maximize the benefits. All States are encouraged to share their operational experiences, and to report anomalies through Mode S DAPs WG and the Surveillance Implementation Coordination Group.

Not all Surveillance and ATM automation systems are capable of processing and using DAPs, therefore investment in all related fields needs to be considered by all States. The coordination team should be consulted for future investment plans and related activities considering the technical and operational aspects. Consideration needs to be given to achieve a balance between investment and benefits.

5.1.2 System Compatibility

a) Technical:

DAPs can be obtained by different surveillance technologies such as Mode S Radar, ADS-B, MLAT and WAM, however not all the transponders can support DAPs. Different surveillance technologies in the ICAO APAC States mean that system compatibility should be considered.

Potential interference between different surveillance technologies should be fully considered before implementation, otherwise the efficiency and safety of the system cannot be ensured. Harmonization between different technologies should be considered and optimized to reduce the RF congestion on 1030MHz and 1090MHz.

Since not all aircraft are equipped with Mode S transponders, and not all the Mode S transponders have the ability to support DAPs, compatibility and efficiency should always be considered before implementation.

When DAPs are implemented, the data rate will increase compared to the conventional radar data, and the related BDS information extraction strategies should be considered. To reduce the load on the 1090MHz spectrum, only those registers intended for operational use should be interrogated/extracted.

b) Operational:

Different processing systems can support DAPs in different levels, hence the quality and information of the target may be different after the processed DAPs have been added. For example, some radar tracking algorithms will consider DAPs as an input to the tracking, so the quality and information of the target will be a little bit different, therefore there should be compatibility considerations between different systems before use of the target data.

There are different air traffic management and operation strategies used by neighboring States. So, the operational procedures should always consider the operational compatibilities. For example, Mode A/C transponders and Mode S transponders may be working in the same area.

5.1.3 DAPs Data Integrity

DAPs data integrity should always be the first consideration when putting DAPs data into use. Since the data integrity from the source is not delivered by any related BDS register now, States are encouraged to find a reliable methodology to ensure the data integrity before the use of the data. Additionally, ongoing means of determining data integrity should be implemented, along with an ability to exclude invalid DAPs data from ATM automation systems.

States which already have experience on data integrity are encouraged to share this information with other States. The coordination team could support and harmonize this activity, and provide a standard method to evaluate the data integrity, and share the method with all the States.

5.1.4 System Integration

By introducing DAPs, the target characteristic from the source to the end user may be different compared to pre-DAPs implementation. In different phases of the processing flow of target data, DAPs can be used by different systems to improve tracking performance. Some key points in the data flow are as follows:

a) Airborne Avionics Systems

As DAPs data comes from different kinds of sensors and avionics systems on the aircraft, the reliability of the data should be ensured before the data is used operationally. Research has shown that some BDS data is missing or not updated correctly. The reasons for this need to be established, as it can mean that the use of some DAPs data is not suitable for implementation. Examples of issues include:

1) Older Flight Management Systems which do not provide all the DAPs data, and
2) Incorrect installation (e.g., onboard equipment wired to wrong registers)

b) Ground Sensor Systems

Ground sensors may use the DAPs to improve their target tracking performance, having an impact on the tracking function; the target data produced by this kind of sensors will show different characteristics to the pre-DAPs implemented tracking function, such as the turning rate, the kinematic movement and so on. Data users need to be aware of this performance improvement.

c) Ground Automation Systems

Ground automation systems can use DAPs information for a wide variety of uses, such as for tracking, safety net processing, situational awareness, en-route meteorological information sharing and so on. Ensuring DAPs information is processed and used in an appropriate way should be considered during implementation.

d) Other Surveillance Systems

Any DAPs data should be capable of being integrated with other surveillance systems data, and any potential difference and impact should be considered before use. Some of the information can be cross checked by different surveillance technologies.

e) Other Related Systems

5.2 Implementation CHECKLIST

The purpose of this implementation checklist is to document the range of activities that need to be considered to bring a DAPs application from an initial concept to operational use. Some activities of this checklist may be specific to individual stakeholders.

5.2.1 Activity Sequence

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

5.2.2 Concept Phase

a) Construct operational concept:
   1) Purpose.
   2) Operational environment.
   3) ATM functions; and
   4) Infrastructure.

b) Identify benefits:
   1) Safety enhancements.
   2) Efficiency.
   3) Capacity.
   4) Environmental.
   5) Cost reductions.
   6) Accessibility; and
   7) Other metrics (e.g., predictability, flexibility, usefulness);

c) Identify constraints:
   1) Air-Ground interoperability.
   2) Compatibility with non-equipped aircraft.
   3) Need for exclusive airspace.
   4) Required ground infrastructure.
   5) RF spectrum.
   6) Integration with existing technology.
   7) Technology availability; and
   8) Actuality of existing infrastructure.

d) Prepare business case:
   1) Cost benefit analysis; and

2) Demand and justification.

5.2.3 Design Phase

a) Identify operational requirements:

1) Security; and
2) Systems interoperability.

b) Identify human factors issues:

1) Human-machine interfaces.
2) Training development and validation.
3) Workload demands.
4) Role of automation vs. role of human.
5) Crew coordination/pilot decision-making interactions; and
6) ATM collaborative decision-making.

c) Identify technical requirements:

1) Standards development.
2) Prevailing avionics standards.
3) Data required.
4) Functional processing.
5) Functional performance.
6) Required certification levels; and
7) Identify the infrastructure that needs upgrade.

d) Equipment development, test, and evaluation:

1) Prototype systems built to existing or draft standards/specifications.
2) Upgrade and test scheme for the existing infrastructure.
3) Developmental bench and flight tests.
4) Acceptance test parameters: Acceptance test should be performed to ensure all the key indicators are met; and
5) Select and procure technology.

e) Develop procedures:

1) Pilot and controller actions and responsibilities.
2) Standardize the interaction and phraseologies.
3) Controller's responsibility to maintain a monitoring function, if appropriate.
4) System certification procedure should be made.
5) Standard Operating Procedure should be made if the human machine interface of the system is changed.
6) Contingency procedures: For example, duplicate Mode S address is detected.
7) Emergency procedures, for example ACAS message is received.

8) General procedures for unforeseen issues should be made; and
9) Develop AIP and Information documentation.

f) Prepare design phase safety case:
1) Safety rationale.
2) Safety budget and allocation; and
3) Functional hazard assessment.

5.2.4 Implementation Phase

a) Prepare implementation phase safety case.

b) Conduct operational test and evaluation:
1) Flight deck and ATC validation simulations; and
2) Flight tests and operational trials.

c) Obtain systems certification:
1) Aircraft equipment; and
2) Ground systems.

d) Obtain regulatory approvals:
1) Air traffic certification of use.

e) Impact Assessment

An impact assessment should be conducted to gauge the effect in terms of security, efficiency, operating regulations, human factors, infrastructure, environment, and so on.

f) Implementation transition:
1) Promulgate procedures.

The regulatory authority shall promulgate general regulations to the participants. Each participant shall formulate corresponding detailed regulations.

2) Deliver training.

Training should be conducted to ensure the personnel is familiar with the standard, regulation, and technology of the Mode S DAPs implementation and operation. Licensing process could be executed if needed.

3) Continue data collection and analysis.
4) Resolve any unforeseen issues; and
5) Continue feedback into standards development processes.

g) Performance monitoring to ensure that the agreed performance is maintained.

6. SYSTEM INTEGRITY AND MONITORING

6.1 Introduction

CNS and ATM environment is an integrated system including physical systems (hardware, software, and communication networks), human elements (pilots, controllers, and engineers), and the operational procedures for its applications. The integration of Mode S DAPs with other surveillance technologies enables more information from an aircraft to be used to provide a safer service.

Because of the integrated nature of such system and the degree of interaction among its components, comprehensive system monitoring is recommended. The procedures described in this section aim to ensure system integrity by validation, identification, reporting and tracking of possible problems revealed during system monitoring with appropriate follow-up actions.

6.2 Personnel Licensing and Training

Prior to operating any element of the Mode S DAPs system, operational and technical personnel shall undertake appropriate training as determined by the ANSP or State Regulatory Authority, including compliance with the Convention on International Civil Aviation where applicable. Such training will ensure that personnel are familiar with the regulation, standards and requirements of the Mode S DAPs implementation and operation.

6.3 ATS System Validation

6.3.1 Safety Assessment Guidelines

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

a) A system safety assessment for new implementations is the basis for definitions of system performance requirements. Where existing systems are being modified to utilize additional services, the assessment demonstrates that the ATS Provider’s system will meet safety objectives.

b) Integration test results confirming interoperability for operational use of airborne and ground systems; and

c) Confirmation that the ATS operation procedure is compatible with those of adjacent providers where the system is used across a common boundary.

6.3.2 System Safety Assessment

The objective of the system safety assessment is to ensure that the implementation and operation of Mode S DAPs are safe. The safety assessment should be conducted for implementation as well as any future enhancements and should include:

a) Identifying failure or error conditions.

b) Assigning levels of criticality.

c) Determining risks/probabilities for occurrence.

d) Identifying mitigating measures.

e) Categorizing the degree of acceptability of risks; and

f) Operational hazard ID process.

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

6.3.3 Integration Test

States should conduct trials with suitably equipped aircraft to ensure the DAPs data meets the operational and technical requirements to provide ATS. The introduction of the Mode S DAPs will give more information about the aircraft, and should not affect the performance of the existing system. States should be satisfied by test results and analysis carried out by the ANSP.

6.3.4 ATS Operation Manuals

States may coordinate with adjacent States to confirm that their ATS operation manuals contain standard operating procedures to ensure harmonization of procedures that impact across common boundaries.

6.4 System Monitoring

During the implementation and operation of the Mode S DAPs technology, routine collection of data is necessary to ensure that the system continues to meet or exceed its performance, safety and interoperability requirements, and that operational service delivery and procedures are working as intended.

6.4.1 Consideration for System Monitoring

Mode S transponders may have been installed a long time ago to support mandatory ACAS functionality. The Mode A/C function has been permanently used by ATC, but the Mode S functions may not have been used. Any failure impacting Mode A/C would have been detected by ATC during normal operation and corrective action would have been undertaken. Before implementing Mode S for surveillance, system checks are usually made to ensure the correct operation of the Mode S transponders (e.g., continue to correctly process Mode A/C and Mode S replies), but possibly no system checks were made to ensure that the DAPs data was correct, so several undetected failures may have existed over the years of operation.

A number of Mode S transponder from different OEMs have been observed to be non-compliant with Annex 10 Volume IV requirements (e.g., no SI code capability, no reply to aircraft register extraction, incorrectly configured aircraft address, incorrect content of BDS registers), even though the transponder is certified to level 2. Although actions have been taken in some areas (mainly where Mode S has been implemented) to address these problems, some aircraft with Mode S which are not working correctly still operate (mostly in areas where Mode S has not yet been implemented).

During the initial deployment of European Mode S, it was discovered that avionics upgrade performed on some aircraft had resulted in erroneous transponder operations so that, in some cases, the aircraft could not even be detected by the ground radar. It is therefore recommended that before commencing Mode S surveillance operations in a given airspace, system monitoring be put in place for timely detection and rectification of hidden transponder problems. This will enable the ANSP and aircraft operators to remedy identified issues prior to using Mode S operationally.

The communication lines for transferring surveillance information in a Mode S radar require much higher data throughput as there is more information per aircraft. For example, compared to a Mode A/C radar, Mode S DAPs require up to three times more data throughput.

Mode S DAPs bring safety benefits even when only a portion of the traffic is properly equipped. Some aircraft can be configured to provide additional data items, but their use should be considered with caution since some airborne installations may not have been certified, hence data may be erroneous. System monitoring to validate the transmitted information is considered desirable for DAPs operation.

6.4.2 Mode S DAPs Problem Reports

During the application of the Mode S DAPs, some problems may be found during the observation of one or more specific events. Faulty Mode S DAPs data should be recorded and analyzed. Problems may be found during the routine analysis of application data. Any problem should be documented and reported to the DAPs WG.

After a problem has been found, the finder can attempt to resolve it with the appropriate party and report the solution to the DAPs WG. The problem and solution will be distributed to the DAPs WG members. If the problem has not been resolved, the problem should be reported to the DAPs WG, and members will be encouraged to resolve the problem. In many cases, a Mode S DAPs problem will be systematic across a particular aircraft or avionics configuration. Engagement with, and correction by the manufacturer may be required.

The mode S DAPs problem should be reported with the form as shown in Table 6-1.

Table 6-1 Mode S DAPs Problem Report Form

PRS#			
Start Time/Date UTC		**End Time/Date UTC**	
Registration		**Aircraft ID**	
Flight ID		**ICAO Aircraft Address**	
Aircraft Type			
Flight Sector/ Location			
ATS Unit			
Description / additional information			
Originator		**Originator Reference number**	
Organization			

PRS#:	A unique identification number assigned by the PRS Administrator to this problem report. Organizations writing problem reports are encouraged to maintain their internal list of these problems for tracking purposes. Once the problems have been reported to the PRS and incorporated in the database, a number will be assigned by the PRS and used for tracking by the SURICG.
Start Time/Date UTC:	UTC time/date when the event started.
End Time/Date UTC:	UTC time/date when the event ended.
Registration:	Registration number (tail number) of the aircraft involved.
Aircraft ID:	Coded equivalent of call sign as entered in FPL Item 7.
Flight ID:	The Flight ID/Flight Number downlinked from the aircraft.
ICAO Aircraft Address:	Unique aircraft address expressed in Hexadecimal form.
Aircraft Type:	The aircraft model involved. For the aircraft type designators please refer to ICAO Doc 8643.

Flight Sector/Location:	The departure airport and destination airport for the sector being flown by the aircraft involved in the event. For the airport indicators please refer to ICAO Doc 7910 or related AIP. Or if more descriptive, give the location of the aircraft during the event.
ATS Unit:	ICAO identifier of the ATC center or tower controlling the aircraft at the time of the event.
Originator:	Point of contact at the originating organization for this report (usually the author).
Organization:	The name of the organization (airline, ATS provider or communications service provider) that created the report.
Description:	This should provide as complete a description of the situation leading up to the problem as is possible. Where the organization reporting the problem is not able to provide all the information (e.g., the controller may not know everything that happens on the aircraft), it would be helpful if they would coordinate with the other parties to obtain the necessary information. The description should include: a) A complete description of the problem that is being reported b) The route contained in the FMS and flight plan c) Any flight deck indications d) Any indications provided to the controller when the problem occurred e) Any additional information that the originator of the problem report considers might be helpful but is not included on the list above If necessary, to contain all the information, additional pages may be added. If the originator considers it might be helpful, diagrams and other additional information (such as printouts of message logs) may be appended to the report.

6.4.3 Example of Mode S DAPs Problem

Through monitoring, it has been reported that erroneous DAPs data have been observed due to failure or improper setting/installation of Mode S equipment. A Working Paper of the ICAO Surveillance Panel Working Group (WP ASP12-20) has indicated that a lot of incorrect, outdated and even erroneous data and parameters are present for DAPs data. The errors and/or miss-matches can be frequent, including:

a) The ACID is not always correct (erroneous)

b) The Selected Altitude is not correct or is not updated (For example Selected Altitude data should be provided by the MCP/FCU instead of the FMS as the FMS data is usually incorrect).

c) Mode S DAPs data does not correspond to the content of the requested register (BDS swap).

6.5 Application Analysis

During the Operation of Mode S DAPs application, the analysis is necessary to ensure that the system continues to meet or exceed its performance, safety, and interoperability requirements. To analyze the Mode S DAPs applications, routine data should be recorded.

6.5.1 Data Recording

It is recommended that ATS providers and communication service providers retain the records defined below for at least 30 days to allow for accident/incident investigation processes. These records should be made available on request to the relevant State safety authority. Where data is sought from an adjacent State, the usual State to State channels should be used.

Where possible these recordings shall be in a form that permits a replay of the situation and identification of the messages that were received by the ATS system. Data exchange across borders may not be possible due to different Radar or ATM message formats or to State regulatory issues.

Not only the data from ground equipment, but also the data from aircraft equipment should be recorded. By analyzing the recorded data, the exact reason for the failures can be found.

6.5.2 Local Data Collection

ATS providers and communication service providers should identify and record Mode S DAPs system component failures that have the potential to negatively impact the safety of controlled flights or compromise service continuity.

6.5.3 Avionics Problem Identification and Correction

ATS providers should develop systems or procedures to:

a) detect Mode S DAPs avionics anomalies and faults

b) advise the regulators and where appropriate the aircraft operators on the detected Mode S DAPs avionics anomalies and faults

c) devise mechanisms and procedures to address identified faults

Regulators should ensure that appropriate corrective actions are taken to address identified faults.

An example of Mode S DAPs analysis is taken in Appendix 1.

6.6 Identified Issues

Several identified issues had already been recognized during the implementation of the Mode S DAPs data application in the ATM automation system. Some of them even disrupted the operation of ATC services. Thus, it is necessary to ensure the reliability of DAPs for utilization for ATC operation. This section will present some issues for helping to figure them out.

Based on the experience gained from States, the common Mode S SSR DAPs problems are summarized under different categories in Appendix 2 ,and ADS-B DAPs problems can refer to the Appendix2 of AIGD. It is noted that many cases of the wrong DAPs found in Mode S implementation were because of the aircraft avionics capability. Some issues resulted from human factors. Experiences showed that it was important to keep close coordination with airlines to promote the DAPs application. Airlines should be informed of the issues in time and to check their aircraft Mode S transponders promptly. At the same time, airlines need to improve their working procedures including ensuring they file flight plans correctly.

7. REGULATIONS AND PROCEDURES

Mode S DAPs involve the transmission of specific data from aircraft. These data messages can be interrogated by the ground equipment (Mode S interrogator) or broadcast by the Mode S extend squitter. ATM uses the data to show the more precise and integrated situation of the surveilled aircraft. The following procedures relate to the use of Mode S DAPs data in ATS ground surveillance applications.

The implementation of the Mode S DAPs system will support the provision of high-performance surveillance, enhancing flight safety, improving the controller efficiency, and reducing the workload of both the controller and pilot.

7.1 Mandating Mode S DAPs

a) Depending on the type of operations that States are going to conduct, States will have to consider whether there is a need to publish mandates. Some operations will require all aircraft within airspace to be suitably equipped while others can still work well on a 'best equipped best served' basis.

b) Use of Multilateration on airport surface is an example of an operation where it is recommended for all aircraft to be equipped with Mode S transponders. Another example is the conspicuity code environment, where Flight Identification may be used as the prime means to couple/correlate flight plans, allowing ANSPs to overcome the shortage of Mode A codes. Equipage mandates would be necessary for such operations.

c) States intending to implement ADS-B based surveillance services may designate portions of airspace within their area of responsibility by:

   i. *mandating the carriage and use of ADS-B equipment; or*

   ii. *providing priority for access to such airspace for aircraft with operative ADS-B equipment over those aircraft not operating ADS-B equipment.*

d) With appropriate software, ATM automation systems can use Mode S DAPs to provide additional information to controllers, enabling a reduction in controller workload and the enhancement of Safety Net systems. Equipage mandates are not necessary, but consideration of the nature of the services required and/or a cost-benefit study, may warrant such mandates.

e) As of May 2018, examples of States which use Mode S SSR DAPs without publishing mandates are Australia[1], New Zealand and Singapore. Examples of States with published mandates for Mode S SSR DAPs are France, Germany and the United Kingdom.

f) In publishing mandate/regulations, States should:

   1) Define the standards applicable to the State.

      i. E.g., *Joint Aviation Authorities (JAA) Temporary Guidance Leaflets (TGL) 13 Revision 1* for Elementary Surveillance in version 0 and version 1 transponders; or
      ii. E.g., *European Aviation Safety Agency (EASA) Acceptable Means of Compliance (AMC) 20-13* for Enhanced Surveillance in version 0 and version 1 transponders; or

[1] **Australia has a mandate for Mode S transponders at selected airports utilizing Multilateration for surface surveillance, but no widespread mandates for airborne DAPs usage**

iii. E.g., *Elementary Surveillance (ELS) requirements stated in European Aviation Safety Agency (EASA) CS-ACNS-Subpart D, Section 2 (i.e., CS ACNS.D.ELS)* for Elementary Surveillance in version 2 transponder; or

iv. E.g., *Enhanced Surveillance (EHS) requirements stated in European Aviation Safety Agency (EASA) CS-ACNS-Subpart D, Section 3 (i.e., CS ACNS.D.EHS)* for Enhanced Surveillance in Version 2 transponder

v. E.g.., *Mode S level 2* if the requirement is simply for Airport Surface Multilateration.

vi. *, ADS-B avionics compliant to Version 2 ES (equivalent to RTCA DO-260B) or later version 2.*

vii. E.*g., European Aviation Safety Agency - Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHZ Extended Squitter (AMC 20-24);or*

viii.E.g., European Aviation Safety Agency - Certification Specifications and Acceptable Means of Compliance for Airborne Communications, Navigation and Surveillance Subpart D — Surveillance (SUR) (CS-ACNS.D.ADS-B);or

ix. *E.g.,* Federal Aviation Administration – Advisory Circular No: 20-165A (or later versions) Airworthiness Approval of Automatic Dependent Surveillance – Broadcast (ADS-B) Out Systems; or

x. E.*g.,* the equipment configuration standards in Appendix XI of Civil Aviation Order 20.18 of the Civil Aviation Safety Authority of Australia.

2) Define the airspace affected by the regulations

   i. E.g., *Within the [FIR Authority] Flight Information Region above Flight Level XXX*

3) Define the category of aircraft that the regulation applies to

   i. E.g., *Aircraft with a maximum certified take-off mass exceeding 5,700 kg or having a maximum cruising true airspeed capability greater than 250 kt*; or

   ii. E.g., *All IFR aircraft*

4) Define the timing of the regulations allowing sufficient time for operators to equip.

   i. E.g., *With effect from 1 Jan 2020*.

Note：More information of mandate for 1090 MHz ADS-B can refer to section 9.2 of AIGD.

7.2 Avionics

7.2.1 Mode S Transponder Capabilities

a) The various levels of capabilities for Mode S Transponders are described in subsequent paragraphs. The state should select the capability as required by its operations.

b) According to ICAO Annex 10, Vol. 4, Mode S transponders shall conform to one of five levels of capability as follows:

   1) Level 1 is the basic transponder. Level 1 permits surveillance based on Mode A/C as well as on Mode S. With a Mode S aircraft address, it comprises the minimum features for compatible operation with Mode S interrogators. It has no datalink capability and will not be used by international air traffic.

2) Level 2 has the same capabilities as Level 1 and permits standard length datalink communication from ground to air and air to ground. It includes automatic aircraft identification reporting. This is the minimum level permitted for international flights. Data parity with overlay control (ICAO Annex 10, Vol. 4, 3.1.2.6.11.2.5) for equipment certified on or after 1 January 2020.

3) Level 3 has the capabilities as level 2 and also those prescribed for ground-to-air ELM communications.

4) Level 4 has the capabilities as level 3 and also those prescribed for air-to-ground ELM communications.

5) Level 5 has the capabilities as level 4 and also those prescribed for enhanced Comm-B and ELM communications.

c) Other than the various levels, transponders also can have the following features:

1) Extended squitter - transponders that shall have the capabilities of level 2, 3, 4, or 5 and those prescribed for extended squitter operation.

2) SI Capability - Transponders with the ability to process SI codes shall have the capabilities of level 2, 3, 4 , or 5 and those prescribed for SI code operation.

3) Data flash Application – transponders that implement the data flash mode.

4) Hijack Mode Capability – transponders that support the Hijack Mode and have the capabilities of level 2, 3, 4, or 5.

5) ACAS Compatibility –transponders compatible with ACAS.

6) Antenna Diversity – in aircraft with transponder using two antennas, receivers and transmitting channels.

7) According to ED-73E, Elementary Surveillance – elementary surveillance transponders will require at least a level 2 transponder and have the following capabilities:

i. Flight status reporting
ii. Barometric pressure altitude reporting
iii. Transponder capability (CA)
iv. II and SI code capable
v. Declaration of capability (BDS code 1,0)
vi. Common usage GICB capability report (BDS code 1,7)
vii. Mode S specific services capability (BDS code 1,8 to BDS code 1,C)
viii. Flight identification (BDS code 2,0)
ix. ACAS Active Resolution Advisory (BDS code 3,0) if equipped with ACAS II
x. Aircraft register (BDS code 2,1) – optional

8) According to ED-73E, Enhanced Surveillance – enhanced surveillance transponders have the capabilities of elementary surveillance transponders, plus the capability to provide the following DAPs:

i. Magnetic Heading (BDS code 6,0)
ii. Indicated Airspeed and/or Mach No. (BDS code 6,0)
iii. Vertical Rate (climb/descend) (BDS code 6,0)
iv. True Airspeed (provided if Track Angle Rate is not available) (BDS code 6,0)
v. MCP/FCU Selected Altitude (BDS code 4,0)
vi. Ground Speed (BDS code 5,0)
vii. Roll Angle (BDS code 5,0)

viii. Track Angle Rate (if available) (BDS code 5,0)
ix. True Track Angle (BDS code 5,0)
x. Barometric Pressure Setting (BDS code 4,0)

Note：For more information of transponder capabilities for 1090 MHz ADS-B refer to section 9.2 and appendix 3 of the AIGD.

7.2.2 Mode S Transponder Mandate

During the 31st APANPIRG meeting, the following Conclusion regarding the fitment of Mode S equipage was adopted, States/Administrations may consider the following conclusion when considering the publishing of Mode S transponder mandate.

<table>
<tr><td colspan="3">Conclusion APANPIRG/31/14 (CNS SG/24/13 (SURICG/5/3(DAPS WG3/1))) - Mode S Forward Fit Equipage in APAC Region</td></tr>
<tr><td colspan="2">What: Regarding fitment of Mode S equipage,
That, States/Administrations in APAC Region be strongly encouraged to mandate that registered aircraft with a maximum certified take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 knots, with a date of manufacture on or after 1 January 2022 be equipped with Mode S avionics compliant with Enhanced Surveillance (EHS).</td><td>Expected impact:
☐ Political / Global
☐ Inter-regional
☒ Economic
☐ Environmental
☒ Ops/Technical</td></tr>
<tr><td>Why: Considering that a number of DAPs applications will require EHS and that it’s easy for new aircraft to be equipped with EHS. Retrofitting existing airframes with EHS will need further deliberation under the challenging pandemic situation.</td><td colspan="2">Follow-up: ☒Required from States</td></tr>
<tr><td>When: 16-Dec-20</td><td colspan="2">Status: Adopted by PIRG</td></tr>
<tr><td colspan="3">Who: ☒Sub groups ☒APAC States ☒ICAO APAC RO ☒APANPIRG ☐ICAO HQ ☒Other: SURICG</td></tr>
</table>

7.2.3 Transition Guidelines

a) Equipage of aircraft will be achieved over a period of time. Not all aircraft will be equipped with the necessary capability. A transition plan is required to accommodate varying degrees of aircraft equipment compliance.

b) As part of the formulation for a transition plan, States should assess the impact of having aircraft that are not suitably equipped within the affected airspace, to enable the implementation of suitable mitigating measures. States should also collect statistics on the readiness of the aircraft within the affected airspace.

c) For different operations, the mitigation measures in the transition plan could be different. For example, if the operation is just to use the Mode S DAPs to provide useful information to the controllers, the impact of having unequipped aircraft is minor. Mitigating measures could be as simple as making the controllers aware that not all aircraft are able to provide the information. On the other hand, where mode S is mandated for airport surface Multilateration, mitigating measures for having unequipped aircraft may include having special procedures for non-equipped aircraft or the deployment of a surface movement radar.

7.2.4 Mode S Transponder Working on the Ground

Table 7-1 summarizes the requirements to inhibit or not inhibit replies from aircraft on the ground.

Table 7-1 The Requirements of Transponders on Ground

Type of interrogations	Transponder reply
Mode A/C	Should be inhibited
Mode A/C/S All Call	Shall always be inhibited
Mode S only All Call (UF =11)	Shall always be inhibited
Mode S (Roll call UF=0,4,5,16,20,21,24)	Shall not be inhibited
Acquisition Squitter (Short Squitter)	Shall be inhibited if surface type of extended squitter is transmitted
Extended Squitter (Long Squitter)	Shall not be inhibited

[Information obtained from Eurocontrol's Clarification Mode S Transponder in an Airport/A-SMGCS Environment Ed 1.1 dated 3 May 2005]

a) Replies to Mode A/C/S all call and Mode S only all call interrogations shall always be inhibited when the aircraft declares the on the ground state. It shall not be possible to inhibit replies to discretely addressed Mode S interrogations regardless of whether the aircraft is airborne or on the ground.

b) Mode A/C replies should be inhibited (i.e., Mode A/C transponder set to standby) when the aircraft is on the ground to prevent interference when in close proximity to an interrogator or other aircraft. Mode S discretely addressed interrogations do not give rise to such interference. An exception on the recommendation to inhibit Mode A/C replies will be at airports having Multilateration systems working with Mode A/C.

c) Mode S transponders shall be set to the correct mode according to its flight status (i.e., airborne mode when it's in the air and ground mode when on the ground). When an aircraft is in ground mode, replies to all call are inhibited. It is recommended that aircraft provide means to determine the on-the-ground state automatically and provide that information to the transponder.

7.2.5 1090MHz Extended Squitter Transponder capability

a) According to the ICAO 1090MH ADS-B Minimum Operational Performance Standard (MOPS), in a Mode S Transponder-Based Subsystem, the ADS-B Message generation function and the modulator and 1090 MHz transmitter are present in the Mode S transponder itself. The transmit antenna subfunction consists of the Mode S antenna(s) connected to that transponder.

b) According to ICAO Annex 10, Volume 4. Extended squitter ADS-B transmission requirements. Mode S extended squitter transmitting equipment shall be classified according to the unit's range capability and the set of parameters that it is capable of transmitting consistent with the following definition of general equipment classes:

1) Class A extended squitter airborne systems support an interactive capability incorporating both an extended squitter transmission capability (i.e., ADS-B OUT) with a complementary extended squitter reception capability (i.e., ADS-B IN) in support of onboard ADS-B applications.

2) Class B extended squitter systems provide a transmission only (i.e., ADS-B OUT without an extended squitter reception capability) for use on aircraft, surface vehicles, or fixed obstructions; and

3) Class C extended squitter systems have only a reception capability and thus have no transmission requirements.

c) According to the ICAO 1090Mhz ADS-B Minimum Operational Performance Standards (MOPS), the 1090ES ADS-B transponder has 4 versions, which included:

1) RTCA DO-260/EUROCAE ED-102 (Version 0)

The International Civil Aviation Organization issued the 1090ES ADS-B initial standard "Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B)" (DO-260/ED-102) in September 2000, and was known as ADS-B version 0.This version defines the 1090 MHz ADS-B Transmitting Subsystem takes position, velocity, status, and intent inputs from other systems onboard the aircraft and transmits this information on the 1090 MHz frequency as Mode S Extended Squitter messages.

According to DO-260/ED-102, the 1090ES transponder should send State Vector (SV), Mode Status (MS) Reports, and support the following DAPs capabilities:

i. airborne position (BDS 0,5).
ii. surface position (BDS 0,6).
iii. identification and type (BDS 0,8).
iv. airborne velocity (BDS 0,9).
v. emergency/priority status (BDS 6,1).
vi. Current/Next Trajectory Change Point (TCP) (BDS 6,2).
vii. Current/Next Trajectory Change Point (TCP+1) (BDS 6,3).
viii. Aircraft Operational Coordination Message (BDS6,4).
ix. Aircraft operational status (BDS 6,5).

