INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

REPORT OF

THE TENTH MEETING OF THE SURVEILLANCE IMPLEMENTATION COORDINATION GROUP (SURICG/10)

21 – 23 April 2025
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

HISTORY OF THE MEETING **Page**

REPORT ON AGENDA ITEMS

LIST OF ATTACHMENTS

LIST OF APPENDICES

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1. Introduction

1.1 The Tenth Meeting of the Surveillance Implementation Coordination Group (SURICG/10) was held at the ICAO APAC Regional Office, Bangkok, Thailand, from 21 – 23 April 2025.

2. Attendance

2.1 The Meeting was attended by **53** participants from **18** Member States/Administrations and **1** International Organizations including Cambodia, China, Hong Kong China, Macao China, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, New Zealand, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, USA, Vietnam and ICAO. Hong Kong China was provided the option to join the Meeting using Microsoft Teams due to travel advisories and prevailing circumstances. The list of participants is provided in **Attachment 1**.

3. Opening of the Meeting

3.1 The Meeting was opened by Mr. Ho Wee Sin, Deputy Director (Air Traffic Management), Civil Aviation Authority of Singapore and a Co-Chair of SURICG. Mr. Ho recalled the intention of creating the SURICG. He shared that the ICAO APAC office conducted the first ADS-B meeting in 2003 in Brisbane, Australia, with the purpose of studying and promoting the use of ADS-B in the APAC region. In 2016, the Meeting was pivoted to become the SURICG to cover the broader topic of Surveillance. He added that the APAC region is one of the pioneer regions in implementing ADS-B operations. He highlighted key achievements of the group, including drafting the guidance document for ADS-B and Mode S Radars, partnering with the ICAO Surveillance Panel to clarify and resolve some of the issues, including the frequency of conducting flight checks, type of II code for MLAT and ADS-B and the need for II/SI code operations for radars using the SI code, etc. He requested active participation and continuous support from participants and expressed the significance of collective efforts to get meaningful and remarkable outcomes.

3.2 Dr. Soniya Nibhani, Regional Officer ANS (CNS) Implementation, welcomed all delegates and shared key agenda item details with the Meeting.

4. Officers and Secretariat

4.1 Mr. Hui Man Ho, Assistant Director-General of Civil Aviation (Air Traffic Management), Civil Aviation Department, Hong Kong China, and Mr. Ho Wee Sin, Deputy Director (Air Traffic Management), Civil Aviation Authority of Singapore, co-chaired the Meeting.

4.2 Dr. Soniya Nibhani, Regional Officer ANS (CNS) Implementation, acted as the Secretary of the Meeting with the support of Ms. Xu Jian, Associate Programme Officer (CNS) Implementation and Ms. Varapan Meefuengsart, the Programme Assistant from ICAO Asia and Pacific Regional Office.

5. Organization, working arrangements and language

5.1 The Meeting met as a single body for the Meeting. The working language for the Meeting was English, including all documentation and this report. The Meeting considered **Seventeen** (17) Working Papers and **Ten** (10) Information Papers, **One** (1) presentation and **One** (1) flimsy under its **Thirteen** (13) Agenda Items. The list of Papers and Presentations is provided in **Attachment 2**.

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

6.1 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's 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.

7. List of Conclusions/Decisions from SURICG/10

	Reference Number		Title of (Draft) Conclusions/Decisions
1.	Draft Conclusion SURICG/10/01	-	Update the Table CNS II-APAC-3
2.	Draft Conclusion SURICG/10/02	-	Workflow for the request and coordination of IC codes with the ICAO APAC Office
3.	Decision SURICG/10/03	-	Adoption of Mode S DAPs Implementation and Operation Guidance Document Edition 6.0

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Agenda Item 1: Election of Co-Chair

1.1 Proposed by Singapore and seconded by India and Lao PDR, Mr. Hui Man Ho, Assistant Director-General of Civil Aviation (Air Traffic Management), Civil Aviation Department, Hong Kong China, was re-elected as a Co-Chair of the Surveillance Implementation Coordination Group.

1.2 Mr. Hui Man Ho thanked all States that had nominated or supported his nomination as a Co-Chair of SURICG.

Agenda Item 2: Adoption of Agenda

2.1 The tentative agenda items provided in WP/01 were adopted by the Meeting as the agenda items for the Meeting.

Agenda Item 3: Review of outcomes of relevant meetings on Surveillance

Review of Relevant Meetings - Sec (WP/02)

3.1 The paper summarised relevant information and updates with a highlight on the reviewed outcomes of SURICG/9, ATMAS TF/5, and relevant discussions of other meetings of CNS SG/28 and APANPIRG/35.

3.2 The CNS SG/28 Meeting adopted **four** (4) Conclusions and **two** (2) Decisions. In addition, based on the outcome of discussions on various agenda items, the CNS SG/28 Meeting developed four Draft Conclusions for consideration by the APANPIRG/35, which were adopted by the APANPIRG/35 Meeting. The Meeting noted the Conclusions/Decisions adopted by the CNS SG/28 and the APANPIRG/35 and discussed the follow-up.

3.3 SURICG Co-Chair shared information about a recent event, the ICAO APAC Radio Navigation Symposium, which was held in New Delhi, India, from 07-09 April 2025. He informed that the theme of the Symposium was ***GNSS RFI: Collectively Bridging Gaps and Shaping the Path Forward*** and that the symposium aimed to provide a collaborative platform to exchange experiences and insights on GNSS RFI, analyze its impact and challenges and facilitate in-depth discussion on mitigation measures and future development to build a resilient aviation system. It was added that Singapore presented *ADS-B spoofing and mitigating measures* in the symposium, and the symposium developed recommended actions to guide future efforts in managing GNSS RFI.

Outcomes of ADS-B Implementation Workshop for APAC LDCs - Sec (WP/03)

3.4 The paper presented the key outcomes of the ICAO APAC ADS-B Implementation Workshop, which was held from 14 to 16 August 2024 in Bangkok, Thailand. The report and other documents of the Workshop can be accessed at the ICAO APAC ADS-B Implementation Workshop webpage.

3.5 The Workshop aimed to address the challenges and promote the implementation of ADS-B technology across the APAC region, with a particular focus on Least Developed Countries (LDCs). The objective was to educate engineers and air traffic controllers on the necessary skills for ADS-B implementation, provide a comprehensive understanding of technical details and operational benefits, and explore the feasibility of establishing an ADS-B Implementation Go Team to assist States facing implementation challenges.

3.6 The Workshop discussed that, as of today, ICAO has multiple documents that provide necessary information related to the usage of ADS-B for various purposes, including aircraft separation.

It was requested that ICAO consider consolidating the references from numerous documents to get the answers to the questions associated with ADS-B implementation in one place. The moderator informed the Workshop that the proposed ICAO Guidance on Performance-Based Surveillance (RSUR) might be a helpful document once published. It was added that RSUR will also supersede Cir 326 Assessment of ADS-B and MLAT Sur to support ATS and guidelines for implementation. In addition, the aeronautical Surveillance manual provides information such as how one should manage ADS-B when something goes wrong and how one should do flight checks

3.7 The Workshop agreed that ADS-B is more accurate and that the update rate is higher than Radar. However, on a question about the complete replacement of Radar with ADS-B Stations by ANSPs, it was suggested that it should not be done without proper contingency service planning for the potential case of ADS-B station failure/GNSS interference/GNSS spoofing. In addition, a cost-benefit analysis and risk analysis should be carried out to ensure that an appropriate risk analysis is carried out.

3.8 The Workshop noted ICAO Aircraft Address (AD) and Target Identification (ID) Discrepancies between Surveillance Data and Flight Plan data and about the Conclusion CNS/SG/28/11 (SURICG/9/2)- Guideline on addressing inconsistencies of Aircraft Address (AD) and Target Identification (ID) between Surveillance Data and Flight Plan. It was informed that by this conclusion, the ICAO APAC guideline on addressing inconsistencies of ICAO Aircraft Address (AD) and Target Identification (ID) between Surveillance Data and Flight Plan was adopted by the CNS SG/28 Workshop held from 1-5 July 2024 in the ICAO APAC Office, Bangkok, Thailand.

3.9 The Workshop agreed that, based on the experiences shared by various speakers, the ADS-B system is easy to implement and maintain. ADS-B benefits the users, regardless of whether it is used for situational awareness or the reduction of separation. However, proper cooperation with stakeholders and collaboration with neighbours is critical for successfully utilising ADS-B benefits.

3.10 The ICAO Secretariat presented the concept of Go-Team and how it supports Member States in enhancing Air Navigation capacity and efficiency. The Workshop discussed the idea and need of the ADS-B Go Team and how it can be beneficial for APAC States/Administrations. The Workshop approved that on-site professional support is always valuable and grants an opportunity to enhance expertise, capacity, and efficiency for States facing issues related to any particular ANS systems or issues.

3.11 Lao PDR requested the support of the ADS-B Go Team for Lao PDR for the issues they are facing with the ADS-B implementation. It was shared that ICAO's prompt action on this matter will be helpful for the Lao PDR. The ICAO Secretariat informed that it will consult internally to discuss how to support the Lao PDR on this matter and communicate with the Lao PDR.

3.12 The Workshop discussed Lao PDR and Nepal’s challenges and deliberated on addressing some of the challenges by SP13 and SP14, which were very beneficial for both States. It was agreed that the ADS-B Go team would provide a significant opportunity and benefit for states that wish to avail themselves of the benefits of on-site expertise to resolve substantial challenges.

3.13 The Workshop concluded that the ADS-B Implementation Workshop was a significant step towards enhancing the understanding and implementation of ADS-B technology in the APAC region. The Workshop facilitated valuable knowledge exchange, identified key challenges, and provided actionable recommendations for States to advance their ADS-B implementation efforts.

3.14 The SURICG/10 Meeting shared its appreciation to the ICAO APAC Office, New Zealand and Singapore for organizing and supporting the Workshop and recommended organizing more events in the future.

3.15 Lao PDR shared that the event helped them resolve some of the key issues faced last year related to ADS-B implementation. It was added that the ICAO Secretary provided extensive support to the Lao PDR, following up on the request made during the Workshop and for the ADS-B Go Team's needs analysis. Lao PDR informed that it is soon going to share more details with the ICAO Secretariat about the ADS-B Go implementation team's scope of work requested by Lao PDR.

Finalization of APAC Common SWIM Information Services – Sec (WP/17)

3.16 According to the outcome of the SWIM survey conducted in 2022, it was recommended that a list of the common set of SWIM information services for APAC be developed. SWIM TF Task Leads on Information Services undertook the work, in coordination with relevant subject matter experts, to identify the types of information to be exchanged via APAC SWIM and propose the necessary business functionality to be supported by APAC Common SWIM Information Services for addressing the operational needs in APAC. This paper shared the latest status of work and requested input from SURICG to modify the list further.

3.17 The Meeting noted that the list of recommended services in the initial APAC Common SWIM Information Services was further reviewed and modified by SWIM TF/9. It was agreed that the SWIM TF Task Lead from Hong Kong China, together with relevant subject matter experts of SWIM TF, would present this updated version to the next Meeting of AAITF, ATFM SG, FF-ICE Ad-hoc group, MET/IE WG, SURSG, MET SG, AOP SG, and ATM SG. All comments received from all proposed groups will be presented to SWIM TF/10. The information about the SWIM TF/9 request to coordinate with different groups was shared by the ICAO Secretary of SWIM TF with Secretaries of AAITF, APSAR/WG, ATFM SG, FF-ICE Ad-hoc Group and MET/IE WG in 2024 after the SWIM TF/9 meeting to initiate discussion in relevant groups.

3.18 It was informed that the Proposed Business Functionality of APAC Common SWIM Information Services WP/23 and the Proposed Amendment to Business Functionality of APAC Common SWIM Information Services (WP/24) were presented by SWIM TF Task Leads and ICAO Secretariat in the Nineteenth Meeting of the ICAO Aeronautical Information Services − Aeronautical Information Management Implementation Task Force (AAITF/19) to get feedback from AAITF on APAC Common SWIM Aeronautical Information Services. Realizing a need for further discussion, the Meeting agreed to form an Ad Hoc group by Decision AAITF/19-3: Establish APAC Common SWIM Aeronautical Information Services Ad hoc Group to discuss both technical and operational aspects of this subject rather than reaching a consensus at AAITF/19. It was expected that the ad-hoc group would provide a revised list in the upcoming SWIM TF/10 Meeting.

3.19 The information was also presented to the ICAO APAC Twenty-Eighth Meeting of the Meteorology Sub-Group (MET SG/28) by WP/20. MET SG/28 provided its comments and updated the catalog for APAC Common SWIM Meteorological Information Services. During the Second Asia/Pacific FF-ICE Ad hoc Group Meeting from 18-20 March 2025, the ad-hoc group reviewed the list and updated it for APAC Common SWIM Flight Information Services.

3.20 The SURICG/10 Meeting was requested to review the proposed initial set of APAC Common SWIM Surveillance Information Services→**Surveillance data sharing services** and provide inputs and comments for:

- Business functionality of the service
- Brief description of the service
- Type of information to be exchanged
- Information exchange model, including the suitable version (e.g., a suitable version of AIXM) or message type
- Message exchange pattern
- Priority as recommended service in the initial APAC Common SWIM Information Services

3.21 The Meeting reviewed the list and recognized that SURSG inputs for the finalization of the list may be valuable. With assistance from Hong Kong China, the list was modified and further consulted with SURSG/4 delegates by email. After incorporating all inputs, the ***final list of APAC Common SWIM Surveillance Information Services*** was prepared by the SURICG/10 meeting, provided in **Appendix A**, that would be considered by the SWIM TF/10 to finalize the list of APAC Common SWIM Information Services.

3.22 It was added that the proposed list could be considered by SWIM TF/10 for publishing the first APAC Common SWIM Surveillance Information Services. In addition, SURSG will review the list and provide further updates, if any, to publish in the next version of APAC Common SWIM Surveillance Information Services. **ACTION ITEM 10-1**

Agenda Item 4: Review Progress of SURSG

Outcomes and lessons learned from the Joint Event of SWIM over CRV demonstration and surveillance data sharing in the SWIM trial - Hong Kong China (WP/04)

4.1 This paper presented the outcome and lessons learned from the Joint Event of SWIM over CRV Demonstration and Surveillance Data Sharing in SWIM Trial, conducted by Surveillance Sharing in SWIM Trial Implementation Group (S3TIG) in Hong Kong, China, from 28 - 29 May 2024.