2) RTCA DO-260A (Version 1)

The International Civil Aviation Organization issued “Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)” (RTCA DO-260A) in April 2003, and was known as ADS-B version 1, The formats and protocols for 1090 ES were revised in part to overcome the limitation of the reporting of surveillance quality using only navigation uncertainty category (NUC). In the revised formats and protocols, surveillance accuracy and integrity are reported separately as:

i. navigation accuracy category (NAC),
ii.navigation integrity category (NIC), and
iii.surveillance integrity level (SIL).

Other features added in Version 1 messages include the reporting of additional status parameters and formats for traffic information service — broadcast and ADS-B rebroadcast (ADS-R). Version 1 formats are fully compatible with those of Version 0, in that a receiver of either version can correctly receive and process messages of either version.

According to D0-260A, the 1090ES ADS-B transponder should send State Vector (SV), Mode Status (MS), Target state (TS), Air Reference Velocity (ARV) Reports, and support the following DAPs capabilities:

i. airborne position (BDS 0,5).
ii. Surface Position (BDS 0,6).
iii. Aircraft Identification and Category (BDS 0,8).
iv. Airborne Velocity (BDS 0,9).
v. Aircraft Status (BDS 6,1).
vi. Target State and Status (BDS 6,2).
vii. Aircraft Operational Status (BDS 6,3).

3) RTCA DO-260B/EUROCAE ED-102A (Version 2)

The International Civil Aviation Organization issued "Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)" (DO-260B/ED-102) in December 2009, and was known as ADS-B version 2. The formats and protocols for 1 090 ES Version 2 were revised based on experience gained from operational usage with ADS-B that revealed a number of needed improvements, which included:

i. separated reporting of source and system integrity.
ii. additional levels of NIC to better support airborne and surface applications.
iii. incorporation of the broadcast of the Mode A code into the emergency/priority message, increased transmission rates after a Mode A code change, and the broadcast of the Mode A code on the surface.
iv. revision to the target state and status message to include additional parameters.
v. eliminated the vertical component of NIC and NAC.
vi. T = 0 position extrapolation accuracy changed from within 200 ms of the time of transmission to within 100 ms; and
vii. capabilities were added to support airport surface applications.

According to D0-260B/ED-102A, the 1090ES ADS-B transponder should send State Vector (SV), Mode Status (MS), Target State (TS) and Air Reference Velocity (ARV) Reports, and support the following DAPs capabilities:

i. Airborne Position (BDS 0,5).
ii. Surface Position (BDS 0,6).
iii. Aircraft Identification and Category (BDS 0,8).
iv. Airborne Velocity (BDS 0,9).
v. Aircraft Status (BDS 6,1).
vi. Target State and Status (BDS 6,2).
vii. Aircraft Operational Status (BDS 6,5).

7.3 Extract Mode S SSR DAPs using a MODE S Interrogator

7.3.1 Working Principles

The Mode S interrogator transmits interrogation to elicit replies for detection of Mode S transponders and more information from the aircraft. The use of a unique ICAO 24-bit aircraft address and provision of all the required aircraft data in one reply will reduce interrogation rates.

Each aircraft can be interrogated selectively, needing only one or two ‘hits’ per aircraft per scan and minimizing interference problems associated with SSR Mode A/C.

The operation of a Mode S interrogator will not interfere with the SSR performance of any aircraft equipped with a Mode A/C transponder.

A Mode S interrogator is capable of performing the conventional surveillance function with Mode A/C transponders.

7.3.2 Interrogator Codes

The Mode S system requires each interrogator to have an IC, which can be carried within the uplink and downlink transmissions. The 4-bit IC uplink field in UF11 shall contain either 4-bit II code or the lower 4 bits of the 6-bit SI codes. It is recommended that whenever possible an interrogator should operate using a single interrogator code.

The II codes shall be assigned to interrogators in the range from 0 to 15. The II code value of 0 shall only be used for supplementary acquisition. The SI codes shall be assigned to interrogators in the range from 1 to 63. The SI code value of 0 shall not be used.

The assignment of interrogator II or SI codes, where necessary in areas of overlapping coverage, across international boundaries of flight information regions, shall be the subject of regional air navigation agreements. The ICAO Asia Pacific Regional Office maintains a register of II codes used – where States have provided this information to the office. States are encouraged to provide this information to the Regional Office and update it when changes are made.

7.3.3 Mode Interlace Pattern

The particular air traffic and environment of each interrogator will influence the selection of suitable interrogation periods, interrogation repeat frequency, MIP and Probability of Reply.

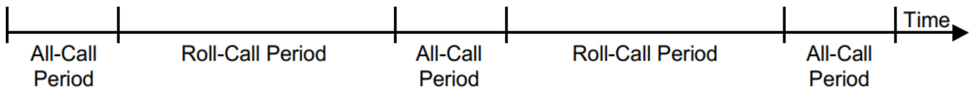

Figure.7-1 The Typical MIP

The repetition frequency and duration of the All-Call period is a local implementation issue (the stated ICAO maximum is 250Hz). The exact duration of either period will depend on the characteristics of the system such as the antenna revolution rate, the beam-width and the maximum range. There will normally be several all-call periods (and hence roll-call periods as one will always follow the other) available to interrogate all targets in range during one revolution.

There is a careful balance between the reliable acquisition of all targets and the potential of flooding the RF environment with unwanted replies to acquisition interrogations. It is necessary to choose an appropriate Mode Interlace Pattern to manage the acquisition activities to ensure minimal interference. The default objective is to define a MIP which effectively detects and performs surveillance on classical SSR Mode A/C aircraft using Mode A/C interrogations which also detects and acquires Mode S aircraft using Mode S interrogations. The MIP is constructed in order to separate Mode A/C and Mode S all-calls from Mode S selective (roll-call) activity. MIP defines the sequences of all-call interrogation types that might be made during cycles of all-call periods. Every interrogator is likely to have different needs and hence different ways of operating.

China presented an IP about the Mode S Parameter Set during the 3rd meeting of DAPs WG. For detailed information please refer to Appendix 4.

7.3.4 Mode S SSR DAPs Extraction using GICB Protocol

The GICB procedure is initiated by a Mode S interrogator for eliciting the Mode S DAPs containing aircraft derived data from a Mode S aircraft installation.

The GICB protocol allows for the immediate transfer of data required by the ground and the extraction of information stored in the Mode S transponder. This information (if available) is contained in the reply to an interrogation specifying the address (BDS code) of the storage location containing that information.

The interrogation with specific BDS can elicit the corresponding Comm-B data where contained in Mode S transponder's registers. The Mode S DAPs can be implemented in two stages: ELS and EHS.

The first processing step for any Mode S data link application is to obtain the transponder CA value from the aircraft. The 3-bit CA field is found in the "Mode S All-Call Reply" (DF=11) and the "Extended Squitter" (DF=17) downlinks. If CA=0, then this transponder is surveillance-only and supports no data link functions at all. If CA⩾4 indicates that the Mode S transponder is fully capable of at least 56-bit short uplink and downlink message transfer. These Mode S transponders may support the ELS, EHS requirements. The values of CA= 1, 2, 3 are reserved.

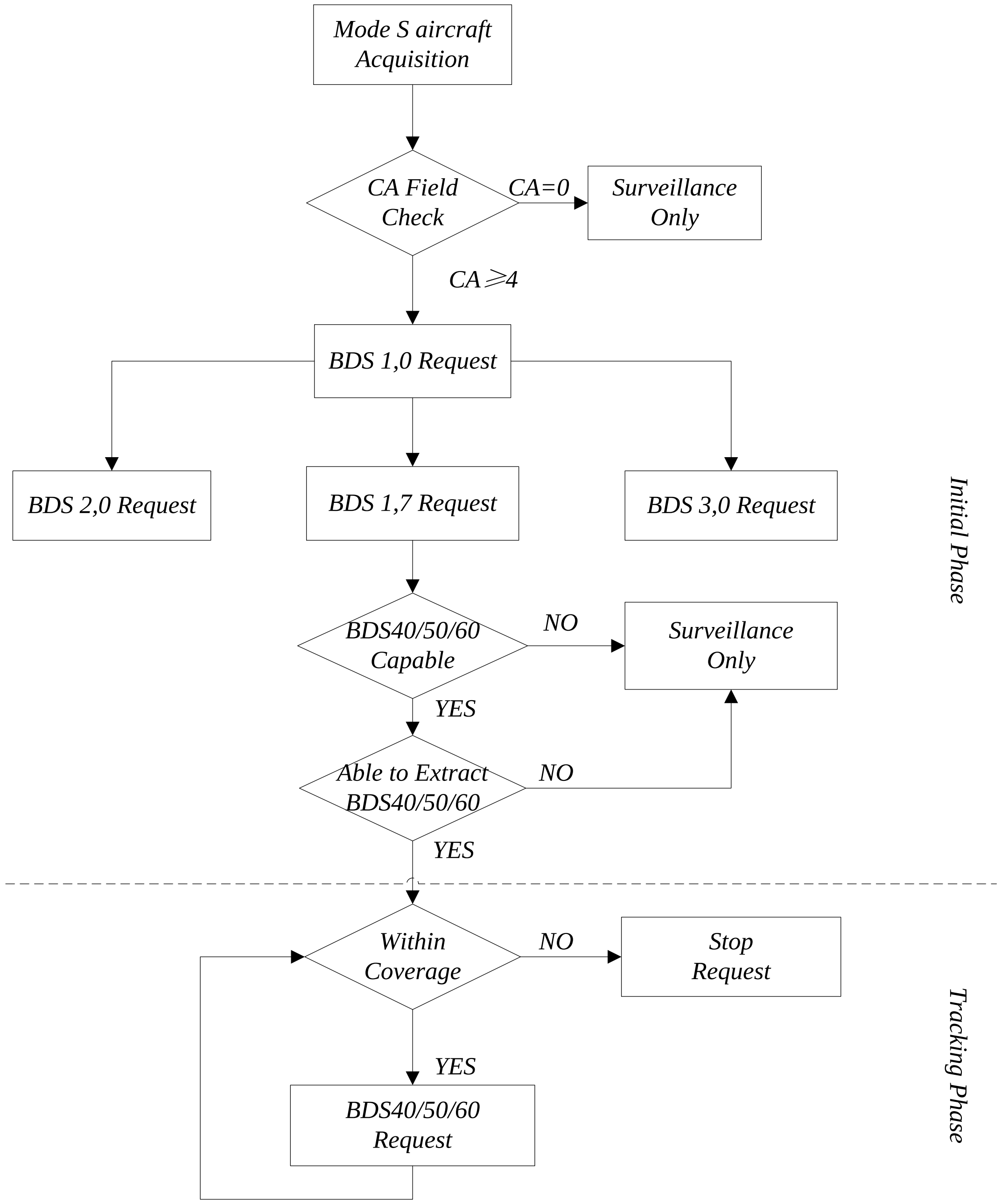

Figure.7-2 The Typical Procedure of DAPs Extraction

Given that the Mode S transponder's CA value is 4 or greater, the second processing step for any Mode S data link application is to extract the transponder's Mode S data link capability report register BDS code

1,0. Bits in this register indicate the support of such Mode S data link functions as aircraft identification (register BDS code 2,0), ACAS (register BDS code 3,0), common-usage capability (register BDS code 1,7) etc. The Mode S-Specific services capability bit in register BDS code 1,0 indicates whether the avionics installation supports further data link functions. If this bit is set, the Mode S data link application would next extract the common-usage capability register BDS code 1,7. All of the registers involved with the EHS application have bit flags assigned in this register BDS code 1,7. If the bit flag is set, it indicates that the corresponding register has been updated in a timely manner and contains valid data which can be extracted by the interrogator. The processing protocol is sufficient initialization for basic data link applications such as ELS, EHS since all their status and configuration information is available from register BDS code 1,0 and register BDS code 1,7.

So, the Mode S interrogator should transmit the selective interrogation to elicit the Mode S transponder reply with the specific formats and Comm-B data contained in the corresponding registers.

Normally, the more Comm-B data requested by the Mode S interrogator, the more information can be extracted from the aircraft transponder registers. It will also help the ATC controller get the aircraft's flight status and flight intention. However, there should be some necessary limitations for the Comm-B data request to avoid the phenomenon of Comm-B data discontinuity because of the limited Roll-Call interrogation duration.

It is suggested that the number, periodicity and priority of BDS data extraction rule be reasonably and effectively implemented according to the requirements and the number of aircraft in the airspace. The scientific strategy can ensure the ATC controller gets Comm-B data timely and effectively.

7.3.5 Mode S SSR DAPs Extraction using AICB Protocol

The AICB procedure is initiated by a Mode S transponder for transmitting a single Comm-B segment from the aircraft installation.

Any changes in the contents of ACAS (register BDS code 3,0) triggers a downlink message via the air-initiated Comm-B broadcast protocol including the updated register contents.

An AICB sequence shall start upon the acceptance of a message intended for delivery to the ground sensor. After receipt of this message, the transponder shall set a valid downlink request code of surveillance or Comm-B reply. On receipt of this message with a valid downlink request code, the interrogator could start to extract the message.

AICB messages are announced by the transponder and are transmitted in a subsequent reply only after authorization by the interrogator. AICB messages are announced to all interrogators and can be extracted by any interrogator. The Mode S data link application should update the aircraft's "state" values with the new ones. The changed state might result in discontinuance (or reinstatement) of certain Mode S data link functions. Mode S transponder AICB broadcast messages are held active in the transponder for 18 seconds after the triggering event. Any Mode S sensor can extract the broadcast information.

7.3.6 Mode S SSR DAPs Extraction using Comm-B Broadcast

A Comm-B broadcast is a message directed to all active interrogators in view. Messages are available for 18 seconds unless a waiting AICB interrupts the cycle. Interrogators have no means to cancel the Comm-B broadcast.

Currently, only registers of datalink capability report (register BDS code 1,0) and aircraft identification (register BDS code 2,0) make use of the Comm-B Broadcast.

7.3.7 Error Protection

An error may occur in the reception of an interrogation or a reply.Mode S interrogations and replies use cyclic polynomial methods to detect errors. A sequence of 24 parity check bits shall be generated by a modulo-2 division of the content of the message by a generator polynomial. The content of the message is bits ($m_1,m_2,...,m_k$) where k is 32 for short transmission or 88 for long transmission. The generator polynomial is $G(x) = 1+ x^3 + x^{10} + x^{12} + x^{13} + x^{14} + x^{15} + X^{16} + x^{17} + x^{18} + x^{19} + x^{20} + x^{21} + x^{22} + x^{23} + x^{24}$.

At the encoder, the content sequence appends 24 zero bits is divided by *G(x)* to result a remainder.

At the ground station encoder, the remainder is uplinked in the AP field. It shall be modulo-2 added with the most significant 24 bits of the 48-bit sequence generated by multiplying *A(x)* by *G(x)*, where *A(x)* is the aircraft address sequence or 24 one bits.

At the transponder encoder, the remainder is downlinked in the AP field of DF0/4/5/16/20/21/24, or in the PI field of DF11/17/18. The AP field shall contain the remainder overlaid on the aircraft address. The PI field shall have the remainder overlaid on the interrogator’s identity code. If the reply is made in response to a Mode A/C/S all-call, a Mode S-only all-call with CL field and IC field equal to 0. If it is an acquisition or an extended squitter, the II and the SI codes shall be 0.

At the ground station decoder, the whole transmission is divided by the same generator polynomial. If the received message is one of DF0/4/5/16/20/21/24, the remainder is added (compare) to the expected 24-bit aircraft address to produce the error syndrome. If the syndrome is ALL ZEROs, an error-free message was received. If the syndrome is non-zero, a single error or error burst is present. The error correction procedure uses the message bit sequence, the initial error syndrome and the confidence bit sequence.# NOTE: For more detailed information please refer to *ICAO Doc 9924 Aeronautical Surveillance Manual (Third Edition 2020), Appendix G: Mode S Error Detection and Correction.*

7.4 Provision of ADS-B DAPs using extended squitter

7.4.1 Working Principles

The “1090 Extended Squitter” is a spontaneous broadcast transmission by the Mode S transponder on the 1090 MHz frequency not initiated by an interrogation on 1030 MHz. The “Automatic Dependent Surveillance – Broadcast (ADS-B)” is a function of airborne or surface aircraft, or other surface vehicles operating in the airport surface area, that periodically transmits its state vector (horizontal and vertical position, horizontal and vertical velocity) and other information via a data link.

The 1090 Extended Squitter allows the transmission of ADS-B messages by means of 1090 Extended Squitter via 1090 MHz. The ADS-B message is formatted data that conveys information used in the development of ADS-B reports that can be used for air traffic management activity. The ADS-B reports can support improved use of airspace, surface surveillance, and enhanced safety such as conflict management.

There are four defined standards for the ADS-B 1090 ES applications. These standardizations were consistent with RTCA/DO-260, RTCA/DO-260A, RTCA/DO-260B and RTCA/DO-260C were termed 1090 ES Version 0, Version 1, Version 2 and Version 3. (1090 ES Version 3 has just been released in December 2020.)

The differences between the first three versions are mainly in the following two areas: (a) its specification of the ADS-B “event driven” transponder register set, and (b) how available avionics surveillance accuracy is specified.

7.4.2 ADS-B Message content

The Mode S transponder has 255 BDS registers. Each register stores aircraft parameters, message or data derived from FMS or other sensors. Some specific registers are defined for the ADS-B application so that related messages can be delivered via ADS-B message broadcast activity.

Table 7-2 Registers Related to ADS-B Application

<table>
<tr><th>Register</th><th colspan="6">Content</th></tr>
<tr><td rowspan="7">BDS code 0,5</td><td colspan="2">Version0</td><td colspan="2">Version1</td><td colspan="2">Version2</td></tr>
<tr><td colspan="6">Airborne Position Message</td></tr>
<tr><td colspan="4">Single Antenna Flag</td><td colspan="2">NIC Supplement-B</td></tr>
<tr><td colspan="6">Airborne Position</td></tr>
<tr><td colspan="6">Pressure Altitude</td></tr>
<tr><td colspan="6">GNSS Height</td></tr>
<tr><td colspan="6">Surveillance Status</td></tr>
<tr><td rowspan="5">BDS code 0,6</td><td colspan="2">Version0</td><td colspan="2">Version1</td><td colspan="2">Version2</td></tr>
<tr><td colspan="6">Surface Position Message</td></tr>
<tr><td colspan="2">Ground Track</td><td colspan="4">Heading</td></tr>
<tr><td colspan="6">Surface Position</td></tr>
<tr><td colspan="6">Movement</td></tr>
<tr><td rowspan="4">BDS code 0,8</td><td colspan="2">Version0</td><td colspan="2">Version1</td><td colspan="2">Version2</td></tr>
<tr><td colspan="6">Aircraft Identification and Type Message</td></tr>
<tr><td colspan="6">Aircraft Category</td></tr>
<tr><td colspan="6">Aircraft Identification</td></tr>
<tr><td rowspan="11">BDS code 0,9</td><td colspan="2">Version0</td><td colspan="2">Version1</td><td colspan="2">Version2</td></tr>
<tr><td colspan="6">Airborne Velocity Message</td></tr>
<tr><td colspan="2">NUC_R</td><td colspan="4">NACv</td></tr>
<tr><td colspan="4">IFR Capability Flag</td><td colspan="2">-</td></tr>
<tr><td colspan="3">Subtypes 1 and 2:Velocity Over Ground</td><td colspan="3">Subtypes 3 and 4:Airspeed and Heading</td></tr>
<tr><td colspan="3" rowspan="2">Ground Speed Vector</td><td colspan="3">Air Speed</td></tr>
<tr><td colspan="3">Heading</td></tr>
<tr><td colspan="6">Intent Change Flag</td></tr>
<tr><td colspan="6">Ground Speed Vector</td></tr>
<tr><td colspan="6">Vertical Rate</td></tr>
<tr><td colspan="6">Difference from Baro Altitude</td></tr>
<tr><td rowspan="5">BDS code 6,1</td><td colspan="2">Version0</td><td colspan="2">Version1</td><td colspan="2">Version2</td></tr>
<tr><td colspan="6">Aircraft Status Message</td></tr>
<tr><td colspan="5">Subtype 1:Emergency/Priority Status</td><td>Subtype 2:1090ES TCAS RA Broadcast</td></tr>
<tr><td colspan="5">Emergency Status</td><td rowspan="2">ACAS RA Report</td></tr>
<tr><td colspan="4">-</td><td>Mode A Code</td></tr>
<tr><td>BDS code 6,2</td><td colspan="2">Version 0</td><td colspan="2">Version 1</td><td colspan="2">Version 2</td></tr>
</table>

<table>
<tr><td rowspan="8"></td><td>Current/Next Trajectory Change Point(TCP) Message</td><td colspan="4">Target State and Status Information Message</td></tr>
<tr><td rowspan="7">TCP data</td><td colspan="2">Target Altitude</td><td colspan="2">Selected Altitude</td></tr>
<tr><td colspan="2" rowspan="2">-</td><td colspan="2">SIL Supplement</td></tr>
<tr><td colspan="2">Barometric Pressure Setting</td></tr>
<tr><td colspan="2">Track Heading / Track Angle</td><td colspan="2">Selected Heading</td></tr>
<tr><td colspan="2">Emergency/Priority Status</td><td colspan="2">Mode Engaged（Autopilot VNAV Altitude Approach LNAV）</td></tr>
<tr><td colspan="2">Capability/Mode Code</td><td colspan="2">TCAS Operational</td></tr>
<tr><td colspan="4">NAC$_P$ 、SIL、NIC$_{BARO}$</td></tr>
<tr><td rowspan="11">BDS code 6,3</td><td>Version 0</td><td colspan="2">Version 1</td><td colspan="2">Version 2</td></tr>
<tr><td rowspan="2">Current/Next Trajectory Change Point Message(TCP+1)</td><td colspan="2">Aircraft Operational Status Message</td><td colspan="2" rowspan="10">-</td></tr>
<tr><td>Subtype 0</td><td>Subtype 1</td></tr>
<tr><td rowspan="8">TCP+1 Data</td><td rowspan="2">Airborne Capability Class</td><td>Surface Capability Class</td></tr>
<tr><td>Length/Width Codes</td></tr>
<tr><td>NIC$_{BARO}$</td><td>TRK/HDG</td></tr>
<tr><td colspan="2">Operational Mode OM</td></tr>
<tr><td colspan="2">Version Number</td></tr>
<tr><td colspan="2">NIC Supplement</td></tr>
<tr><td colspan="2">NAC$_P$、SIL</td></tr>
<tr><td colspan="2">HRD</td></tr>
<tr><td rowspan="5">BDS code 6,4</td><td>Version 0</td><td colspan="2">Version 1</td><td colspan="2">Version 2</td></tr>
<tr><td>Aircraft Operational Coordination Message</td><td colspan="4">-</td></tr>
<tr><td>Paired Address</td><td colspan="4" rowspan="3">-</td></tr>
<tr><td>Runway Threshold Speed</td></tr>
<tr><td>Roll Angle</td></tr>
<tr><td rowspan="6">BDS code 6,5</td><td>Version 0</td><td colspan="2">Version 1</td><td colspan="2">Version 2</td></tr>
<tr><td>Aircraft Operational Status Message</td><td colspan="2">-</td><td colspan="2">Aircraft Operational Status Message</td></tr>
<tr><td rowspan="4">CC</td><td colspan="2" rowspan="4">-</td><td>Subtype = 0</td><td>Subtype = 1</td></tr>
<tr><td rowspan="2">Airborne Capability Class</td><td>Surface Capability Class</td></tr>
<tr><td>Length/Width</td></tr>
<tr><td>Airborne O[erational Mode</td><td>Surface Operational Mode</td></tr>
</table>

			GVA	-
			NIC_{BARO}	TRK/HDG
			Version Number	
	OM		NIC Supplement-A	
			NAC_P、SIL	
			SIL Supplement	
			HRD	

As shown in the above table, all the versions of 1090 ES application involve the 7 basic registers (Airborne Position, Surface Position, ES Status, ES Identification and Category ES Airborne Velocity ES Event Driven Register and ES Aircraft Status). The remaining registers (BDS code 6,2, BDS code 6,3, BDS code 6,4) in the table have different definitions and applications for the three versions of 1090 ES application. Generally, for version 0, only five registers (BDS code 0,5, code 0,6, code 0,8, code 0,9 and BDS code 6,1) will be broadcast. In addition to the above five registers, version 1 will also broadcast message about BDS code 6,2 and code 6,3, while version 2 will broadcast message about BDS code 6,2 and code 6,5 additionally.

Table 7-3 ADS-B Message

Version	Common usage ADS-B Message
0,1,2	ES Airborne Position
	ES Surface Position
	ES Identification and Category
	ES Airborne Velocity
	ES Aircraft Status / Type Code=28
1,2	Target State and Status Information / BDS code 6,2/Type Code=29
1	Aircraft Operational Status / BDS code 6,3/Type Code=31 for version 1
2	Aircraft Operational Status /BDS code 6,5/Type Code=31 for version 2

The three versions of the ADS-B application have different definitions of surveillance accuracy and the application of “event-driven” register messages. Therefore, the prerequisite for the correctly decoding the surveillance accuracy information and “event-driven” messages is the determination of the 1090 ES version.

There are two steps to check the ADS-B version, due to the fact that ADS-B version information in version 0 is not included in any message. ***Step 1***: Check whether an aircraft is broadcasting ADS-B messages with Aircraft Operational Status message (Type Code=31) at all. If no message is ever reported, it is safe to assume that the version is equal to “0”. ***Step 2***: If messages with Type Code =31 are received, check the version numbers located in the bits 41–43 in ME (or bits 73–75 in the message). The bits “001” correspond to version 1 and “010” to version 2 respectively.

7.4.3 ADS-B message Transmission Broadcast rate

The maximum ADS-B Message transmission rate shall not exceed 6.2 transmitted messages per second averaged over any 60 second interval. **There are periodic messages which are broadcast in the periodic manner and event-driven messages which are broadcast following the event-driven protocol. The event-driven protocol limits event-driven message transmissions to 2 per second in any second.**

a) **Airborne position Message (Version 0, 1, 2) is a periodic message, and** shall be emitted at random intervals that are uniformly distributed over the range from 0.4 to 0.6 seconds.

b) **Surface position Message (Version 0, 1, 2)** is a periodic message, and shall be emitted using one of two rates (high or low rate). The low rate is used when the aircraft is stationary, the high rate is used when the aircraft is moving. When the high squitter rate has been selected, the transmission interval of the surface position message obeys a uniform distribution within the interval of 0.4 to 0.6 seconds, and when the low squitter rate is used, it shall be emitted at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds.

c) **Aircraft identification Message (Version 0, 1, 2) is a periodic message,** which transmission interval follows a uniform distribution over 4.8 to 5.2 seconds when the aircraft is reporting the airborne position message, or when the aircraft is reporting the surface position message at the high rate (moving). When the surface position message is being broadcasted at the low rate (stationary), the message shall be emitted at random intervals that are uniformly distributed over the range of 9.8 to 10.2 seconds.

d) **Airborne velocity Message ((Version 0, 1, 2) is a periodic message, and** shall be emitted at random intervals that are uniformly distributed over the range from 0.4 to 0.6 seconds.

e) **Target State and Status Message (Version 1, 2) is delivered using the event-driven protocol in version 1 and is periodic message in version 2, and** shall be initiated only when the aircraft is airborne and when target state (vertical or horizontal) information is available and valid. The TSS Message shall be broadcast at random intervals with the uniformly distributed over the range of 1.2 to 1.3 seconds.

f) **Aircraft Operational Status Message –Airborne is delivered using the event-driven protocol in version 1 and is periodic message in version 2, and** shall be emitted for a period of 24 seconds at random intervals that are uniformly distributed over the range of 0.7 to 0.9 seconds, when the Target State and Status (TSS) Message is not being broadcast and there has been a change within the past 24 seconds in the value of one or more of the specific parameters (*TCAS Operational/TCAS RA Active/ NAC_P/SIL for **Version 1** and TCAS RA Active/NAC_P/SIL/NIC_{SUPP} for **Version 2***) included in the Operational Status Message.

For other case when there is not any change within the past 24 seconds in the value of the specific parameters mentioned previous paragraph, the transmission interval of the message obeys a uniform distribution within the interval of 2.4 to 2.6 seconds.

g) **Aircraft Operational Status Message –Surface is delivered using the event-driven protocol in version 1 and is periodic message in version 2, and** shall be always broadcast at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds for **Version 1**. For **Version 2**, the Surface Aircraft Operational Status Messages shall be broadcast at random intervals that are uniformly distributed over the range of 4.8 to 5.2 when the aircraft is on-ground and not moving. If the Aircraft is moving and there has been no change in the specific parameters (*NIC_{SUPP} / NAC / SIL*) then the message shall be broadcast at random intervals that are uniformly distributed over the range of 2.4 to 2.6 seconds for Version 2. When the Version 2 aircraft is on-ground and moving and there has been a change in the parameters mentioned above then the message shall be broadcast at random intervals that are uniformly distributed over the range of 0.7 to 0.9 seconds.

h) **Extended Squitter Aircraft Status message (Version 0)** is an event-driven message, and shall be broadcast at random intervals that are uniformly distributed over the range of 0.8 to 1.2 seconds for the duration of the emergency condition (temporary or permanent). If the Mode A Code is changed to 7500, 7600 or 7700, the duration of emergency condition shall be permanent. If the Mode A Code is changed to any other value, the emergency condition shall be temporary, and duration is equal to 18 seconds (TC).

i) **Extended Squitter Aircraft Status message (Version 1) is an event-driven message, and the** transmission rate varies depending on whether the TSS Message is not being broadcast, versus being broadcast.

In the case where the TSS Message is not being broadcast, the Extended Squitter Aircraft Status message shall be broadcast at random intervals that are uniformly distributed over the range of 0.7 to 0.9 seconds for the duration of the emergency condition. It shall be broadcast at random intervals that are uniformly distributed over the range of 2.4 to 2.6 seconds for the duration of the emergency condition, when the TSS Message is being broadcast.

j) **Extended Squitter Aircraft Status message with Subtype=1 (Version 2)** is an event- driven message, and shall be broadcast at random intervals that are uniformly distributed over the range of 0.7 to 0.9 seconds for the duration of the emergency condition, or the Message shall not be broadcast (no emergency condition established), When the Mode A Code transmission is disabled (be set to Mode S Conspicuity Code “1000”).

When the Mode A Code transmission is enabled, the Aircraft Status message with Subtype=1 shall be broadcast at random intervals that are uniformly distributed over the range of 0.7 to 0.9 seconds for a duration of 24 ±1 seconds following a Mode A Code change by the pilot.

In the absence of conditions above for version 2, the Message shall be broadcast at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds.

The Aircraft Status Message with Subtype=2 (TCAS RA Broadcast) for version 2 shall be broadcast at random intervals that are uniformly distributed over the range of 0.7 to 0.9 seconds. The transmission shall be terminated 24 ±1 seconds after the *Resolution Advisory Termination* (RAT) flag transitions from ZERO (0) to ONE (1).

7.5 Application of the Mode S DAPs in ATM Automation System

7.5.1. Implementation of the General DAPs information

General DAPs information refers to the information that both Mode S SSR, MLAT and ADS-B can provide. This information from aircraft can be beneficial to the ATM automation system:

a) ICAO 24-bit Aircraft Address/Aircraft Identification

1) The ATM automation system should collect the real aircraft address/aircraft identification from the received message, and the aircraft address/aircraft identification can be shown on the control HMI to identify the aircraft.