4.2 The Meeting noted that various States/Administrations have participated in the preparation of the Joint Event, including 7 States/Administrations (Hong Kong China, India, Japan, Malaysia, Republic of Korea, Singapore and Thailand) as Data Contributors and/or Consumers and 10 States/Administrations (Australia, China, Fiji, Indonesia, Laos PDR, New Zealand, Pakistan, Philippines, Sri Lanka and Vietnam) as Observers. In addition, a total of over 100 participants from various States/Administrations, industrial leaders, airlines, data service providers, and the CRV service provider attended the Joint Event in person.

4.3 For the Joint Event, several potential SWIM services were devised and demonstrated, covering the full spectrum of existing SWIM data exchange models and the proposed surveillance data exchange models. To showcase the operational benefits brought by SWIM, S3TIG identified **three operational scenarios** with a higher probability of realization as SWIM use cases for demonstration. PCCWG, the CRV provider, constructed a pseudo-CRV network for the Joint Event. A 2-tier hierarchical architecture, as proposed by the SWIM Implementation Pioneer Group (SIPG), was adopted for the Joint Event. S3TIG designed three data exchange models: a) JSON Structure for Surveillance Data with Flight Plan Information (TRACK_JSON + FPL); b) JSON Structure for Surveillance Data Only (TRACK_JSON); and c) ASTERIX CAT 21 Raw Data (TRACK_RAW) for sharing surveillance data over SWIM, along with the corresponding message headers.

4.4 The lessons learned from the Joint Event included both the SWIM and CRV perspectives. The Meeting learned that message headers/metadata, including the names of the fields and format of the contents, must be properly considered and standardized to maintain interoperability within the region and across different regions. It was noted that the 2 Mbps bandwidth tentatively offered to each State/Administration in the pseudo-CRV and adopted by most States/Administrations is insufficient for sharing surveillance data at a 1-second data rate for some States/Administrations, depending on their FIR traffic volume and their roles in sharing or consuming ADS-B surveillance data within the SWIM environment in the future. This situation necessitates subscribing to a higher CRV bandwidth.

4.5 Some participants expressed doubts about whether the hierarchical architecture is the appropriate architecture for the APAC region. There were several observations with this architecture identified during the preparation of the Joint Event, such as specific configuration required for different brands of EMS, potential message loop back if source and recipient checking was not implemented properly, combining byte message and text message into a single queue, single point of failure of the current architecture, etc.

4.6 There was some confusion between the use of AMQP Topics and Queues by participants, which needs to be further examined for using them more efficiently.

Outcome of SURSG/4 - Sec (WP/05)

4.7 The Fourth Meeting of the Surveillance Study Group (SURSG/4) was held in Hong Kong, China, as an In-Person Meeting from 30 to 31 May 2024, after the Joint event of SWIM over CRV Demonstrations and Surveillance data sharing over SWIM trial from 28-29 May 2024 in Hong Kong, China. The SURSG/4 Meeting recalled SURSG's journey since its establishment and reviewed its work plan. The Meeting deliberated on the proposed plan and updated the timelines and deliverables of the remaining tasks. The approved and modified SURSG work plan from the Meeting is as follows:

3	Report on the possible implementation of surveillance data sharing in SWIM	-	SURSG/2	SURICG/ 7	TBD	Completed Outcomes of Joint event were presented in SURSG/4 Meeting.
3-1	Consolidation of all the outcomes of Task 2 into a report according to the contents defined in ToR for submission to SURICG	-	SURSG/2	SURICG/ 7	Hong Kong China, IATA, Singapore, Thailand, Viet Nam	
~~3-2~~	~~Preparation of draft multi-lateral agreement on surveillance data sharing and data consumption~~ [**absorbed into Task 4**]	~~SURSG/2~~	~~SURICG/ 7~~ ~~(to be reviewed at SURSG/3)~~	~~TBD~~	~~3-2~~	
4	Guidance materials for the sharing and access of surveillance data	~~SURICG/ 7~~ ~~(after demo)~~ **SURICG/ 11 (2026)**	~~SURICG/ 9~~ **SURICG /11**	TBD	4	**Guidance Material**
4-1	Preparation of the framework and 1st draft of guidance material	~~SURICG/ 7~~ ~~SURICG/ 8~~ ~~(after demo)~~ **SURICG/**	~~SURSG/3~~ ~~SURSG/4 or SURSG/5~~[1] **SURICG /11 (2026)**	TBD	4-1	

[1] Subject to timing of Demo.

		11 (2026)				
4-2	Further development of the working draft of guidance material for endorsement by SURICG and CNS SG	~~SURSG/3~~ ~~(after demo)~~ **SURICG/ 11 (2026)**	~~SURICG/ 9~~ **SURICG /11**	TBD	4-2	

4.8 The SURSG/4 Meeting discussed the proposed framework of guidance material. It was agreed that the study report published by SURSG in 2022 could serve as an initial draft to initiate work on the guidance material. It was decided that the guidance material would restrict the scope of sharing ADS-B surveillance only. Additionally, key aspects that would be considered in the draft of the documents were (1) surveillance information service security, (2) infrastructure and bandwidth considerations, (3) surveillance data performance requirements, and (4) data formats – ASTERIX, JSON, or new data formats.

4.9 The SURSG/4 Meeting requested volunteers to lead the work on the draft of guidance material. Hong Kong China volunteers to lead the surveillance information service, security, and Infrastructure and bandwidth consideration draft. The USA shared their willingness to lead the surveillance data performance requirements draft, and Singapore shared their willingness to lead the Data formats draft. The SURSG/4 Meeting requested a volunteer to compile the draft documents received from four leads on four initial topics being considered in the guidance material. As no volunteers shared an interest in leading this task, Hong Kong China and the USA agreed to lead the task. The respective topic leads will solicit inputs and expert advice from SURSG-nominated Member States/Administrations.

4.10 The SURSG/4 Meeting discussed the outcomes of the Joint event and agreed that with the successful completion of the Joint event, S3TIG can be dissolved. The S3TIG was dissolved by the SURSG/4 Meeting.

4.11 Hong Kong China shared the outcomes of the Study on bandwidth used for ADS-B data being transmitted on SWIM CRV. Thailand and Singapore requested Hong Kong China to capture and analyze ADS-B data supplied by their surveillance system, as the current setup for the Joint event will be accessible for one month until the end of June 2024 for participants. Hong Kong China accepted the request.

4.12 The SURSG/4 Meeting discussed the date and venue of the next SURSG Meeting. It was advised that the SURSG could work on the remaining deliverables offline and coordinate by email. The next SURSG Meeting should be held after completing all remaining deliverables. The Meeting agreed that the next Study Group Meeting could be conducted online or in person based on the anticipated level of discussion.

Progress update of SURSG - Hong Kong China (WP/06)

4.13 Hong Kong China shared the progress of the work of SURSG after 2024. It informed that after the successful conduct of the Joint Event of SWIM Demonstration over CRV and surveillance data in SWIM trial held in Hong Kong China, from 28 – 29 May 2024, SURSG has started to prepare the last deliverable of the Study Group (i.e., guidance material), based on the proposed framework to include (1) surveillance information service security; (2) infrastructure and bandwidth consideration; (3) surveillance data performance requirement; and (4) data formats.

4.14 The Meeting noted that Hong Kong China, Singapore and the USA have volunteered and contributed to producing the guidance materials. The table of contents of the guidance material was drafted as below in Aug 2024:

a) Chapter 1 – Introduction
b) Chapter 2 - Acronyms and Abbreviations
c) Chapter 3 - Summary of Major Considerations from the Study Report and their Outcomes from the Joint Event
d) Chapter 4 - Surveillance Information Service Security
e) Chapter 5 – Infrastructure and Bandwidth Considerations
f) Chapter 6 – Performance Requirements
g) Annex – Data Formats

4.15 The Meeting was informed that the first draft of Chapters 1, 3, 4, and Annex has been completed and reviewed by the team. The complete draft is planned to be ready by mid-2025 to seek further comments from SURSG members. The finalized version is targeted for endorsement by SURICG/11 in 2026.

4.16 During the discussion of the next meeting date of SURSG, it was stated that the next Meeting will be planned before the SURICG/11 Meeting in 2026. **ACTION ITEM 10-2**

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

Review of SUR information in CNS TABLES in e-ANP Vol II - Sec (WP/07)

5.1 The ICAO Secretariat summarized the need for review and update to the TABLE CNS II-3- SURVEILLANCE specified in ICAO APAC e-ANP Vol II by APAC States / Administrations. It reminded States/Administrations to review the data affecting their administration and provide feedback to ICAO on the data's accuracy in the requisite format to update the relevant CNS requirements in all volumes of e-ANP.

5.2 During SURICG/8 and after the SURICG/8 Meeting, APAC States/administrations requested the ICAO Secretariat to update the respective information contained in Table CNS II-APAC-3 SURVEILLANCE of ANP Volume II. The Secretariat consolidated the updates into the table and circulated the revised information through state letter Ref.: AN 3/3 – AP192/23 (CNS) on 20 December 2023. With the circulation of the state letter, the Secretariat revised the table again with some feedback from the States.

5.3 SURICG/9 reviewed the consolidated table by the Secretariat with reference to the Revised Surveillance Strategy of APAC. The updated table is provided in **Appendix B** of this report. The Meeting urged states to verify and update the TABLE CNS II-3- SURVEILLANCE following the PfA process.

5.4 The SURICG/10 Meeting was informed that the ICAO Secretariat has been presenting papers in various CNS contributory bodies' Meetings in the last 2 years to request States/Administrations to update the CNS tables mentioned in e-ANP Vol II, as most tables are outdated. However, no significant updates have been shared by the States/Administrations. Therefore, this year, the papers are being presented in various responsible contributory bodies to update relevant tables, and a draft conclusion is being proposed. Once adopted, States/Administrations will be committed to updating the required information in ICAO APAC e-ANP Vol II. After the CNS SG/29 Meeting, if all proposed draft conclusions are adopted by CNS SG/29, the ICAO Secretariat will issue a State Letter to all States/Administrations for necessary action. The States/Administrations can use information from **Appendix B** to update the proposed table.

5.5 The Meeting requested that the ICAO Secretariat demonstrate the PfA process to States. The ICAO Secretariat demonstrated the process and informed that all CNS tables in the Word file mentioned in ICAO APAC e-ANP Vol II are uploaded to the ICAO APAC e-ANP Webpage with instructions on how to file a PfA. It was added that while issuing the State Letter, after CNS SG/29, if CNS SG/29 adopts the draft conclusions, information about the PfA process will be shared in the letter.

5.6 The Meeting discussed the significance of updated information in the Asia-Pacific Regional Air Navigation Plan and adopted the draft conclusion for CNS SG/29 adoption:

Draft Conclusion SURICG/10/01- Update the TABLE CNS II-APAC-3	
What: The current TABLE CNS II-APAC-3 SURVEILLANCE of e-ANP Vol II is outdated and requires immediate updates.	Expected impact: ☐ Political / Global ☐ Inter-regional ☐ Economic ☐ Environmental ☒ Ops/Technical
Why: to update ICAO APAC e-ANP Vol II	Follow-up: ☒Required from States
When: 23 April 2025	Status: Draft to be adopted by Sub-group
Who: ☒Sub groups ☒APAC States ☒ICAO APAC RO ☐ICAO HQ ☒Other: SURICG	

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

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

6.1 Two breakout sessions were conducted for *ADS-B planning and implementation – Bay of Bengal ad-hoc group* and *ADS-B planning and implementation – South East Asia Ad-hoc group*. The following members joined two Ad-hoc groups:

SN	ADS-B planning and implementation– Bay of Bengal Ad-hoc group	ADS-B planning and implementation– South East Asia Ad-hoc group
1.	China	China
2.	India (Lead)	Hong Kong China
3.	Indonesia	Indonesia
4.	Maldives	Lao PDR (new member)
5.	Malaysia	Malaysia
6.	Pakistan (new member)	Philipines
7.	Sri Lanka	Singapore (Lead)
8.	Thailand	Thailand
9.	Observers NIL	Vietnam
10.		**Observers** Macau China, Japan, New Zealand, USA

6.2 During breakout sessions, various members shared updates on different projects with the chairs of both groups. The chairs prepared the final report and updated the ADS-B Data Sharing Implementation Status table. 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 India and Singapore, respectively. The reports updated by BOB and SEA Ad Hoc groups are provided in **Appendices C and D,** which could serve as a basis for further development of the sub-regional implementation plans and follow-up actions for coordination by States/Administrations.

c) Updates by other States

6.3 There were no papers under this sub-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, in which states and administrations provided updates during the ad-hoc working group sessions. The updated table is provided in **Appendix E** 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 Thailand (IP/05)

7.1 This paper provided a brief summary of observed NIC/NACp values to assess the performance quality of aircraft using ADS-B in Thailand, along with ADS-B equipage status in Thailand. Thailand informed that since September 2024, seven ADS-B ground stations have been installed and integrated into the Air Traffic Management Automation System (ATMAS) in Thailand to enhance the efficiency, flexibility, and coverage of ATS surveillance within the Bangkok Area Control Center and selected Approach Control Centers. It was added that to address concerns regarding ADS-B performance within the Bangkok FIR, the Aeronautical Radio of Thailand, AEROTHAI (Thailand's ANSP), has initiated a monitoring program to assess ADS-B quality indicators at each ADS-B station.

7.2 This paper focused on ADS-B reports (ASTERIX CAT021) collected over a one-year period in 2024 of four ADS-B receivers, with site monitor reports excluded. ADS-B messages encompassed positional performance indices (NIC and NACp) whose values were analyzed, but the information concerning avionics installation issues (SDA, SIL, NACv) was not used to evaluate the performance of aircraft. Thailand presented statistical results for all collected ADS-B data that indicated that the ADS-B position quality met/not meet the requirements of 14 CFR 91.227. Thailand also presented the coverage of 12 SSRs and 4 ADS-B systems within the Bangkok FIR, along with displaying the intersection coverage of SSRs and ADS-B, which were used to evaluate the number of ADS-B-equipped aircraft within the FIR.

7.3 In response to a question, Thailand clarified that there are plans to use DO-260, DO-260A and DO-260B for surveillance.

ADS-B Performance Monitor under Development at ENRI - Japan (IP/06)

7.4 Japan introduced an ADS-B performance monitor that is currently being developed at ENRI, Japan. It was informed that the Electronic Navigation Research Institute (ENRI) created an algorithm for appropriately analyzing ADS-B messages and is now developing a performance monitor to evaluate the quality of ADS-B performance based on this algorithm. This monitor can be used to assess the current ADS-B situation in Japanese airspace and to identify erroneous aircraft that do not meet surveillance requirements.