2) The ATM automation system can use the aircraft address/aircraft identification to correlate an aircraft’s track with the flight plan, so the use of aircraft address/aircraft identity can alleviate the shortage of Mode 3/A code. Correlation between track and flight plans is normally based on either the 24-bit aircraft address, aircraft identification, or the Mode 3/A code. The correlation will depend on their weights and priority.

3) The ATM automation system can also utilize the aircraft address/aircraft identification to improve the tracking function.

4) The ATM automation system could provide DUPE warning between aircrafts which have the same ICAO 24-bit aircraft address, same aircraft identification or the same Mode 3/A code.

b) Altitude reporting in 25ft interval

The ATM automation system can collect aircraft altitude reporting in 25ft increments and provides valuable improvements to the quality of safety nets. The improvements should reduce the number of nuisance alerts and enhance the integrity of separation assurance.

c) Selected Altitude

1) The ATM automation system can collect the selected altitude of the aircraft from Mode S SSR DAPs BDS 4,0 or ADS-B DAPs BDS 6,2 (Version 2) that can be shown to the controller to improve the situational awareness of the controller.

2) The ATM automation system can generate a SFL Mismatch Alarm when the SFL chosen by the crew does not match the cleared altitude given by the controller (CFL), alerting the controller to take appropriate action to remedy the issue. A SFL Mismatch Alarm shall be presented to the responsible controller as an indication in the coupled/correlated surveillance track label and in the associated flight strip.

3) The ATM automation system can also utilize the SFL to improve the accuracy of the safety net.

In MTCD function, the ATM automation system can use the selected altitude as the target climbing/descending altitude in the flight look-ahead time, and calculate the possibility of conflict with the predicted flight trajectories of other flights in the airspace through trajectory prediction. Calculations involving SFL could be more accurate, and improve the performance of MTCD.

In MSAW function, the ATM automation system generally provides MSAW warning by using track data (heading and rate of climb/descent and mode c). The ATMs use of CFL or SFL can enhances the MSAW algorithms use of vertical data to predict MSAW alerts and reduce the number of false alerts.

It is important to note that, in a given situation, there is a possibility of inconsistency between the selected altitude and the target height indicating the actual vertical intent. When using the selected altitude for prediction and warning, we still need to continuously monitor whether the actual trajectory is consistent with the selected altitude.

d) Barometric Pressure Setting

The ATM automation system can collect the barometric data of the aircraft from Mode S SSR DAPs BDS 4,0 or ADS-B DAPs BDS 6,2 (Version 2) and provide this information to the controller. The system can provide a warning when the barometric data transmitted by the aircraft does not match the parameter of the area where the aircraft is operating.

e) Ground Speed, True Track Angle, Magnetic Heading, True Airspeed

1) The ATM automation system can collect Ground Speed, True Track Angle from Mode S SSR DAPs BDS 4,0 or ADS-B DAPs BDS 0,9 and 0,6, True Airspeed from Mode S SSR DAPs BDS 5,0 or ADS-B DAPs BDS 0,9 (if ground speed is unavailable), Magnetic Heading from Mode S SSR DAPs BDS 6,0 or ADS-B DAPs BDS 0,9 (if ground speed is unavailable).The system may provide the display of some of the information to the controller to improve the situational awareness of the controller. This information can be displayed in various ways (e.g., a DAP Window) as offline defined, according to the requirement of the controllers. Display of some parameters provides a clearer picture to the controllers generating a reduction in radio calls with the pilot, so the R/T usage between the controller and individual aircraft under service is reduced.

2) The system can make use of DAPs kinematics parameters for consistency checking, and perform a more precise tracking function.

3) The system can utilize the kinematics information of the aircraft to improve the accuracy of safety net functions, (e.g., Short-Term Conflict Alert (STCA)), through the provision of more accurate aircraft tracks.
4) The system may use True track angle, Magnetic Heading, True Airspeed and Ground Speed to calculate a wind direction and speed of a specific area, which will enable the updating of forecast winds and improve trajectory modeling in the system. The system may also show the wind information to the controller to improve the situational awareness of the controller.

f) Barometric Altitude Rate

The ATM automation system can collect the vertical rate data of the aircraft from Mode S SSR DAPs BDS 4,0 or ADS-B DAPs BDS 0,9 to improve the precision of the compute altitude and the accuracy of the related alert. The system can make use of the data to realize an optimized CFL protection in STCA and MSAW analysis function.

g) Indicated Air Speed

The ATM automation system can acquire indicated airspeed of the aircraft from Mode S SSR DAPs BDS 6,0 or ADS-B DAPs BDS 0,9 (if ground speed is unavailable), allow ATC to monitor the aircrew compliance with the controller's instructions, and if required provide a warning to the controller when there is a mismatch.

h) ACAS Resolution Advisory Report

Some of the ATM automation system can collect the ACAS Resolution Advisory Report from Mode S SSR DAPs BDS 3,0 or ADS-B DAPs BDS 6,5 (Version 2). The ACAS Resolution Advisory information can be shown in the system to improve situational awareness of the controller. On receipt of ACAS Resolution Advisory notification, a prominent notification is displayed in a field that may be acknowledged. The indication is removed when the ACAS RA is resolved.

Note: The display of ACAS Resolution Advisory Report in ATM automation system can be turned on or turned off by a user, and it's use if not recommended by IFATCA. The user is suggested to do the relevant safety evaluation before applying this function.

7.5.2. Mode S SSR DAPs

Mode S SSR DAPs information refers to the information that only Mode S SSR can provide. This following information of aircraft can be beneficial to the ATM automation system:

a) Roll Angle, Track Angle Rate,

1) The ATM automation system can collect these parameters from Mode S SSR DAPs BDS 5,0 and may allow the display of some of the information to the controller to improve the situational awareness of the controller. This information can be displayed in various ways (e.g., a DAP Window) as offline defined, according to the requirement of the controllers. Display of some parameters provides a clearer picture to the controllers generating a reduction in radio calls with the pilot, so the R/T usage between the controller and individual aircraft under service is reduced.
2) The system can make use of DAPs kinematics parameters for consistency checking, and perform a more precise tracking function.
3) The system can utilize the kinematics information of the aircraft to improve the accuracy of safety net functions, (e.g., Short-Term Conflict Alert (STCA)), through the provision of more accurate aircraft tracks.
4) The system may use True track angle, Magnetic Heading, True Airspeed and Ground Speed to calculate a wind direction and speed of a specific area, which will enable the updating of

forecast winds and improve trajectory modeling in the system. The system may also show the wind information to the controller to improve the situational awareness of the controller.

b) Inertial Vertical Velocity

The ATM automation system can acquire the vertical rate data of the aircraft from Mode S SSR DAPs BDS 6,0 to improve the precision of the compute altitude and the accuracy of the related alert. The system can make use of the data to realize an optimized CFL protection in STCA and MSAW analysis function.

c) Mach Number

The ATM automation system can acquire Mach number of the aircraft from Mode S SSR DAPs BDS 6,0. This information can allow ATC to monitor the aircrew compliance with the controller's instructions, and if required provide a warning to the controller when there is a mismatch.

d) Flight status (airborne/on the ground)

The ATM automation system can collect the flight status of the aircraft from reply of the Mode S SSR Roll-Call interrogation. Whether the aircraft is airborne or on the ground can be shown in the system to improve the situational awareness of the controller. Also, the flight status can be used to filter the aircraft on the ground in the system if necessary.

7.5.3. ADS-B DAPs

a) Aircraft emitter category

The emitter category can be acquired from ADS-B DAPs BDS 0,8 can be provided information about the type of vehicle to the controller by the ATM automatic system. The system can provide a warning to the controller when the information transmitted by the aircraft does not match the Flight Plan.

b) GNSS information (latitude, longitude, height, altitude, velocity, vertical rate, accuracy and

integrity of GNSS information)

1) The precision of aircraft position in GNSS information should be higher than normal radars. The ATM automation can make use of DAPs GNSS information to perform a more precise tracking function.
2) The ATM automation system can utilize the GNSS information in different ways or display in different symbols to the controller based on the accuracy and integrity values of current GNSS information received in the messages.
3) In order to meet the requirements of ICAO Annex 6 and Annex 10 for aircraft RVSM altitude maintenance performance monitoring, the geometric altitude in ADS-B (using as the real altitude of aircraft operation), can be compared with the air pressure altitude (Mode C) to analyzes the aircraft altitude keeping performance. The comparison verifies whether the aircraft is flying according to the selected altitude setting by the crew, and validates the continual compliance for RVSM altitude monitoring.
4) Airborne horizontal position/Geometric altitude can be used in data analysis. Based on flight trajectory, an analyzer can classify different trajectory models, view different traffic pattern, find abnormal trajectory, analyze the operation efficiency of traffic flow, and predict the flight time of future trajectory.

c） Selected Heading/Target Heading

1) The ATM automation system can use the selected heading/target heading of the aircraft, and may display the information to the controller to improve the situational awareness of the controller.
2) The ATM automation system can generate a heading Mismatch Alarm when the selected heading/target heading does not match the heading given by the controller, alerting the controller to take appropriate action to remedy the issue.
3) The ATM automation system can also utilize the selected heading/target heading to improve the accuracy of the safety net.

7.6 Flight Planning

7.6.1 ICAO Flight Plan Item 7 - Aircraft Identification

ACID must be accurately recorded in item 7 of the ICAO Flight Plan form as per the following instructions:

Aircraft Identification, not exceeding 7 alphanumeric characters and without hyphens or symbols is to be entered both in item 7 of the flight plan and replicated exactly when set in the aircraft (for transmission as Flight ID) as follows:

Either,

a) The ICAO designator for the aircraft operating agency followed by the flight identification (e.g., KLM511, NGA213, JTR25), when in radiotelephony the call sign to be used by the aircraft will consist of the ICAO telephony designator for the operating agency followed by the flight identification (e.g., KLM 511, NIGERIA213, JESTER25).

Or,

b) The nationality or common mark registration marking of the aircraft (e.g., EIAKO, 4XBCD, N2567GA), when:
    1) in radiotelephony the callsign used by the aircraft will consist of this identification alone (e.g., CGAJS), or preceded by the ICAO telephony designator for the operating agency (e.g., BLIZZARD CGAJS),
    2) the aircraft is not equipped with a radio.

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

Note 2: Appendix 2 to ICAO DOC4444 (PANS-ATM 16th edition, 2016) refers.

Note 3: Standards for nationality, common and registration marks to be used are contained in Annex 7, section 3.

Note 4: Provisions for the use of radiotelephony call signs are contained in Annex 10, Volume II, Chapter 5. ICAO designators and telephony designators for aircraft operating agencies are contained in Doc 8585 — Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services.

7.6.2 Equipment (Surveillance Equipment /SSR Equipment)

a) ICAO Flight Plan Item 10 – Surveillance Equipment and Capabilities

When an aircraft is equipped with a Mode S Transponder, appropriate Mode S designators shall be entered in item 10 of the flight plan to indicate that the flight is capable of transmitting Mode S DAPs messages.

These are defined in ICAO DOC 4444 as follows:

‘N’ No surveillance equipment for the route to be flown is carried, or the equipment is unserviceable

SSR Mode A and C

‘A’ Mode A transponder

‘C’ Mode A and Mode C transponder

SSR Mode S

‘E’ Mode S transponder, including aircraft identification, pressure-altitude and extended squitter (ADS-B) capability

‘H’ Mode S transponder, including aircraft identification, pressure-altitude and enhanced surveillance capability

‘I’ Mode S transponder, including aircraft identification, but no pressure-altitude capability

‘L’ Mode S transponder, including aircraft identification, pressure-altitude, extended squitter (ADS-B) and enhanced surveillance capability

‘P’ Mode S transponder, including pressure-altitude, but no aircraft identification capability

‘S’ Mode S transponder, including both pressure altitude and aircraft identification capability

‘X’ Mode S transponder with neither aircraft identification nor pressure-altitude capability

Note: Enhanced surveillance capability is the ability of the aircraft to down-link aircraft derived data via a Mode S transponder.

b) ICAO Flight Plan Item 18 – Other Information

Where required by the appropriate authority the ICAO AA (24 Bit Code) may be recorded in Item 18 of the ICAO flight plan, in hexadecimal format as per the following example:

CODE/7C432B

Members or states should note that use of hexadecimal code may be prone to human error and is less flexible in regard to airframe changes for a notified flight.

7.6.3 Inconsistency between Mode S Flight Planning and Surveillance Capability

Inconsistency between flight planning of Mode S and surveillance capability of an aircraft can impact ATC planning and situational awareness. States are encouraged to monitor for consistency between flight plan indicators and actual surveillance capability. Where discrepancies are identified aircraft operators should be contacted and instructed to correct flight plans, or general advice (as appropriate to the operational environment and type of flight planning problems) should be issued to aircraft operators.

Advice to Operators:

Concerning inconsistency between Mode S Flight Planning and Surveillance Capability:

a) ICAO AA (24 Bit Code) not submitted, or submitted incorrectly.

b) Mode S and surveillance capabilities indicators incorrectly.

The flight planning requirements and relevant designators for aircraft are described in local document reference or ICAO DOC 4444 Appendix 2. The capability of the aircraft transponder and ADS-B capability will typically be available in the transponder manual or the aircraft flight manual for the aircraft. If in doubt, consult the transponder manual, aircraft flight manual or the Licensed Aircraft Maintenance Engineer.

7.6.4 Setting Flight ID in Cockpits

a) Flight ID Principles

The Flight ID is the equivalent of the aircraft callsign and is used in both Mode S SSR and ADS-B technology. Up to seven characters long, it is usually set in airline aircraft by the flight crew via a cockpit interface. It enables air traffic controllers to identify an aircraft on a display and to correlate a radar or ADS-B track with the filed flight plan ACID. Flight ID is critical, so it must be entered carefully. Punching in the wrong characters can lead to ATC confusing one aircraft with another.

The Flight ID entered in the transponder exactly must match the ACID entered in the flight plan.

Intuitive correlation between an aircraft's flight identification and radio callsign enhances situational awareness and communication. Airlines typically use a three letter ICAO airline code in flight plans, NOT the two letter IATA codes.

b) Setting Flight ID

The callsign dictates the applicable option below for setting Mode S or ADS-B Flight ID:

1) The flight number using the ICAO three-letter designator for the aircraft operator if a flight number callsign is being used (e.g., QFA1 for Qantas 1, THA54 for Thai 54).
2) The nationality and registration mark (without hyphen) of the aircraft if the callsign is the full version of the registration (e.g., VHABC for international operations).
3) The registration mark alone of the aircraft if the callsign is the abbreviated version of the registration (e.g., ABC for domestic operations).
4) The designator corresponding to a particular callsign approved by the ANSP or regulator (e.g., SPTR13 for firespotter 13).
5) The designator corresponding to a particular callsign in accordance with the operations manual of the relevant recreational aircraft administrative organization (e.g., G123 for Gyroplane 123).

Note：More information of Flight plan for 1090 MHz ADS-B can refer to section 9.10 of AIGD.

7.7 Contingency Plan

ANSPs should prepare appropriate contingency plans in the event of a system failure that prevents the use of Mode S DAPs.

8. TRAINING AND COMPETENCY

8.1 Introduction

Training and development play an important role in the effectiveness of organizations and to the experiences of people in work. Training on DAPs has implications in improving productivity, aviation safety and personal development. The primary goal of the training is to develop and maintain an appropriate level of trust in DAPs related module, i.e., to make ATC and ATSEP aware of the likely situations where DAPs will be effective and, more importantly, situations in which DAPs will not be so effective (e.g., sudden, unexpected maneuvers).

8.2 Training of an Air Traffic Controller (ATC) in DAPs

With the inclusion of DAPs into surveillance and ATM automation system, an ATC training plan should adopt a modular approach. This approach progressively introduces various features, functionality of the new system on one hand and allows for integration with the ATC operational procedures. Additional benefits include shorter, logical self-contained units, clear attainable goals, better evaluation of training effectiveness and simplified self-assessment.

The ANSP should develop familiarization and rating focused training to ATC prior to adoption of DAPs in Surveillance and ATM automation systems.

The ANSP should ensure that all ATC concerned are assessed as competent for the use of the relevant DAPs module.

8.3 Training of an ATSEP in DAPs

a) The ANSP should develop an ATSEP training programme that is acceptable to the ANS Regulator prior to its implementation.

b) As a minimum, the training programme should comprise three levels as described below:
   1) Level 1 (Basic training). This should comprise training on the basic Surveillance and ATM automation systems operating in the State and their impacts on the safety of aircraft operations. The ANSP should ensure every ATSEP undergoes the basic training.
   2) Level 2 (Qualification training). This should comprise training to develop knowledge and skills on Surveillance and ATM automation systems. The ANSP should ensure each ATSEP is trained in one or more domains depending on their job scope.
   3) Level 3 (Specialized training). This should comprise training on specific Surveillance and ATM automation systems installed in the State, followed by on-the-job training.

c) The ANSP should conduct a yearly review of the training plan for each ATSEP at the beginning of the year to identify any gaps in competency or changes in training requirements and priorities the type of training required for the coming year in regards of DAPs development.

d) The ANSP should keep records of individual ATSEP training, competency assessment and approval history, where applicable, and associated documents. The records should be kept at least until the Surveillance and ATM automation system of which the ATSEP was trained on is no longer in use with the ANSP.

e) The individual training records for each of ATSEP should include a training plan detailing the courses completed as well as the time-frame for attending future courses as required under his/her training plan.

8.4 Competency Assessment of an ATSEP in DAPs

a) The ANSP should develop an assessment methodology to determine the competency of an ATSEP in accordance with the competency framework developed in PANS-Training and which should be adapted to suit the local context.

b) The ANSP may select a person to be a competency assessor only if the person –

   1) is an ATSEP approved in accordance with paragraph 8.3 for the particular Surveillance and ATM automation system; and

   2) has received adequate training in the conduct of competency assessment, practical checks and oral questionings.

c) A competency assessor should not conduct a competency assessment on an ATSEP who is under the direct supervision of the competency assessor unless the assessment is done in the presence of a second independent assessor.

d) The assessment methodology should include a process for on-going competency checking and refresher training to ensure retention of competence.

9. SPECIFIC EXAMPLES ON MODE S DAPs APPLICATION

9.1 Use of Selected Altitude

Since August 2013, Mode S data processing functions have been implemented in Chengdu ATM automation system. The system uses the select altitude data extracted from the Mode S DAPs to provide an optimized CLAM alert for controllers. The system will generate the alert when the SFL chosen by the crew does not match the cleared altitude recorded in the ATM automation system. And a time delay parameter is predefined for the response time of the flight after controllers' input to the ATM automation system (typically at the time of instruction given to the pilot).

Thanks to this new kind of alert, controllers have a better awareness of the intention of the airplanes and may discover the crew's mis-operation much earlier than the traditional CLAM, and then take actions timely to avoid the potential conflict.

In April 2017, an A320 aircraft was maintaining level flight at 27600 feet with another flight flying nearby at 26600 feet. Suddenly, the crew set an error altitude 22600 feet. The ATM automation system triggered the alert immediately even before the aircraft began to descend. The controller quickly noticed the alert and informed the crew in time. The aircraft successfully stopped descend at 27400 feet.

9.2 Use of ACAS RA

With the advancement of the ASTERIX standards and DAPs application, an ATM system can handle the derived data from Aircraft, which is detected, received and transmitted through the Mode S Radar, ADS-B station, and WAM sensors. In the event that an Airborne Collision Avoidance System (ACAS) Resolution Advisory (RA), the ATM system is able to provide a visual and aural alarm warning and indicative pilot intention to the controller.

Resolution Advisory (RA) alerting function works as follows:

- A resolution advisory is present when, in the subfields I048/260, I020/260, I021/260, I021/260 or I062/380 subfield #12(ACS), the bits are set as follows:

• the first bit of the ARA field set to 1 and the RAT bit set to 0 or,

• the first bit of the ARA field set to 0, the MTE bit set to 1 and the RAT bit set to 0.

- A resolution advisory is removed when:

• the ACAS RA report subfield (I048/260, I020/260, I021/260 or I062/380 subfield #12(ACS)) contains the RAT bit set to 1, or

• An ACAS RA report is not received in the relevant Data Item of the ASTERIX report.

Besides, the Resolution Advisory Intention is populated base on the PILOT selection and according to the following table:

MTE (60)	ARA (41)	42	43	44	45	46	47	RA Selection	RA Intention

1	0	Any	0	Any	1	Any	Any	Descend	Positive descend (Descent to avoid the threat)
1	0	Any	1	Any	0	Any	Any	Climb	Positive climb (Climb to avoid the threat)
1	0	Any	0	Any	0	Any	Any	Other	Other

*NOTE1: ACAS Airborne Collision Avoidance System, applied in the EURO Aviation System, has the same meaning as TCAS abbreviated to Traffic Alert and Collision Avoidance System in the USA Aviation System

*NOTE2: The function and the matters needing attention related to ACAS Resolution Advisory Report in ATM automation system, please refer to 7.4.1 e).

9.3 Use of Mode S DAPs data for weather forecast

Meteorological Research Institute (MRI) and Electronic Navigation Research Institute (ENRI) conducted experiments for improving weather forecast accuracy utilizing Mode S DAPs data. In the experiments, horizontal wind and temperature were estimated from the data in registers BDS code 5,0 and BDS code 6,0 listed below.

Table 9-1 DAPs information for weather forecast

Register	**Name**	**Data Item**
BDS code 5,0	Track and turn report	True Track Angle
		Ground Speed
		True Airspeed
BDS code 6,0	Heading and speed report	Magnetic Heading
		Mach Number

The temperature is the function of Mach number and true airspeed. To estimate horizontal wind speed and direction, calculating zonal wind speed and meridional wind speed from ground speed, true airspeed, true track angle and true heading angle. The true heading angle is obtained from magnetic heading angle and magnetic declination which is given by a quadratic equation of aircraft position. Then the wind and temperature as observation data were used to produce the initial fields of the numerical model, resulting in the improvements of weather forecast accuracy.

The results of the experiments indicate that Mode S DAPs data have the potential to improve forecasts of rainfalls and shear-lines. For details, please refer to the IP11 presented by Japan at the Mode S DAPs/3.

9.4 Use of Barometric Pressure Setting

When the aircraft is below the transition level the pilot is required to set barometric pressure setting in altimeter to local QNH/QFE. Wrong barometric pressure setting (especially QNH higher than actual) can lead to cleared flight level deviation or more serious controlled flight into terrain, as the pilot sees higher altitude on his altimeter and the flight management system determines the lower target altitude base on barometric pressure setting and selected altitude. Every millibar of barometric pressure setting error may add 30 feet of error to altimeter and target altitude.

Constantly checking if the barometric pressure setting in DAPs is consistent with the airport's QNH can alert the controller to avoid similar situations. In Feb 2021, an aircraft was cleared to descend to 7000 feet. The pilot set the right selected altitude, but forgot to set barometric pressure setting. At that time, the airport QNH was 1013, while the crew barometric pressure setting was 1118.5. An alarm system notified the controller of this situation. The error was corrected after the controller prompted the pilot preventing a dangerous situation.

9.5 Application of geometric height of ADS-B in analysis of Height-Keeping-Performance in RVSM

TVE, AAD and ASE are important indicators reflecting the height keeping performance of aircraft， which can be calculated based on ADS-B data, the definitions of TVE, AAD, ASE and FTE in Doc 9574 are as followed:

> ***Total vertical error (TVE).*** *The vertical geometric difference between the actual pressure altitude flown by an aircraft and its assigned pressure altitude (flight level).*
>
> ***Assigned altitude deviation (AAD).*** *The difference between the transponder Mode C altitude and the assigned altitude/flight level.*
>
> ***Altimetry system error (ASE).*** *The difference between the altitude indicated by the altimeter display, assuming a correct altimeter barometric setting, and the pressure altitude corresponding to the undisturbed ambient pressure.*
>
> ***Flight technical error (FTE).*** *The difference between the altitude indicated by the altimeter display used to control the aircraft and the assigned altitude/flight level.*

The section 4.10 of Appendix A of Doc 9574 outlines the method for estimating ASE. The description is as followed:

An aircraft's actual ASE at any time is the difference between its actual TVE and contemporaneous actual FTE. Given a measure of TVE and a contemporaneous AAD for the aircraft, the difference between TVE and AAD provides an estimate of ASE.

Figure 9-1 shows the relationship between the vertical errors. As noted in Doc 9574, correspondence error can be negligible when estimating ASE, so RMAs only estimates TVE, AAD and AES usually.

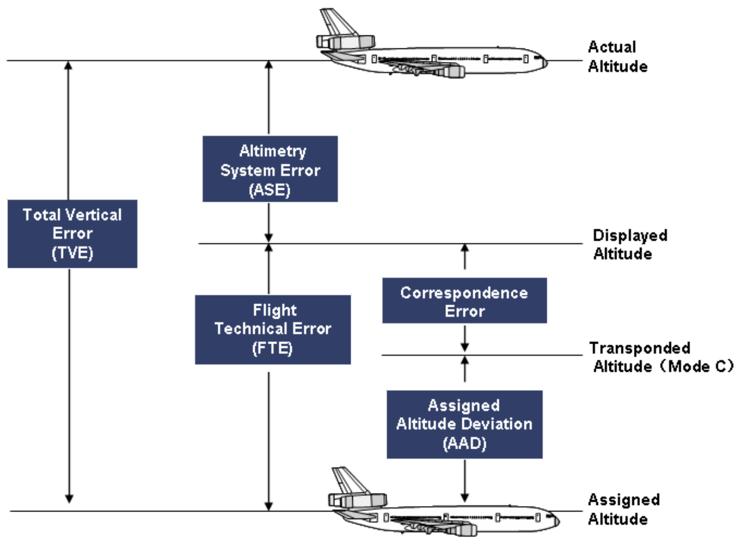

Figure 9-1: Relationship between the vertical errors

Figure 9-2 shows the calculation process of TVE, AAD and ASE based on ADS-B data. It should be known that the aircraft actual geometric altitude and Mode C pressure altitude are included in ADS-B data. For assigned pressure altitude, it can be inferred from Mode C pressure altitude. And for the corresponding geometric altitude, it can be calculated by combining the inferred assigned pressure altitude/FL and the MET data. The difference between aircraft actual geometric altitude and geometric altitude of the inferred assigned pressure altitude/FL is TVE, the difference between inferred assigned pressure altitude/FL and Mode C pressure altitude is AAD, and the difference between TVE and AAD is ASE.

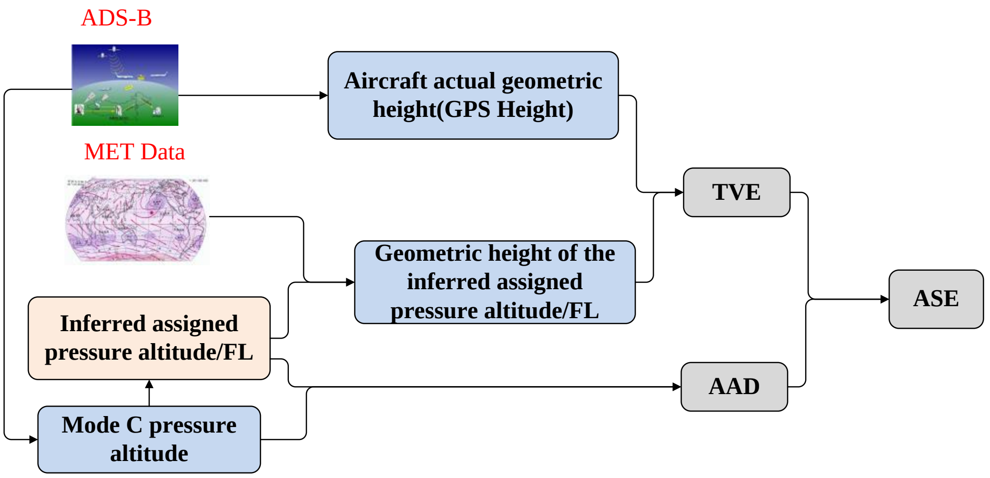

Figure 9-2: Calculation process of TVE, AAD and ASE based on ADS-B

In 9574, the error ranges of TVE, AAD and ASE are defined at the same time

1) TVE ≥ 90 m (300 ft).
2) ASE ≥ 75 m (245 ft); and
3) AAD ≥ 90 m (300 ft).

9.6 Use of ADS-B DAPs for GPS interference identification

ADS-B positioning relies on GPS systems. In recent years, the number of civil aircraft affected by GPS interference has increased rapidly that affected the ADS-B positioning performance of civil aviation and the safety of civil aviation transportation.

Through the monitoring and analysis of historical data, we found that when the rate of velocity and position changes, NIC, NACp, all change simultaneously, it can be considered as ADS-B abnormal due to GNSS interference. If only one or two of these features change, the abnormal data may not be caused by GNSS interference..

According to this feature, the ADS-B DAPs data can be used for real-time monitoring of GPS interference, which can assist radio management departments to quickly locate GPS interference sources. For details, see MODE S DAPs WG/5-IP/10-“A GPS INTERFERENCE IDENTIFICATION METHOD BASED ON ADS-B DATA”.

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APPENDIX 1: Mode S DAPs Analysis

a) Data Recording Configuration

Figure 1 represents an example of a configuration for data recording. The Mode S sensor sends interrogations to an individual aircraft using a unique ICAO 24-bit aircraft address. The Mode S transponder has 255 BDS Registers. Each register stores aircraft parameters data derived from FMS or other sensors. The messages can be readout on demand by a ground interrogator, in addition to/or being broadcasted.

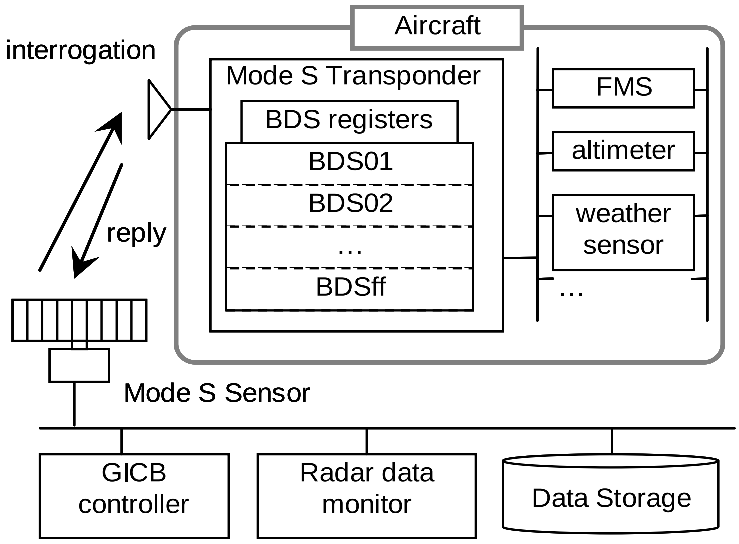

Figure1 - Example of Data Recording Configuration

b) Data Analysis

As described above section, erroneous DAPs data have been observed due to failure or improper setting/installation of Mode S avionics equipment. Bad data hinders the use of DAPs by the ATM service. To employ DAPs for ATM services, the reliability of DAPs is important. Therefore, it is necessary to analyze the recorded data to ensure reliability of the DAPs data.