7.5 The Meeting noted the block diagram of ADS-B processing and that the software operates in two formats: one is the use of Mode S messages, and the other is the use of CAT21, which is an ADS-B ASTERIX format processed by the operational systems. It was informed that the developed software provides statistical values regarding the quality of ADS-B performance, as well as variations in these values across individual trajectories. Additionally, it assisted in identifying erroneous aircraft, such as those with low-quality values or implementation errors. It was stated that the software will be updated to add more functions and better meet operational needs.

7.6 The Meeting appreciated the tool developed by ENRI, Japan, considering that the development of such a tool is an extensive work and it is complicated to acquire such tools from the market. The Meeting shared their interest in following up on the outcomes of further studies and requested Japan to present the outcomes of additional studies in the future meetings of SURICG.

Update on IP/18 SURICG/9 Challenges Finding the cause of non-compliant ADS-B data – New Zealand (IP/07)

7.7 New Zealand presented a brief update on the challenges of finding the cause of Non-Compliant ADS-B data in New Zealand. New Zealand informed that in 2024, Airways presented a paper that identified several issues in finding the cause of non-compliant ADS-B data and resolving these issues. This paper provided an update on the progress to find a resolution and identified another issue found in late 2024.

7.8 New Zealand informed that ADS-B transponder type “Y” is being detected outputting NACp, NIC, and NACv ZERO with a SIL of THREE, which is non-compliant ADS-B data under NZCAA rule 91 and cannot be used for Surveillance Separation. It was added that when the non-compliant ADS-B data occurred, an ADS-B alert was generated to controllers – either a yellow starfish RPS for targets in ADSB-only airspace or a Degraded ADSB Data (DAD) alert for aircraft in airspace covered by both ADSB and either MLAT or MSSR. New Zealand shared more detailed statistics of non-compliant ADS-B data.

7.9 It was reported that GPS coverage was lost at the Invercargill (NZNV) regional airport in September 2024. The loss of coverage occurred on short finals to Runway 04, which affected multiple aircraft but was intermittent. Some form of GPS interference was suspected, possibly from a GPS jammer. Airways reported the issue to the Ministry of Business, Innovation and Employment (MBIE), Radio Spectrum Division, as per NZCAA reporting requirements.

7.10 After a number of days of investigation by the MBIE radio inspector, it was found that the cause of the interference was a GPS jammer installed in a caravan recently purchased from overseas. The new owner was storing the caravan in a shed, and when he pulled the caravan out of the shed to do some maintenance on it, the interference started. When the caravan was put back in the shed, the interference stopped. The new owner had no idea there was a GPS jammer in the caravan. New Zealand shared that the detection of ADS-B issues, such as GPS interference or jamming, was often easy to determine but difficult to resolve. Airways has found that some OEMs are reluctant to acknowledge the problems with their equipment and work speedily to resolve these issues. Additionally, government channels designed to fix day-to-day issues for the general population are not always suitable for the needs of the Aviation community, which is looking for a quick resolution to enable normal operations to recommence.

7.11 The Meeting deliberated on the issue, and it was stated that the presented issue is related to a specific model of ADS-B transponders. It was added that the USA has encountered the same issue and it is engaging with the manufacturer to resolve the problem.

7.12 In response to a question about the details of the tool being used by New Zealand to conduct the abovementioned analysis, the Meeting was informed that New Zealand had developed the tool in-house. USA added that it has also developed a similar tool for monitoring and analyzing ADS-B data to check the quality and performance of ADS-B data from aircraft entering USA airspace in a timely manner.

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

a) States/Administrations

GNSS vulnerabilities and the significance of ADS-B central data processor - Hong Kong China (WP/10)

8.1 Hong Kong China presented the critical role of the ADS-B Central Data Processor System (CPS) in enhancing air traffic surveillance. It was stated that ADS-B CPS collects, processes, and analyzes the aircraft surveillance data received from ADS-B ground stations and disseminates the processed data to air traffic management systems. It provides trustworthy ADS-B data to air traffic management systems for precise presentation of aircraft positions and movements, particularly in the presence of GNSS vulnerabilities, thus enhancing the safety and efficiency of air traffic operations.

8.2 Hong Kong, China informed that for GNSS spoofing, the affected area is usually rather local. When it occurs, various aircraft at different locations within the area are GNSS spoofed to be located at the false location. Depending on the fusion algorithm of the air traffic management systems, they might not be capable of identifying the circumstance but display the false location of the aircraft on the air situation display. These falsified targets can potentially trigger false conflict alerts, leading to situational confusion while increasing the workload of manually verifying the actual aircraft positions with the pilots. All of these pose risks to air traffic safety.

8.3 Hong Kong China highlighted that the implementation of an ADS-B CPS could be effective in addressing the issues of falsified target displays caused by GNSS spoofing and encouraged States to consider its implementation based on their needs.

8.4 In response to a question, Hong Kong China informed that ADS-B CPS did not aim for detecting GNSS jamming or spoofing, but was effective in filtering ADS-B targets with spoofed locations over areas of suspected GNSS spoofing.

8.5 In response to a question on whether there is any way for operations to continue as per normal in an ADS-B exclusive airspace when spoofing occurs, the Co-Chair informed that procedural separations will have to take place. He also shared that Aireon has some tools to detect GNSS RFI instances by comparing ADS-B reported positions and the calculated positions using the time difference of arrival at their satellite payloads.

Analysis of Abnormal Tracks Caused by Electromagnetic Environment - China (WP/12)

8.6 China presented missing targets, erratic tracks, and reflection targets caused by trees and lightning arrestors, and it put forward solutions and recommendations for electromagnetic environment protection and lightning arrestor construction of radar stations.

8.7 It was added that in February 2024, during the independent parallel instrument approach, a radar generated erratic tracks due to the occlusion of trees, which mismatched the turning mechanism of the automated system, and generated a false target turn to the adjacent runway, resulting in the go-around of the subsequent flight on the adjacent runway. Further analysis found that targets were missed in the direction of tree occlusion. The quality of the track was significantly improved after clearing the trees. In addition, in the direction of the lightning arrestor, the track was erratic, and some reflection plots were observed. Once the tracks were generated, they could result in reflection targets.

8.8 China informed that in order to detect and deal with illegal construction or tree occlusion in a timely manner, China carried out electromagnetic environmental protection monitoring based on AI technology, by setting up cameras and laser rangefinders on the radar tower, automatically identifying building construction, calculating the obstructing angle of trees, and providing early warning information.

8.9 It was recommended that the installation angle and position of the lightning arrestors be carefully planned during the design phase to minimize their impact. Additionally, research should be conducted on the impact of lightning arrestor material, thickness, etc, on Radar based on the surveillance radar frequency and operating characteristics, and relevant standards and specifications should be developed to guide the installation of lightning arrestors.

Assessing a New Surveillance System for Operational Use – New Zealand (WP/13)

8.10 This paper presented Airways' use of the EUROCONTROL Specification for ATM Surveillance System Performance (ESASSP) document to assess a new surveillance system for use within the Air Traffic Management System (ATMS).

8.11 It was informed that in 2024, Airways began the process of assessing a new non-cooperative radar (PSR) for use within the ATMS. The scope of this testing was to ensure the validity of the data for non-cooperative target detection and assist with issues such as transponder failure. In addition, ATC management wished to assess the capability of the PSR for 5NM surveillance separation in instances where no other surveillance source was available. To carry out the assessment, Airways used the ESASSP document ED 1.1 Sept 2015, as agreed with the PSR vendor. ESASSP Edition 1.1, Sept 2015, lays out a set of requirements to provide an assessment of the ability of a PSR to provide 5NM surveillance separation. ESASSP Table 6: Mandatory and recommended performance for 5NM horizontal separation provided by ATCO using a non-cooperative surveillance system was shared with the Meeting. In using ESASSP, Airways' aim was to assess the PSR to the same quality standard we would do for MSSR, ADS-B and Multilateration, which was to use the recommended values due to their higher quality standard and only use the Mandatory where there are no recommended requirements.

8.12 Initial test results showed that the PSR was failing the mandatory requirement 5N_N-R3 (long gaps) and the recommended requirements 5N_N-R2 (probability of update), 5N_N-R7 (track velocity RMS error) and 5N_N-R8 (track velocity angle RMS error). Continued improvement made by the vendor reduced the error values, but the results still failed some of the requirements. Changes were also made by the Airways software team to the ATMS Surveillance Data Processor (SDP) to help improve the track velocity. After these improvements, the data continued to fail both 5N_N-R3 and 5N_N-R7.

8.13 As a result of this assessment, Airways has decided not to use this Radar for surveillance separation and will employ it solely for situational awareness - that is to assist with our prime purpose for the Radar for the detection of non-cooperative targets and those targets with issues such as a transponder failure. Both of the remaining new PSR’s will undergo the same assessment process when ready. In addition, other issues were encountered during the final acceptance tests.

8.14 The assessment of the new PSR against established standards for more accurate surveillance equipment, such as MSSR, ADS-B, and Multilateration, revealed that the PSR is unable to meet **all** the required mandatory and recommended standards required for 5NM surveillance separation in New Zealand's environment. It was reported that Airways has chosen not to assess the PSR against the old non-cooperative standards for 5NM surveillance separation. Additionally, the evaluation identified several issues with the PSR, including a slower update rate, jumpy tracks and velocity leader lines, speed inaccuracies, coasting tracks, manual identification and correlation of tracks, and an overly generous false target rate per scan.

8.15 The Meeting noted that in New Zealand, controllers have been provided with a 1-second screen refresh update rate for the last 7 years, together with the accuracy of data provided by ADSB, Multilateration and MSSRs DAPs data to enhance tracking. Based on the assessed PSR data, it was felt that from an HMI perspective, it would be difficult for controllers to suddenly be asked to adapt to the intricacies of a PSR, to provide a 5NM surveillance separation service.

8.16 The Meeting noted that a Performance-Based Surveillance Sub-Group (PBSSG) is discussing using a cooperating surveillance system for separation, not for non-cooperative systems. However, the proposal to add non-cooperative sensors can be shared with the group by Alex from the USA during next week's Meeting from 28 – 30 April 2025. **ACTION ITEM 10-3** It was added that future versions of the RSUR manual could be modified to add guidance for this. USA will provide outcomes of the discussion in future SURICG meetings.

Surveillance Activities in Singapore - Singapore (IP/02)

8.17 This paper provided a summary of surveillance activities in Singapore, including radars, A-SMGCS, ADS-B, ADS-C/CPDLC and DAPS. This paper also shared the equipage requirements for ADS-B out exclusive airspace and airport surface, and ADS-B equipage, which was monitored over the past few years.

8.18 The Meeting noted that the Civil Aviation Authority of Singapore (CAAS) has two terminal radars and one long-range Radar. Each of the radars comprised primary and secondary antennae. All three radars are Mode S radars. Currently, all three radars are using II codes. CAAS is planning to replace the long-range Radar and one of the terminal radars by 2029/2030. CAAS will take the opportunity of the replacement to migrate from II to SI codes for these two radars.

8.19 Singapore also shared details of ASMGCS, ADS-B, ADS-C, CPDLC, and Mode S Downlinked Aircraft Parameters (DAPS).

8.20 Singapore informed that with the implementation of ADS-B services along selected ATS routes in the Singapore FIR, reduced longitudinal separation is applied in conjunction with Direct Controller Pilot Communication (DCPC)/VHF capabilities. In addition, as Changi Airport is using the surface MLAT system, aircraft operating at Changi Airport must be equipped with Mode S transponders. The Meeting noted that in Singapore, DO-260B aircraft continued to increase as old aircraft with DO-260 or DO-260A were being replaced with new aircraft equipped with DO-260 B.

8.21 In response to a question about the appropriate action to be taken by air traffic controllers in Singapore in case of ACAS Resolution Advisory notification, it was stated that no action is needed from air traffic controllers.

Update on Surveillance Status in China - China (IP/03)

8.22 This paper updated the status of surveillance sensors as of the end of 2024 in China, as well as the construction of sensors in 2024, including the progress of the Surveillance Radar, ADS-B, SMR, MLAT and the ADS-B Level-1 Data Center Upgrade Project. The Meeting noted that China had begun constructing the upgrade project for the ADS-B Level-1 data center, which is expected to be completed in the first half of 2026. Upon completion, the ADS-B Level-1 data center will have the capability to serve 40 whole airspace data users and will also have enhanced cybersecurity protection capabilities.

Surveillance Activities in Sri Lanka (IP/04)

8.23 This paper provided an update on the surveillance activities in Sri Lanka in 2024, including the replacement schedule for radars and the implementation and usage of ADS-B. It was reported that Sri Lanka currently operates two secondary surveillance mode A/C radar stations for approach control and terminal area control purposes. The replacement project for the Terminal Area Control Radar is currently in progress, and it is scheduled to be commissioned by December 2025. Feasibility studies for upgrading the Approach Control Mode A/C Radar were discontinued since some of the modules became out of production. Consequently, the plan is being revised to replace this Radar with a new Mode S Radar by 2027.

8.24 It was informed that Sri Lanka had implemented an ADS-B surveillance system comprising five (5) ADS-B Ground Receiving Stations and a Central Processing Station. This system ensures extensive ADS-B coverage of up to 330 NM. The ADS-B is being used as the primary means of Surveillance for area control purposes.

8.25 The Meeting noted the challenges Sri Lanka faced during the integration of ADS-B into the new Approach Control Air Traffic Management (ATM) system, where unexpected ground clutter was observed on ATM displays. Investigations revealed that the issue was caused by erroneous Ground Bit Setting (GBS) data, which is derived from various avionics sensors, making it challenging to isolate the problem across all affected aircraft. Sri Lanka informed that discussions are ongoing with airlines and regulatory bodies to understand the GBS data issues further. Since Sri Lanka does not possess Surface Movement Surveillance systems or any other surveillance sensors that cover areas with grounded aircraft (taxiways, aprons, etc.), the possibility of filtering ground clutter using multi-sensor data is not available. Additionally, filtering based on other information in ADS-B broadcasts, such as altitude, is not possible since altitude information is sometimes transmitted as 'unknown.' Accordingly, suitable manipulation should be implemented in the ATM system without impacting the safety of operations. The Co-Chair has recommended Sri Lanka to study the reasons for altitude information sometimes transmitted as "unknown" in ADS-B, as altitude information should be desirable information to be transmitted in ADS-B which is important to ATC. Subject to satisfactory resolution of altitude information in ADS-B, the Co-Chair has recommended Sri Lanka to consider using an altitude filter in ATM system to filter ground clutter.

8.26 Singapore informed that it also used Ground Bit Setting to check if aircraft are on the ground.

Update on New Zealand Surveillance Status – New Zealand (IP/08)

8.27 New Zealand provided an update on the surveillance activities in New Zealand in 2025. It was reported that from 1 January 2024, New Zealand's surveillance structure was based on ADS-B as the primary surveillance source. Further Surveillance is provided by MSSRs and an MLAT system, providing a contingency cooperative surveillance backup, and PSRs provide a non-cooperative backup where required. ADS-B, as New Zealand's primary surveillance source, is mandated in all controlled airspace within the NZZC FIR. Twenty-seven terrestrial sites provide country-wide coverage of controlled airspace and a significant amount of uncontrolled airspace. It was added that the high uptake of ADS-B In is seen as significant in improving safety, especially for VFR GA traffic.

8.28 The Meeting was informed that there are 3 MSSRs and 1 PSR, which are all 30-plus years old and at the end of their operational life. The purchase of spares to keep these systems running remains extremely difficult. A decision on either replacing or removing the MSSRs is yet to be made. In addition, the Wide Area Multilateration (WAM) system, used for approach and en route in the lower South Island, and the Multilateration (MLAT) system used for surface movements at Auckland, are both 15 years old and nearing the end of their lives. Replacement systems are being considered. An ATS Surveillance OPS concept document is being developed to assist with the RFI/RFP process going forward.

8.29 It was noted that New Zealand regulatory requirements require ADS-B surveillance to be backed up by a non-GNSS contingency surveillance system covering the main trunk Jet routes between Auckland, Christchurch, Wellington, and Auckland. Additionally, consideration should be given to the use of PSR for airports that have what is termed "dense complex airspace" (i.e., airspace with over 100,000 RPT movements a year). Three combined MSSR/PSR3D systems at NZCH, NZAA, and NZWN are being installed to cover the regulatory requirements.

8.30 It was added that the use of low-cost ADS-B avionics, such as EC devices, is not permitted in controlled airspace, as regulatory rules do not cover them. The effects of clutter, erroneous information on controllers' screens, and the resulting inability to use EC-derived data for surveillance separation have meant that the data from such devices is filtered out from controllers' displays.

8.31 On the question about the reason for using ADS-B as primary Surveillance in New Zealand, it was stated that New Zealand policy recommends using ADS-B as a primary sensor with backup as MSSR and PSR.

8.32 For a reason for 99.1% of the DO260B ADS-B systems equipage, New Zealand informed that from 2018, as per New Zealand policy, all new or upgraded transponders should be DO260B compliant.

Surveillance activities in India – India (IP/09)

8.33 This paper provided information on surveillance activities in India. The Meeting noted that ATM services are provided by AAI within the entire Indian airspace over continental and oceanic areas, as well as state and private aerodromes. The total area of Indian airspace is 2.8 Million Square NM, of which 1.7 Million Square NM is oceanic and the remaining 1.1 million square NM is continental. To cope with the exponential increase in traffic density, apart from the installation of new surveillance sensors, the current surveillance capabilities are continuously being upgraded and augmented with state-of-the-art surveillance systems. Old RADAR, ADS B and ASMGCS systems are also being replaced with new systems with the latest features, continuing to augment its capabilities for Surveillance of its airspace as well as airfield ground movements.

8.34 India informed that presently, almost 100% of Indian FIRs are covered by surveillance facilities, and around 70% of them are covered by redundant Surveillance. Various surveillance facilities, including PSR, collocated with SSR Radar, ground-based ADS-B, SSR, ASMGCS, and Space-based ADS-B. In addition, India informed that it had built an extensive data distribution network to allow for surveillance data sharing between any interested ATC centers. With the Indian Telecom infrastructure moving away from point-to-point links to the cloud, this redundant surveillance network is being extensively used to distribute all of the surveillance sensors to the area control center, offering seamless surveillance coverage over the full Indian FIR. India concluded that it continued to augment its capabilities for Surveillance of its airspace as well as airfield ground movements and is now making greater use of ADS-B and Mode S Radars with the introduction of space-based ADS-B for oceanic airspace surveillance.

8.35 India added that in India, there is a mix of Mode A/C and Mode S Radars. Eventually, all the radars will be Mode S. There is an integration of various surveillance sensors to provide 3 NM separation in the final approach phase in approach control unit at major airports. .

Surveillance activities in Maldives (IP/10)

8.36 Maldives summarized the status of the current Surveillance infrastructure in the Maldives, including radars, ADS-B, and Surveillance Data Processors (SDP). It was informed that a new Mode-S Secondary Surveillance Radar (SSR) was commissioned in 2020. This system provided surveillance coverage up to 230 NM, effectively covering most of the Maldives Flight Information Region (FIR) at FL290. The radar installation included an integrated ADS-B receiver and was interfaced with the Air Traffic Management (ATM) System, enhancing the overall situational awareness and surveillance capabilities within the FIR. In addition, since 2012, three (3) ADS-B ground stations have provided surveillance coverage for approximately 90% of the Male FIR above FL290. In 2024, five (5) new ground receiving stations were installed as part of an ongoing enhancement of the ADS-B surveillance network. These augment the existing ADS-B infrastructure and significantly improve low-level coverage, particularly in areas with high volumes of seaplane operations. The Meeting noted that the carriage of ADS-B Out equipment is not yet mandatory in the Maldives FIR.

ADS-B-based surveillance services are provided on a capability basis. SSR continues to serve as the primary source of Surveillance within a 230 NM radius of VIA.

8.37 It was added that the existing Surveillance Data Processor (SDP), in operation since 2008, has become increasingly difficult to maintain due to the discontinuation of support for its COTS hardware. In light of this, a decision was made in 2023 to upgrade and extend the operational life of the current ATM system until the implementation of a new system planned for 2027. The Flight Data Processor (FDP) component was successfully upgraded in 2024, and the SDP upgrade is currently in progress, with completion targeted for Q4 2025. Lastly, it was added that a consultancy process is currently underway to define the scope and requirements for the new ATM system aimed for 2027.

8.38 In response to a question, the Maldives informed that Ground Bit Settings are enabled when seaplanes are in the sea and are disabled when they take off.

b) Updates from the ICAO Surveillance Panel, Standards Making Organization

ICAO Surveillance Panel Activities - ICAO Surveillance Panel (WP/11)

8.39 This paper provided an overview of the recent and upcoming activities of the ICAO Surveillance Panel (SP). It was informed that the work programme and activities of the ICAO Surveillance Panel (SP) are divided into two Working Groups: the Aeronautical Surveillance Working Group (SP-ASWG) and the Airborne Surveillance Working Group (SP-AIRBWG).

8.40 The Meeting noted that in response to the ICAO job card SP.008.03 “Ensure the performance of surveillance systems”, task 5 “Develop measurable technical performance specifications for surveillance systems and update information on ADS-B versions 1 and 2 as well as WAM definitions included in Cir 326”, the SP created a Performance-Based Surveillance Sub-Group (PBSSG). The PBSSG is charged with developing new guidance material containing performance-based surveillance requirements, including updated materials that would replace ICAO Cir 326, which is now outdated. In September 2023, at the Fifth Meeting of the SP, a major revision of this draft Manual was provided to SP by PBSSG for review and comment. A discussion was held at the recent SP-ASWG held in Montreal from 17 – 21 March 2025 pertaining to the next steps for finalizing the RSUR manual. Along with the ICAO SP Secretary, the ASWG decided to initiate inter-panel coordination to obtain ICAO Panel feedback prior to the official submittal for publication.

8.41 It was informed that the Eighteenth Meeting of the Airborne Surveillance Working Group (AIRBWG) and the Twentieth Meeting of the Aeronautical Surveillance Working Group (ASWG) were held as consecutive hybrid meetings in Montreal at ICAO Headquarters. AIRBWG/18 was held from 18 to 20 September 2024; ASWG/20 was held from 23 to 27 September 2024. AIRBWG/18 is considered a Change Proposal (CP) to the Manual on Airborne Collision Avoidance Systems (Doc 9963). The CP suggested incorporating information and guidance to clarify recent amendments to the manual further. The Airborne Collision Subgroup was also tasked to investigate further ICAO documents referencing ACAS to ensure alignment with the introduction of the ACAS III provisions.

8.42 In addition, a significant discussion was held about an increase in recent GNSS interference cases. Several recommendations were presented and discussed, including mechanisms to help controllers and Air Navigation Service Providers identify when a GNSS RFI event was taking place. The Meeting agreed on the importance of further researching ways in which these types of events can be identified in a timely manner. The ICAO Technical Subgroup was tasked with taking on such discussions and determining potential mitigations. Additionally, it was shared that ICAO published the State Letter AN7/65.1.2-24/94 on 26 November 2024. The State Letter is related to the introduction of the new ICAO Annex 10 Volume III and IV SARPS, which include the updates for transponder functionality and ADS-B Version 3. The new effective date for these SARPS will be 26 November 2026. The SP Working Group timeline for the next Panel meeting was shared with the Meeting.

c) Aircraft Manufacturers and Avionics Suppliers

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

Agenda Item 9: New and Innovative Technologies in Surveillance

9.1 No paper under this agenda.

Agenda Item 10: Review MODE S DAPs Implementation and Operations Guidance Document

Process and Requirements of IC Coordination and Assignment for APAC - Singapore (WP/08)

10.1 Singapore proposed the process for States to request and coordinate interrogator codes (IC) for mode S interrogators.

10.2 It was informed that, according to a study conducted by the Mode S and DAPs Working Group, II codes are no longer sufficient to support the growing number of Mode S radars. ICAO APAC, therefore, made the decision to transition from the use of II codes to SI codes for the Mode S radars. For SI codes to be used, aircraft transponders must be capable of using SI codes. Although ICAO Annex 10 Vol IV mandated SI code capability for all aircraft transponders by 1 January 2005, some transponders are still not SI-capable and will not be detected by SI code interrogators unless using a special II/SI code operation mode. The 5th Surveillance Panel meeting endorsed a proposal for an amendment to Annex 10 Vol IV in September 2023, requiring interrogators with SI codes to support the II/SI operations.

10.3 The coordination for IC codes is very similar to that for the request of VHF frequencies. Based on the mentioned considerations and building on the existing procedures for the request of VHF frequencies, a workflow was proposed. The workflow was discussed and reviewed by the Meeting.

10.4 With the abovementioned, the following draft conclusion was endorsed by the Meeting for CNS SG/29 adoption.

<table>
<tr><td colspan="2">Draft Conclusion SURICG/10/02 - Workflow for the request and coordination of IC codes with the ICAO APAC Office.</td></tr>
<tr><td>What: Interrogator Codes (IC) of Mode S interrogators in the Asia Pacific region are to be coordinated and assigned through the ICAO APAC Regional Office. States/Administrations requiring ICs should request to the ICAO APAC Regional Office following the approved workflow as per Appendix F to facilitate the request.</td><td>Expected impact:
☐ Political / Global
☐ Inter-regional
☐ Economic
☐ Environmental
☒ Ops/Technical</td></tr>
<tr><td></td><td>Follow-up: ☐Required from States</td></tr>
<tr><td>When: 23-Apr-25</td><td>Status: Draft to be adopted by CNS SG</td></tr>
<tr><td colspan="2">Who: ☒Sub groups ☒APAC States ☒ICAO APAC RO ☐ICAO HQ ☐Other: SURICG</td></tr>
</table>

Presentation of the 6th edition of Mode S Downlink Aircraft Parameters Implementation and Operations Guidance Document – China, Singapore, New Zealand and USA (SP01)

10.5 China, Singapore, New Zealand, and the USA proposed the revised draft of Edition 6.0 of the Mode S DAPs Implementation and Operations Guidance Document, which was developed based on the adopted Edition 5.0. The revised draft supplemented the guidance material on the following topics:

a) Add the general strategy on the assignment of and migration to the SI code that was adopted during the 35th APANPIRG meeting in section 7.3.2 and Appendix 6;
b) Supplement the information about the management of the 1030/1090 MHz utilization in section 7.8;

10.6 The document was presented and deliberated during the Meeting, and further modifications were made. Subsequently, the following Draft Decision was discussed and adopted by the SURICG/10 meeting:

Decision SURICG/10/03 – Adoption of Mode S DAPs Implementation and Operation Guidance Document Edition 6.0	
What: The Mode S DAPs Implementation and Operation Guidance Document Edition 6.0 provided in **Appendix G** has been modified to add the general strategy on the assignment of and migration to SI code and some information about the management of the 1030/1090 MHz utilization.	Expected impact: ☐ Political / Global ☐ Inter-regional ☐ Economic ☐ Environmental ☒ Ops/Technical
Why: Update the general strategy on the assignment of and migration to the SI code was adopted during the 35th APANPIRG meeting	Follow-up: ☐Required from States
When: 23-Apr-25	Status: Adopted by SURICG
Who: ☒Sub groups ☒APAC States ☐ICAO APAC RO ☐ICAO HQ ☐Other: SURICG	

10.7 The Meeting shared sincere appreciation to China for leading the drafting of the Mode S DAPs Implementation and Operation Guidance Document since its inception, and continues to update it in coordination with APAC States/Administrations in a timely manner.

Agenda Item 11: Review ADS-B Implementation and Operations Guidance Document (AIGD)

11.1No paper under this agenda.

Agenda Item 12: Review of the Terms of Reference (ToR) and the Action Items

Review ToR of SURICG and Action Items - Sec (WP/09)

12.1 SURICG/8 endorsed a revised version of the ToR of SURICG and further adopted in CNS SG/27 through Decision CNS SG/27/12 - Revised ToR of Surveillance Implementation Coordination Group to reflect the change due to the dissolution of Mode S and DAPs. The SURCIG/10 Meeting reviewed the ToR and considered that there was no need to modify it. The consolidated action items of SURICG were reviewed and updated at the Meeting. The updated action items of SURICG are provided in **Appendix H** of this report.

Agenda Item 13: Next Meeting and Any Other Business

CNS-Related ASBU in Asia/Pacific Seamless ANS Plan – Sec (WP/14)

13.1 ICAO Secretariat recalled the steps taken in past CNS SG meetings to provide inputs for Seamless ANS Plan v4.0, which was adopted by the Thirty-Fifth Meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/35) held at the ICAO Asia and Pacific Regional Office in Bangkok, Thailand, from 25 to 27 November 2024 by Conclusion 35/1.

13.2 The Meeting was informed that recently, it was observed that the priorities of some CNS ASBUs finalized by CNS-related ASBUs review Ad-hoc Group for the next edition of the Seamless ANS Plan were not correctly reflected in the published Asia/Pacific Seamless ANS Plan Version 4.0. This discrepancy could be due to an inadvertent mistake when compiling feedback from all sources. It was also added that if a Priority 1 were assigned to the NAVS ASBU elements, it would require a consequential review and amendment to the following paragraphs in the Asia/Pacific Seamless ANS Plan Version 4.0.