If a controller finds some problem during the application of the Mode S DAPs, the ATS providers can analyze the recorded data to find the exact reason which caused the problem. If the ATS equipment has a fault which caused the problem, the ATS provider should implement a solution as soon as possible. If the ATS provider proves that the problem is caused by an avionics fault, then the problem should be reported to the appropriate party to solve the problem. The ATS providers need to devise mechanisms and procedures to address identified faults.

ATS providers should develop systems to analyze the routine recorded data. From the analyses, ATS providers can provide more information of the transponder’s performance such as SI capability, datalink capability etc. The information can be used to improve the capability of the operation of Mode S DAPs equipment. By analyzing the recorded data, advice on avionics anomalies and faults, which have been detected, can be passed onto the regulators and the aircraft operators.

c) DAPs Data Validation

To ensure that Mode S DAPs are operating in conformance with the ICAO requirements, validating DAPs data is highly recommended. It has been noted that there are some drawbacks in the traditional methodology of executing tests for aircraft on the ground as follows:

1) Avionics for DAPs consist of several devices and functional blocks. They are interconnected, and the configuration is complicated.
2) Avionics and configuration differ depending on each aircraft.
3) It is difficult to cover the possible test patterns completely.
4) Ground test methodology would not detect failures or anomalies that occur after the testing.

Responding to these drawbacks, MIT Lincoln Laboratory developed and proposed a DAPs validation methodology, which monitors DAPs data received from actual flying aircraft to detect erroneous data. The MIT validation methodology is mainly categorized by two groups, static value tests and dynamic value tests.

Static value tests are executed to detect erroneous values of the bits and fields in BDS registers which do not change during a flight. Those bits and fields represent the avionics system's configuration, capability, and status information. These tests verify that those bits and fields are proper values in compliance with the ICAO regulations for DAPs applications. Table 1 shows an example of static value tests. As can be seen by the table, failed data were detected in each BDS register test. For BDS Register 20_{16}, failed data with wrong character coding were caused not due to equipment problem, but to faulty data input.

Table 1 Example of Static Value Tests

BDS Register	**Test Item**	**Total Count**		**Aircraft**	
		Executed	**Failed**	**Executed**	**Failed**
BDS code 1,0	Aircraft identification capability flag = '1'	544,980	7,183	3,615	146
BDS code 2,0	Each character conforms to ICAO 6-bit character coding	737,993	1,516	3,596	144
BDS code 4,0	Unavailable data fields are set at zero	54,248,802	1,755	3,614	4

Dynamic value tests validate the values which dynamically change according to aircraft motion, such as aircraft speed and track angle. The tests compare the DAPs values with equivalent data like radar-measured positions. If the difference between DAPs values and radar-derived parameters exceeds the acceptability threshold, the DAPs value is accounted as an error. Figure 2 represents an example of dynamic value tests. This figure indicates that ground speed differences between DAPs data and radar-derived data fall inside the threshold range.

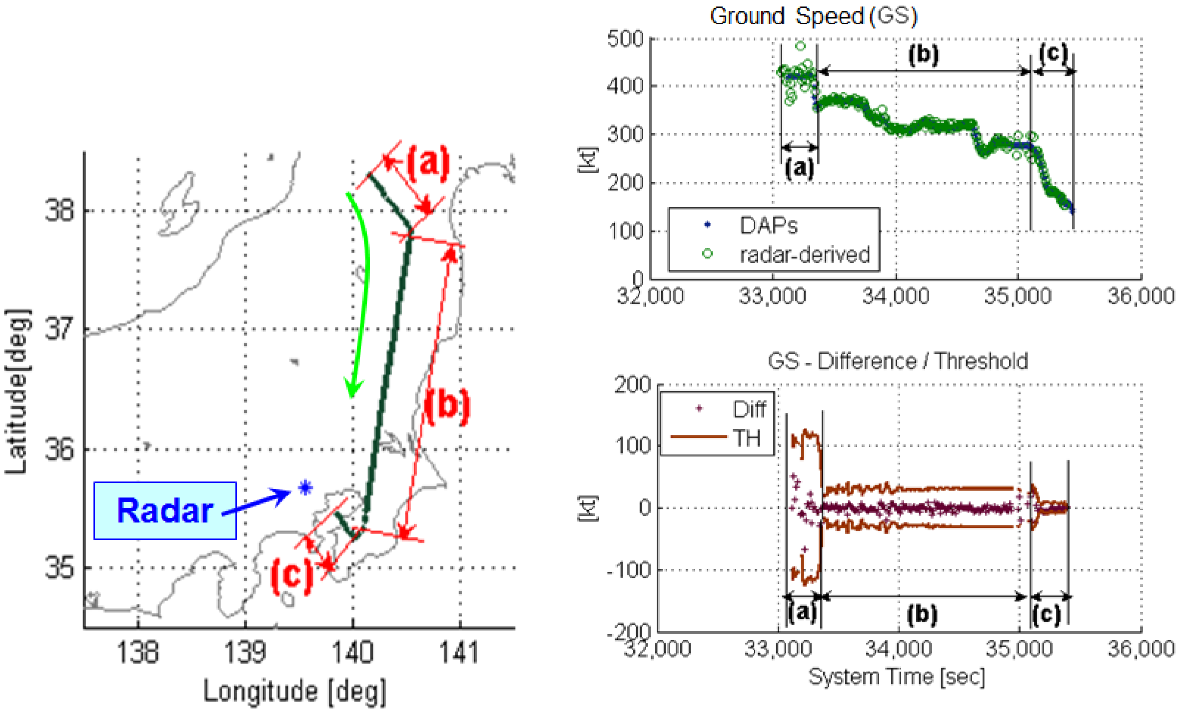

Figure 2 - Example of Dynamic Value Tests

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APPENDIX 2: LIST OF IDENTIFIED ISSUES

Ref.	Issue	Cause	Safety Implications to ATC (Yes / No)	Recommendations
1.	Wrong ground bits in DAPs led to the track decoupling from the flight plan	Through joint investigation with the airlines, it found that parts of the aircraft A were exchanged with another aircraft B for test. The malfunction part was discovered when the wrong ground bits data was found coming from the aircraft B.	**Yes** The wrong ground bits in DAPs could make ATM automation system display track decoupled with flight plan	
2.	Wrong aircraft identification	Many cases of wrong aircraft identification were found at the beginning of mode S operation. All related data collected and sent to the relevant airlines by the management department. Through joint investigation with the airlines, it was found that the issue is normally due to pilot's error.	**Yes** Wrong aircraft identification could lead to wrong flight plan coupling.	Through the joint efforts of ATMB and the airlines, the aircraft identification data became more and more accurate.
3.	Wrong Barometric Pressure	Barometric Pressure, such as BARO or QNH, is available in Mode S BDS code 4,0. Initial testing found that data above the transition level for some aircraft types would not be useful due to a mismatch between what the crew set in the cockpit, and what the aircraft Downlinked.	Yes There will display a wrong Barometric Pressure with aircraft in ATM automation system.	EASA Safety Information Bulletin SIB-2016-05R2 ("Incorrect Downlink Barometric Pressure Settings") covers this issue.
4.	Different processing between Mode A/C and Mode S Altitude	Currently, the altitude accuracy of Mode A/C radar is 100ft, while that of Mode S radar is 25ft. The altitude tracking, and display mechanism of ATM automation systems could be received both precisions altitude data.	**Yes** In Mode S radar and Mode, A/C radar overlapped area, the ATM automation systems might display an altitude jumping.	The altitude tracking, and display mechanism of ATM automation systems need to be optimized to avoid altitude jumping.

5.	Mode S interrogators request the aircraft transponder registers too frequently in busy airspace	If Mode S interrogators request the aircraft transponder registers too frequently in busy airspace, it may appear that the transponder registers information cannot complete the whole transmission process. The BDS parameters requesting rule needs to be set by the Mode S interrogator reasonably.	**Yes** ATM automation system would display track delay or intermittent interruption of radar data.	The data transmission rate of Mode S radar to feed ATM automation system needs to be selected reasonably to meet the requirements of ATC operations in busy airspace to prevent track delay or intermittent interruption of radar data.
6.	Mode S DAPs data does not correspond to the content of the requested register	It has been noted that from time to time Mode S DAPs data does not correspond to the content of the requested register. For example, the content of BDS code 5,0 is received when extracting BDS code 4,0. This phenomenon is called “BDS swap”. Table 1 represents an example data of BDS swap. The table shows the data of BDS code 0,5/4,0/5,0 data downlink from an aircraft in three sequential scans. As can be seen by the table, BDS swap occurred at 08:05:45.	**Yes** Wrong information could display to controller.	Different options can be implemented to decrease the impact of such as: 1. limit the number of radars extracting aircraft registers 2. implement specific filters in radar or in the surveillance data processing to discard the erroneous data (e.g. when two different registers are received with the same content they are both discarded)

7.	Duplicated aircraft address	One case was related to a local airline, wrong spare parts of the airplane were installed by mistake during maintenance. The airline replaced the spare parts after being informed. Another case was military aircraft. Another reason has been observed that in many cases the 24-bit aircraft address transmitted by the aircraft does not match its nationality (i.e. its State of Registry's block) or is otherwise incorrectly configured in the transponder. Care needs to be taken to ensure that the registration and the 24- bit address of every aircraft are processed and assigned simultaneously by the regulatory authority, and reporting mechanisms are in place to rectify incorrect configurations.	**Yes** The possible consequences are as follows: 1. An aircraft may be locked out in error, if it is the same beam. This may result in a new aircraft not being detected when it enters Mode S radar coverage. 2. Possible track label swap for crossing aircraft, this may result in incorrect labeling of an aircraft on the Radar screen. 3. In the technical operation of Mode S Elementary surveillance, duplicated address may result in the possible loss of a track when the two aircraft are crossing due to the interrogation scheduling within the ground station.	According to Annex 10, the aviation authority of each State is responsible for assigning 24-bit addresses to all aircraft in its registry using the block allocated by ICAO to that State. The duplicate address should be detected and reported. Without duplicate address detection, if an aircraft enters the range of the Mode S SSR with the same ICAO 24-bit address as that of an existing target, the information of the new aircraft could be erroneously associated with the existing target. Once the Mode S DAPs System detect more than one aircraft is transmitting the same ICAO 24-address, it will initiate a duplicate address report and a duplicate address condition shall be declared, and when receive new information of this address, the system should associate the information by ID or position but not the address.
8.	incorrect aircraft address in flight plan	Although the overwhelming majority aircrafts are equipped with Mode S transponders, many flight plans are not filed with the correct aircraft address in item 18.	**Yes** This affects the function of aircraft address correlation in ATM automation system.	

9.	incorrect wind speed and direction	Aircrew round the system output figures from Spot Wind data was the main reason for variations by crew response. e.g. Recorded wind 283/42kts, crew response 280/40kts.	**No**	
10.	empty ACAS RA message	ASTERIX message "I048/260, ACAS Resolution Advisory Report" indicates that airplane is in ACAS RA condition. In some cases, all zero I048/260 reports are received in the ATM automation system through Mode S radar.	**Yes** ATM automation system may generate false ACAS alarm from Empty RA message.	ACAS message handling feature at ATM system must be checked on at its installation stage following the ACAS message flow
11.	erroneous SFL information	It is noticed ATM automation system could receive erroneous SFL information due to the BDS swap problem and other reasons.	**Yes** ATM automation system may generate false SFL mismatch alarm due to the erroneous SFL information.	ATM automation system could use multiple data sources to check the SFL data.
12.	Incorrect ACAS RA information	Many cases of incorrect ACAS RA information were found at the Mode S operation. After analysis the incorrect ACAS RA data，the reason is so called "BDS Swap" and only the old type of Mode S radar has the "BDS Swap" problem.	Yes Wrong information could display to controller.	Short term solution: Reject data (BDS content and/or reply) in case of difference between UF and DF. Reject BDS content (BDS 1,0; 2,0 and 3,0) in case of first byte error. Medium /long term solution: "Overlay" function is introduced in the fifth edition of Volume IV of ICAO document annex 10. the DP (data parity) field is designed to replace the AP field to check the BDS register number in the downlink DF20 / 21. It aims to

				solve BDS swap problem from the source.
13	ADS-B Ground station generated an abnormal CPR decoding phenomenon	An abnormal CPR decoding phenomenon that caused by the airborne aircraft transmits the Surface Position state.	YES Abnormal CPR decoding may cause the aircraft target to jump or split on the ATM automation system.	The CPR decoding algorithm of the ground station should follow the standard of DO260

Table 1 Example Data of BDS Swap

BDS Register	**Time of Scan**		
	08:05:35	**08:05:45 (BDS swap occurred)**	**08:05:55**
BDS code 0,5	605f80c056966f	a3280030a40000	605f845303ce8d
BDS code 4,0	a3280030a40000	a3280030a40000	a3280030a40000
BDS code 5,0	fff8cf1f800489	a3280030a40000	ffb8cf1f80048a

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APPENDIX 3: A Brief Introduction of Mode S SSR DAPs Data Source

1. Introduction

1.1 During the 2nd meeting of ICAO APAC Mode S DAPs WG, China presented an information paper regarding the Mode S DAPs data source, the meeting was of the view that the content of the paper will help in the understanding of the basic mechanism of avionics relevant to surveillance application and implementation of DAPs.

-Refer to Mode S DAPs WG/2 IP05 "Preliminary Study of DAPs Data Sources"

1.2 The Mode S DAPs provides useful information on aircraft that will enhance ATM operations. More attention should be paid when introducing Mode S DAPs and it's important to clearly understand what these parameters are and where these parameters come from. This text provides give some brief information about the parameters.

2. Mode S SSR DAPs ELS and EHS

2.1 Mode S DAPs-based surveillance includes ELS (Elementary Surveillance) and EHS (Enhanced Surveillance).

2.2 Most of the ELS parameters are capability parameters of the aircraft, hence are static. They can be used for improved aircraft identification, and have less direct impact on ATC operations. The ELS parameters are shown in Table 2.1.

Table 2.1 ELS Parameters Information

	Register	DAP Set	Bits	Units	Quantity	Range
ELS		24-Bit Aircraft Address (AA)	NA	NA	NA	NA
		Transponder Capability (CA)	NA	NA	NA	NA
		Flight Status (FS)	NA	NA	NA	NA
		Altitude Reporting in 25ft	NA	ft	25	[-1000, 50175]
	BDS 1,0	Datalink Capability Report	56	NA	NA	NA
	BDS 1,7	Common GICB Capability Report	56	NA	NA	NA
	BDS 2,0	Aircraft Identification Report	56	NA	NA	NA
	BDS 3,0	ACAS Resolution Advisory Report	9-22	NA	NA	NA

2.3 EHS parameters are more related to the aircraft's intention and status, and most of them are dynamic. The implementation of EHS parameters has a larger impact on controllers. The EHS parameters are shown in Table 2.2.

Table 2.2 EHS Parameters Information

	Register	DAP Set	Bits	Units	Quantity	Range
EHS	BDS 4,0	Selected Altitude (MCP/FCU)	2-13	ft	16	[0, 65520]
		Selected Altitude (FMS)	15-26	ft	16	[0, 65520]
		Barometric Pressure Setting	28-39	mb	0.1	[0, 410]
	BDS 5,0	Roll Angle	3-11	dg	45/256	[-90, +90]

	True Track Angle	14-23	dg	90/512	[-180, +180]
	Ground Speed	25-34	kt	2	[0, 2046]
	Track Angle Rate	37-45	dg/s	8/256	[-16, +16]
	True Airspeed	47-56	kt	2	[0, 2046]
BDS 6,0	Magnetic Heading	3-12	dg	90/512	[-180, +180]
	Indicated Airspeed	14-23	kt	1	[0, 1023]
	Mach No	25-34	NA	2.048/512	[0, 4.092]
	Barometric Altitude Rate	37-45	ft/min	32	[-16384, +16352]
	Inertial Vertical Velocity	48-56	ft/min	32	[-16384, +16352]

3. Mode S SSR DAPs Data System

3.1 The ELS and EHS parameters originate from varies sensors and cockpit settings. After being organized by the avionics systems, the information is being sent to the transponder through standard aircraft data buses, and subsequently formatted by the transponder and stored inside the relevant Binary Data Storages (BDS). The ground-based surveillance system could downlink desired DAPs by specific Mode S GICB (Ground Initiated Comm-B) protocol.

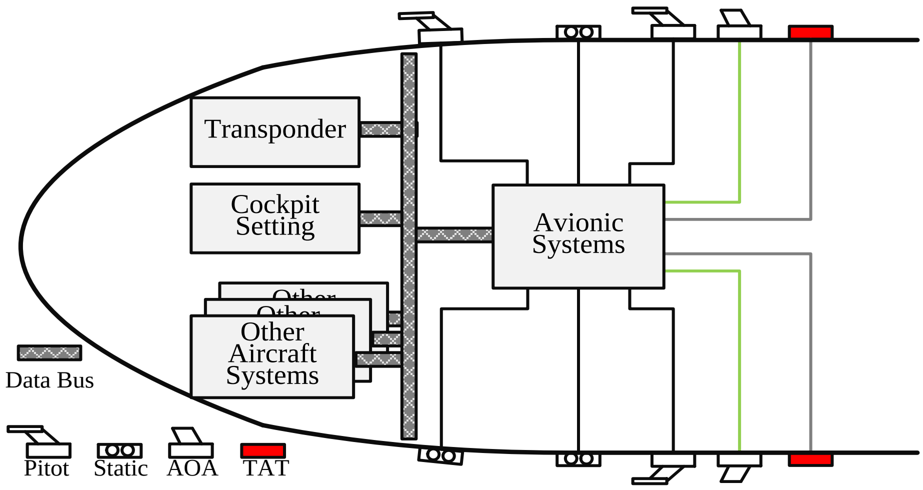

Figure 3.1 Typical DAPs Data Source Block Diagram

<u>Transponder and TCAS Computer</u>

3.2 The most common standard of the civil aircraft transponder, the Mark 4 Air Traffic Control Transponder, is based on the ARINC 718A standard. There are 3 main interface plugs defined on the rear panel, namely TP (Top Plug), MP (Middle Plug), and BP (Bottom Plug).

3.3 The airborne collision avoidance system, Traffic Computer TCAS and ADS-B Functionality, is based on the ARINC 735B standard . There are 6 main interface plugs defined on the rear panel, namely LTP (Left Top Plug), LMP (Left Middle Plug), LBP (Left Bottom Plug), RTP (Right Top Plug), RMP (Right Middle Plug) and RBP (Right Bottom Plug).

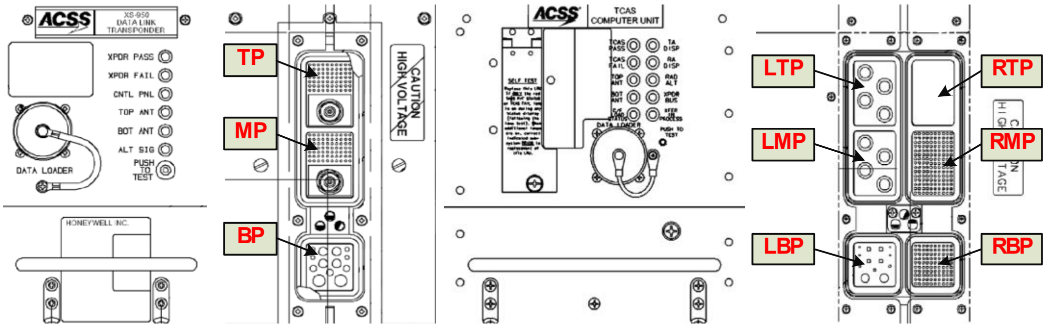

Figure 3.2 Transponder and TCAS Computer Examples from ACSS

Data Bus

3.4 The most common data bus, the Digital Information Transfer System, is based on the ARINC 429 standard. The standard defines the data transfer between most of the avionics systems. There are also other standards such as the ARINC 629 used on Boeing B777, Airbus A330 and A350, as well as the ARINC 664 (AFDX, Avionics Full Duplex Switched Ethernet) used on A380 and B787.

Avionics and DAPs Data

3.5 The Aircraft Address (AA) is a parameter programmed into the aircraft frame after the address is allocated by the State registration authority. Normally there are 2 ways to program this parameter, one is to program the pins of the MP (connected for "1", open for "0"), and the other is to use Aircraft Personality Module (ARINC 607) to store the address, and then interface to the MP.

Note: For more detailed information about Aircraft Address, refer to ARINC 718A Attachment 2B. For APM implementation guidelines, refer to ARINC 718A Attachment 9.

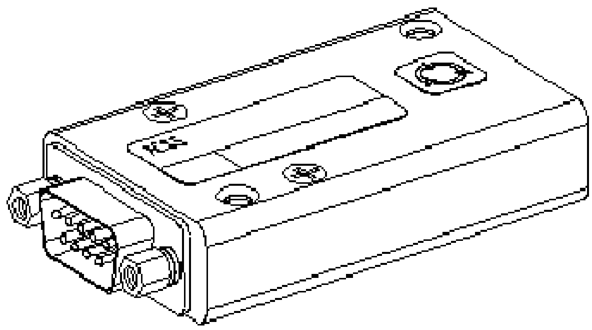

Figure 3.3 APM Example from ACSS

3.6 The Transponder Capability (CA) is a result of the combination of on-the-ground status and transponder capability level. Normally the on-the-ground status is automatically indicated by the weight sensor fitted on the aircraft, but some GA planes use manual means to indicate the status by switching the transponder knob to the GND option. The transponder receives on-the-ground status from the TP pins (5J and 5K), make validation of the status with Ground Speed, Radio Altitude or Airspeed, and then announce the status. The transponder capability level is a static value which is fixed after manufacturing.

Figure 3.4 TT31 Mode S Transponder from TRIG

3.7 The Flight Status (FS) is a result of combination of the on-the-ground status, SPI, and Alert. The on-the-ground is the same as in 3.6, the SPI is from pushing IDENT function button of the transponder by pilot, and the Alert is produced by changing Mode A code (If changed to 7500, 7600, 7700, that's permanent alert; and if changed to other codes, that's 18 seconds temporary alert).

3.8 The Common Usage GICB Capability Report is generated by the transponder itself by detecting the corresponding input data availability, and then set the corresponding bit related to that GICB register.

3.9 The main source of Aircraft Identification is from FMS, input by pilot through Flight ID (or Flight No) menu, and the related data transmitted to transponder by specific data bus (ARINC 429 Labels 233~237). If the Flight ID is empty, then the Aircraft Registration data may be provided within another data bus (ARINC 429 Labels 301-303).

3.10 According to TCAS standard (ARINC 735B Chapter 3.3.4.1), the Datalink Capability Report and the Resolution Advisories Report are sent to the Transponder from TCAS Computer by specific protocol (TGD-TCAS to Transponder data transfer protocol, and Transponder to TCAS data transfer protocol is named XGD. The data bus used is ARINC 429 Label 270). The data are sent from RMP of the TCAS Computer to TP of the Transponder, related pins refer to Figure 3.5.

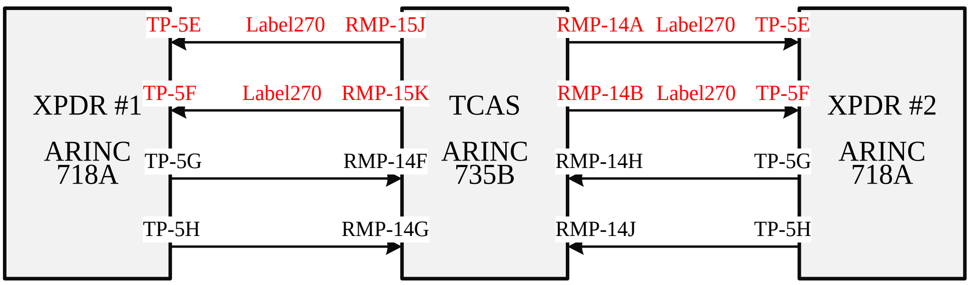

Figure 3.5 Illustrations of Datalink Capability and RA Report Transfer

3.11 There are 2 kinds of Selected Altitude, one is from MCP/FCU (Boeing's Mode Control Panel and Airbus's Flight Control Unit), and the other is from FMS (Flight Management System). The first one is set by the pilot in response to a controller's instruction during the flight, the second one is calculated by the FMS automatically to achieve the best cost-efficient.

Figure 3.6 MCP of Boeing B787 & FCU of Airbus A380

3.12 The Barometric Pressure Setting (BPS) is also located in the MCP/FCU, and set by the pilot rotating the knob to the pressure value comes from the aerodrome’s ATIS (Automatic Terminal Information System).

3.13 The other parameters mainly come from the sensors onboard the aircraft, the sensors are organized in 3 groups, the air data sensors, the inertial sensors and the magnetic sensor.

3.14 The air data sensors are used to sense the medium through which the aircraft is flying, including pitot (static) probe, static port, temperature sensor, angle of attack sensor. Typical sensed parameters are total pressure (Pt), static pressure (Ps), pressure changing rate, air temperature (TAT), and angle of attack. Derived data includes Barometric Altitude (ALT), Indicated Airspeed (IAS), Vertical Speed (VS), Mach (M), Static Air Temperature (SAT), Total Air Temperature (TAT), True Airspeed (TAS) and Angle of Attack (AOA). The simplest system provides ALT and IAS.

Figure 3.7 Air Data Sensors and Integrated Sensor on Airbus A380

3.15 The inertial sensors are used to detect the motion of the aircraft in a universal reference system, including position gyroscopes, rate gyroscopes and accelerometers. By detection of the 3D dynamic of the aircraft, derived data includes Ground Speed (GS), Wind Speed, Wind Direction, True Track Angle, Roll Angle, and Track Angle Rate and so on.

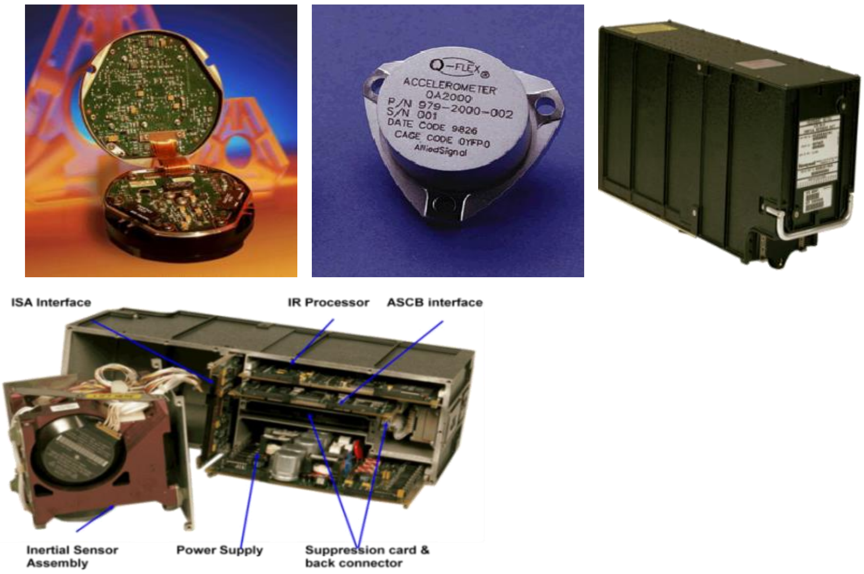

Figure 3.8 Gyro, Accelerometer and LASEREF IV IRU from Honeywell

3.16 The magnetic sensor is used to sense the direction and to find the magnetic north, and give out the main parameter of Magnetic Heading. The world magnetic model is show below:

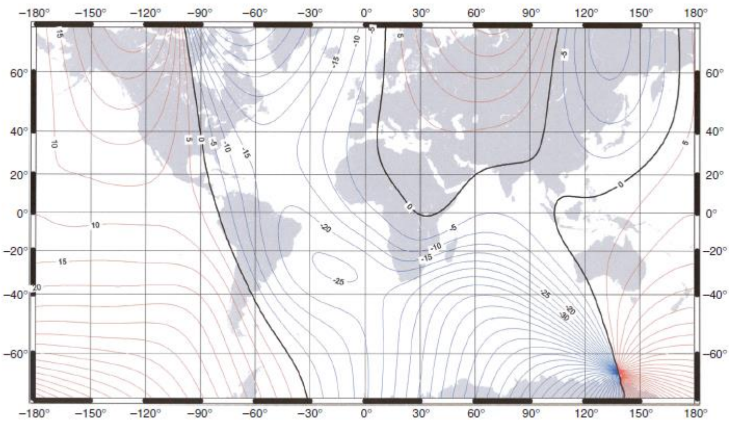

Figure 3.9 World Magnetic Model 2000

3.17 Some airplane platform uses an integrated solution to process these data, each air data sensor is connected with an Air Data Module (ADM) which converts the analog data to digital data and make the compensation of the instrumental and positional error. These data then feed to the input of Air Data Inertial Reference Systems (ADIRS) to calculate all the parameters mentioned before. And after that the parameters are sent to transponder and other avionics systems by the Data Bus.

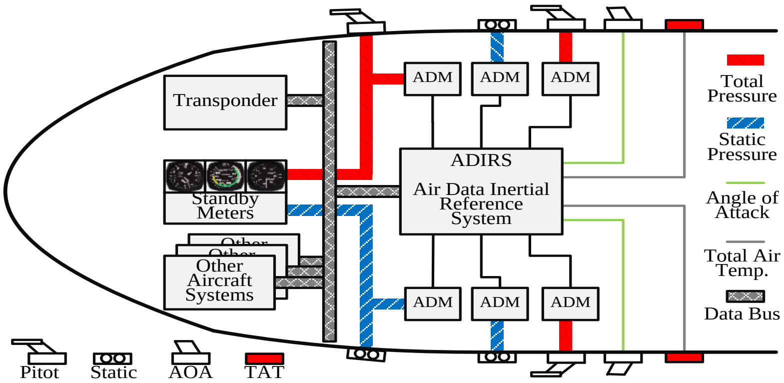

Figure 3.10 Typical ADIRS Architecture

3.18 The most commonly used data bus for parameters from ADIRS is ARINC 429 (and the newest evolution is AFDX invented by Airbus and implemented in varies new aircrafts like A380 and B787), and the standard ARINC 429 Labels used by these parameters are as follows:

Table 3.1 ADIRS Parameters Used Labels of ARINC 429

No	DAP Item	Label
1	Mach No.	205
2	Indicated Air Speed	206
3	True Air Speed	210
4	Barometric Altitude Rate	212
5	Ground Speed	312
6	True Track Angle	313
7	Magnetic Heading	320
8	Roll Angle	325
9	***Track Angle Rate***	***335****
10	Inertial Vertical Velocity	365

**Note: This label in GAMA configuration is not used for Track Angle Rate*

3.19 By using these parameters, the aircraft dynamic is illustrated as in Figure 3.11.

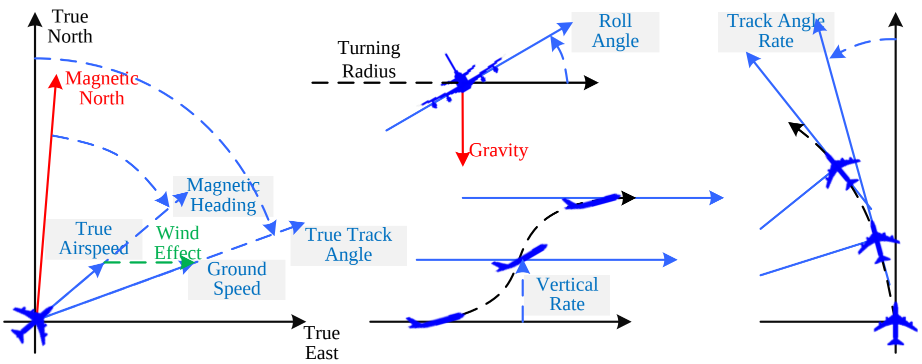

Figure 3.11 Illustration of Aircraft Dynamic

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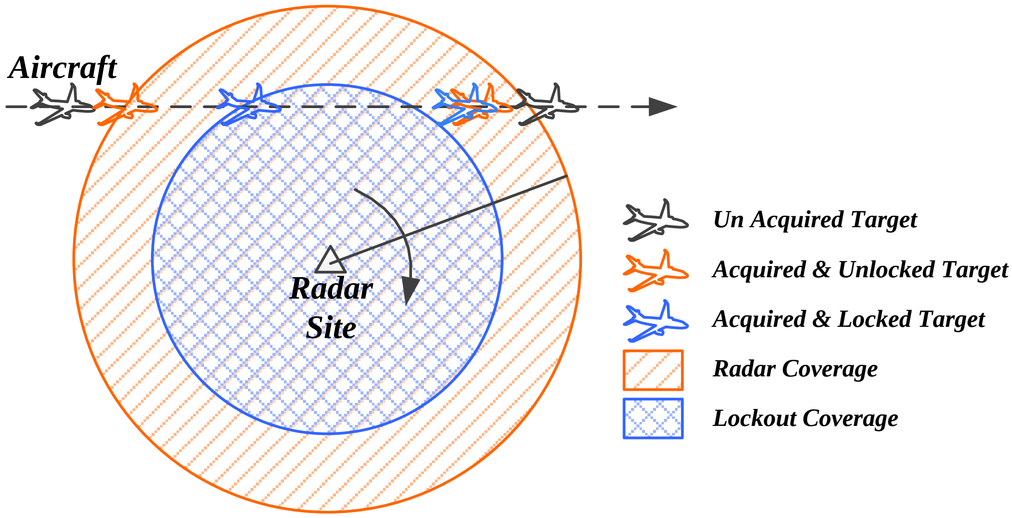
APPENDIX 4: Mode S Parameter Set

<u>*Radar Coverage **R***</u>

1.1 The Mode S radar coverage is defined as the farthest target the radar will process. If the Mode S radar uses a lockout map, the difference of the two coverage ranges should be noticed.