13.3 To resolve this issue, after internal coordination within the ICAO Secretariat, it was decided that the responsible ICAO Secretariat would share the issues associated with proposed changes in the priorities of NAVS ASBUs with the responsible contributory bodies. These included GBAS-SBAS ITF and PBNICG. It was also decided that the ICAO secretariat will share this information with all contributory bodies under CNS for their information and necessary action, if any. Based on the outcomes of the discussion with relevant contributory bodies, the plan to correct the list of CNS-related ASBUs and other impacted ASBUs, if any, will be finalized and shared with the CNS SG/29 meeting planned to be held from 16-20 June 2025. The Meeting was requested to review CNS/other ASBUs in the Seamless ANS plan and share any discrepancies, if any.

Outcomes of Second APAC Ministerial Conference on Civil Aviation – Sec (WP/15)

13.4 The Second Asia Pacific Ministerial Conference on Civil Aviation was held from 11 - 12 September 2024 in New Delhi, India. In the Conference, the APAC Ministers reviewed commitments made under the Beijing Declaration and agreed to another set of commitments to high-priority aviation strategic objectives in the form of the Asia Pacific Ministerial Declaration on Civil Aviation (Delhi). The Conference endorsed the Second Asia and Pacific Ministerial Declaration on Civil Aviation (Delhi), also known as the Delhi Declaration, which is provided in **Appendix I**.

13.5 The Meeting noted that the Delhi Declaration generates the political will needed to support the organization's various objectives for an effective and efficient aviation system. The Declaration incorporated various critical aspects that required immediate attention from the APAC States. It included substantial commitments needed from the APAC States for effective implementation of ICAO global plans, implementation of aviation safety and air navigation services priority elements, and addition of resilience to health-related disruptions. Furthermore, it has highlighted commitments required for gender equality, resourcing for civil aviation, aviation environment protection, and ratification of international air law treaties.

13.6 The Meeting was invited to collaborate towards achieving the targets of the Delhi Declaration and to share the latest implementation status of commitments with the ICAO APAC Office for accurate progress tracking.

Update on SSR module of Frequency Finder tool – Sec (WP/16)

13.7 This paper presented the latest work, enhancements and functionalities brought to the SSR module of the Frequency Finder tool to assist ICAO Regional Offices and States to manage and coordinate SSR Mode S II/SI codes.

13.8 The Meeting noted that the modified version of the Frequency Finder tool will be distributed to the Regional Offices upon the completion of the current testing phase. States/Administrations were encouraged to utilize the tool extensively, discuss any pertinent matters, and provide feedback on FF tool usage, suggestions, bugs, and recommendations.

Date and Venue for the Next Meeting

13.9 The Meeting considered that the next SURICG meeting would be held for 3 days, tentatively planned for ***23-25 March 2026***. Any States/Administrations interested in hosting the Meeting may contact the ICAO APAC Office for hosting discussions at least 4 months before the Meeting. The exact dates and venue will be communicated to the member states in due course.

Closing of the Meeting

13.10 On behalf of the Group, Mr. Hui Man Ho, Assistant Director-General of Civil Aviation (Air Traffic Management) of Civil Aviation Department of Hong Kong China, Co-Chair of SURICG, expressed thankfulness to the ICAO APAC Regional Office, Co-Chair, experts of ICAO Surveillance Panel, all participants from Member States/Administrations and sponsoring organizations for their significant contributions in making the meeting a successful and fruitful one. Mr. Hui also expressed that it had been a pleasure having opportunities to collaborate with all participants and he was grateful for the strong support and patience rendered to him over the years as a Co-Chair since 2016. He is confident that the Group will continue to serve the Region well and shape the future of aeronautical surveillance.

13.11 The ICAO Secretariat expressed her gratitude for contributions and the continued support of experts in surveillance and industry partners for their assistance in organising this meeting.

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List of Participants

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1.		**CAMBODIA (1)**		
	1.	Mr. SOT TOLA	Chief of Bureau of Aeronautical Services Management Department	tolasot@ssca.gov.kh;
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	10.	Mr. Lanang Wibisono	VP of Network Planning, Airnav Indonesia	
	11.	Mr. Mohamad Ali Said	Assistant VP Data Processing	
	12.	Ms. Fauzalizta Trichia Zaleta Latuconsina	Data Processing Engineer Airnav Indonesia	
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8.		**LAO PEOPLE'S DEMOCRATIC REPUBLIC (4)**		
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LIST OF WORKING/INFORMATION PAPERS

WP/IP No.	Agenda Item	Subject	Presented by
		WORKING PAPERS	
WP/01	2	Provisional Agenda	Secretariat
WP/02	3	Review of Relevant Meetings	Secretariat
WP/03	3	Outcomes of ADS-B Implementation Workshop for APAC LDCs	Secretariat
WP/04	4	Outcome and Lesson Learned from Joint Event of SWIM over CRV Demonstration and Surveillance Data Sharing in SWIM Trial	Hong Kong China
WP/05	4	Outcomes of SURSG/4	Secretariat
WP/06	4	Progress update of SURSG	Hong Kong China
WP/07	5	Review of SUR information in CNS TABLES in e-ANP Vol II	Secretariat
WP/08	10	Process and Requirements of IC Coordination and Assignment for APAC	Singapore
WP/09	12	Review ToR of SURICG and action items	Secretariat
WP/10	8	GNSS vulnerabilities and the significance of ADS-B central data processor	Hong Kong China
WP/11	8	ICAO Surveillance Panel Activities	ICAO Surveillance Panel
WP/12	8	Analysis of Abnormal Tracks Caused by Electromagnetic Environment	China
WP/13	8	Assessing a New Surveillance System for Operational Use	New Zealand
WP/14	13	CNS-Related ASBU in Asia/Pacific Seamless ANS Plan	Secretariat
WP/15	13	Outcomes of the Second Asia Pacific Ministerial Conference on Civil Aviation	Secretariat
WP/16	13	Update on the Surveillance Module in Frequency Finder	Secretariat
WP/17	3	Finalization of APAC Common SWIM Information Services	Secretariat
		INFORMATION PAPERS	
IP/01	-	Meeting Bulletin	Secretariat
IP/02	8	Surveillance Activities in Singapore	Singapore

WP/IP No.	Agenda Item	Subject	Presented by
IP/03	8	Update on Surveillance Status in China	China
IP/04	8	Surveillance Activities in Sri Lanka	Sri Lanka
IP/05	7	ADS-B Equipage and Quality Performance Observed in Thailand	Thailand
IP/06	7	ADS-B Performance Monitor under Development at ENRI	Japan
IP/07	7	Update on IP/18 SURICG/9 Challenges Finding the cause of non-compliant ADS-B data	New Zealand
IP/08	8	Update on New Zealand Surveillance Status	New Zealand
IP/09	8	Surveillance Activities in India	India
IP/10	8	Surveillance Activities in Maldives	Maldives
		FLIMSY	
Flimsy No.		**Subject**	**Presented by**
Flimsy/01		Updates to APAC Common SWIM Surveillance Information Services to WP17	Secretariat

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Proposed business functionality of APAC Common SWIM Information Services
(Updated by SWIM TF/9, FF-ICE Ad-hoc Group and MET SG/28)

(Editorial note – changes made after SWIM TF/9, MET SG/28, FF-ICE ad-hoc group and SURICG/10 are indicated with ~~strikethrough~~ and highlighted text.)

Notes. – Recommended services in initial APAC Common SWIM Information Service (IS) ((1)/(2)/(3)):
(1) Recommended for region-wide implementation for region-wide benefits
(2) Recommended for implementation as much as practicable
(3) Additional information services without common regional requirements and not included as part of common regional information services

Business functionality of the service	Brief description of the service	Type of information to be exchanged	Information exchange model / Message type	Message exchange pattern	Recommended service in initial APAC Common SWIM IS (1) / (2) / (3)
APAC Common SWIM Aeronautical Information Services					
Airspace management service	Exchanges of airspace status information between ASM Support System and Air Traffic Control (ATC) System. The sharing of airspace availability and airspace structure in real-time will contribute to a more efficient execution of the flight as information impacting the trajectory will be exchanged.	Airspace availability, restricted area, danger area, search and rescue regions	AIXM	Pub/Sub	2
Airspace feature service	Provides the characteristics of the three-dimensional airspace, described as horizontal projection with vertical limits, and their relevance to air traffic.	FIR/UIR boundaries, waypoints, enroute ATS routes, SIDs and STARs, navaids, procedures	AIXM	Pub/Sub or Req Reply	2
Aerodrome feature service	Provides current and/or planned airport layout features, such as aerodrome mapping data, runway, taxiway, passenger facilities.	Runways, movement areas, aerodrome services, navaids, instrument landing systems, Aerodrome location, communication facilities (frequencies)	AIXM	Pub/Sub	2
Digital NOTAM distribution service	Provides aeronautical information in accordance with the Digital NOTAM Specification, such as runway closure.	Digital NOTAM	AIXM	Pub/Sub	2

Business functionality of the service	**Brief description of the service**	**Type of information to be exchanged**	**Information exchange model / Message type**	**Message exchange pattern**	**Recommended service in initial APAC Common SWIM IS (1) / (2) / (3)**
		(e.g. Special activity airspace (SAA) NOTAMs, or other types of NOTAMs)			
Runway Condition Report service	Provides runway surface conditions and contaminants (least to most slippery) that are directly correlated to aircraft take-off and landing performance.	Global Reporting Format (GRF) for runway surface conditions	AIXM	Pub/Sub or Req/Reply	2
ATIS distribution service	Provides continuous and automated broadcast of recorded aeronautical information in airport and terminal areas.	Current weather conditions, runway in use, available approaches, and other data relevant to arriving and departing aircraft, specific ATC procedures, and any airport construction activity that could affect taxi planning	TBD	Pub/Sub	2
Search and rescue service	Allows Rescue Coordination Centres (RCCs) to exchange information with neighbouring RCCs and ATS units for coordination during SAR operations.	Search and rescue regions, Registered aircraft operator details and contacts, ICAO Autonomous Distress Tracking (ADT) data, Location of Aircraft in Distress Repository (LADR) data, ICAO OPS CTRL database contact information, SAR Unit (SRU) location and capability data	TBD	Pub/Sub	3
APAC Common SWIM Flight Information Services					
GUFI service	GUFI (Globally Unique Flight Identifier) generation and provision	GUFI	FIXM	Req/Reply	1
ATFM/A-CDM integrated service	Allows exchanges of flight plans and A-CDM milestone parameters among different stakeholders (such as arrival/departure ATFM units, airlines and airport	CTOT, CTO, TTOT, TSAT, etc.	FIXM	Pub/Sub	1

Business functionality of the service	Brief description of the service	Type of information to be exchanged	Information exchange model / Message type	Message exchange pattern	Recommended service in initial APAC Common SWIM IS (1) / (2) / (3)
	operators) to connect A-CDM process to ATFM operations.				
FF-ICE filing service	Provides a means to submit, update or cancel flight plans through a SWIM-based interface using FIXM.	Flight plan for registration, update or cancellation	FIXM	Req/Reply Pub/Sub	1
FF-ICE ~~data~~ publication service	Provides harmonised sharing of flight ~~plan~~ information in a global standard supporting common situation awareness.	Flight ~~plan~~ information for publication	FIXM	Pub/Sub	2
FF-ICE trial service	Allows operators to test the effect of a potential change in a flight plan prior to committing to the change.	Proposed changes in a flight plan	FIXM	Req/Reply	2
FF-ICE flight data request service	Allows an operator to request the current status of a flight plan, or an ANSP can request an operator to submit the latest version of their flight plan.	Current status of a flight plan, a copy of flight plan or supplementary plan	FIXM	Req/Reply	1
FF-ICE notification service	Provides notification of a change in flight state, such as Departure (DEP) and Arrival (ARR) Air Traffic Service (ATS) messages.	ARR, DEP messages	FIXM	Pub/Sub Req/Reply	1
FF-ICE planning service	Allows operators to submit preliminary flight plans for early Air Traffic Flow Management (ATFM) planning and to obtain feedback regarding restrictions/constraints affecting the flight.	Preliminary Flight plan for early ATFM planning	FIXM	Req/Reply Pub/Sub	2
Traffic flow status service	Provides users with notification of any traffic flow management measures which are in affect and how they may affect their aircraft.	Demand and constraints, Miles-in-Trail (MIT), Minutes-in-Trail (MINIT), ATFM daily plan, Ground Delay Program (GDP)	TBD	Pub/Sub	2

Business functionality of the service	**Brief description of the service**	**Type of information to be exchanged**	**Information exchange model / Message type**	**Message exchange pattern**	**Recommended service in initial APAC Common SWIM IS (1) / (2) / (3)**
APAC Common SWIM Meteorological Information Services					
FOR AERODROME					
METAR/SPECI information service	Provides ~~of~~ IWXXM-formatted METAR/SPECI product specified in ICAO Annex 3.	Provision of the existing product in Annex 3. Information service will be enabled through Amendment 81 to Annex 3 as recommended practice with applicability from Nov 2024.	IWXXM	Pub/Sub Req/Reply	1
TAF information service	Provides of IWXXM-formatted TAF product specified in ICAO Annex 3.		IWXXM	Pub/Sub Req/Reply	1
Aerodrome observation information service	Provides continuous observations of weather parameters at an aerodrome. Advanced meteorological SWIM (MET-SWIM) service being developed by MET Panel.	To be introduced as recommended practice in Annex 3 (Amd 83) in Nov 2027 tentatively (Note: Level of standardisation needs to be considered, as different aerodrome information services may be required for different use cases.)	IWXXM	Pub/Sub or Req/Reply	2
Aerodrome forecast information service	Provides information of the expected meteorological conditions, including probability, at an airport during a specified period. Advanced meteorological SWIM (MET-SWIM) service being developed by MET Panel.		IWXXM	Pub/Sub or Req/Reply	2
FOR ENROUTE					
SIGMET information service	Provides of IWXXM-formatted SIGMET product specified in ICAO Annex 3.		IWXXM	Pub/Sub Req/Reply	1
AIRMET information service	Provides of IWXXM-formatted AIRMET product specified in ICAO Annex 3.		IWXXM	Pub/Sub Req/Reply	1
Tropical Cyclone Advisory information service	Provides of IWXXM-formatted Tropical Cyclone Advisory product specified in ICAO Annex 3. (Designated provider: States with Tropical Cyclone Advisory Centre)		IWXXM	Pub/Sub Req/Reply	1