1.2 The radar coverage will decide the minimal All-Call period, this is to say, the time of All-Call period should:

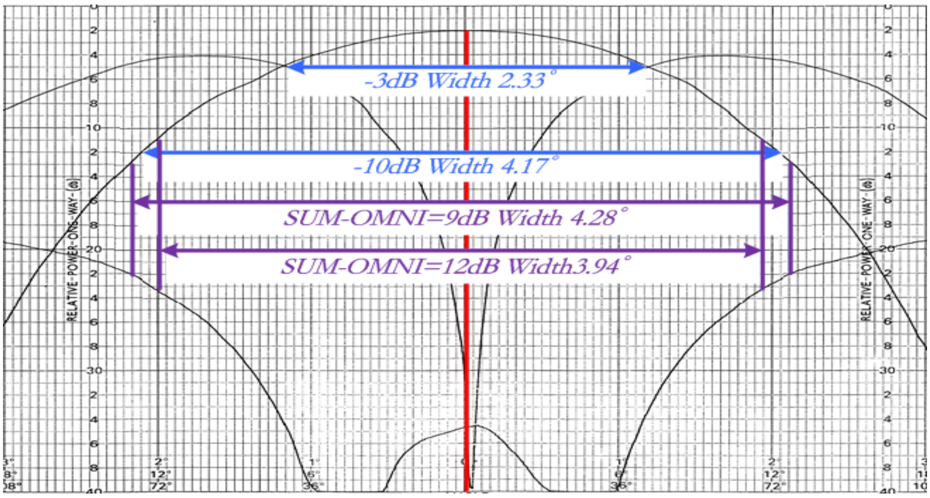
$$T \geq \frac{R * 2 * 1852}{3 * 10^8}$$

<u>*Antenna Period **Ta***</u>

2.1 The antenna period is the time of a successful antenna rotation, this time actually has very important influence of the total time resource of the radar. Lower antenna rotation speed will provide rich antenna period, hence time resource of the radar. The most commonly used antenna period is 4000ms (15rpm) and 6000ms (10rpm) for terminal surveillance radar.

<u>*Antenna Beamwidth **B***</u>

3.1 Most of the secondary surveillance radar uses the same LVA antenna, the beam is more or less the same, and the standard interrogation beam has a -3dB width of 2.45° ±0.25 °. In Mode S interrogation, the suppression requirement actually allow to use a wider beam width than -3dB width, most of the radar choose 3.8° or roughly the -10dB beam width.



*Time on Target **Tt***

4.1 The time on target is the total time amount the radar beam covers the target during one scan, it defines the time resource upper limit for one dedicated target, it is determined by both the antenna period and the beamwidth, and the relation is as follows:

$$Tt = \frac{Ta}{360} * B$$

4.2 It should be noticed that during a mix air operation (Conventional targets and Mode S targets flying in the same area in the same time), there is a need for the Necessary Transaction. That is during an antenna scan, there should be at least 4 transactions between the radar and the conventional target, in order not to miss conventional target.

*All-Call Period **Tac** and Roll-Call Period **Trc***

5.1 The All-Call period and Roll-Call period setting are different radar by radar, but there should be some principles:

1) All-Call period should long enough to allow the coverage requirement.

2) During the time on target, the Necessary Transaction should be guaranteed.

3) Time resource should allocate to Roll-Call as much as possible; and

4) Algorithm should be used to optimize the scheduling in the Roll-Call period.

*Mode Interlace Pattern **MIP***

6.1 Mode Interlace Pattern defines the radar operating mode setting. The setting is related to the specific radar environment, hence there is no standard MIP.

6.2 All the modes Mode S radar can use is listed in the following table:

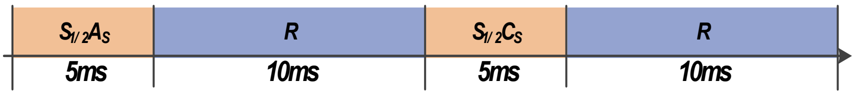
No.	Mode	Description	Pulse Used
1	A	Mode A interrogation	8μs between P1 and P3
2	C	Mode C interrogation	21μs between P1 and P3
3	A_S	Mode A Only All-Call	8μs between P1 and P3, and short P4
4	C_S	Mode C Only All-Call	21μs between P1 and P3, and short P4
5	S_L	Mode ACS All-Call	8μs, 21μs between P1 and P3, and Long P4
6	S_{PO}	Mode S Only All-Call P for PR, O for LO	2μs between P1 and P2, and P6 UF11 inside P6
7	R	Mode S Roll-Call	2μs between P1 and P2, and P6 UF0/4/5/16/20/21 inside P6

6.3 For a specific MIP, the describe phraseology defines as follows, and also one example is listed below:

Mode[Time]/ Mode[Time]/ Mode[Time]/......

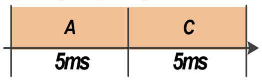
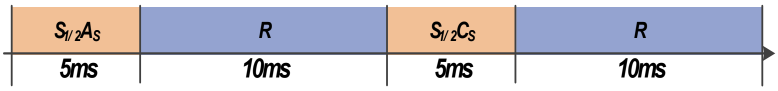
Note: The All-Call and Roll-Call periods are separated by "/", the "Mode" is one of the Modes listed above, and the "[Time]" stands for the duration of the periods.

6.4 An example is show as follows:

No.	Mode	MIP
1	Conventional	A[5.0]/C[5.0]  Mode A and Mode C repeat, both durations are 5ms
2	Mode S #1	$S_{1/2}A_S$[5.0]/$S_{1/2}C_S$[5.0]/R[10.0]  2All-Call periods and 1 Roll-Call period repeat, All-Call duration is 5ms, Roll-Call duration is 10ms In the first All-Call, the PR=1/2, and use Mode A with short P4 In the second All-Call, the PR=1/2, and use Mode C with short P4
3	Mode S #2	$S_{1/2}A_S$[5.0]/R[10.0]/$S_{1/2}C_S$[5.0]/R[10.0]  1All-Call,1Roll-Call,1All-Call,1Roll-Call repeat, All-Call duration is 5ms, Roll-Call duration is 10ms In the first All-Call, the PR=1/2, and use Mode A with short P4 In the second All-Call, the PR=1/2, and use Mode C with short P4

Interrogation Repetition Frequency ***IRF***

7.1 The Mode S introduced the Roll-Call period, which makes the interrogation repetition frequency a little bit different from the Conventional Mode. There is a need to define the interrogation repetition frequency by Mode IRF_{Mode}. Normally use IRF stands for the IRF_{AC} of Conventional mode and IRF_S of the Mode S All-Call. One example is listed below:

No.	MIP	IRF
1	A[5.0]/C[5.0] 	IRF_A=100Hz IRF_C=100Hz IRF_{AC}=200Hz
2	$S_{1/2}A_s$[5.0]/R[10.0]/$S_{1/2}C_s$[5.0]/R[10.0] 	IRF_A=33.3Hz IRF_C=33.3Hz IRF_{AC}=66.7Hz IRF_S=66.7Hz IRF_R=66.7Hz

<u>DAPs Extraction Strategy</u>

8.1 The DAPs extraction strategy normally includes the BDS number, extraction priority, extraction period, and re-extraction.

1) BDS number stands for the setting of the number of BDSs which radar is going to extract. It doesn't include the ELS registers, these registers should not be extracted periodically.

2) Extraction priority stands for the priority of each BDS when the radar is performing extraction, the priority should be in accordance to the user's needs;

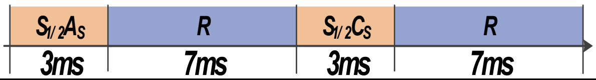
3) Extraction period stands for the period of the dedicated BDS extraction, normally described by the antenna scan number.

4) Re-extraction stands for the function of re-extraction of the dedicated BDS in the same beam dwell when the extraction is failed, but it's not recommended to use re-extraction more than 2 times.

<u>Mode S Parameter Set Example</u>

9.1 The following is an example of the Mode S Parameter Set:

No.	Parameter	Unit	Value	Note
1	R Coverage Range	NM	200	Equivalent All-Call Time $\frac{200*2*1852}{3*10^8}*10^3 \approx 2.47ms$
2	Ta Antenna Period	ms	3800	Antenna Rotation Period
3	B Work Beamwidth	°	3.8	Mode S Work Beamwidth Normally Greater Than -3dB width of 2.45°
4	Tt Time on Target	ms	40.1	The Time on Target In One Scan $\frac{3.8}{360}*3800 \approx 40.1ms$
5	Tac	ms	3.0	Equivalent Coverage Range

	All-Call Period			$\frac{3 * 10^{8} * 3.0 * 10^{-3}}{1852 * 2} \approx 243\text{NM}$
6	Trc Roll-Call Period	ms	7.0	This Period Related To The Extraction Efficiency
7	MIP	——	——	$S_{1/2}A_s[3.0]/R[7.0]/S_{1/2}C_s[3.0]/R[7.0]$ 
8	IRF_{AC}	Hz	100	Interrogation Repetition Frequency of Mode S All-Call
9	DAPs Extraction	——	——	No. of BDS: 3 (BDS 4,0 5,0 6,0) Extra. Priority: BDS 4,0 6,0 5,0 Extra. Period: 1 Scan Re-Extraction: Yes

APPENDIX 5: Radio Frequency (RF) Measurements and Analysis

The following is excerpted from ICAO Doc 9924 Aeronautical Surveillance Manual (Third Edition 2020), Appendix M: Interference Considerations.

1. Overview

1.1 The 1030 and 1090 MHz frequency bands form the worldwide RF network, which enables the cooperative surveillance of mobile vehicles involved in ATM including airborne vehicles (aircraft) and ground vehicles (e.g., specific vehicles operating on airport surface in critical areas). It is utilized to support civil and military (IFF) air-ground surveillance applications, air-air surveillance applications and collision avoidance applications.

1.2 In general, the 1030/1090 MHz network is robust in its ability to support the systems that utilize it but as more systems are added, performance of one or more of these systems may degrade to unacceptable levels. Since many systems are safety critical in nature, protecting the 1030/1090 MHz spectrum from reaching unacceptable utilization is paramount.

1.3 Capacity of the system is impacted by the number and types of users. Aircraft density and the number and type of interrogators directly influence the activity on these links. Information extraction from ground and aircraft to aircraft interrogators increases the activity of these RF links. High density airspace is a particular challenge as these locations tend to contain accompanying higher density of ground interrogators. The systems that utilize the 1030/1090 MHz bands have standards that limit their impact to protect the performance of all users and provide robust capacity to the system. However, available capacity can be limited in the highest density areas of the world.

1.4 Therefore, it is necessary to monitor the usage of the 1030/1090 RF network, as is required for any telecommunication network, in order to regulate its use. Such monitoring should support the determination of the remaining margin of the network. It should help identify the sources of the utilization and whether the limits are being reached by misuse of some systems operating in a non-conforming or inefficient manner to the detriment of the good operation of the other systems using the same network.

2. Radio frequency (RF) measurements

2.1 Measurements need to provide information to answer the following questions:

a) what is the probability that a transponder correctly receives and decodes an interrogation sent on 1030 MHz (the utilization of the 1030 MHz frequency);

b) what is the probability that a transponder is available to receive and decode interrogations and is able to reply (the availability of the transponder); and

c) what is the probability that a 1090 MHz message is correctly received by a 1090 MHz receiver, which is impacted by overlaps of messages on 1090 MHz (the utilization of the 1090 MHz frequency).

2.2 Measurement methodologies

2.2.1 Data produced by RF measurement activities is recommended to include a minimum set of information that can adequately characterize the RF environment of the geographical area under assessment and support comparison to other measurements. Additionally, the data is intended to support comparison to other data collection measurements in other geographical areas which can provide insight to areas with high or unusual activity and help identify areas that warrant further investigation. To allow comparison between different measurements performed in different locations around the world, it is very important to define the types and the conditions of measurements. Measurements can be made from the ground and/or from the air. Each of them provides critical insight into the 1030/1090 MHz utilization.

2.2.2 Airborne measurements provide a larger area of measurement but are more difficult to conduct and result in higher cost. The airborne measurements provide both the ability to characterize ground sensor operations (1030 MHz) and transponder occupancy. Providing a 1030 MHz measurement enables the detection of all types of interrogations to which a transponder is receiving, i.e, interrogations to which a transponder does or does not transmit a reply. Therefore, it allows an estimation of transponder occupancy at the given points of measurement. It also allows the tracking of interrogations received but not generating replies (e.g., SLS interrogations, interrogations directed to other aircraft).

2.2.3 Ground measurements are more easily accomplished, less expensive but geographically limited. They allow the verification of transponder transmissions on 1090 MHz but are limited in their ability of providing a complete understanding of the environment that airborne aircraft are experiencing. Estimates of 1030 MHz activity can be somewhat estimated from measurement of 1090 MHz replies. However, there is no way to completely account for interrogations that do not result in a reply that impact transponder occupancy.

2.3 Metrics and measurement methods

2.3.1 Frequency occupancy

2.3.1.1 Method 1, In order to allow simple comparison of signal activity received on either 1030 MHz or 1090 MHz frequency, one method is to calculate a simple time occupancy that corresponds to the amount of time that there is a signal present above a given threshold without trying to extract or even decode the content of the messages. The process can be based on the following criteria:

- 1090 MHz frequency occupancy is defined by the proportion of time that there is a signal above the MTL (-84 dBm) for pulses greater than 0.3 microseconds in duration; and
- 1030 MHz frequency occupancy is defined by the proportion of time that there is a signal above the MTL (-74 dBm) for pulses greater than 0.3 microseconds in duration.

2.3.1.2 Method 2, which analyses the signal received on 1090 MHz, would be determined by decoding of, and counting the number of signals for, different types of messages. The 1090 MHz frequency band occupancy can also be estimated using a predefined occupancy time for each type of message. This message occupancy time is defined as the time there is a signal transmitted on the frequency, i.e., a pulse is transmitted. It signifies how long the transmission is occupying the frequency and therefore possibly interfering with another signal. The table below provides the values to be used to estimate the effective occupancy time and allow comparison between different measurements/estimations made by different authorities.

Type of message	*Time occupancy in μs*
Mode A/C reply	4.05 (9*0.45)
Short Mode S reply or squitter	30 (60*0.5)
Long Mode S reply or Extended Squitter	58 (116 *0.5)

2.3.1.3 Note that the occupancy of a Mode A/C reply depends on the number of pulses transmitted in each reply. For this calculation, an average value of 9 pulses (2 framing + 7 code pulses) has been used. This is sufficient to provide a first order estimation for comparison with the occupancy of other signal types.

2.3.1.4 The calculation of the number of replies of a given type multiplied by their corresponding time occupancy enables characterizing the impact of different message types on the frequency. Since this uses a fixed defined time occupancy for each type of message, the occupancy determined using this method, in general, will be lower than the occupancy computed using method 1 above, since it can be expected that interfering pulses that may occur during a detected message are not accounted for using method 2.

2.3.1.5 Method 3 is similar to the previous methods. An alternate occupancy calculation is based on the number of signals received on 1030 and 1090 MHz, which are decoded and from which signal rates are determined. However, the occupancy considers the entire signal length from the leading edge of the first pulse until the trailing edge of the last pulse as the time duration regardless of whether and how many intermediate pulses are transmitted. The rationale behind this method is that in RF high-density areas, multiple signal garbling is likely to occur and therefore pulse gaps are unpredictably filled. The determination of the band occupancy is based on the signal durations, as shown in table below.

Type of message	***1030 MHz signal duration***	***1090 MHz signal duration***
Mode 1	3.8 µs	20.75 µs
Mode 2	5.8 µs	20.75 µs
Mode 3/A	8.8 µs	20.75 µs
Mode C	21.8 µs	20.75 µs
Mode C (Whisper/Shout)	23.8 µs	20.75 µs
Mode A only All Call	10.8 µs	20.75 µs
Mode C only All-Call	23.8 µs	20.75 µs

Mode A/Mode S All-Call	11.6 µs	20.75 µs or 64 µs
Mode C/Mode S All-Call	24.6 µs	20.75 µs or 64 µs
Mode C only All-Call (W/S)	25.8 µs	20.75 µs
Mode A only All-Call (W/S)	12.8 µs	20.75 µs
Short Mode S	19.75 µs	64 µs
Long Mode S	33.75 µs	120 µs

2.3.2 Determination of transponder reply and broadcast activity

2.3.2.1 By analyzing the transmissions made by a transponder, it is possible to verify if a transponder is transmitting above the minimum capabilities specified in Annex 10, Volume IV. The number of messages can be counted over 1 second and 100 msec sliding windows. The peak rates (i.e., the interval with the highest number of messages) detected over a given interval (e.g. 1 minute) can be compared to the values defined in Annex 10, Volume IV. Such information provides a good overall estimate of transponder activity caused by interrogators and makes possible the detection and further analysis of unexpected activity on the channel.

2.3.2.2 One method to estimate the number of messages transmitted by individual aircraft is by counting the number of messages received by a 1090 MHz receiver for aircraft in the vicinity of the receiver with a good link budget. However, achieving sufficient decoding performance is difficult but this method lends itself to a long-term ground-based monitoring system.

2.3.2.3 Another method is to conduct flight tests and detect and record the transmissions made by the operational transponder installed on the test aircraft. This is a good way to determine with high confidence the activity of an individual transponder in the environment. Decoding ownship replies is more accurate than attempting to analyses all the replies transmitted by all the other aircraft because the transmissions are received at high power, thereby reducing the problem of degarbling with other transmissions.

3. Additional data

3.1 Considering additional data such as aircraft environment and traffic density is desirable to assist in understanding the RF measurements that are obtained by the various methods previously identified. RF activity is a function of the number of systems operating, which includes the number and types of interrogators operating on the 1030 MHz frequency as well as the number and equipage of aircraft operating in the geographical area surrounding the measurement location.

3.2 Data to describe the aircraft environment during a measurement activity is helpful to understand the relationship between the RF measurements and the aircraft traffic in the surrounding area. Traffic density and traffic patterns influence the RF activity in any given area or region. Determining the aircraft environment may require collecting and recording data from one or more ground SSRs. Data in time intervals of 10 to 15 minutes is suggested. To some extent, aircraft information can be determined by the

RF measurement system itself. Mode S equipped aircraft can be detected by 1090 MHz reply data via the 24-bit aircraft address and additionally the position of many aircraft can be determined by extended squitter data. ACAS equipage can be determined from 1030 MHz TCAS broadcast data, extended squitter as well as DF 0/16 reply content. These methods are limited to the receiver range of the measurement system but enable determining the nearby aircraft environment.

3.3 Information to describe the ground interrogator environment during a measurement activity is helpful to understand the relationship between the RF measurements and the number of interrogators in the surrounding area. Ground interrogators vary in characteristics that influence the impact to the RF environment. The expected RF contribution from ground interrogators can be predicted based on their characteristics such as PRF, scan rate, mode interlace pattern, beamwidth, power, etc. Although there is no way to associate measured 1030 MHz Mode A/C or Whisper-Shout interrogations to a given ground interrogator without detailed analysis of interrogation timing, particularly in the mainbeam, Mode S interrogator All-Call activity can be associated via the II/SI codes. There are many factors that influence overall RF activity with Mode S since ground interrogators may be extracting many GICB registers that increase the contribution of Mode S FRUIT caused by ground interrogators. It is possible to associate All-Call interrogations with UF 4, 5, 20 and 21 interrogations by examining mainbeam activity of detected Mode S ground interrogators.

3.4 Additional data that can be helpful in assessing the RF activity in a given region is the use of interrogation and reply data that is broadcast on extended squitter by so equipped aircraft. The capability to broadcast interrogation and reply data is incorporated into the future version of 1090 MHz extended squitter as a means of collecting useful 1030 and 1090 MHz activity data. The interrogation data is useful in conjunction with flight test measurements as it provides insight to the interrogation activity at different locations in addition to own aircraft. The reply data counts from the broadcasting aircraft enable comparison to the own aircraft rates as a function of time. For the purpose of ground monitoring of RF activity over time, decoding of the interrogation and reply monitoring extended squitter messages can be used for long term assessment of RF activity and enable capture of unusual or excessive RF activity events.

ICAO APAC POINT OF CONTACT ON MODE S AND DAPS MATTERS

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3.		**CAMBODIA**			
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		STATE/NAME	TITLE/ORGANIZATION	E-MAIL	TEL/FAX
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LIST OF ACTION ITEMS of Mode S and DAPs WG

No.	Subject	Forum Raised	Status / Target Date	Remarks / follow-up	Action Party
1.	II code coordination for ADS-B and MLAT	DAPs WG/2	On-going	New guidance material is under development by SP, DAPS WG will monitor the progress	China, Malaysia and Singapore
2.	Update DAPs Implementation Status table for APAC region	DAPs WG/2	On-going basis	To update the information in the table as necessary.	Member States
3.	Harmonization with air space users	SURICG/2	On-going basis	Invite avionics manufacturers and airlines to share experience, where possible.	Co-chairs and hosting States
4.	Align with APAC Seamless ANS Plan 3.0, GANP 2019 and A40, ANC/13 outcome	DAPs WG/3	Closed	As the IGD2.0 and roadmap have been developed, it's necessary to further align the direction and timeline of regional implementation with global guideline by updating the action list, IGD and roadmap.	Co-chairs, ICAO
5.	Propose to Surveillance Panel on the addition of SI code allocation criteria in a mixed II and SI mode into Doc 9924	DAPs WG/4	DAPs WG/5 (Completed)	It was noted that Doc 9924 does not provide guidance for the allocation of IC in a mixed II and SI mode.	Co-chairs, ICAO, Robert Witzen
6.	Create an ad-hoc group to study the migration from II code to SI code schemes and strategies for APAC	DAPs WG/4	DAPs WG/6 (Completed)	Recognizing the challenges for APAC in migrating to mixed II and SI operation	Co-chairs, ICAO, States, Robert Witzen
7.	Study allocation of II code 14 and 15 for specific purposes in APAC	DAPs WG/4	DAPs WG/5 (Completed)	As II code 14 and 15 have been implemented in States. Undertaken by the same ad-hoc group created for Action Item 6.	Co-chairs, ICAO, States, Robert Witzen
8.	Conduct a survey with APAC states to request the information about the current use of EHS mode	DAPs WG/4	DAPs WG/5 (Completed)	Understanding the challenges and difficulties faced by states in implementing APANPIRG conclusion C 31/14	ICAO

LIST OF ACTION ITEMS of Mode S and DAPs WG

No.	Subject	Forum Raised	Status / Target Date	Remarks / follow-up	Action Party
9.	Take necessary action to update the accurate SAC allocation in APAC to EUROCONTROL website.	DAPs WG/4	DAPs WG/5 (Completed)	To update EUROCONTROL with the latest SAC allocation within Asia Pacific, and correct the SAC assignment of Afghanistan as it is now in APAC region	Co-chairs, ICAO
10.	Reservation of II codes 14 and 15 for Research, Test and Military Purposes	DAPs WG/5	On-going	To decide when significant number of radars migrated from II to Surveillance Identifier (SI) codes. ICAO APAC will make a conscious effort to avoid allocating II 14 and 15 (and the matching SI codes) to new radars unless due to capacity issue.	Co-chairs, ICAO
11.	Update IGD with the discussion outcome on IC planning and coordination	DAPs WG/6	Target in 2024		China
12.	Workshop on the use of Mode S and DAPs and Assignment of /migration to II/SI codes	DAPs WG/6	Target in 2024		ICAO

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MODE S DAPs IMPLEMENTATION STATUS IN THE APAC REGION

No.	State/ Administration	Mode-S Surveillance Facilities and ATM System Readiness	Operational Status	Remark
1	**CHINA**	78 Mode-S capable radars. Now ATM automation systems could process the DAPs including the position altitude and Mode 3/A Code. Almost all the ATM automation systems could process DAPs, just a few site systems not finished the software version upgrade.	Radars and DAPs application in ATM system for the second stage are operational.	
2	**INDIA**	30 Mode-S capable Radars have already been installed. All ATM systems except Chennai are capable to process DAPs.	Out of 30 Mode-S capable Radars, 28 radars are presently operational. All DAPs capable ATM systems are operational.	Commissioning of remaining 02 Mode-S capable radars is under process.
3	**INDONESIA**	28 Mode-S capable Radars 12 ATM systems	26 Radars are in operational. 6 ATM systems are capable for DAPs; and the rest are in evaluation process.	
4	**JAPAN**	13 En-route Radars are Mode-S capable, of which 4 Radars are in evaluation for DAPs. 4 Mode-S capable En-route WAMs. ATM system is in evaluation process for DAPs. ~~132 En-route Radars are Mode-S capable radars, of which 4 Radars are in evaluation for DAPs.~~ ~~4 Mode-S capable En-route WAMs.~~ ~~ATM system is in evaluation process for DAPs.~~	Radars/WAMs are operational and DAPs application in ATM is in evaluation.	

No.	State/ Administration	Mode-S Surveillance Facilities and ATM System Readiness	Operational Status	Remark
5	**LAO PDR**	- 4 Mode-S Capable MSSRs are operational (3 MSSR-Mode S Enhance Mode) - 5 ADS-B Ground Sations (2 GS with DO-260 A Compliant and 3 GS with DO-260 B Compliant) 2 ATM System with DAPs capable	4 Mode-S MSSR and ADS-B integrated into the ATM Systems.	Full Mode S are not yet put in operation (1 Mode-S MSSR station need to be replace due to aging) ADS-B operational as for Monitoring
~~5~~6	**MALAYSIA**	10 Mode-S capable SSR are operational 7 ADS-B ground stations are operational	Radars and DAPs application in ATM system are operational	3 New Mode-S capable SSRs are currently being installed and are expected to be fully operational by the year 2024 6 New Mode-S capable SSRs are in the procurement process starting from 2023 – 2026.

No.	State/ Administration	Mode-S Surveillance Facilities and ATM System Readiness	Operational Status	Remark
~~6~~7	**NEW ZEALAND**	Current Operational Surveillance equipment: Primary: 27 ADSB sites (some dual, others single) Contingency: 5 MSSR, 1 combined MSSR/PSR and 2 PSR 1 MLAT for surface movements, 1 MLAT for WAM ~~Current Operational Surveillance equipment:~~ ~~5 MSSR, 1 combined MSSR/PSR and 2 PSR~~ ~~1 MLAT for surface movements, 1 MLAT for WAM~~ ~~27 ADSB sites (some dual, others single).~~	All current surveillance systems are operational. The ATM is processing all DAPS data from ADSB, MLAT and MSSR – MODE A/C/S Code, Flight ID, SFL, IAS, and MACH data is provided to controllers, other data is used by the ATM – e.g., for calculating the wind speed/direction.	Planned Install 3 New MSSR/PSR. Remove Old MSSR/PSR - 5 MSSR, 1 combined MSSR/PSR and 2 PSR Review MLAT and WAM systems Note, New Zealand does not have a MODE S Mandate.
~~7~~8	**PHILIPPINES**	12 Mode-S capable radars ATM system Capable of DAPs.	All radar systems are Operational ATM systems are likewise operational with DAPs capability disabled	~~Temporarily turned off/disabled due to some issues as advised by the vendor (Thales).~~ Operational
~~8~~9	**REPUBLIC OF KOREA**	13 Mode-S capable radars ATM system capable to process DAPs.	Out of 13 Mode-S capable Radars, 8 Radars are operational DAPs application in ATM system are operational	
~~9~~10	**SINGAPORE**	3 Mode-S capable radars ATM system ready to process DAPs.	Radars and DAPs application in ATM system are operational	
~~10~~11	**SRI LANKA**	two non-Mode-S radars that are working at BIA (Bandaranaiyake International Airport and mountain Pidurutalagala, Nuwara Eliya, Sri Lanka)		1. Mountain Pidurutalagala Mode - S Radar will be available by end of March 2024. 2. ATM system for the Approach control center at BIA with mode -S

No.	State/ Administration	Mode-S Surveillance Facilities and ATM System Readiness	Operational Status	Remark
				and DAP's processing is available by end of the second quarter of 2023. 3. WAM system with DAP's capability and or BIA Mode -S Radar update, planned to implement by end of 2024. 4. ATM system for area control center at Ratmalana (Colombo Airport) with Mode-S and DAP's processing is fully implemented by end of 2024 after implementing Pidurutalagala Mode-S Radar by March-2024.
~~11~~12	**THAILAND**	12 Mode-S EHS RADARs. The new ATM system, Thailand Modernization CNS/ATM System (TMCS) project, is capable to process DAPs. The TMCS made use of DAPs as information for ATC for determining. 7 ADS-B stations are already installed and waiting for operational approval	The TMCS project has been fully operating since last quarter of year 2020.	Plan to use Mode S DAPs data for tracking and warning process - Trial by the end of 2023 - Consider for operation in 2024

No.	State/ Administration	Mode-S Surveillance Facilities and ATM System Readiness	Operational Status	Remark
~~12~~13	**VIET NAM**	- 2 Mode-S capable radars - 2 ATM system ready to process DAPs. - 23 ADS-B stations - 1 MLAT	- Radars and ATM are capable of handling Mode S DAPs but not yet officially operation. - ADS-B is on operation	Vietnam is deploying following projects: - New 5 SSR Mode Station (EHS), - New Ho Chi Minh ATCC and new Da Nang ATCC (with new modern ATM system).