Business functionality of the service	Brief description of the service	Type of information to be exchanged	Information exchange model / Message type	Message exchange pattern	Recommended service in initial APAC Common SWIM IS (1) / (2) / (3)
Volcanic Ash Advisory information service	Provides of IWXXM-formatted Volcanic Ash Advisory product specified in ICAO Annex 3. (Designated provider: States with Volcanic Ash Advisory Centre)		IWXXM	Pub/Sub Req/Reply	1
Space Weather Advisory information service	Provides of IWXXM-formatted Space Weather Advisory product specified in ICAO Annex 3. (Designated provider: States with Space Weather Advisory Centre)		IWXXM	Pub/Sub Req/Reply	1
Volcano Observatory Notice for Aviation (VONA) information service	Provides of IWXXM-formatted VONA specified in ICAO Annex 3. Provision of VONA ~~will become the~~ is expected to become a recommended practice in Annex 3 in 2025. (Designated provider: States with designated State Volcano Observatory)		IWXXM	Pub/Sub Req/Reply	2
Quantitative volcanic ash (QVA) concentration information service	Provides detailed information of volcanic ash in the atmosphere, including probabilities of ash concentration thresholds over space and time. Advanced meteorological SWIM (MET-SWIM) service being developed by MET Panel. (Designated provider: States with ~~VAAC~~ Volcanic Ash Advisory Centre (VAAC))	QVA ~~grids~~ grid point forecasts including probabilities, QVA objects. ~~To~~ Expected to be introduced as a recommended practice in Annex 3 (Amd 82) ~~in Nov 2025 tentatively~~ for VAACs in a position to do so from Nov 2025, and for all VAACs from Nov 2026.	Gridded data (e.g. NetCDF), IWXXM	Pub/Sub or Req/Reply	1
WAFC (World Area Forecast Centres) grid point forecast	Provides global gridded weather forecasts. (Designated provider: WAFCs (UK and US))	Global gridded forecasts of upper winds, upper-air temperatures and humidity, flight level and temperature of tropopause, and	Gridded data in GRIB	Pub/Sub or Req/Reply	1

Business functionality of the service	Brief description of the service	Type of information to be exchanged	Information exchange model / Message type	Message exchange pattern	Recommended service in initial APAC Common SWIM IS (1) / (2) / (3)
		direction, speed and flight level of maximum wind			
WAFC significant weather (SIGWX) forecast	Provides global WAFC SIGWX data sets with coverage expressed in polygons or gridded data. (Designated provider: WAFCs (UK and US))	Significant weather forecast such as tropical cyclone, ~~severe squall lines,~~ turbulence, icing, etc.	IWXXM, gridded data	Pub/Sub or Req/Reply	1
Special Air Report (ARS)	Provides reports of special observations made by aircraft when they encounter special weather phenomena, such as moderate/severe turbulence or icing. (Note: Currently there is plan to implement this information service)	Special aircraft observations of weather phenomena as specified in Annex 3, including turbulence, icing, mountain wave, thunderstorms, duststorm, sandstorm, volcanic cloud, volcanic activity / eruption	TBD	Pub/Sub or Req/Reply	2
MET derived from Mode S DAPs	Provides upper air winds and temperatures derived from Mode S Downlinked Aircraft Parameters (DAPs) (e.g. true airspeed, ground speed, magnetic heading, true track angle) and facilitates exchange of derived winds and temperatures among MET service providers.	Upper air winds and temperatures derived from Mode S DAPS	TBD	Pub/Sub or Req/Reply	3
Satellite image service	Provides satellite observational information.	Satellite derived MET information (e.g. significant convection)	Gridded format (e.g. NetCDF) and image format	Req/Reply	2
Weather radar image service	Provides two- or three-dimensional radar observational information.	Weather radar reflectivity to visualise the intensity of convection	Gridded format (e.g. NetCDF) and image format	Req/Reply	2

Business functionality of the service	Brief description of the service	Type of information to be exchanged	Information exchange model / Message type	Message exchange pattern	Recommended service in initial APAC Common SWIM IS (1) / (2) / (3)
APAC Common SWIM Surveillance Information Services					
Surveillance data **only** sharing service	Provides three-dimensional position, time and identification surveillance data of aircraft and other data as appropriate.	Position latitude, longitude, altitude, flight level ground speed (optional), track angle, magnetic heading (optional), call sign, Mode S address, target identification, target address, **mode 3/A code** (optional), **date**, time of message reception for position, data quality, quality indicators, Mode S DAP, **SAC, SIC**	ASTERIX Cat 21 (payload in JSON or RAW format)	Pub/Sub	21
Surveillance data with flight plan information sharing service	Provides surveillance data of aircraft with flight plan information.	globally unique flight identifier aircraft identification departure aerodrome destination aerodrome aircraft type (optional) wake turbulence category **(optional)** latitude, longitude, flight level, ground speed **(optional)**, magnetic heading **(optional)**, target identification, target address, mode 3/A code **(optional)**, date, time of message reception for position, quality indicators sac, sic	ASTERIX Cat 21+FPL (payload in JSON or RAW format)	Pub/Sub	2

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			YES	YES	PSR+ SSRm(S)+SSRm(A/C)		
Other aerodromes							
Broome	D		YES	YES	ADS-B		Broome
Albury	D		YES	YES	Higher level SSR coverage		Mt Bobbara
Tamworth	D		YES	YES	?		The Round Mountain
Mackay	D		YES	YES	SSRm(A/C)		Swampy Ridge
Hamilton Island	D		YES	YES	SSRm(A/C)		Swampy Ridge
BANGLADESH							
Dhaka APP	C				PSR+SSRm AC		
BRUNEI DARUSALAM							
Brunei APP					PSR + SSRmAC		
CAMBODIA							
Phnom Penh ACC			YES	YES	~~SSRmAC~~ SSRmS + ADS-B		
Phnom Penh APP			YES	YES	SSRmS + ADS-B		
Phnom Penh TWR			YES	YES	SSRmS + ADS-B + MLAT		
Siem Reap APP			YES	YES	SSRmS + ADS-B		
Siem Reap TWR			YES	YES	SSRmS + ADS-B		
Sihanoukville APP			YES	YES	SSRmS + ADS-B		
Sihanoukville TWR			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
CHINA							
Beijing ACC			YES	YES	PSR + SSRmS +SSRmAC+ADS-B		
Beijing APP			YES	YES	PSR + SSRmS +SSRmAC+ADS-B		
Beijing TWR (ZBAA)			YES	YES	~~PSR~~ + ~~SSRmAC~~ SSRmS+SSRmAC+SMR+~~AD~~ ADS-B	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		
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		

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
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		
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		

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
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		
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		

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
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	
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		

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
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		
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		

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**
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		
Xiamen ACC			YES	YES	~~PSR+~~ SSRmAC +ADS-B		
Xiamen APP			YES	YES	SSRmAC +ADS-B		
Xiamen TWR			YES	YES	~~PSR+~~ SSRmAC +ADS-B+ SMR+MLAT+A-SMGCS	2	
Shenyang ACC			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B		
Shenyang APP			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B		
Shenyang TWR			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B SMR+A-SMGCS	2	
Dalian ACC			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B		
Dalian APP			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B		
Dalian TWR			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B SMR+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**
Harbin ACC			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B		
Harbin APP			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B		
Harbin TWR			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B SMR+ MLAT+ A-SMGCS	2	
Xi'an ACC			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B		
Xi'an APP			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B		
Xi'an TWR			YES	YES	PSR+ SSRmS +SSRmAC + ADS-B SMR+ MLAT		
Lanzhou ACC			YES	YES	SSRmS+ SSRmAC+ ~~AC~~ + ADS-B		
Lanzhou APP			YES	YES	SSRmS+SSRmAC+ADS-B		
Lanzhou TWR			YES	YES	SSRmS+ SSRmAC +ADS-B		
Urumqi ACC			YES	YES	PSR+SSRmS +SSRmAC +~~AC~~ ADS-B		
Urumqi APP			YES	YES	PSR+SSRmS+SSRmAC+ADS-B		
Urumqi TWR			YES	YES	PSR+ SSRmS +SSRmAC +ADS-B+SMR+MLAT+A-SMGCS	2	
HONG KONG, CHINA							
Hong Kong ACC	S		Yes	Yes	PSR + SSRmAC + ADS-B		
Hong Kong APP	T		Yes	Yes	PSR + SSRmAC + ADS-B		
Hong Kong TWR	AD		Yes	Yes	PSR + SSRmAC + ADS-B + MLAT	2	SMR, A-SMGCS
MACAO, CHINA							
Macao TWR	AD		Yes	Yes	SSRmS+SSRmAC		SMR

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**
DPR KOREA							
Pyongyang							
Pyongyang ACC					PSR + SSRmAC + ADS-B		
Pyongyang APP					PSR + SSRmAC + ADS-B		PAR
Pyongyang TWR							
FIJI							
Naid ACC					ADS-B + ADS-C		
Nadi APP					ADS-B		
FRENCH POLYNESIA							
Tahiti ACC					SSRmAC + ADS-B + ADS-C		
Tahiti APP					SSRmAC		
Tahiti TWR							
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

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
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							
Jakarta ACC	S		YES	YES	PSR + SSRmS + ADS-B		~~ADS-B Trial A-SMGCS, MLAT, SMR~~
Ujung Pandang ACC	S		YES	YES	SSRmS + ADS-B + ADS-C		
Jakarta APP	T		YES	YES	PSR + SSRmS + ADS-B	2	MLAT & SMR
Ujung Pandang APP	T		YES	YES	SSRmS + ADS-B		
Medan APP	T		YES	YES	SSRmS		
Pekanbaru APP	T		YES	YES	SSRmS + ADS-B		
Tanjung Pinang APP	T		YES	YES	SSRmS + ADS-B		
Palembang APP	T		YES	YES	SSRmS + ADS-B		
Yogyakarta APP	T		YES	YES	SSRmS + ADS-B		
Surabaya APP	T		YES	YES	SSRmS + ADS-B	1	MLAT

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**
Bali APP	T		YES	YES	SSRmS + ADS-B		
Pontianak APP	T		YES	YES	SSRmS + ADS-B		
Balikpapan APP	T		YES	YES	SSRmS		
Jayapura APP	T		YES	YES	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~~		

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
~~Balikpapan APP~~			~~YES~~	~~YES~~	~~PSR + SSRmAC SSRmS + ADS-B~~		
~~Yogyakarta APP~~			~~YES~~	~~YES~~	~~PSR SSRmS~~		
~~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~~					~~PSR + ADS-B~~		
~~Tarakan APP~~			~~YES~~	~~YES~~	~~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~~		

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**
~~Merauke APP~~			~~YES~~	~~YES~~	~~SSRmS + ADS-B~~		
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
Kobe ACC			Yes	Yes	SSRmAC + SSRmS+WAM		
~~Naha ACC~~					~~PSR + SSRmAC + SSRmS~~		
Naha APP			Yes		PSR + SSRmAC + SSRmS		
Naha TWR			Yes		MLAT		SMR

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
Hakodate APP			Yes		PSR + SSRmAC		
Sendai APP			Yes		PSR + SSRmAC		
Tokyo ACC			Yes	Yes	~~PSR~~ + SSRmAC + SSRmS +WAM		
Tokyo APP			Yes		PSR + SSRmAC + SSRmS		
Tokyo TWR			Yes		MLAT + PRM		SMR
Niigata APP			Yes		PSR + SSRmAC		
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		

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
Kagoshima APP			Yes		PSR + SSRmAC		
~~Shimojishima APP~~ Sakishima APP			Yes		PSR + SSRmAC		
~~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							
Kuala Lumpur ACC	R,S	YES	YES	YES	PSR + SSRmAC+ SSRmS + ADS-B+ ADS-C		Spaced based ADS-B and ADS-B Data Sharing projects are under reviewed.
Kuala Lumpur APP	T		YES	YES	PSR + SSRmAC+ SSRmS + ADS-B		
Kuala Lumpur TWR	AD		YES	YES	MLAT	2	SMRs are used for situational awareness. Planned for A-SMGCS level upgrade in 2026.
Langkawi APP	T		YES	YES	PSR + SSRmAC + SSRmS + ADS-B		
Johor Bharu APP	T		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**
K. Kinabalu ACC	S		YES	YES	PSR + SSRmAC + SSRmS + ADS-B		
K. Kinabalu APP	T		YES	YES	PSR + SSRmAC + SSRmS + ADS-B		
Kuching ACC	S		YES	YES	PSR + SSRmAC + SSRmS + ADS-B		
Kuching APP	T		YES	YES	PSR + SSRmAC + SSRmS + ADS-B		
Miri APP	T		YES	YES	PSR + SSRmAC + SSRmS		
~~Kuala Lumpur ACC~~ ~~Lumpur APP~~					~~PSR + SSRmAC + SSRmS~~ ~~PSR + SSRmAC + ADS-C~~		
~~Johor Bharu APP~~					~~PSR + SSRmS~~		
~~Kota Bharu APP~~					~~PSR + SSRmS~~		
~~K. Kinabalu ACC~~ ~~K. Kinabalu APP~~					~~PSR + SSRmAC~~ ~~PSR + SSRmAC~~		
~~Kuching ACC~~ ~~Kuching APP~~					~~PSR + SSRmAC~~		
MALDIVES Maldives ACC Maldives APP Maldives TWR	A,D,G	No	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**
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 Chrischurch ACC Christchurch TWR	C D G C D G		YES YES	YES YES	ADS-B+MLAT+PSR + SSRmAC + SSRmS ADS-B+PSR+SSRmAC+SSRmS	NOT APPLICABLE NA	 Surface movements for situational awareness using ADSB

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**
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 Karachi ACC	S		Yes	Yes	PSR + SSRmAC+SSRmS+ADS-B		
Karachi APP	T		Yes	Yes	PSR + SSRmAC+SSRmS+ADS-B		
Karachi TWR	AD		Yes	Yes	PSR + SSRmAC+SSRmS+ADS-B	NIL	PSR, SSR and ADS-B data is only being used for situational awareness

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
Lahore ACC	S	NIL	Yes	Yes	PSR + SSRmAC+SSRmS+ADS-B		
Lahore APP	T		Yes	Yes	PSR + SSRmAC+SSRmS+ADS-B		
Lahore TWR	AD		Yes	Yes	PSR + SSRmAC+SSRmS+ADS-B+MLAT+SMR	V	PSR, SSR and ADS-B data is only being used for situational awareness
Islamabad ACC	S		Yes	Yes	PSR + SSRmAC+SSRmS+ADS-B		
Islamabad APP	T		Yes	Yes	PSR + SSRmAC+SSRmS+ADS-B	~~Nil~~	
Islamabad TWR	AD		Yes	Yes	PSR + SSRmAC+SSRmS+ADS-B	NIL	PSR, SSR and ADS-B data is only being used for situational awareness
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					SSRmAC + SSRmS		
Manila APP					PSR + SSRmAC + SSRmS		
Clark 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**
Mactan APP					PSR + SSRmAC		
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 + ADS-B + MLAT	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 + ADS-B		
Incheon TWR	T	No	Yes	No	PSR + SSRmAC + SSRmS + ADS-B + MLAT	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		