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Table CNS II-APAC-3 SURVEILLANCE of e-ANP Volume II with Proposed Changes

EXPLANATION OF THE TABLE

Column

1 ATS Units to consider are ACC units and Approach units responsible for International airports and alternate aerodromes, International airports and alternate aerodromes.

2 The category may be: R, S, T or AD. Categories R,S, T are defined in the Seamless ATM plan. AD means Aerodrome.

3 Indicate Yes if part(s) of the airspace referred to in Column 2 is (are) not covered by surveillance listed in column 6, and in column remarks when such gaps are planned to be bridged

4 Indicate Yes or No.

Indicate No in case of standalone displays of ATS surveillance data (should not be used operationally)

5 Indicate Yes or No

6 List all types of surveillance used:

PSR
SSRmS
SSRmAC
ADS-B
ADS-C
MLAT
WAM
PRM

7 According to the definition in Doc 9830 Appendix B

8 Remarks

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
AUSTRALIA International Airports							
Adelaide	C						Adelaide, Summertown
TCU			YES	YES	PSR+SSRmS+SSRmAC		
APP			YES	YES	PSR+SSRmS+SSRmAC		
TWR			YES	YES	PSR+SSRmS+SSRmAC		
Cairns	C						Redden Creek, Hanns Tableland
TCU			YES	YES	PSR+SSRmS+SSRmAC		
APP			YES	YES	PSR+SSRmS+SSRmAC		
TWR			YES	YES	PSR+SSRmS+SSRmAC		
Brisbane	C						Mt Hardgrave, Brisbane, Mt Sommerville
EC			YES	YES	PSR+SSRmAC+SSRmS+ADS-B		
APP			YES	YES	PSR+SSRmAC+SSRmS+		
ACC			YES	YES	PSR+SSRmAC+SSRmS+ADS-B		
TWR			YES	YES	PSR+SSRmAC+SSRmS+A-SMGCS+SMR	2	
Gold Coast	C						Mt Sommerville, Mt Hardgrave
APP			YES	YES	PSR+SSRmS+SSRmAC		
TWR			YES	YES	PSR+SSRmS+SSRmAC		
Melbourne	**C**						Gelliebrand Hill, Mt Macedon
EC			YES	YES	PSR+SSRmAC+SSRmS+ADS-B+		
APP			YES	YES	PSR+SSRmAC+SSRmS		
ACC			YES	YES	PSR+SSRmAC+SSRmS+ADS-B		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
TWR			YES	YES	PSR+SSRmAC+SSRmS+ADS-B+A-SMGCS+SMR	2	
Perth	**C**						Perth, Kalamunda, Eclipse Hill
TCU			YES	YES	PSR+SSRmAC+SSRmS		
APP			YES	YES	PSR+SSRmAC+SSRmS		
TWR			YES	YES	PSR+SSRmAC+SSRmS+A-SMGCS+SMR	2	
Sydney	**C**						Sydney, Mt Boyce, Cecil Park
TCU			YES	YES	PSR+SSRmS+SSRmAC+WAM+MLAT		
APP			YES	YES	PSR+SSRmS+SSRmAC+WAM+MLAT		
TWR			YES	YES	PSR+SSRmS+SSRmAC+A-SMGCS+WAM+MLAT+SMR	2	
Darwin	**C**						Darwin, Knuckeys Lagoon
APP			YES	YES	PSR+SSRmS+SSRmAC		
TWR			YES	YES	PSR+SSRmS+SSRmAC		
Hobart	**D**						Hobart
APP			YES	YES	WAM+ADS-B		
TWR			YES	YES	WAM+ADS-B		
Karratha	D						Karratha
APP			YES	YES	ADS-B		
TWR			YES	YES	ADS-B		
Alternate aerodromes							
Alice Springs	D						Alice Springs

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
APP			YES	YES	ADS-B		
TWR			YES	YES	ADS-B		
Avalon	D						Gellibrand Hill, Mt Macedon
APP			YES	YES	PSR+ SSRm(S)+SSRm(A/C)		
TWR			YES	YES	PSR+ SSRm(S)+SSRm(A/C)		
Canberra	C						Mt Majura, Mt Bobbara
APP			YES	YES	PSR+ SSRm(S)+SSRm(A/C)		
TWR			YES	YES	PSR+ SSRm(S)+SSRm(A/C)		
Coffs Harbour	D						The Round Mountain, Point Lookout
APP			YES	YES	SSRm(S)+SSRm(A/C)+ADS-B		
TWR			YES	YES	SSRm(S)+SSRm(A/C)+ADS-B		
Kalgoorlie	G	Over aerodrome	YES	YES	-		
Launceston	D						Launceston
APP			YES	YES	WAM+ ADS-B		
TWR			YES	YES	WAM+ ADS-B		
Learmonth	G		YES	YES	ADS-B		Learmonth
Port Hedland	G	Over aerodrome	YES	YES	-		
Rock Hampton	D						Mt Alma
APP			YES	YES	SSRm(S)+SSRm(A/C)		
TWR			YES	YES	SSRm(S)+SSRm(A/C)		
Tindal	C						Tindal
APP			YES	YES	PSR+SSRm(A/C)		
TWR			YES	YES	PSR+SSRm(A/C)		
Townsville	C						Townsville, Tabletop
APP			YES	YES	PSR+ SSRm(S)+SSRm(A/C)		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
TWR **Other aerodromes**			YES	YES	PSR+ SSRm(S)+SSRm(A/C)		
Broome Albury Tamworth Mackay Hamilton Island	D D D D D		YES YES YES YES YES	YES YES YES YES YES	ADS-B Higher level SSR coverage ? SSRm(A/C) SSRm(A/C)		Broome Mt Bobbara The Round Mountain Swampy Ridge Swampy Ridge
BANGLADESH Dhaka APP	C				PSR+SSRm AC		
BRUNEI DARUSALAM Brunei APP					PSR + SSRmAC		
CAMBODIA					SSRmAC		
CHINA Beijing ACC Beijing APP Beijing TWR (ZBAA)			YES YES YES	YES YES YES	PSR + SSRmAC +SSRmAC+ADS-B PSR + SSRmAC +SSRmAC+ADS-B PSR + ~~SSRmAC~~ SSRmS+SSRmAC+SMR+AD	2	
Beijing TWR (ZBAD)			YES	YES	PSR+SSRmS+SSRmAC+SMR+ADS-B+MLAT+A-SMGCS	4	
Tianjin APP			YES	YES	PSR+SSRmS+SSRmAC+ADS-B		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
Tianjin TWR			YES	YES	~~SSRmAC~~ SSRmS+SSRmAC+SMR+ADS-B+MLAT+A-SMGCS	2	
Shijiazhuang APP			YES	YES	SSRmS+SSRmAC+ADS-B		
Shijiazhuang TWR			YES	YES	~~SSRmAC~~ SSRmS+SSRmAC+ADS-B		
Taiyuan ACC			YES	YES	~~PSR + SSRmAC~~ PSR+SSRmS+SSRmAC+ADS-B		
Taiyuan APP			YES	YES	PSR+SSRmS+SSRmAC+ADS-B		
Taiyuan TWR			YES	YES	~~PSR + SSRmAC~~ PSR+SSRmS+SSRmAC+ADS-B		
Hohhot ACC			YES	YES	SSRmAC +ADS-B		
Hohhot APP			YES	YES	SSRmAC+ADS-B		
Hohhot TWR			YES	YES	SSRmAC +ADS-B		
Guangzhou ACC			YES	YES	PSR+SSRmS+SSRmAC+ADS-B		
Guangzhou APP			YES	YES	PSR+SSRmS+SSRmAC+ADS-B		
Guangzhou TWR			YES	YES	PSR+SSRmS+SSRmAC+SMR+ADS-B+A-SMGCS	2	
Shenzhen APP			YES	YES	SSRmS+SSRmAC+ADS-B		
Shenzhen TWR			YES	YES	~~PSR~~ + SSRmS+ SSRmAC +ADS-B+SMR+A-SMGCS		
Zhuhai ACC			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Zhuhai APP			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
Zhuhai TWR			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Sanya ACC			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Sanya APP			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Sanya TWR			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Haikou ACC			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Haikou APP			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Haikou TWR			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B +SMR+MLAT		
Changsha ACC			YES	YES	~~PSR +~~ SSRmS+ SSRmAC +ADS-B		
Changsha APP			YES	YES	SSRmS+SSRmAC+ADS-B		
Changsha TWR			YES	YES	~~PSR +~~ SSRmS+ SSRmAC +ADS-B +SMR+MLAT+A-SMGCS		
Enshi TWR			YES	YES	SSRmAC		
Wuhan ACC			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Wuhan APP			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Wuhan TWR			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B +SMR+MLAT+A-SMGCS	2	
Zhengzhou ACC			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Zhengzhou APP			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Zhengzhou TWR			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B +SMR+MLAT+A-SMGCS	2	
Guilin ACC			YES	YES	~~PSR +~~ SSRmS+ SSRmAC +ADS-B		
Guilin APP			YES	YES	~~PSR +~~ SSRmS+ SSRmAC +ADS-B		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
Guilin TWR			YES	YES	~~PSR +~~ SSRmS+ SSRmAC +ADS-B +SMR+MLAT		
Nanning ACC			YES	YES	SSRmS+SSRmAC+ADS-B		
Nanning TWR			YES	YES	SSRmAC+ADS-B		
Zhanjiang ACC			YES	YES	PSR+SSRmS+SSRmAC+ADS-B		
Zhanjiang APP			YES	YES	PSR+SSRmS+SSRmAC+ADS-B		
Zhanjiang TWR			YES	YES	PSR+SSRmS+SSRmAC+ADS-B		
Shantou ACC			YES	YES	~~PSR~~ SSRmS + SSRmAC +ADS-B		
Shantou APP			YES	YES	~~PSR~~ SSRmS + SSRmAC +ADS-B		
Shantou TWR			YES	YES	~~PSR~~ SSRmS + SSRmAC +ADS-B		
Kunming ACC			YES	YES	PSR +SSRmS + SSRmAC + ~~AC~~ ADS-B		
Kunming APP			YES	YES	PSR +SSRmS + SSRmAC + ~~AC~~ ADS-B		
Kunming TWR			YES	YES	PSR +SSRmS + SSRmAC + ~~AC~~ ADS-B + SMR+MLAT		
Chengdu ACC			YES	YES	PSR +SSRmS + SSRmAC + ~~ADS-C~~ +ADS-B		
Chengdu APP			YES	YES	PSR +SSRmS + SSRmAC + ~~ADS-C~~ +ADS-B		
Chengdu TWR (ZUUU)			YES	YES	PSR +SSRmS + SSRmAC + ~~ADS-C~~ +ADS-B+SMR+MLAT+A-SMGCS	2	

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Chengdu TWR (ZUTF)			YES	YES	PSR+SSRmS+SSRmAC+ADS-B+SMR+MLAT+A-SMGCS	2	
Guiyang ACC			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Guiyang APP			YES	YES	PSR+SSRmS+SSRmAC+ADS-B		
Guiyang TWR			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B+SMR+MLAT+A-SMGCS	2	
Chongqing ACC			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Chongqing APP			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Chongqing TWR			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B+SMR+MLAT+A-SMGCS	2	
Shanghai ACC			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Shanghai APP			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B		
Shanghai TWR (ZSSS)			YES	YES	PSR + SSRmS+ SSRmAC +ADS-B+SMR+MLAT+A-SMGCS	2	
Shanghai TWR(ZSPD)			YES	YES	PSR+SSRmS+SSRmAC+ADS-B+SMR+A-SMGCS	2	
Jinan ACC			YES	YES	SSRmS+ SSRmAC +ADS-B		
Jinan APP			YES	YES	SSRmS+SSRmAC+ADS-B		
Jinan TWR			YES	YES	SSRmS+ SSRmAC +ADS-B		
Qingdao ACC			YES	YES	SSRmS+ SSRmAC +ADS-B		
Qingdao APP			YES	YES	SSRmS+SSRmAC+ADS-B		
Qingdao TWR			YES	YES	SSRmS+SSRmAC+ADS-B	2	
Hefei ACC			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
Hefei APP			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		
Hefei TWR			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		
Nanjing ACC			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		
Nanjing APP			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		
Nanjing TWR			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B+SMR+A-SMGCS	2	
Lianyungang ACC			YES	YES	SSRmS+ SSRmAC +ADS-B		
Lianyungang APP			YES	YES	SSRmS+ SSRmAC +ADS-B		
Lianyungang TWR			YES	YES	SSRmS+ SSRmAC +ADS-B		
Xuzhou TWR			YES	YES	SSRmS+ SSRmAC +ADS-B		
Hangzhou ACC			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B		
Hangzhou APP			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B		
Hangzhou TWR			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B+SMR+MLAT+A-SMGCS	2	
Nanchang ACC			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		
Nanchang APP			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		
Nanchang TWR			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		
Fuzhou ACC			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		
Fuzhou APP			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		
Fuzhou TWR			YES	YES	~~PSR+~~SSRmS+ SSRmAC +ADS-B		
Wenzou TWR			YES	YES	SSRmS+ SSRmAC +ADS-B		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Xiamen ACC Xiamen APP Xiamen TWR			YES YES YES	YES YES YES	~~PSR+~~ SSRmAC +ADS-B SSRmAC +ADS-B ~~PSR+~~ SSRmAC +ADS-B+ SMR+MLAT+A-SMGCS	 2	
Shenyang ACC Shenyang APP Shenyang TWR			YES YES YES	YES YES YES	PSR+ SSRmS +SSRmAC + ADS-B PSR+ SSRmS +SSRmAC + ADS-B PSR+ SSRmS +SSRmAC + ADS-B SMR+A-SMGCS	 2	
Dalian ACC Dalian APP Dalian TWR			YES YES YES	YES YES YES	PSR+ SSRmS +SSRmAC + ADS-B PSR+ SSRmS +SSRmAC + ADS-B PSR+ SSRmS +SSRmAC + ADS-B SMR+A-SMGCS	 2	
Harbin ACC Harbin APP Harbin TWR			YES YES YES	YES YES YES	PSR+ SSRmS +SSRmAC + ADS-B PSR+ SSRmS +SSRmAC + ADS-B PSR+ SSRmS +SSRmAC + ADS-B SMR+ MLAT+ A-SMGCS	 2	
Xi'an ACC Xi'an APP Xi'an TWR			YES YES YES	YES YES YES	PSR+ SSRmS +SSRmAC + ADS-B PSR+ SSRmS +SSRmAC + ADS-B PSR+ SSRmS +SSRmAC + ADS-B SMR+ MLAT		
Lanzhou ACC Lanzhou APP Lanzhou TWR			YES YES YES	YES YES YES	SSRmS+ SSRmAC+ ~~AC~~ + ADS-B SSRmS+SSRmAC+ADS-B SSRmS+ SSRmAC +ADS-B		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
Urumqi ACC Urumqi APP Urumqi TWR			YES YES YES	YES YES YES	PSR+SSRmS +SSRmAC +~~AC~~ ADS-B PSR+SSRmS+SSRmAC+ADS-B PSR+ SSRmS +SSRmAC +ADS-B+SMR+MLAT+A-SMGCS	 2	
HONG KONG, CHINA Hong Kong ACC Hong Kong APP Hong Kong TWR	 S T AD		 Yes	 Yes	 PSR + SSRmAC + ADS-B PSR + SSRmAC + ADS-B PSR + SSRmAC + ADS-B + MLAT	 2	 SMR, A-SMGCS
MACAO, CHINA Macao TWR	AD		Yes	Yes	SSRmS+SSRmAC		SMR
DPR KOREA **Pyongyang** Pyongyang ACC Pyongyang APP Pyongyang TWR					 PSR + SSRmAC + ADS-B PSR + SSRmAC + ADS-B		 PAR
FIJI Naid ACC Nadi APP					 ADS-B + ADS-C ADS-B		
FRENCH POLYNESIA Tahiti ACC					 SSRmAC + ADS-B + ADS-C		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Tahiti APP Tahiti TWR					SSRmAC		
INDIA							
Chennai ACC					PSR + ADS-C		MI
Chennai APP					PSR + ADS-C		MI
Chennai TWR					PSR + ADS-C		A-SMGCS
Delhi ACC					PSR + ADS-C		MI
Delhi APP					PSR + ADS-C		MI
Delhi TWR					PSR + ADS-C		A-SMGCS
Kolkata ACC					PSR + ADS-C		MI
Kolkata APP					PSR + ADS-C		MI
Kolkata TWR					PSR + ADS-C		A-SMGCS
Mumbai ACC					PSR + ADS-C		MI
Mumbai APP					PSR + ADS-C		MI
Mumbai TWR					PSR + ADS-C		A-SMGCS
Bangalore APP					PSR		MI
Bangalore TWR					PSR		MI
Shamshabad ACC					PSR		MI
Shamshabad APP					PSR		MI
Shamshabad TWR					PSR		MI
INDONESIA							

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Jakarta ACC			YES	YES	PSR + SSRmS + ADS-B		~~ADS-B Trial~~ A-SMGCS, MLAT, SMR
Jakarta APP			YES	YES	PSR + SSRmS + ADS-B		
~~Medan ACC~~					~~PSR + SSRmAC + ADS-B~~		
Aceh APP			YES	YES	SSRmS + ADS-B		
Medan APP			YES	YES	~~PSR~~ SSRmS + ADS-B		
Tanjung Pinang APP			YES	YES	SSRmS		
Padang APP			YES	YES	SSRmS		
Pontianak APP			YES	YES	SSRmS + ADS-B		
Pekanbaru APP			YES	YES	~~PSR + SSRmAC~~ SSRmS + ADS-B		
Palembang APP			YES	YES	~~PSR + SSRmAC~~ SSRmS + ADS-B		
Ujung Pandang ACC			YES	YES	~~PSR + SSRmAC~~ SSRmS + ADS-B		
Ujung Pandang APP			YES	YES	~~PSR + SSRmAC~~ SSRmS + ADS-B		~~ADS-C Trial, A-SMGCS~~
Banjarmasin APP			YES	YES	~~SSRmAC~~ SSRmS + ADS-B		
Balikpapan APP			YES	YES	~~PSR + SSRmAC~~ SSRmS + ADS-B		
Yogyakarta APP			YES	YES	~~PSR~~ SSRmS		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Surabaya APP			YES	YES	~~PSR~~ SSRmS + ADS-B		A-SMGCS, MLAT
Semarang APP			YES	YES	SSRmS + ADS-B		
Bali APP			YES	YES	SSRmS + ADS-B		~~A-SMGCS~~
Biak APP			YES	YES	~~SSRmAC~~ SSRmS + ADS-B		
~~Jayapura ACC~~ Jayapura APP			YES	YES	~~PSR~~ ~~PSR~~ SSRmS + ADS-B		
~~Kupang ACC~~ Kupang APP			YES	YES	~~ADS-B~~ SSRmS + ADS-B		
~~Tarakan ACC~~ Tarakan APP			YES	YES	~~PSR + ADS-B~~ SSRmS + ADS-B		
~~Batam ACC~~ ~~Batam APP~~					~~SSRmS~~ ~~SSRmS + ADS-B~~		
~~Sorong ACC~~					~~SSRmS + ADS-B~~		
Manado APP			YES	YES	SSRmS + ADS-B		
Ambon APP			YES	YES	SSRmS + ADS-B		
Merauke APP			YES	YES	SSRmS + ADS-B		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
JAPAN							
Fukuoka ATMC			Yes		ADS-C		
Narita APP			Yes		PSR + SSRmAC + SSRmS		
Narita TWR			Yes		MLAT ~~, PSRMLAT~~ +PRM		SMR
Haneda TWR			Yes		MLAT+PRM		SMR
Chubu APP			Yes		PSR + SSRmAC + SSRmS		
Chubu TWR			Yes		MLAT		SMR
Osaka APP			Yes		PSR + SSRmAC + SSRmS		
Osaka TWR			Yes		MLAT		SMR
Kansai APP			Yes		PSR + SSRmAC + SSRmS		
Kansai TWR			Yes		MLAT		SMR
Fukuoka ACC			Yes	Yes	PSR + SSRmAC + SSRmS +WAM		
Fukuoka APP			Yes		PSR + SSRmAC + SSRmS		
Fukuoka TWR			Yes		MLAT		SMR
~~Naha ACC~~					~~PSR + SSRmAC + SSRmS~~		
Naha APP			Yes		PSR + SSRmAC + SSRmS		
Naha TWR			Yes		MLAT		SMR
Hakodate APP			Yes		PSR + SSRmAC		
Sendai APP			Yes		PSR + SSRmAC		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
Tokyo ACC			Yes	Yes	PSR + SSRmAC + SSRmS +WAM		
Tokyo APP			Yes		PSR + SSRmAC + SSRmS		
Niigata APP			Yes		PSR + SSRmAC		
~~Chubu APP~~					~~PSR + SSRmAC + SSRmS~~		
Hiroshima APP			Yes		PSR + SSRmAC		
Takamatsu APP			Yes		PSR + SSRmAC		
Kochi APP			Yes		PSR + SSRmAC		
~~Matsuyama TWR~~					~~SSRmAC~~		
~~Kitakyusyu TWR~~					~~SSRmAC~~		
Nagasaki APP			Yes		PSR + SSRmAC		
Oita APP			Yes		PSR + SSRmAC		
Kumamoto APP			Yes		PSR + SSRmAC		
Miyazaki APP			Yes		PSR + SSRmAC		
Kagoshima APP			Yes		PSR + SSRmAC		
Shimojishima APP			Yes		PSR + SSRmAC		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Ishigaki APP			Yes		PSR + SSRmAC		
Sapporo ACC			Yes	Yes	PSR + SSRmAC + SSRmS +WAM		
LAO PDR							
Vientiane ACC	S		Yes	Yes	SSRmAC + SSRmS +ADS-B		ADS-B for monitoring only
Vientiane APP	T		Yes	Yes	~~PSR~~ SSRmS		
MALAYSIA							
Langkawi APP					PSR + SSRmAC		
Kuala Lumpur ACC					PSR + SSRmAC + SSRmS		
Lumpur APP					PSR + SSRmAC + ADS-C		
Johor Bharu APP					PSR + SSRmS		
Kota Bharu APP					PSR + SSRmS		
K. Kinabalu ACC					PSR + SSRmAC		
K. Kinabalu APP					PSR + SSRmAC		
Kuching ACC					PSR + SSRmAC		
Kuching APP							

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
MALDIVES Maldives ACC Maldives APP Maldives TWR	A,D,G	No	Yes	Yes	SSRmS + ADS-B		
MONGOLIA							
Ulaanbaatar ACC Ulaanbaatar APP					ADS-C ADS-C		
MYANMAR Yangon ACC Yangon APP Mandalay APP			Yes Yes Yes	Yes Yes Yes	SSRmAC + ADS-C SSRmAC + ADS-C PSR + SSRmAC		
NEPAL Kathmandu APP					PSR + SSRmAC		
NEW CALEDONIA Tontouta ACC Tontouta APP	A, D G	Yes	Yes	Not applicable	ADS-B	Not applicable	ADS-B Tier 3 implemented, Tier 2 in progress
NEW ZEALAND							

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Chrischurch ACC	C D G		YES	YES	ADS-B+MLAT+PSR + SSRmAC + SSRmS	NOT APPLICABLE	
Christchurch TWR	C D G		YES	YES	ADS-B+PSR+SSRmAC+SSRmS	NA	Surface movements for situational awareness using ADSB
Auckland ACC	C D G		YES	YES	ADS-B+PSR + SSRmAC + SSRmS	NA	
Auckland TWR	C D G		YES	YES	ADSB+MLAT+PSR+SSRmAC+SSRmS		~~Auckland A-SMGCS has no SMR~~ Auckland uses surface movements for LVO using ADSB+MLAT - it has no SMR
Wellington TWR	C D G		YES	YES	ADSB+PSR+SSRmAC+SSRmS	NA	Surface movements for situational awareness using ADSB
Queenstown TWR	C D G		YES	YES	ADSB+MLAT	NA	~~Wide Area MDS planned for Queenstown in 2010~~ Surface movements for situational awareness using ADSB+MLAT
PAKISTAN							

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Karachi ACC					PSR + SSRmAC		
Karachi APP Karachi TWR			Yes	Yes	PSR + SSRmAC PSR + SSRmAC	Nil	
Lahore ACC Lahore APP Lahore TWR			Yes	Yes	PSR + SSRmAC PSR + SSRmAC PSR + SSRmAC	Nil	
Islamabad APP Islamabad TWR			Yes	No	PSR + SSRmAC PSR + SSRmAC	Nil	
PAPUA NEW GUINEA Jacksons APP					PSR + SSRmAC		
Moresby ACC					PSR + SSRmAC		
PHILIPPINES Manila ATM Center					SSRmAC + SSRmS + ADS-B		Planned implementation on Dec. 16
Manila ACC Manila APP					SSRmAC + SSRmS PSR + SSRmAC + SSRmS		
Clark APP					PSR + SSRmAC		
Mactan APP					PSR + SSRmAC		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
Kalibo/Caticlan APP					PSR + SSRmAC + SSRmS		Planned implementation on Dec. 16
Bacolod APP					PSR + SSRmAC + SSRmS		Planned implementation on Dec. 16
Davao APP					PSR + SSRmAC + SSRmS		Planned implementation on Dec. 16
REPUBLIC OF KOREA							
Jeju APP	T	No	Yes	Yes	PSR + SSRmAC + SSRmS		
Jeju TWR	T	No	No	No	PSR + SSRmAC + SSRmS	2	SMR, A-SMGCS
Jungwon APP	T	No	No	Yes	PSR + SSRmAC		
CheongjuTWR	T	No	No	No	PSR + SSRmAC		
Incheon ACC	S	No		Yes	PSR + SSRmAC		
Incheon TWR	T	No	Yes	No	PSR + SSRmAC	3	SMR, A-SMGCS
Seoul APP	T	No	Yes	Yes	PSR + SSRmAC		
Gimpo TWR	T	No	Yes	No	PSR + SSRmAC		SMR
Gangneung APP	T	No	No	No	PSR + SSRmAC		
Yangyang TWR					PSR + SSRmAC		
Gimhae APP	T	No	No	Yes	PSR + SSRmAC		
Gimhae TWR	T	No	No	No	PSR + SSRmAC		SMR
Daegu APP	T	No	No	No	PSR + SSRmAC		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
Daegu TWR	T	No	No	No	PSR + SSRmAC		
Gwangju APP	T	No	No	Yes	PSR + SSRmAC		
Gwangju TWR	T	No	No	No			
Muan TWR	T	No	No	No	PSR + SSRmAC		
SINGAPORE							
Singapore ACC	S		Yes	Yes	PSR + SSRmS + ADS-B + ADS-C		
Singapore APP	T		Yes	Yes	PSR + SSRmS+SSRmAC		
Singapore TWR	AD		Yes	Yes	PSR+ADS-B+MLAT	2	
SRI LANKA							
Colombo ACC					SSRmAC + ADS-B + ADS-C		ADS-C Trial
Colombo APP					PSR		
THAILAND							
Bangkok ACC	S		YES	YES	PSR + SSRmAC + SSRmS		
Bangkok APP	T		YES	YES	PSR + SSRmAC + SSRmS		
Suvarnabhumi TWR	AD		YES	YES	SMR + MLAT + A-SMGCS	2	
Don Mueang TWR	AD		YES	YES	SSRmAC		
Chiang Mai APP	T		YES	YES	SSRmS		
Chiang Mai TWR	AD		YES	YES	SSRmS		
Hat Yai APP	T		YES	YES	SSRmS		
Hat Yai TWR	AD		YES	YES	SSRmS		
Phuket APP	T		YES	YES	SSRmS		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Phuket TWR	AD		YES	YES	SSRmS		
Suratthani APP	T		YES	YES	SSRmS		
Suratthani TWR	AD		YES	YES	SSRmS		
Ubonratchathani APP	T		YES	YES	SSRmS		
Ubonratchathani TWR	AD		YES	YES	SSRmS		
Phitsanulok APP	T		YES	YES	PSR		
Phitsanulok TWR	AD		YES	YES	PSR		
Hua Hin APP	T		YES	YES	PSR		
Hua Hin TWR	AD		YES	YES	PSR		
U Taphao					SSRmAC		
TONGA					ADS-B		
UNITED STATES							
Alaska ACC					ADS-B + ADS-C		
Hilo, Hawaii ACC					SSRmAC		
Hilo, Hawaii APP					PSR		
Hilo, Hawaii TWR							

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
Honolulu, Hawaii ACC					SSRmS		
Honolulu, Hawaii APP					PSR		
Honolulu, Hawaii TWR							
Kahului, Hawaii APP					PSR + SSRmAC		
Kahului, Hawaii TWR							
Kokee, Hawaii ACC					PSR		
Lihue, Hawaii APP					PSR + SSRmAC		
Lihue, Hawaii TWR							
Mount Kaala, Hawaii ACC					PSR + SSRmAC		
Pahoa, Hawaii ACC					SSRmAC		
Kunianiau, Hawaii ACC					SSRmAC		
Guam ACC					PSR + SSRmAC		
Mount Santa Rosa, Guam ACC					PSR + SSRmS		

ATS Units Served	Category of airspace	Surveillance Gaps	Integration of Surveillance Information into ATC Situation Display	Multi-Surveillance Data Processing Capability	Surveillance Used	Level of A-SMGCS Implemented	Remarks
1	2	3	4	5	6	7	8
Mount Santa Rosa, Guam APP					PSR + SSRmAC		
Mount Santa Rosa, Guam TWR							
Kona, Hawaii ACC					SSRmAC		
VIET NAM							
Hanoi ACC					PSR + SSRmAC + ADS-B		
Noibai APP					PSR + SSRmAC + ADS-B		
Noibai TWR					PSR + SSRmAC + ADS-B		SMR, A-SMGCS
Ho Chi Minh ACC					PSR + SSRmAC + ADS-B +ADS-C		
Danang APP					PSR + SSRmAC+ SSRmS + ADS-B		
~~Honoi ACC~~							
Tansan Nhat APP					PSR + SSRmAC + SSRmS + ADS-B		
Tansan Nhat TWR					PSR + SSRmAC + SSRmS + ADS-B		SMR, A-SMGCS

ADS-B IMPLEMENTATION STATUS IN THE APAC REGION

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/ effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
AFGHANISTAN	ADS-B & Multilateration system installed.				subject to safety assessment
AUSTRALIA	A total of 50 ADS-B ground stations and 28 WAM stations are operational (Total 78) ATC readiness since 2004 ADS-B data sharing with Indonesia operational since 2/2011. ASMGCS using multilateration and ADS-B is operational in Brisbane, Sydney, Melbourne and Perth November 2016 – ADS-B converted to “radar like” Cat 48 for use in Melbourne Terminal Area and Perth Terminal Area in early 2017. CMATS replacing the current ATM system is expected to be fully operational in 2026 period.	2009/effective date of mandating in upper airspace 12/12/2013. An ADS-B mandate for all IFR aircraft applies from 2/2017. Some limited exemptions for foreign registered aircraft and some private operations.	All airspace for IFR aircraft from 2/2017	2.5NM, 3NM and 5 NM surveillance separations. 3/2016 - Manual of ATC updated to include 3 nautical mile separation using ADS-B in terminal control unit. 3/2017 – 2.5NM separation authorized using ADS-B when also used with radar. Vectoring allowed using ADS-B Precision Runway Monitoring for Sydney WAM	WAM is operating in Tasmania since 2010 with 5 NM separation service. WAM is also operating in Sydney for 3 NM separation service in TMA and for precision runway monitoring function. CASA has approved the use of reduced specification ADS-B avionics to support ADS-B IN and ATC situational awareness for VFR aircraft

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BANGLADESH	Bangladesh has taken the “Modernization of CNS-ATM System of CAAB” project which is going on G2G agreement with France and likely to be implemented by 2024. This project included a plan of five ADS-B ground stations to be installed at Dhaka, Cox’s Bazar, Sylhet, Saidpur and Barisal. ADS-B data will be integrated with new ATM system at Dhaka. Bangladesh has also a plan to install MLAT stations to provide surface movement control at HSIA, Dhaka as well as TMA coverage as a backup and complimentary RADAR coverage to the Dhaka MSSR.				Bangladesh is willing to share ADS-B data with neighbouring States to enhance the safety and surveillance capability in the sub-region.
BHUTAN	ADS-B ground infrastructure feasibility study will be completed in the middle of 2020.	Equipage mandate will be issued once after the completion of feasibility study.			
BRUNEI DARUSSALAM	5 ADS-B ground stations with WAM functionality installed in 2015 and full operation in October 2016. ADS-B/WAM data are fused with radar data in the TopSky ATC Automation system (Thales) to enhance full radar				

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	surveillance coverage for Brunei Darussalam. Memorandum of Understanding (MOU) on ADS-B data sharing with Singapore and Brunei Darussalam is expected to sign in April 2019.				
CAMBODIA	3 ADS-B ground stations installed at Phnom Penh, Siem Reap and Stung Treng City since 2011 and able to provide full surveillance coverage for Phnom Penh FIR. Cambodia is willing to share data with others.				
CHINA	5 UAT ADS-B stations are used for flight training of CAFUC. The upgrade to 1090ES ADS-B stations project has already finished. In the training airspace, a hybrid operation mode of UAT and 1090ES is currently used. 308 ADS-B ground stations nationwide have already in operation by 2019. 4 ADS-B stations operational in Sanya FIR since 2008. Chengdu-Jiuzhai and Chendu - Lhasa route with 8 ADS-B stations.	The operation of national ADS-B Service is implementing in step -by-step way. Phase I: from October 10, 2019 ➢ ADS-B control services will be provided in APP where radar control services are not available; ➢ ADS-B control services will be implemented in control area above 8400m (inclusive) where Radar control services are not available; ➢ Radar control services will be provided, using integrated surveillance data of ADS-B and radar, in control areas	The ADS-B mandate published in October 2020, in a separated AIC Nr.09/19 named "Implementation of ADS-B Control Services" ~~The ADS-B mandate published in October 2020, in a separated AIC Nr.09/19 named "Implementation of ADS-B Control Services"~~		

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/ effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	9 ADS-B stations deployed on the routes H15 and Z1 by the end of 2015. 19 ADS-B stations at the small airport. 5 UAT ADS-B stations are used for flight training of CAFUC. The upgrade to 1090ES ADS-B stations project has already started in 2017, and the project is planned to finish by 2022. 308 ADS-B stations nationwide have already finished the final acceptance activities. 4 ADS-B stations operational in Sanya FIR since 2008. Chengdu-Jiuzhai and Chendu - Lhasa route with 9 ADS-B stations. 9 ADS-B stations deployed on the routes H15 and Z1 by the end of 2015. 19 ADS-B stations at the small airport.	above 8400m (inclusive) where radar control services are available. Phase II: from December 31, 2020 ➢ ADS-B control services will be provided in APP and ACC where radar control services are not available; ➢ Radar control services will be provided, using integrated surveillance data of ADS-B and radar, in APP and ACC where radar control services are available; and ➢ ADS-B equipment will be used at the tower of transport airports to display flight movements. The operation of national ADS-B Service is implementing in step - by-step way. Phase I: from October 10, 2019 ➢ ADS-B control services will be provided in APP where radar control services are not available; ➢ ADS-B control services will be implemented in control area above 8400m (inclusive) where Radar control services			

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/ effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
		~~are not available;~~ ➢ ~~Radar control services will be provided, using integrated surveillance data of ADS-B and radar, in control areas above 8400m (inclusive) where radar control services are available.~~ ~~Phase II: from December 31, 2020~~ ➢ ~~ADS-B control services will be provided in APP and ACC where radar control services are not available;~~ ➢ ~~Radar control services will be provided, using integrated surveillance data of ADS-B and radar, in APP and ACC where radar control services are available; and~~ ➢ ~~ADS-B equipment will be used at the tower of transport airports to display flight movements.~~			
HONG KONG CHINA	ADS-B out operations over PBN routes L642 and M771 at or above FL 290 within HK FIR was effective in December 2013 and within HK FIR at or above FL 290 has been effective since December 2016.	AIP supplement issued on 29 Aug 2014 with 8 Dec 2016 as effective date. Mandate ADS-B out equipage for locally registered GA/helicopters since 31 January 2023.	HKFIR at or above FL290	5NM surveillance separation	Fully implemented ADS-B in HKFIR by phased approach to ensure safe and smooth integration of ADS-B into the Air Traffic Management System to

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	ADS-B ground station infrastructure completed in 2013. ADS-B signal provided by Mainland China to cover southern part of Hong Kong FIR commenced in 2010 and has been put into operational use after commissioning of the new ATMS since November 2016. Trial on Space-based ADS-B data was conducted in 2021 and completed in 2022. The data are used to support long-range air traffic surveillance for ATFM purpose. ADS-B out operations over PBN routes L642 and M771 at or above FL 290 within HK FIR was effective in December 2013 and within HK FIR at or above FL 290 has been effective since December 2016. ADS-B ground station infrastructure completed in 2013. ADS-B signal provided by Mainland China to cover southern part of Hong Kong FIR	AIP supplement issued on 29 Aug 2014 with 8 Dec 2016 as effective date. Mandate ADS-B out equipage for locally registered GA/helicopters since 31 January 2023.			provide aircraft separation service since November 2018.

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/ effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	~~commenced in 2010 and has been put into operational use after commissioning of the new ATMS since November 2016.~~ ~~Trial on Space-based ADS-B data was conducted in 2021 and completed in 2022. The data are used to support long-range air traffic surveillance for ATFM purpose.~~				
MACAO, CHINA	Mode S MSSR coverage available for monitoring purposes.				Airspace – ATZ only
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA	ADS-B has been used as back-up surveillance of SSR since 2008.				
FIJI ISLANDS	ADS-B /multilateration ground stations installed. Situational awareness service provided in 2013. New ATM System commissioned on 1 April 2021 to support surveillance in the Domestic Airspace. ADS-B Ground stations replacement in progress. Phase 1: Installation of new 6 sites completed.	ADS-B mandate commenced from 31st December 2013	ADS-B equipage mandate for domestic registered aircraft. Airspace mandate TBA	5nm separation service to commence within the Domestic Airspace from November 2022. a) TMA 2500ft to F250 (Class D) b) CTA 6500ft to F600 (Class D)	Simulator training in progress with transition commencing from mid-September to mid December 2022.

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	Phase 2: Replacement of 4 existing sites. Commissioning of new ADS-B system by 3 August 2022.				
FRANCE ***(French Polynesia)***	ATM system is ready for ADS-B sensors/Installation of 5 first GS expected at beginning of 2017. 2nd stage with implementation of 7 GS and associated VHF coverage.			5 NM for airspace under coverage.	
INDIA	ASMGCS (SMR + Multilat) is operational at Delhi, Mumbai, Chennai, Kolkata, Bangalore, Hyderabad, Jaipur, Amritsar, Lucknow, Ahmedabad and Guwahati Airports. ASMGCS (SMR+MLAT) proposed at Cochin and Bhubaneswar (VOCI&VEBS) Expected to be completed by Sept 2022. ADS-B Ground Stations are installed at 36 locations to cover continental and Oceanic airspace. Out of these 36 ADS-B ground receivers, 30 receivers have been operationalized and remaining 6 ADS-B ground receivers will also be operationalized soon.	AIP supplement issued on 25th October, 2018 with effective date of implementation from 01st January 2019 which was subsequently revised through NOTAM G1995/18 to be effective from 01st January 2020.	On all ATS Routes within continental airspace at and above F290.	a) 5 NM within 60 NM of ADS-B ground station i.e. in the terminal airspace served by the ADS-B receiver. b) 10 NM beyond 60NM of ground station i.e. in the en route airspace.	Standalone ADS-B based APP Surveillance service provided at VOCL, VOCB, VEPT, VEAT,VIJP, VOTR and VEBS. MSSR/ADS-B integrated mode APP Surveillance service provided at VILK, VOML, VEBN,VANP and VIAR.

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	India has entered into a contract with M/s Aireon in July 2019 to receive ADS-B data for Oceanic regions of Indian FIR to ensure seamless Surveillance coverage across its oceanic airspace, Space Base ADS-B system has been successfully integrated with Data fusion systems of Mumbai, Chennai and Kolkata in January 2021 and presently being used for situational awareness only ATM automation systems at 22 ATC Centres are capable of processing ADS-B data.				
INDONESIA	All 30 ADS-B ground station have been met with DO260B in November 2019; The 18 new ADS-B ground stations, with DO260B capability, will be established to cover the traffic in terminal and area. The 7 ADS-B ground station has been installed in Papua. ~~The rescheduling of completion for 11 ground stations in 4Q2021.~~11 ground stations has been completed. The ADS-B ground stations has		Starting on 23rd April 2020, Indonesia has implemented mandatory ADS-B equipment for all transport aircraft category flying at all level (SFC up to FL600) in 2 ACCs, 9 TMAs and 10 Airports.	Using 5 NM separation standard.	ADS-B data sharing had been conducted by Indonesia with Australia and Singapore. LOA of collaboration in ADS-B data sharing has been achieved with India. LOA of collaboration in ADS-B data sharing are under reviewing by

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	been integrated to 9 ATC systems and 3 others will follow after being upgraded.				Malaysia, Philippines and PNG.
JAPAN	Multilateration Systems for surface monitoring have been implemented at eight airports PRM (WAM) has been implemented at Narita Airport and Haneda Airport. En-route WAM system have been implemented at four areas Plan to use ADS-B information under RAD conditions starting in 2024.				
KIRIBATI					
LAO PDR.	2 ADS-B ground stations(DO-260A compliant) were installed in Vientiane and Louangphabang Int'l Airport in 2015 and the ADS-B data is fused with MSSR data target in the ATM Automation system. 3 ADS-B ground stations (DO-260B compliant) completed the installation at existing MSSR sites (Xiengkhouang, Savannakhet and				Still use for Monitoring as signals from Ground Stations are integrated to ATM System

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	Champasack) in 2017 to enhance the full ADS-B coverage of Lao FIR. ~~2 ADS-B ground stations were installed in Vientiane and Luangprabang Int'l Airport in 2015 and the ADS-B data is fused with MSSR data target in the ATM Automation system.~~ ~~3 additional ADS-B ground stations (DO-260B compliant) will be completed the installation at existing MSSR sites (Xiengkhouang, Savannakhet and Champasack) by 2016 to Q1 of 2017 to enhance the full ADS-B coverage of Lao FIR.~~				
MALAYSIA	Ground Infrastructure: Kuala Lumpur FIR: 1. Three (3) ADS-B GS i.e. Terengganu, Langkawi and Genting have been installed in Kuala Lumpur FIR and the ADS-B data from those stations are now fully integrated into the new ATM system in Kuala Lumpur ATCC. Kota Kinabalu FIR: Four (4) ADS-B GS have been installed in Kuching, Bintulu,	AIC Issued on September 2017. AIP Supp on 16 Jan 2020.	Phase 1: On ATS routes N571, P628, L510, P627, L645 and P574 at FL 290 to FL 410 within Kuala Lumpur FIR Phase 2: En-route airspace in Kuala Lumpur and Kota Kinabalu FIR Target date: Mar 2023	ICAO approved surveillance separation.	

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	Kota Kinabalu and Sandakan and the ADS-B data from these stations are now fully integrated into the new ATM system in Kota Kinabalu ATCC. Implementation Plan: Phase 1: ADS-B services on specific ATS routes and Flight Levels within Kuala Lumpur FIR, Operational trial since March 2020. Phase 2: ADS-B as secondary means of surveillance within the Kuala Lumpur FIR and Kota Kinabalu FIR for en-route airspace. Target date: Mar 2023. Phase 3: ADS-B used as the primary means of surveillance for en-route airspace. Target date: Mar 2025				

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/ effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
MALDIVES	4 ADS-B stations installed in Nov. 2012 (2 at Male' Ibrahim Nasir Intl Airport, 1 at Kulhudhuffushi Island in the North and 1 at Fuah Mulah Island in the South to cover 95% of the FIR at/above FL290. Maldives' ADS-B is integrated with the ATM system (in November 2013), and under observation prior to commencing trials. Maldives has planned to share ADS-B data with its adjacent FIRs. Updated by email				Seaplane in Maldives equipped with ADS-B for AOC purpose. These seaplanes have ADS-B IN functions as well.
MARSHALL ISLANDS					
MICRONESIA (FEDERATED STATES OF)					
MONGOLIA	Ten ADS-B ground stations for combination SSR and filled the surveillance gaps implemented in 2015 and integrated with ATM system and trial operation in early 2016.				

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MYANMAR	**a) The ADS-B Implementation Update** - The five ADS-B ground stations have been installed in Myanmar. Among them, SITTWE and CoCo Island ground stations are installed in 2014, and are DO260 compliant. The other 3 stations, YANGON, MANDALAY and MYEIK airport ground stations are DO260B compliant and installations were finished in 2016. - All ADS-B data are fused with MSSR data in the TopSky ATC Automation system (Thales) in 2016 and using as MSSR backup in Yangon ACC. **b) The ADS-B data sharing update between neighbouring States** - Myanmar and India signed the MOU agreement for ADS-B data sharing on 6th May 2015. ADS-B data sharing test between Agartala (India) - Sittwe (Myanmar), and Port Blair (India) - CoCo Island (Myanmar) have been accomplished between technical teams since June 2018.	Doing ADS-B data analysis and statistic for ADS-B equipped Aircraft in Yangon FIR.			Supplement radar and fill the gaps to improve safety and efficiency ADS-C/CPDLC integrated in Yangon ACC since 2010.

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	At present, the shared ADS-B data from Myanmar side is now using as backup automation system at Kolkata for test purpose. But, Myanmar side is needed to discuss with ATM manufacturer for operational use of the India's Data at Yangon ACC. - Myanmar have planned to install new ADS-B Station in the 2nd quarter of 2019 at LASHIO Airport located in north-eastern part of Myanmar closed to the China-Myanmar border near the LINSO transfer point on A599 ATS route. After the installation finished, the ADS-B data sharing process can be proceeded between Myanmar and China.				
NAURU					
NEPAL	Four ADS-B ground stations have been installed in 2019 at Kathmandu (Phulchowki), Bhairahawa, Nepalgunj and Dhangadi.				Safety assessment will be done soon.

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NEW CALEDONIA	Three ADS-B ground stations commissioned in 2010 to cover international traffic at La tontouta airport serving Tontouta ACC & APP. It is used for Situation awareness and SAR.				
NEW ZEALAND	MLAT and ADS-B data from WAM system centered in and around Queenstown. Provides surveillance coverage for Queenstown TOWER and Approach as well as Surveillance services using 3/5NM ~~using 3/5NM~~ separation over the southern half of the South Island of New Zealand MLAT and ADSB data from the NZAA MLAT system to support surface movements control at NZAA ADSB data at 6 domestic aerodromes to provide ADSB APT surface movements control 27 ADSB-B Sites for Enroute, Terminal and ADSB APT services	Current: ADSB mandate for all controlled airspace from DEC 31, 2022, promulgated by NZCAA ~~Current: ADSB mandate for all controlled airspace from DEC 31, 2022, promulgated by NZCAA~~ **Current:** Since July 2018, any current NZ registered aircraft upgrading transponder(s) is required to install DO260B transponder(s) which meet the NZCAA rule set. The rule specifies the minimum Technical Standing Orders (TSO) or transponder GNSS receiver models for position input into ADS-B	Current: All controlled airspace within the NZZC FIR ~~Current: All controlled airspace within the NZZC FIR FL245 and above.~~ ~~**Proposed:** All controlled airspace within the NZZC FIR~~	5NM surveillance separation in enroute controlled airspace, and 3NM surveillance separation in Terminal approach controlled (Class C) airspace.	Currently situational awareness surveillance targets are displayed for ADS-B targets from which the data supplied does not meet the requirements for surveillance separation.

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PAKISTAN	The Installation of ADS-B system at Pasni, Lakpass, Rojhan and Islamabad has been already completed and its data is integrated with ATM system and operational since 2019. The installation of additional QTY-5 ADS-B system has been completed at Dalbandin, Zhob, Laram Top, Karachi & Lahore to further strengthen the surveillance capability over Pakistan airspace. The sensors will be integrated with ATM systems after successful completion of Site Acceptance Tests and safety assessment.				The data of ADS-B will provide redundancy to the existing surveillance Radar system and will also serve as gap filler in the identified grey areas within Pakistan Airspace.
PAPUA NEW GUINEA	Initially 7 ADS-B sites to be deployed across PNG to provide seamless coverage above FL285. Three (3) sites installed as of December 2017. Two (2) of these are operational. First site to be installed May/June 2017, with remainder to be completed in 2018. Additional 7 sites to be rolled-out in the 2018/19 timeframe. Site location will be dependent on infrastructure, security and an	An ADS-B mandate is on CASA PNG roadmap, however legislation yet to be developed. The Australian mandates will largely drive equipage for overflights (e.g. East-Asia to Australia/South Pacific). Expectation is that PNGASL (the ANSP) will lead development of ADS-B mandate framework. Initial steps may include mandate above F245 – but will depend on	None	**Air Traffic Control** <u>Approach/ Arrivals</u> 2018 – 5NM 2019 – 3NM (approach) <u>Upper Airspace (>FL245)</u> 2017/18 – Situational awareness.	

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	analysis of Phase 1 site performance. PNGASL (ANSP) will commence a transition to new ATM automation system in May 2018. The system will support fusion of ADS-B and RADAR data. 5 mile separation to be provided using ADS-B and fused ADS-B/Radar from May 2018. From 2018 onwards, PNGASL will be looking to share ADS-B data with Indonesia and Australia.	performance of Phase 1 ADS-B deployment. Country-wide mandate not envisaged before 2021/22.		2018/19 – 5NM Note: Implementation dictated by training requirements and new ATM system transition priorities. **Flight Service** <u>Directed Traffic (FIS)</u> 2019 – Situational awareness	
PHILIPPINES	One ADS-B GS installed at the Manila ATM Center for situational awareness. One ADS-B Ground Station installed at Bataraza, Palawan for data sharing with Singapore. Additional ground stations are planned to be installed in Laoag Airport, Tagaytay, Jomalig Island, Puerto Princesa Airport, Mt. Majic Mactan, and General Santos “Tambler” Airport.				

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REPUBLIC OF KOREA	Installed 10 ADS-B receivers and in operation since May 2020. 2~~3~~ more receivers will be installed by 2024.	To be confirmed.	To be confirmed.	To be confirmed.	
SINGAPORE	The airport MLAT system was installed in 2007 and "far-range" ADS-B sensor was installed in 2009. ATC system has been processing ADS-B data since 2013.	AIC was issued on 28 December 2010/effective from 12 Dec.2013. ADS-B OUT equipment requirement for all aircraft operating on selected ATS routes within the WSSS FIR from 27 January 2022. ADS-B OUT equipment requirement for all aircraft operating within the WSSS FIR from 26 January 2023. AIP updated in May 2018 to reflect the ADS-B equipment certified as meeting: a. EASA - (AMC 20-24), or b. EASA CS-ACNS (Subpart D - Surveillance - SUR), or	At and above FL290, affecting the following ATS routes L642, L644, M753, M771, N891 & N892 At and above FL290, affecting the following ATS routes L517, L625, L649, M758, M767, M768, M772 & N884.	40nm implemented on ATS routes L644 and N891. 20nm implemented on ATS routes L642, M771, M753 and N892.	Safety case was completed end of November. 2013.

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		c. FAA - Advisory Circular No: 20-165A (or later versions), or d. The equipment configuration standards in Appendix XI of Civil Aviation Order 20.18 of CASA.			
SRI LANKA	Total of 5 ADS-B Ground Receiving Stations and 01 Central Processing Station have been installed in March 2017. ADS-B Data is fused with Multi-sensor Data, including MSSR and ADS-C in the ATM system at Colombo ACC Ratmalana was launched for operational used on 15 Nov. 2017. New ATM system planned for operational at APP Centre in 2018 will also be capable of fusing Multi-sensor Data, including MSSR and ADS-B	Revised Date of Equipage mandate would be 31st Dec 2020. Ref: AIC A02/16 (Initially AIC A02/14 was issued in November 2014)	All ATS Routes within Colombo TMA	Initially 5 NM within Approach Radar Coverage, 8 Nm within Area Radar Coverage & Procedural Separation minima outside Radar Coverage.	On completion of a safety assessment, use of ADS-B alone for ATC separation purposes.
THAILAND	Five ADS-B ground stations (DO-260B and lower compliant) have been primarily installed for research and development purpose and are being undergone the approval process to be used for air traffic services with a target date by the end of 2021.	The airspace re-structure and aircraft equipage mandate are planned to be studied in 2021 and are expected to be started implementation in 2022.	TBD	TBD	

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	The new ATM automation system was successfully implemented in Q1 2020. It can The ATS surveillance data sharing with the adjacent FIRs was approved in principle in October 2018.				
TONGA	Trial planned for 2017				
UNITED STATES	The US identified required ADS-B Service Volumes in 2007. Using data from over 600 terrestrial radio sites, the US domestic ADS-B system became operational in 2014. As of 1 January 2020, ADS-B aircraft equipage was mandated in most controlled airspace within the US. Over 172,000 ~~Over 172,000~~ US- registered aircraft are now equipped. ADS-B is used by all U.S. air traffic control facilities for ATC separation.	The U.S. ADS-B Out rule (14 CFR 91.225 and 14 CFR 91.227) was issued in May 2010 and specified that the ADS-B Out mandate was effective on 1 January 2020.	Class A, B, and C airspace, plus Class E airspace above 10,000 ft MSL and some additional airspace. See 14 CFR 91.225 for complete details. The U.S. is using ADS-B for TMA separation including the following criteria: - 3nm separation - 2.5nm between aircraft established on final approach course within 10nm of landing runway (when other conditions are met) - independent parallel approach operations down to 3600 ft centreline separation	The U.S. is using ADS-B for en route 3nm separation at or below FL230, and 5nm separation at higher altitudes. The U.S. is using ADS-B for TMA separation including the following criteria: - 3nm separation - 2.5nm between aircraft established on final approach course within 10nm of landing runway (when other conditions are met) - independent parallel approach operations down to	The U.S. has implemented integrated WAM/ADS-B to support 5nm separation in the following areas: • Airspace around Juneau, Alaska • Airspace surrounding various airports in the mountains of western Colorado The U.S. has implemented integrated WAM/ADS-B to support terminal separation in the following areas: • KCLT terminal area • KLAX terminal area

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/ effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
			- dependent parallel approach operations down to 2500 ft centreline separation (currently 1.0 nm diagonal distance).	3600 ft centreline separation - dependent parallel approach operations down to 2500 ft centreline separation (currently 1.0 nm diagonal distance).	Implementation of integrated WAM/ADS-B is underway in the New York terminal area underway in the New York terminal area and is being considered for additional U.S. terminal areas.
VANUATU					
VIET NAM	Two phases ADS-B implementation plan adopted. Phase 1 implemented in March 2013. Phase 2 commenced in 2015 for whole lower and upper Hanoi FIR and 2018 for Ho Chi Minh FIR	1) AICAIC issued on 20 June 2013/ADS-B mandating effective from 12 December 2013 in Ho Chi Minh FIR. 2) AIC A08/16 issued on 15 December 2016/ the policy on Automatic Dependent Surveillance – Broadcast (ADS-B) equipage and operation for civil aircraft within Ho Chi Minh and Ha Noi FIRs/ + Mandating effective from 01 July 2017.	1) M771, L642, L625, N892, M765, M768, N500 and L628 At/above FL290. + Mandating effective from 01 July 2017, all civil aircraft operating within Sectors of Ha Noi ACC from FL290 up to FL460 must be operated ADS-B OUT. Civil aircraft without ADS-B OUT will be operated below FL290 or at other flight levels assigned by Ha Noi ACC. + Mandating effective from 01 July 2018: aircraft having maximum take-off		Operators required to have operational approval from State of aircraft registry.

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/ effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
		+ Mandating effective from 01 July 2018 + Mandating effective from 01 January 2020, aircraft having maximum take-off weight of 5 700 kg or heavier and operating within Ha Noi and Ho Chi Minh FIRs must be ADS-B OUT equipped and operated.	weight of 15 000 kg or heavier and operating within Ha Noi and Ho Chi Minh FIRs must be ADS-B OUT equipped and operated. + Mandating effective from 01 January 2020: aircraft having maximum take-off weight of 5 700 kg or heavier and operating within Ha Noi and Ho Chi Minh FIRs must be ADS-B OUT equipped and operated.		

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REPORT FROM BAY OF BENGAL AD HOC WORKING GROUP
6 - 9 June 2023

States Presented:
China
Indonesia
Malaysia
Thailand
India
Maldives
Nepal

Observer:
IATA

The participants met to update the status of implementation of ADS-B and possible Data sharing between the neighbouring States.

Implementation Updates

1. Bangladesh (no update provided in 2022)

We are trying to modernize our systems through the implementation of ATM project. At first it was in PPP & now it is on G2G with France. This was under the process of government approval. Government approval is granted, and 5 ADS-B receivers will have been installed at detailed below,

Cox's Bazar, Barisal, Saidpur, Dhaka and Sylhet, there is another one for Extended Economic Zone at new area in the Bay of Bengal which is 200NM at south of the country.

2. Bhutan (no update provided in 2023)

Bhutan cannot join previous SEA/BOB ADS-B meeting as we do have plan to implement ADS-B, but now we are targeting to complete ADS-B feasibility study by mid of 2019 and now it is extended up to mid of 2020.We found out that feasibility study (Coverage and ground station location) is necessary as Bhutan is surrounded by mountain terrain.

As per the result of feasibility study we are going to implement installation of ground station.

Bhutan do not have any national policy or regulation about data sharing, so we will be sharing data with any neighbouring countries/states as per the regional norms and conditions.

3. China (no update provided in 2023)
China has been continuously promoting to push forward the application of ADS-B technology. China provided update on the installation and related activities regarding ADS-B surveillance system as follows:

- 5 UAT ADS-B stations are used for flight training of CAFUC. The upgrade to 1090ES ADS-B stations project has already started in 2017, and the project is finished by 2022;
- 4 ADS-B station in operational in Sanya FIR since 2008;
- Chengdu - Lhasa route with 7 ADS-B stations;
- 9 ADS-B stations deployed on the routes H15 and Z1 by the end of 2015;
- 19 ADS-B station at the small airport; and

- 308 ADS-B stations nationwide have already finished in operation ~~stallation and SAT by~~ at the end of 2018. And there are 2 level-1 data processing centres working in main-standby mode for redundancy, 8 level-2 data processing centres to concentrate data from data stations within its area of responsibility, as well as 36 data stations to collect received data from GSs. All the installation and SAT of GSs, level-2 data processing centres and level-1 data processing centres have already complete. The trial operation has started from October 10, 2019 and the ADS-B mandate had also been published on October 1, 2019, which is effective from October 10.2019.

4. Indonesia (no update provided in 2023)

Indonesia earlier informed that ADS-B ground station at Aceh is already operational and updated to comply with DO-260B (ver 2) and expressed willingness to share data with India (It was earlier decided to have Port Blair-Aceh data sharing, but for better coverage and usability it was suggested in the meeting to have data sharing of upcoming Campbell Bay ADS-B - Aceh when India is ready).

Indonesia now will share the data with Campbell Bay ADS-B – Aceh only.
Campbell Bay ADS-B is installed.

Letter of Agreement between Indonesia and India regarding ADS-B data sharing is on progress
Letter of agreement is agreed by Indonesia and India, yet to be signed.

5. Malaysia

Malaysia has completed the installation of the two new ADS-B ground station in Langkawi and Genting and were now fully integrated into the new ATM system. Both stations are compliant with DO-260B with output data handling function as plot and tracks (ASTERIX CAT21 ver. 0.23, ver. 0.26 and ver. 2.1.)

Malaysia is venturing to share ADS-B data with Indonesia, India and Thailand. Data sharing from India (Port Blair or Campbell Bay ADS-B GS), or from Indonesia (Aceh ADS-B GS)or from Thailand will close the surveillance gap within the KL FIR.

The ADS-B data (from Genting and Langkawi) processed through ADS-B central processing system is now integrated into new ATC Systems and is now ready for data sharing. Malaysia is reviewing the sample agreement proposed by India and Indonesia and will revert as soon as possible.

At present, ADS-B Data Sharing with Indonesia is currently on hold due to decision by Indonesia in BOBTFRG/3 meeting to refrain conducting surveillance data sharing in Bay of Bengal due to certain reasons until further notice.

6. Maldives

Maldives started using ADS-B to enhance ATS surveillance capability in Male FIR on 7th February 2016.

With 4 ground stations (2 autonomous stations at Male; 2 unduplicated ground stations: 1 at an island in the North and the other in the South), the ADS-B provides coverage up to 90% of Male FIR above FL290.

ADS-B serves as the backup for Male radar and is in use for vectoring and 5NM separation commensurate with Radars

As part of the effort towards full implementation of ADS-B, from March 2017 aircraft imported for commercial air transport in the Maldives are required to be equipped with ADS-B Out, as published in AIP ENR 1.6-3.

The full implementation, which would require carriage of ADS-B Out, is targeted for the year 2020

Maldives is making efforts to complete the airworthiness approval for all locally registered aircraft, already equipped with ADS-B.

Out of the 73 aircraft registered for commercial air transport in the Maldives, 62 aircraft have given approval for ADS-B by Maldives Civil Aviation Authority (MCAA).

This include 55 seaplanes (Twin Otter aircraft with floats) conducting commercial air transport between Velana International and resort islands. These aircraft, although operate on VFR, are fitted with ADS-B out functionality combined with GPS to give highly accurate positional information.

Maldives is in the process of installing two additonal ADS-B Ground Station in 2023, to improve the coverage at low flight levels.

7. Myanmar (no update provided in 2023)

The 5 ADS-B ground stations have been installed in Myanmar. Among them, Sittwe and Co Co Island ground stations are installed in 2014 and they are DO260 compliant, and Yangon, Mandalay and Myeik airports ground stations are DO260B compliant and installation was finished in 2016.

All ADS-B data are fused with MSSR data target in the Top Sky ATC Automation system (Thales) in 2016, and using as MSSR backup and surveillance monitoring in Yangon ACC.

In addition, Myanmar have planned to install new ADS-B Station in the First quarter of 2020 at Lashio Airport located in north-eastern part of Myanmar closed to the China-Myanmar border near the LINSO transfer point on A599 ATS route. After the installation finished, the ADS-B data sharing process can be proceeded between Myanmar and China *after March, 2020*.

For the communication links between Yangon and Beijing, it can use the existing 2M E1 IPLC link which is now using for AFTN messaging and (AIDC Testing) Voice, and also can be used the existing Yangon-Beijing VSAT link as backup.

Myanmar also willing to participate the special coordination meetings to promote relevant works in terms of the surveillance data sharing among the countries to enhance the safety and surveillance capability in the sub-region.

Lashio installation will be completed by First quarter of 2020.
Redundant Communication link via Land line / CRV / V-SAT is proposed under discussion.

8. Thailand

Thailand provided update on the installation and related activities regarding ADS-B and other related surveillance system as follows:

<u>ADS-B Ground Infrastructure and ATC System Readiness or Implementation Plan</u>

- MLAT has been in operation at Suvarnabhumi Airport (VTBS) since 2006. Another MLAT installation was carried out at Don Mueang Airport (VTBD) in 2017 and operational since mid

2019 at the same time when the new ATM automation system, which is the system that receives and processes data, was implemented.

- 4 ADS-B ground stations (DO260B and lower compliant) have been installed at Doi Inthanon (Chiangmai), Hatyai Airport (VTSS), Samui Airport (VTSM) and Ubon Ratchathani Airport (VTUU). Moreover, 3 SSRs at Surat Thani Airport (VTSB), Ubon Ratchatani Airport (VTUU), and Phuket Airport (VTSP) have been upgraded with ADS-B capability. In total, 7 ADS-B stations are under approval process and is expected for air traffic services by the end of 2024.

Data sharing

- ATS surveillance data sharing with adjacent FIRs was approved in principle in October 2018.

- User requirements, particularly ATS routes to be served, and communication link test plan are discussed in 2018.

9. India (no update provided in 2023)

ADS-B Usage and Mandate in India:

India has installed 36 ADS-B ground receivers to enhance redundancy in existing Radar airspace and also to extend Surveillance coverage in low density airports and in certain oceanic airspace. It will also facilitate extension of Surveillance coverage for low altitude (below existing Radar coverage) leading to more efficient use of airspace. ADS-B data is being used for Terminal as well as Enroute Surveillance operations.

Out of 36 ADS-B ground receivers presently 30 receivers have already been operationalized and efforts are on to operationalize remaining 6 ADS-B ground receivers soon. Further, India has entered into a contract with M/s Aireon in July 2019 to receive ADS-B data for Oceanic regions of Indian FIR to ensure seamless Surveillance coverage across its oceanic airspace, Space Base ADS-B system has been successfully integrated with Data fusion systems of Mumbai, Chennai and Kolkata in January 2021 and presently being used for situational awareness only.

In order to promote ADS-B usage in India, the Director General of Civil Aviation (DGCA) India has issued ADS-B avionics mandate w.e.f. 01st January 2020, all aircrafts flying over Indian continental airspace at or above FL290, are to be equipped with on-board ADS-B equipment.

10. Sri Lanka (no update provided in 2023)
Not Present
Sri Lanka has installed 5, ADS-B stations and data received by the stations have been integrated and available for sharing. The ADS-B coverage is approximately 350NM from Piduruthalagala, the highest mountain situated in central Sri Lanka. Sri Lanka is willing to share this data with India and Maldives. India is requested to provide a soft copy of draft agreement for sharing of ADS-B data with Sri Lanka so as to enable Sri Lanka to look into the terms and conditions of draft agreement.

11. Nepal

Nepal has also completed installation of 4 ADS-B GS at Mt. Phulchowki (Kathmandu), Nepalgunj, Bhairahawa and Dhangadhi Airports and have been integrated with MSDPS.

Efforts are on to operationalize soon.

ADS-B Data Sharing

Project 1 - ADS-B Data Sharing between China, Laos and Myanmar

Phase 1 *China and Laos sharing ADS-B data from following:*
Kunming ADS-B data processing Centre (china), which can customize the output of ADS-B data in version, specific area and height range depend on Laos's requirement.

Route to be affected B465.

China and Myanmar sharing ADS-B data from the following sites:
Lashio (Myanmar) Not yet installed – Target to be installed by March 2020.Route to be affected A599

China and Myanmar sharing ADS-B data from the following:
Kunming ADS-B Data Processing Centre (China), which can customize the output of ADS-B data in version、specific area and height range depend on Myanmar's requirement.

Operational Status
N/A

Expected benefits
- Enhanced air navigation safety at FIRs boundary.
- Promoting air traffic control work efficiency.

Project 2 - ADS-B Data Sharing between India and Indonesia

Phase 1
Aceh – Indonesia
Camp Bell Bay – India

Route to be affected B466, P574 and N563

Operational Status
ADS-B data from Campbell Bay (India) is proposed to be integrated with Jakarta (Indonesia) ATC centre. Similarly, data from Banda-Aceh (Indonesia) ADS-B is proposed to be integrated with Chennai (India) ATC centre. Draft Letter of Agreement (LOA) has been shared with Indonesia and necessary Government approval is awaited for implementation of data sharing.

Benefits
Enhanced safety by reduction in occurrences of LHDs and LLDs in BOB region.

Project 3 - ADS-B Data Sharing between India and Malaysia

Phase 1
Port Blair/Campbell Bay - Langkawi (2023)
Route to be affected N571, P628, L510, P627, L645 and P574

Operational Status
ADS-B data from Campbell Bay (India) is proposed to be integrated with Kuala Lumpur (Malaysia) ATC centre. Similarly, data from Langkawi (Malaysia) ADS-B is proposed to be integrated with

Chennai (India) ATC centre. Draft Letter of Agreement (LOA) has been shared with Malaysia and necessary Government approval is awaited for implementation of data sharing. India and Malaysia are exchanging comments on the Draft LOA.

Expected benefits
Enhanced safety by reduction in occurrences of LHDs and LLDs in BOB region.

Project 4 - ADS-B Data Sharing between India and Myanmar (no update provided in 2022)

Phase 1
The ADS-B data sharing between Kolkata and Yangon FIR was an initiative taken by India and Myanmar to enhance safety and reduce LHDs along Kolkata-Yangon FIR boundary.

In 6 May 2015, Myanmar and India have signed the MOU agreement for ADS-B data sharing between the two countries.

As per the data sharing agreement, ADS-B data sharing test between Agartala(India) and Sittwe (Myanmar) and Port Blair(India) and Coco Island(Myanmar) has been accomplished between technical teams since June 2018. Kolkata has integrated the ADS-B feed from Sittwe and Co Co Island in its Automation system. Presently the data is given in the back up automation system at Kolkata for test purpose and ADS B equipped aircrafts are tracked from as far as 250 nm west of Bangkok.

But for Myanmar side, India's data is just received to Yangon ACC technical management room and need to discuss with ATM Manufacturer (Thales) of Surveillance Display System to integrate India's ADS-B data to existing Surveillance Display System for operational use in Yangon ACC. Because the multicast address and port from India's ADS-B data are different with existing setup.

The communication link used for ADSB data transfer between Yangon and Kolkata is the existing E1 IPLC link which is used for DSC phone between the two ATS units.

Route to be affected A201, A599, B465, G463, L507, P646, P762, G472, L524, M770 and L759

Operational Status
Operationalized for situational awareness. India-Myanmar data sharing has been completed successfully through under sea cable between Mumbai (India) and Yangoon (Myanmar). Data from Sittwe (Myanmar) and Coco Island (Myanmar) has been successfully integrated with Kolkata Automation system, and there were no reported instability issue. Similarly, data from Agartala (India) and Port Blair (India) has been provided to Yangoon ATC centre.

Expected benefits
Enhanced safety by reduction in occurrences of LHDs and LLDs in BOB region.

Project 5 - ADS-B Data Sharing between Indonesia and Malaysia

Phase 1
Langkawi - Aceh (TBD)
Route to be affected B466, N571, P628, L510, P627, L645 and P574
ADS-B data from Aceh (Indonesia) is proposed to be integrated with Kuala Lumpur (Malaysia) ATC centre. Similarly, data from Langkawi (Malaysia) ADS-B is proposed to be integrated with Jakarta (Indonesia) ATC centre. Draft Letter of Agreement (LOA) has been shared with Indonesia and Malaysia and necessary Government approval is awaited for implementation of data sharing.

Malaysia and Indonesia is planning to use CRV for the data sharing link.
ASTERIX CAT21 Ver 0.26 format to be used for data sharing.

*Surveillance data sharing between Malaysia and Indonesia in Bay of Bengal is currently on hold until further notice.

Operational Status
New ATM Automation system Kuala Lumpur is now complete and ready for data sharing.
Expected benefits
Enhanced safety at FIR boundary

Project 6 - ADS-B Data Sharing between Malaysia and Thailand

Phase 1
Langkawi - Phuket

General discussion about possibility to share ADS-B data for route N571, P628, L510, P627, L645 and P574. Malaysia and Thailand to continue discussion to exchange views of the possible ADS-B data sharing.

Operational Status
N/A

Expected benefits
- Enhanced visibility of surveillance targets in Bay of Bengal.
- Enhanced situational awareness at FIR boundary.

Project 7 - ADS-B Data Sharing between India and Sri Lanka (no update provided in 2018 - 2022)

Phase 1
In view of integration of Space Based ADS-B data, India's requirement of ADS-B data from Sri Lanka is supplemented, by the data from Aireon. Hence there is no further follow up from India on the data sharing. However, in case Sri Lanka desires to have ADS-B data from India, project may be approached, afresh by Sri Lanka.

Operational Status
N/A

Expected benefits
Enhanced safety at FIR boundary

General remark for all the above projects: As agreed at previous ADS-B Task Force, WG and SURICG meetings, sharing of ADS-B data should include sharing of VHF radio facilities/services, where possible

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REPORT FROM SOUTHEAST ASIA SUB GROUP

Bangkok, ThailandVideo Teleconference, *24-27 May 20226 to 9 June 2023*

States Present

Australia
China
Hong Kong China
Indonesia
Malaysia
The Philippines
Singapore
Thailand
Viet Nam

Observer

Japan

Previously Identified Projects

The South East Asia Group provide an update on the near term implementation of the following projects that were identified in previous meetings.

Project 1 – ADS-B Data Sharing Between Australia and Indonesia

Phase 1a
Indonesia and Australia sharing ADS-B data from the following sites:

- Saumlaki (Indonesia) (Installed)
- Merauke (Indonesia) (Installed)
- Waingapu (Indonesia) (Installed)
- Kintamani - Bali (Indonesia) (Installed)
- Thursday Island (Australia) (Installed)
- Gove (Australia) (Installed)
- Broome (Australia) (Installed)
- Doongan (Australia) (Installed)

Data Sharing Agreement signed in Nov 2010;
Communications links between Australia and Indonesia were upgraded from VSAT to terrestrial links in Mar 2016. The service quality was improved.

Benefits
Data used for air situational awareness and safety nets.
Enhanced Safety at FIR boundary.
Operational service commenced by Australia in 2010.
Indonesia has been using the data for Tier 2 services since Sep 2014

Phase 1b
Indonesia and Australia plan to share ADS-B data from the following additional sites:
- Timika (Indonesia) (Installed) - Commenced data sharing

- Kupang (Indonesia) (Installed) - Commenced data sharing
- Christmas Island (Australia) (Not yet installed)
- Browse Basin oil rig (Australia) (installed in 2018 and not yet operational)

Data Sharing Agreement signed on 18 Jun 2014.:

~~Indonesia announced the use of ADS-B for situational awareness on 24 July 2014. Indonesia announced on 30 Apr 2015 that ADS-B will be used for separation from FL290 to FL460 (tier-1) with effect from 25 June 2015. The carriage of ADS-B equipment for flights between FL290 and FL460 remain optional until Dec 2017. From 1 Jan 2018, Indonesia implemented ADS-B mandate from FL290 to FL600 in Jakarta and Ujung Pandang FIRs.~~

Project 2 – ADS-B Data Sharing In Southeast Asia

Phase 1
Under the near term implementation plan, the parties have commenced ADS-B data sharing from the following sites:

- Singapore (Singapore provide data to Indonesia)
- Natuna (Indonesia provide data to Singapore)
- Matak (Indonesia provide data to Singapore)
- Con Son (Viet Nam provide data to Singapore)
- Sanya FIR (China provide fused data from four ADS-B stations to Hong Kong China)

VHF radio communication services (DCPC) were provided from the following stations to Singapore and Hong Kong China. This is to enable implementation of radar-like separations in the non-radar areas within the Singapore FIR as well as routes L642 and M771.

- Natuna VHF (Install for Singapore by Indonesia) (Installed)
- Matak VHF (Install for Singapore by Indonesia) (Installed)
- Con Son VHF (Install for Singapore by Viet Nam) (Installed)
- Sanya VHF (Install for Hong Kong China by China) (Installed)

ADS-B Data sharing and DCPC services agreement between Singapore and Indonesia signed in Dec 2010.

ADS-B Data sharing and DCPC services agreement between Singapore and Vietnam signed in Nov 2011.

DCPC services agreement between China and Hong Kong China signed in 2005.
ADS-B Data sharing agreement between China and Hong Kong China signed in 2013.

Operational Status
Singapore agreed on separation minima with Viet Nam and have commenced on ADS-B operations since Dec 2013. Singapore commenced with 40nm separation and subsequently reduced to 30nm separation between Singapore and Ho Chi Minh FIR. Further reduction to 20nm longitudinal separation was implemented on 10 Nov 2016.

All 4 administrations (China, Hong Kong China, Singapore and Viet Nam) agreed that operational approval is not required.

Initial Benefits

The above sharing/collaboration arrangements will benefit L642, M771, N891, M753, N892 and L644. Enhanced safety and reduced separation have been achieved. Mandate was effective in Singapore FIR from Dec 2013. China published the mandate in Oct 2019. Mandate for domestic fleet was effective on 10 Oct 2019. Mandate for international fleet will effective on 31 Dec 2020. Hong Kong China's ADS-B mandate was effective from Dec 2016 for aircraft at FL290 and above.

Phase 2

The Philippines has installed ADS-B station at Manila ATM Centre. It will install six other ADS-B stations within Manila FIRs (Puerto Princesa-Palawan, Laoag, Jomalig, Mt Majic, General Santos Airport and Iba Zambales).

Singapore and the Philippines signed an MOU in Oct 2015 to make available ADS-B data and VHF facilities at Bataraza, Palawan for Singapore. The project was completed in Aug 2017.

The Philippines indicated that there is a surveillance gap at Northwestern part of Manila FIR and is studying acquisition of space-based ADS-B data to cover the surveillance gap.

China's four ADS-B ground stations deployed in Sanya FIR may be able to cover parts of the surveillance gap. China is prepared to share its ADS-B data, via its ADS-B data processor, with neighbouring states.

Brunei signed an MOU with Singapore in April 2019 where Brunei ~~will~~ shared ADS-B data with Singapore and provide the VHF facilities for Singapore ATC use. Data sharing ~~will~~ commenced 1 September 2021.

Singapore and Viet Nam signed an agreement in Jul 2016 to make available ADS-B data and VHF facilities at Ca Mau for Singapore. The facilities were commissioned in Nov 2018.

Phase 3

Vietnam has ADS-B coverage at the Southern part of L625, N892, N884, M767 and M772 and Vietnam is willing to share the ADS-B data with the Philippines and Singapore. The discussion between Singapore and Vietnam is in progress.

The Philippines is studying the use of space-based ADS-B to cover its surveillance gaps.

In addition to sharing ADS-B data from its ADS-B station in Terengganu, Malaysia is also willing to share the ADS-B data from its ADS-B stations in Kuching, Bintulu, ~~and~~ Kota Kinabalu and Sandakan.~~, which are scheduled to be installed by 2021~~. The data from these ~~three~~ four stations are also useful to Indonesia and will be shared under Project 3. Singapore will share data from its Singapore ADS-B station with Malaysia.

Malaysia and Singapore will initiate discussions on data sharing from the following sites:

- Terengganu (Malaysia) - Installed
- Bintulu (Malaysia) – Installed
- Kota Kinabalu (Malaysia) – Installed
- Kuching (Malaysia) – Installed
- Sandakan (Malaysia) - Installed
- Singapore (Singapore) - Installed

Initial benefits

Enhanced Safety at FIR boundary and coverage redundancy

Project 3 – ADS-B data sharing between Indonesia and Malaysia

Indonesia and Malaysia are willing to share the ADS-B data from the following sites:

- Pontianak (Indonesia) – Installed
- Tarakan (Indonesia) - Installed
- Bintulu (Malaysia) – Installed
- Kota Kinabalu (Malaysia) – Installed
- Kuching (Malaysia) – Installed
- Sandakan (Malaysia) - Installed

Malaysia and Indonesia are reviewing the collaboration agreement.

Initial benefits
Enhanced Safety at FIR boundary and coverage redundancy

Project 4 – ADS-B data sharing between Cambodia, Thailand and Viet Nam

Cambodia is willing to share the ADS-B data from the following sites:

- Phnom Penh International Airport (installed)
- Siem Reap International Airport (installed)
- Stung Treng City (installed)

Vietnam completed installing 11 new ADS-B ~~installed~~ stations in the HCM FIR ~~from 2016 t~~ino ~~2020~~2023. Vietnam is willing to share data with Cambodia and Thailand.

Thailand installed ADS-B ground stations and is in the process of issuance of air navigation ~~facility establishment~~service licence. Expected completion by end of ~~2022~~2024.

Initial benefits
For redundancy

Project 5 – ADS-B data sharing between Indonesia and the Philippines

Indonesia and the Philippines initiated discussion in 2019 on data sharing:

- Melonguane (Indonesia) (~~will be installed in end 2022~~installed)
- General Santos (The Philippines) (yet to install)

Initial benefits
Situational awareness

Project 6 – ADS-B data sharing between Australia, Indonesia and Papua New Guinea

Data Sharing between Australia and Papua New Guinea -

- Thursday Island (Australia) (installed)
- Gove (Australia) (installed)

- Kintore (Australia) Not yet installed – Target to be installed by 2025
- Burns Peak – Port Moresby (PNG) (installed)
- Mt Robinson (PNG) (to be installed by 2018) or Mt Nauwein (to be installed by 2018)

The above data sharing proposal will be re-evaluated due to implementation of space-based ADS-B in Papua New Guinea

Note that the above information from Papua New Guinea was based on previous updates as Papua New Guinea was not present at the meeting.

Data Sharing between Indonesia and Papua New Guinea

- Mt Nauwein (PNG) (to be installed by 2018) – Phase 1
- Merauke (Indonesia) (installed) – Phase 1
- Jayapura (Indonesia) (installed) – Phase 2

New ATM system installed in PNG.
The parties have yet to sign the agreement.

General remark for all the above projects: As agreed at previous APAC ADS-B Task Force, WG and SURICG meetings, sharing of ADS-B data should include sharing of VHF radio facilities/services, where possible

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ADS-B Data Sharing Implementation Status in the Asia/Pacific Region

Related States/Administrations	ATS Route Served	Initiation Year	Agreement Date	Target Data Sharing Year	Implementation Status	Remarks/Challenges
Australia - Indonesia	Phase 1a L511, R592, G578, B349, M735, G326, A587, M768, A461, R340, B472, B473, G459	2010	2010	2010	Completed	SEA Report: Project 1
	Phase 1b M774, A458, J199, M766, G326, A587	2014	2014	TBD	Ongoing	Browse Basin oil rig (Australia) awaiting acceptance testing
	Phase 2 L895, A585	2017	2019	TBD	Completed	SEA Report: Project 2
Australia - Papua New Guinea	TBN				Ongoing	SEA Report: Project 6 (to be re-evaluated due to the implementation of space-based ADS-B in Papua New Guinea)
Brunei - Singapore	M758, M768, M767	2015	2019	2021*	Completed	SEA Report: Project 2 *Data sharing start Sep 2021
China – Hong Kong, China	Project 1 M771, L642	2010	2013	2013	Completed	
	Project 2 M771, L642, A1	2017		2018	Completed	Supplementary data sharing of Route A1
China - Lao PDR	A581, B465	2019		TBD	Ongoing	BOB Report: Project 1
China - Myanmar	A599	2019		TBD	Ongoing	BOB Report: Project 1
India - Indonesia	B466, P574, N563	2018		2022	Ongoing	BOB Report: Project 2 Data Sharing LoA on progress by end of 2022

Related States/Administrations	ATS Route Served	Initiation Year	Agreement Date	Target Data Sharing Year	Implementation Status	Remarks/Challenges
India - Malaysia	N571, P628, L510, P627, L645, P574	2017		2023	Ongoing	BOB Report: Project 3 Data Sharing LoA on progress by 2023
India - Myanmar	A201, A599, B465, G463, L507, P646, P762, G472, L524, M770, L759	2015	05/06/2015	2018	Completed	BOB Report: Project 4 Myanmar side: Discussion with ATM manufacturer for operational use at ACC is needed. Indian side completed.
Indonesia - Papua New Guinea	R204, A215, B462, B456	2018	2019	TBD	Ongoing	SEA Report: Project 6
Indonesia - Malaysia	B466, N571, P628, L510, P627, L645 and P574	2017		TBD	Ongoing	BOB Report: Project 5
Indonesia-Malaysia	**Project 3** R455, M772, B648, R223, M522, M768 and A211	2023		TBD	Ongoing	SEA Report: Project 3
Indonesia - Philippines	A461, R590, B472	2018	2019	TBD	Ongoing	SEA Report: Project 5
Indonesia - Singapore	M646, M758, M761, N875	2010		2013	Completed	SEA Report: Project 2
Malaysia - Singapore	**Project 1** M758, M768, L649,	2017		TBD	Ongoing	SEA Report: Project 2
	Project 2 M904, M765, N875, N891	2018		TBD	Ongoing	SEA Report: Project 2
Malaysia - Thailand	N571, P628, L510, P627, L645, P574	2018		TBD	Ongoing	BOB Report: Project 6

Related States/Administrations	ATS Route Served	Initiation Year	Agreement Date	Target Data Sharing Year	Implementation Status	Remarks/Challenges
Myanmar - India	Project 1: Effect on Myanmar A201, A599, B465 Effect India: G463, L507, P646, N895	2018	2015	2020/2021	Ongoing	Data communication between Myanmar and India is stable with two links. Different Multiaircraft Address from India ADS-B Data
	Project 2: L301, M770	2019	2016	2020/2021	On trial	
Philippines - Singapore	N884, M522, M754, M767, M772, L649	2018		2018	Completed	SEA Report: Project 2
Singapore - Vietnam	**Project 1** N892, N891, M771, M753, M758, L642, L644	2007		2013	Completed	SEA Report: Project 2
	Project 2 N892, N891, M771, M753, M758, M904, L642, L644	2014	2016	2018	Completed	SEA Report: Project 2

LIST OF ACTION ITEMS FOR SURICG

Action Item No.	Subject	Forum Raised	Status / Target Date	Remarks / follow-up	Action Party	Status
6-1	Mode S and DAPs WG to reflect the required updates for II and SI mixed code allocation in Mode S DAPs IGD.	SURICG/6	SURICG/8		DAPs WG in consultation with Surveillance Panel	COMPLETED
6-2	DAPs Working Group to consider rename to better reflect the focus of work scope not only on DAPs but also on Mode S Radars	SURICG/6	DAPs WG/5		DAPs WG	Completed
6-3	Regional coverage map of surveillance and DCPC included in the Seamless ANS Plan (3.0) to update the coverage map during next Seamless ANS Plan review	SURICG/6	Next Seamless ANS Planning and Implementation WG Meeting or suitable forum		Hong Kong China and Thailand with Secretariat Support	In progress
~~6-4~~	~~Ad-hoc Working Group to discuss performance specifications and sharing of baselining of performance of radar for APAC Region~~	~~SURICG/6~~	~~SURICG/8~~		~~Secretariat and States (including China, India, Indonesia, ROK, Singapore)~~ ~~IP/17 SURICG8 Refer to ICAO Doc 8071~~	~~Removed Outcome: Guidance Material on radar performance and testing~~
6-5	Development of a SI code allocation/implementation plan and related issues	SURICG/6	SURICG/8		Secretariat with DAPs WG	**COMPLETED** Enhancement on Tool to support the allocation of SI code

LIST OF ACTION ITEMS FOR SURICG

Action Item No.	Subject	Forum Raised	Status / Target Date	Remarks / follow-up	Action Party	Status
7-1	Set up a List of Points of Contact for Mode S II/SI Coordination Matters	SURICG/7	Mode S WG/6		Secretariat with Mode S and DAPs WG	COMPLETED
7-2	ROK to provide their point of contact on sharing their software *Astecat* for measuring performance of radar	SURICG/7	SURICG/8		ROK, with Secretariat support	COMPLETED
7-3	Working Paper on reporting the inconsistent ICAO Aircraft Address and Target Identification between surveillance data and flight plan be submitted to RASG-APAC	SURICG/7	RASG-APAC/12		Hong Kong China	COMPLETED Hong Kong China to liaise with RASG-APAC on way forward Need further discussion with ATM
7-4	Workshop on consistency of ICAO Aircraft Address and Target Identification between surveillance data and flight plan	SURICG/7	SURICG/8		Hong Kong China, Secretariat	COMPLETED Need further discussion with ATM
7-5	Guidance Material on consistency of ICAO Aircraft Address and Target Identification between surveillance data and flight plan	SURICG/7	SURICG/8		Hong Kong China, Secretariat	Superseded by ACTION ITEM 8-1 Need further discussion with ATM

LIST OF ACTION ITEMS FOR SURICG

Action Item No.	Subject	Forum Raised	Status / Target Date	Remarks / follow-up	Action Party	Status
7-6	Alignment of SUR SG Report with AIGD regarding definitions of Tiers 1 and 2	SURICG/7	CNS SG/26		Hong Kong China, Chair of SUR SG	COMPLETED
8-1	Regional guidance material to mitigate the discrepancies observed in ICAO Aircraft Address and Target Identification between surveillance data and flight plan by consolidating the outcomes of the workshop.	Workshop &SURICG/8	SURICG/9		Ad-hoc group led by Hong Kong China, supported by China, New Zealand, Singapore, USA and IATA.	
8-2	The Action Items List of Mode S and DAPs WG will be incorporated into the Action Items of SURICG.	SURICG/8	SURICG/9		ICAO Secretariat	
8-3	Formally update the e-ANP Volume II Table CNS II-APAC-3 SURVEILLANCE in due course at earliest convenience.	SURICG/8			concerned Member States, ICAO Secretariat	

All members States/Administrations to contribute with papers at next meeting on any of the following items.

- ASBUs relating to ADS-B IN
- Implementation of Space Based ADS-B
- Increased Effectiveness of Ground-based Safety Nets using ADS-B
- Use of lower cost, lower performance ADS-B systems (TSO199)
- Use of Mode S DAPS in APAC region
- Use of electronic scan primary radars in APAC region
- Use of Mode C transponder veils in APAC region
- Use of Flight ID data from mode S interrogation and ADS-B
- Mode S problem reporting in APAC region
- Mode S analysis tools used in APAC region
- ADS-B test equipment used in APAC region
- Need to amend SUPPs 7030 on SIL matter
- Management issues with 24 bit ICAO codes in APAC
- Update and maintain ADS-B problem database
- Consider need for aircraft transponder Mode S mandates

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TERMS OF REFERENCE OF
SURVEILLANCE IMPLEMNTATION COORDINTION GROUP (SURICG)

Consists of objectives and deliverables as follows:

The Objectives of the SURICG are to:

1) *Ensure continuous and coherent development of the Surveillance parts of the Asia/Pacific Regional Air Navigation Plan (APAC e-ANP) in a manner that is harmonized with adjacent regions, consistent with ICAO SARPs, the Global Air Navigation Plan and the Global Aviation Safety Plan;*

2) *Facilitate the implementation of Surveillance systems and services identified in the Aviation System Block Upgrades (ASBU) modules, APAC ANP, and Asia/Pacific Seamless ATM Plan elements using the project management principles where appropriate; and*

3) *Review, identify and address major issues in technical, operational, safety and regulatory aspects to facilitate the implementation or provision of efficient Surveillance services in the Asia and Pacific Regions.*

Deliverables to meet the Objectives:

1) *Progress report to be submitted to CNS SG addressing the SURICG deliverables (listed in 2 to 13 below);*

2) *Surveillance parts of the APAC ANP to be reviewed and aligned with work programme of States and, as necessary, amendment proposals prepared to update the APAC ANP to reflect changes in the operational and global requirements;*

3) *To review the outcome of the Surveillance Panel, SAS Panel, AN-Conf, APANPIRG and CNS SG related to surveillance, revise and update a tasks list and action items for the SURICG and formulate relevant Working Groups to work on those tasks / action items;*

4) *To develop regional targets/metrics for planning, implementation, measurement and monitoring of Surveillance systems and services;*

5) *To review and update the Surveillance Strategy by considering currently available and emerging technologies with respect to concept of operations, relative costing, technical and operational performance and maturity of alternative technology/solutions such as primary radar, secondary radar including Mode-S, ADS-B, Multilateration, ADS-C, multi-static primary radar (MPSR) and existing and emerging technology for detection of UAS including RPAS;*

6) *To study and identify applicable multilateration applications in the Asia and Pacific Regions considering:*

- *Concept of use/operation*
- *Required site and network architecture*
- *Expected surveillance coverage*
- *Cost Benefits Analysis*
- *Recommended separation minimums*

7) *To study and identify applicable Mode S ~~radar~~ and DAPs applications in the Asia and Pacific Regions considering:*

- *Concept of use/operation;*
- *Assignment of and migration to SI code in APAC;*
- *Required site and network architecture;*
- *Expected surveillance coverage;*
- *Cost of system;*
- *Requirement of surveillance systems (focusing on radar)*
- *Matching functionality required in ~~ATC~~ ATM automation system;*
- ~~*the use of Enhanced MODE S data (DAPS)*~~
- *Other currently available or emerging technologies;*
- ~~*ICAO GANP and ASBU; and*~~
- *Evaluation method for Mode S and DAPs performance.*

8) *To develop an implementation plan for ADS-B applications in the Asia and Pacific Regions including implementation target dates taking into account:*

- *available equipment standards;*
- *readiness of airspace users and ATS providers;*
- *identifying sub-regional areas (FIRs) where there is a positive cost/benefit for implementation of ADS-B and associated VHF voice communications;*
- *developing a standardised and systematic task-list approach to ADS-B implementation; and*
- *major traffic flows.*

9) *To coordinate ADS-B implementation plan and concept of operations with other ICAO regions where ADS-B implementation is going on and with relevant external bodies such as EUROCONTROL, EUROCAE, RTCA and Industry;*

10) *To encourage research and development, trials and demonstrations in the field of Surveillance and other relevant areas; ~~,~~*

11) *Facilitate implementation of surveillance data sharing (including DCPC) and sharing surveillance information and expertise between States through organizing educational seminars and providing guidance materials to educate States and airspace users*

12) *To support the ICAO in making specific recommendations, developing guidance materials, aimed at improving the Surveillance services by the use of existing and/or new procedures, facilities and technologies; and*

13) *Draft Conclusions and Decisions to be formulated relating to matters in the field of Surveillance that come within the scope of the APANPIRG or CNS Sub-group work plan.*

[Note: The Implementation Coordination Group, while undertaking the tasks, should take into account of the work being undertaken by SAS, Surveillance Panels with a view to avoid any duplication.

The Implementation Coordination Group will report to CNS Sub-group and CNS Sub-group will coordinate with ATM Sub-group.]

Membership:

All APAC member States/Administrations providing air navigation services in the Asia and Pacific Regions.

The Surveillance Implementation Coordination Group shall normally invite representatives of International Organizations recognized by the ICAO Council and Industry partners as required by the group which represent important civil aviation interests to participate in its work in a consultative capacity.

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