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
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		
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		

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**
Hat Yai APP Hat Yai TWR	T AD		YES YES	YES YES	SSRmS SSRmS		
Phuket APP Phuket TWR	T AD		YES YES	YES YES	SSRmS SSRmS		
Suratthani APP Suratthani TWR	T AD		YES YES	YES YES	SSRmS SSRmS		
Ubonratchathani APP Ubonratchathani TWR	T AD		YES YES	YES YES	SSRmS SSRmS		
Phitsanulok APP Phitsanulok TWR	T AD		YES YES	YES YES	PSR PSR		
Hua Hin APP Hua Hin TWR	T AD		YES YES	YES YES	PSR PSR		
U Taphao					SSRmAC		
TONGA					ADS-B		
UNITED STATES Alaska ACC	R, S		YES	YES	ADS-B + ADS-C + SSRmS + SSRmAC + PSR + WAM		This facility also provides limited approach control

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
							services to the Juneau aerodrome
Anchorage, Alaska APP	T		YES	YES	ADS-B + SSRmAC + PSR		Anchorage, Alaska APP
Anchorage, Alaska TWR	AD		YES	YES	ADS-B + MLAT + SMR	2	Anchorage, Alaska TWR
Fairbanks, Alaska APP	T		Yes	Yes	ADS-B + SSRmAC + PSR		Fairbanks, Alaska APP
Anchorage, Alaska APP	T		YES	YES	ADS-B + SSRmAC + PSR		Anchorage, Alaska APP
~~Hilo, Hawaii ACC~~ ~~Hilo, Hawaii APP~~ Hilo, Hawaii TWR	AD				~~SSRmAC~~ ~~PSR~~		
Honolulu, Hawaii ACC	S		YES	YES	ADS-B + SSRmS + PSR		Honolulu ACC and APP are a single, integrated facility with one ATC automation system
Honolulu, Hawaii APP	T		YES	YES	ADS-B + SSRmS + PSR		APP provides services for Hilo, Kahului, Kona, and Lihue aerodromes
Honolulu, Hawaii TWR	AD		YES	YES	ADS-B + MLAT + SMR	2	
~~Kahului, Hawaii APP~~ Kahului, Hawaii TWR	AD				~~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
~~Kokee, Hawaii ACC~~					~~PSR~~		
~~Lihue, Hawaii APP~~ Lihue, Hawaii TWR	AD				~~PSR + SSRmAC~~		
~~Mount Kaala, Hawaii ACC~~					~~PSR + SSRmAC~~		
~~Pahoa, Hawaii ACC~~					~~SSRmAC~~		
~~Kunianiau, Hawaii ACC~~					~~SSRmAC~~		
Guam ACC	S		YES	YES	ADS-B + SSRmS + SSRmAC + PSR		Guam ACC and APP are a single, integrated facility with one ATC automation system
~~Mount Santa Rosa, Guam ACC~~					~~PSR + SSRmS~~		
~~Mount Santa Rosa, Guam APP~~					~~PSR + SSRmAC~~		
~~Mount Santa Rosa, Guam TWR~~							
Kona, Hawaii ~~ACC~~ TWR	AD				~~SSRmAC~~		
VIET NAM Hanoi ACC					PSR + 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
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

REPORT FROM BAY OF BENGAL AD HOC WORKING GROUP
21 April to 23 April 2025

States Presented:
China
Indonesia
Malaysia
Thailand
India
Maldives
~~Nepal~~ (not present)
Sri Lanka
Pakistan
~~Bangladesh~~ (not present)
~~Bhutan~~ (not present)

Observer:
~~IATA~~
~~Japan~~

Participants met to update the status of implementation of ADS-B in their states and possible Data sharing between the neighbouring States.

Implementation Updates

1. Bangladesh (no update provided in 2024 and 2025)
Not Present

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 2024 and 2025)
Not Present

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 (status same in 2025**)**

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 (update in 2025**)**

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.
Indonesia is proposing to share ADS-B data using CRV Network.
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 (update in 2025**)**

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.

6. Maldives (update in 2025**)**

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 require carriage of ADS-B Out, was implemented for the year 2021~~

~~Maldives is making efforts to complete the airworthiness approval for all locally registered aircraft, already equipped with ADS-B.~~

~~Maldives is in the process of installing five additional ADS-B Ground Station in 2024, to improve the coverage at low flight levels.~~

Five new ADS-B ground stations were installed in 2024. These stations extend the existing infrastructure and significantly improve surveillance in areas with dense seaplane operations, especially in VFR corridors. Integration of these new ground stations into the ATM system is underway and is expected to be completed by the third quarter of 2025. With this implementation, the Maldives will look into the possibilities of sharing ADS-B data with neighboring FIRs.

The carriage of ADS-B Out equipment is not yet mandatory within the Maldives FIR. SSR remains as the primary surveillance method.

The complete implementation of ADS-B, which includes mandatory carriage requirement, is targeted for 2027.

7. Myanmar (no update provided in 2024 and 2025)
Not Present

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 (update in 2025**)**

Thailand provided update on the installation and related activities regarding ADS-B and other related surveillance system as follows:

ADS-B Ground Infrastructure and ATC System Readiness or Implementation Plan

- 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.~~ Seven ADS-B are in operation. This integrated surveillance system is designed to complement the existing radar infrastructure, enhancing the efficiency, reliability, and coverage of Thailand's air traffic surveillance from 5 September 2024 onwards.
-

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 (update till 2025)

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~~ 34 receivers have already been operationalized and efforts are on to operationalize remaining ~~6~~ 2 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, Kolkata and Guwahati 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 (update in 2025**)**

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~~ neighbouring FIRs. ~~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 (Not present**)**

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.
They are in test operation.

12. **Pakistan (update in 2025)**

Pakistan has installed a network of nine (9) redundant ADS-B ground stations to enhance its surveillance coverage in areas traditionally underserved by radar, known as grey areas or cones of silence.

Pakistan has phase wise deployed a network of multivendor ADS-B ground stations to enhance surveillance coverage within its airspace. Out of 09 (nine) stations 06 (six) are collocated with MSSR Mode S, however remaining 03 (three) ground stations are deployed independently to enhance surveillance coverage and performance in Grey Areas of Radar Coverage.

In the first phase installation, deployment, and Site Acceptance activities for Islamabad, Rojhan, Pasni and Lakpass were completed in 2019. The remaining 05 sites of Lahore, Karachi, Dalbandin, Zhob and Laramtop were deployed and commissioned in 2023.

The system meets Tier 1 service capabilities as defined in APANPIRG/18, ensuring baseline ADS-B service performance parameters are met. Dalbandin, Zhob, Laramtop, Lahore and Karachi ADS-B ground stations are version 2 i.e. DO-260B compliant. And output target reports in data protocol formats Asterix CAT 21 v2.4, CAT 23 v1.2, CAT25 v1.1 and CAT 247 v1.2.

Islamabad, Lakpass, Rojhan and Pasni ADS-B ground stations are version 2 i.e. DO- 260B compliant. And output target reports in data protocol formats Asterix CAT 21 v1.8, CAT 23 v1.2 and CAT 247 v1.2.

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 (updates till 2025)

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 (updates till 2025)

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.
CAT21 Ver 0.26 format to be used for data sharing.

Operational Status

New ATM Automation system in Kuala Lumpur has been completed and ready for data sharing.

Expected benefits

Enhanced safety at FIR boundary

Project 6 - ADS-B Data Sharing between Malaysia and Thailand (updates till 2025)

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

~~Currently on hold until further discussion~~
Malaysia has initiated technical discussion with Thailand on ADS-B Data Sharing for Phuket, Hatyai, Langkawi and Kuala Terengganu sensors as the initiative to reduce the surveillance GAP at the BOB area within both FIRs.

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)~~ (updates till 2025)

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
Feasibility studies are being conducted by Sri Lanka

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 SUBGROUP

Bangkok, Thailand, *21 to 23 April 2025*

States Present
~~Australia~~
~~Cambodia~~
China
Hong Kong, China
Indonesia
Malaysia
Lao PDR
The Philippines
Singapore
Thailand
Viet Nam

Observer
~~Fiji~~
Japan
New Zealand
Macao, China
USA

Previously Identified Projects

The South East Asia Group provided 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)
- Based on previous data as Australia was not present.

Data Sharing Agreement signed on 18 Jun 2014.

Sharing agreement extended from 2023 to 2026.

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 and Bataraza. It is planning to install other ADS-B stations within Manila FIR.

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 ADS-B of Bataraza is yet to be integrated into Manila ATM Centre and it will be done after the hardware is upgraded.

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 shared ADS-B data with Singapore and provide the VHF facilities for Singapore ATC use. Data sharing 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, Kota Kinabalu and Sandakan. The data from these 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)

Based on previous data as Cambodia is not present.

Viet Nam completed installing 11 new ADS-B stations in the HCM FIR in 2023. Viet Nam is willing to share data with Cambodia and Thailand.

Thailand has 4 ADS-B ground stations (DO260B and lower compliant) 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 Ratchathani Airport (VTUU), and Phuket Airport (VTSP) have been upgraded with ADS-B capability. In total, 7 ADS-B stations implemented and operational since~~are under approval process and is expected for air traffic service by end of 2024.~~ 5 September 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) (installed)
- General Santos (The Philippines) (~~(The plan to install to be reviewed)~~Under procurement)

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 2027
- 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

Based on previous data as Australia and Papua New Guinea were not present in the meeting.
~~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

Based on previous data as Papua New Guinea were not present in the meeting.

New ATM system installed in PNG.
The parties have yet to sign the agreement.

The above data sharing proposal will be re-evaluated due to implementation of space-based ADS-B in Papua New Guinea.

Project 7 – Lao PDR

Data Sharing between Lao PDR and Thailand

Lao PDR is willing to share the ADS-B data from the following site:

- Savannakhet (installed in 2017)

Lao PDR expressed desire to obtain data from Thailand to cover surveillance gaps.

There will be further discussion between Lao PDR and Thailand

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

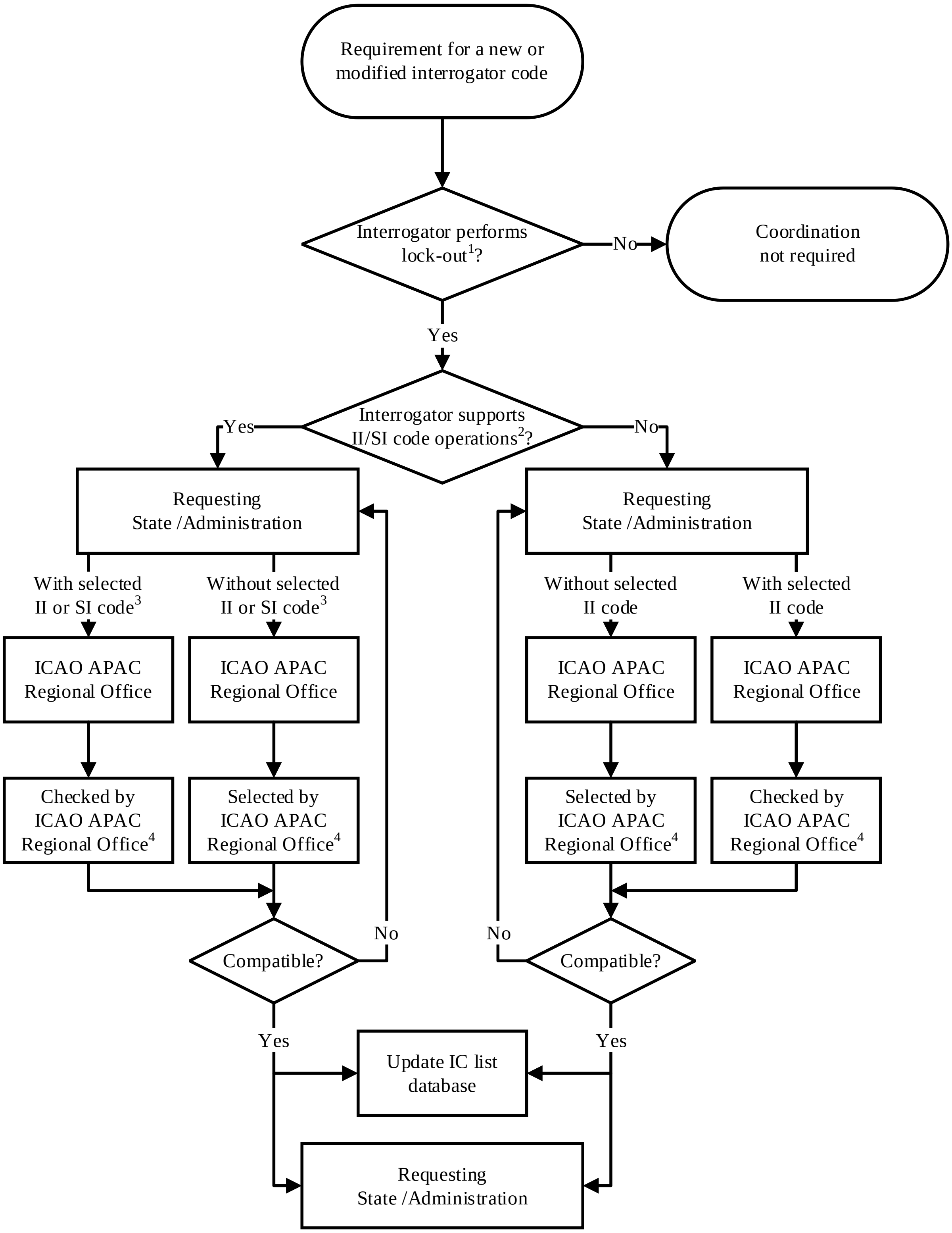
Related States/Administrations	ATS Route Served	Initiation Year	Agreement Date	Target Data Sharing Year	Implementation Status	Remarks/Challenges
Australia - Indonesia	Phase 1a L511, R592, G578, B349, M735, G326, A587, M768, A461, R340, B472, B473, G459	2010	2010	2010	Completed	SEA Report: Project 1
	Phase 1b M774, A458, J199, M766, G326, A587, L895, A585	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		~~2024~~2025	Ongoing	BOB Report: Project 2 ~~Data Sharing LoA on progress by end of 2022~~. ADS-B data from Campbell Bay (India) is proposed to be integrated

Related States/Administrations	ATS Route Served	Initiation Year	Agreement Date	Target Data Sharing Year	Implementation Status	Remarks/Challenges
						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.
India - Malaysia	N571, P628, L510, P627, L645, P574	2017		~~2024~~2025	Ongoing	BOB Report: Project 3 ~~Data Sharing LoA on progress by 2023.~~ 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.
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 (to be re-evaluated due to the implementation of space-based ADS-B in Papua New Guinea)

Related States/Administrations	ATS Route Served	Initiation Year	Agreement Date	Target Data Sharing Year	Implementation Status	Remarks/Challenges
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
Myanmar - India	Project 1: Effect on Myanmar A201, A599, B465 Effect India: G463, L507, P646, N895	2018	2015	TBD	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

Related States/Administrations	ATS Route Served	Initiation Year	Agreement Date	Target Data Sharing Year	Implementation Status	Remarks/Challenges
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
Lao PDR – Thailand	A202, A1	2025	TBD	TBD	Ongoing	SEA Report: Project 7

WORKFLOW FOR THE REQUEST AND COORDINATION OF INTERROGATOR CODES



Note:

1) Interrogators that do not perform lock-out do not require coordination for IC. Example of such interrogator is the interrogator of an active MLAT
2) Interrogators must support II/SI code operations before it is allowed to use SI code.
3) States/Administrations are encouraged to use SI codes for interrogators that support II/SI code operations. But States/Administrations may choose to use II code for reasons such as safety assessment for the use of SI code has yet to be completed.
4) II=0, SI=16, 32 and 48 will not be assigned by ICAO APAC Regional Office.

INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

MODE S DOWNLINK AIRCRAFT PARAMETERS IMPLEMENTATION AND OPERATIONS GUIDANCE DOCUMENT

Edition ~~5~~6.0 - March 202~~3~~5

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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~~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. Edition 5.0 was adopted by CNS SG/27. The revised draft is prepared and proposed to be endorsed by ~~Mode S DAPs WG~~SURICG/10.~~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~~buses and stored inside the relevant transponder's ~~256 different~~ 56-bit wide Binary Data Store register. 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 Mode S SSR DAPs can be extracted using either the ground-initiated Comm-B (GICB) ~~protocol, or~~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 situational 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~~ held 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	
6.0	March~~April~~ 20245	China Singapore	Add material on the general strategy on assignment of and migration to SI code

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

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

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~~using 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 NIC Supplement-B Pressure Altitude GNSS Height Surveillance Status	To provide accurate airborne position information
BDS code 0,6	Surface Position	Surface Position Ground Speed Vector	To provide accurate surface position information.
BDS code 0,8	Aircraft Identification and Category	Aircraft Identification Emitter Category	To provide aircraft identification and category
BDS code 0,9 Subtype 1/2	Velocity Over Ground	Ground Speed Vector NACv Vertical Rate Intent Change Flag Difference from Baro Altitude	To provide additional state information for both normal and supersonic flight
BDS code 0,9 Subtype 3/4	Airspeed and Heading	Air Speed Heading NACv Vertical Rate Intent Change Flag Difference from Baro Altitude	To provide additional state information for both normal and supersonic flight based on airspeed and heading
BDS code 6,1 Subtype 1	Emergency/Priority Status	Emergency/Priority Status Mode A Code	To provide additional information on aircraft status
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 Barometric Pressure Setting Selected Heading NAC_P, SIL, NIC_{BARO}, SIL Supplement MCP/FCU Mode TCAS/ACAS Operational	To provide aircraft state and status information
BDS code 6,5 Subtype 0	Aircraft Operational	Airborne Capability Class Airborne Operational Mode	To provide the capability class and current operational mode

	Status- While Airborne	MOPS Version	of ATC-related applications and other operational information.
		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		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	I048/250	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~~can 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 that can not be obtained via ADS-B and intended for operational use should be interrogated/extracted.

b) Operational:

Different processing systems can support DAPs in different ~~levels,~~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~~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~~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;~~transponders: or

      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;~~transponder: 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**

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. E.g., –*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~~and 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 1090MHz 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~~several 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 DO~~0~~-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.

As II codes are no longer sufficient to support the growing number of Mode S radars, ICAO APAC made the decision to transit from the use of II codes to SI code for the Mode S radars. The following Conclusion regarding the general strategy on assignment of and migration to SI code was adopted during the ~~34th~~ APANPIRG/35. The strategy is provided in Appendix 6 of this document.

Conclusion APANPIRG/35/10 *(Conclusion CNS/SG/28/10 (SURICG/9/1)* **Update of the General Strategy on Assignment of and Migration to SI Code in the APAC Region**	
That: 1. The ICAO APAC Regional Office will manage the assignment of II codes 14 and 15 and their matching SI codes like the rest of the II and SI codes. 2. Revised General Strategy on Assignment of and Migration to SI Code provided in **Appendix B** is adopted.	Expected impact: ☐ Political / Global ☒ Inter-regional ☐ Economic ☐ Environmental ☒ Ops/Technical
Why: A study by SURICG concluded that reservation of II codes 14 and 15 and their matching SI codes for research/test radars and military radars on a region-wide basis is not practicable in APAC.	Follow-up: ☐Required from States
When: 27-Nov-24	Status: Adopted by PIRG
Who: ☒Sub groups ☒APAC States ☒ICAO APAC RO ☐ICAO HQ ☐Other: XXX	

Conclusion APANPIRG/34/11 *(CNS SG/27/10 (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 C to Agenda Item 3.4** 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: 13-Dec-23	Status: Adopted by PIRG
Who: ☒Sub groups ☒APAC States ☒ICAO APAC RO ☐ICAO HQ ☐Other: -	

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.

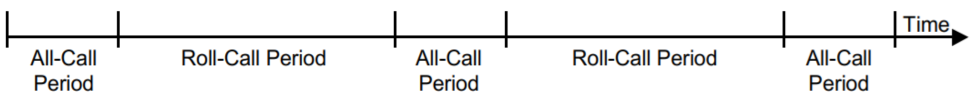

Figure.7-1 The Typical MIP

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~~beamwidth 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~~were 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.

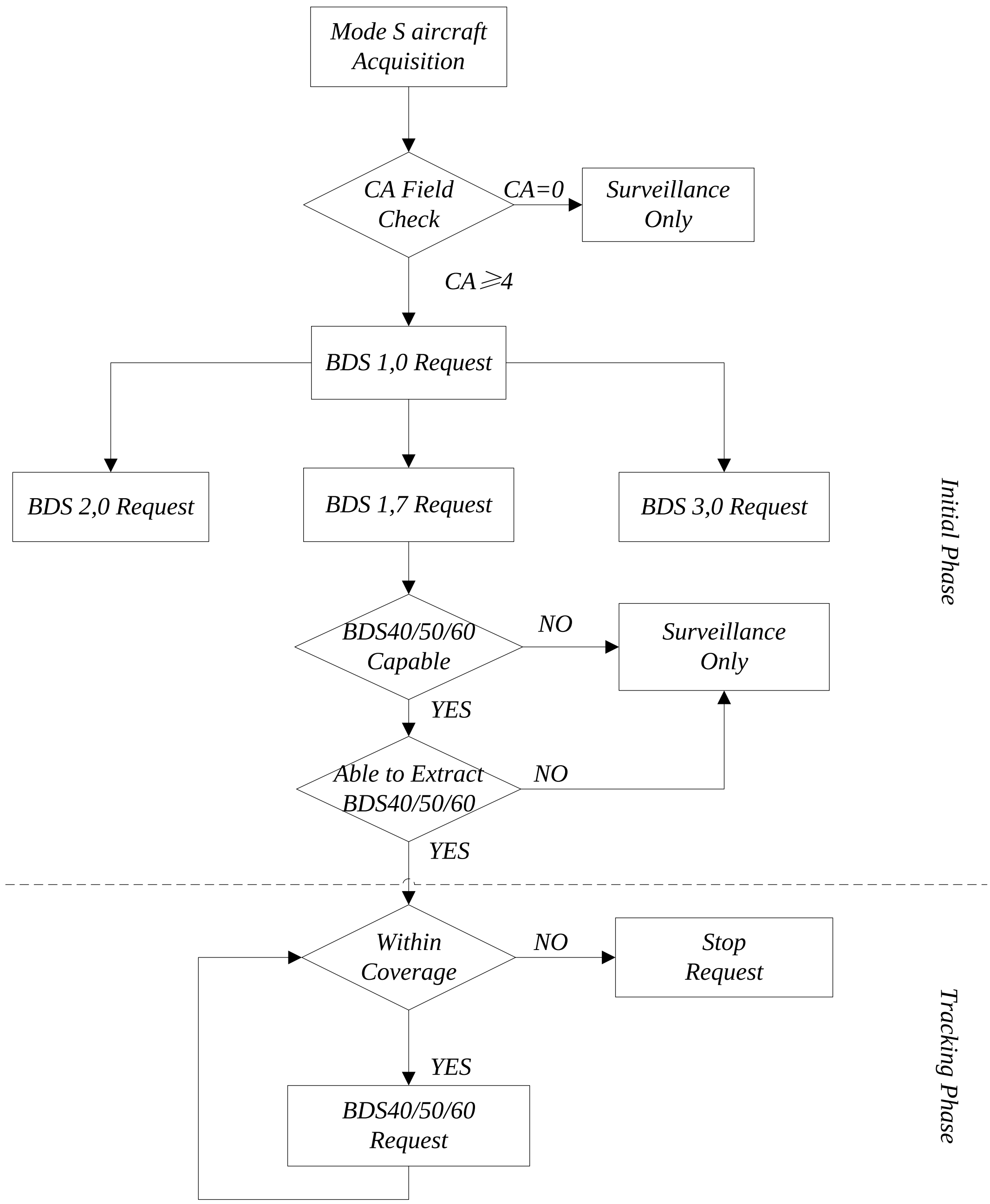

Figure.7-2 The Typical Procedure of DAPs Extraction

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 to 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 ($m_1, m_2, \ldots, m_k$) 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 appendeds 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

Register	Content		
BDS code 0,5	**Version0**	**Version1**	**Version2**
	Airborne Position Message		
	Single Antenna Flag		NIC Supplement-B
	Airborne Position		
	Pressure Altitude		
	GNSS Height		
	Surveillance Status		
BDS code 0,6	**Version0**	**Version1**	**Version2**

	Surface Position Message		
	Ground Track	Heading	
	Surface Position		
	Movement		
BDS code 0,8	**Version0**	**Version1**	**Version2**
	Aircraft Identification and Type Message		
	Aircraft Category		
	Aircraft Identification		
BDS code 0,9	**Version0**	**Version1**	**Version2**
	Airborne Velocity Message		
	NUC_R	NACv	
	IFR Capability Flag		-
	Subtypes 1 and 2:Velocity Over Ground	Subtypes 3 and 4:Airspeed and Heading	
	Ground Speed Vector	Air Speed	
		Heading	
	Intent Change Flag		
	Ground Speed Vector		
	Vertical Rate		
	Difference from Baro Altitude		
BDS code 6,1	**Version0**	**Version1**	**Version2**
	Aircraft Status Message		
	Subtype 1:Emergency/Priority Status		Subtype 2:1090ES TCAS RA Broadcast
	Emergency Status		ACAS RA Report
	-	Mode A Code	
BDS code 6,2	Version 0	Version 1	Version 2
	Current/Next Trajectory Change Point(TCP) Message	Target State and Status Information Message	
	TCP data	Target Altitude	Selected Altitude
		-	SIL Supplement
			Barometric Pressure Setting
		Track Heading / Track Angle	Selected Heading
		Emergency/Priority Status	Mode Engaged（Autopilot VNAV Altitude Approach LNAV）
		Capability/Mode Code	TCAS Operational
		NAC_P 、SIL、NIC_{BARO}	
BDS code 6,3	Version 0	Version 1	Version 2
	Current/Next Trajectory Change Point Message(TCP+1)	Aircraft Operational Status Message	-
		Subtype 0 / Subtype 1	

	TCP+1 Data	Airborne Capability Class	Surface Capability Class		
			Length/Width Codes		
		NIC_{BARO}	TRK/HDG		
		Operational Mode OM			
		Version Number			
		NIC Supplement			
		NAC_P、SIL			
		HRD			
BDS code 6,4	Version 0	Version 1		Version 2	
	Aircraft Operational Coordination Message	-			
	Paired Address	-			
	Runway Threshold Speed				
	Roll Angle				
BDS code 6,5	Version 0	Version 1		Version 2	
	Aircraft Operational Status Message	-		Aircraft Operational Status Message	
	CC	-		Subtype = 0	Subtype = 1
				Airborne Capability Class	Surface Capability Class
					Length/Width
				Airborne Operational Mode	Surface Operational Mode
	OM			GVA	-
				NIC_{BARO}	TRK/HDG
				Version Number	
				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)~~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~~ Due to the fact that ADS-B version information ~~in~~ is not included in the version 0 message, 2 steps are required to check the ADS-B version ~~-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 a periodic message in version ~~2, and~~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 a 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 a periodic message in version ~~2, and~~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~~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~~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~~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~~in each 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~~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 IFATCLPA. 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, andchecking 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 information about the type of vehicle provided to the controller by the ATM system 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~~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 analyze~~s~~ the aircraft altitude keeping performance. The comparison verifies whether the aircraft is flying according to the selected altitude setting by the ~~crew, and~~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~~aircraft and may display the information to the controller for~~to~~ improved~~ 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 or submitted incorrectly.

b) Mode S and surveillance capabilities indicators submitted 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: Refer to Section 9.10 of AIGD for Mmore 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.

7.8 Management of 1030/1090MHz Utilization

The utilization of the 1030/1090 MHz frequencies has greatly increased in certain areas of the world. If no action is taken, the situation would reach an unacceptable level that would result in harmful corruption or loss of information to the aeronautical surveillance and collision avoidance systems. The total or partial loss of this data would affect the ATM systems and aircraft to-aircraft systems resulting in an increase in the probability of mid-air collisions, disruption to Air Traffic Services, and a reduction in airspace efficiency. It must be ensured that the spectrum capacity is utilized in the most efficient way to preserve the performance of current systems and to consider future applications that require an increase in capacity.

The Surveillance Panel therefore established the Surveillance Spectrum Focus Team (SSFT) in September 2019 to look into the overall issue of 1030/1090 MHz utilization.–

in September 2019 to look into the overall issue of 1030/1090 MHz utilization. The works resulting from the SSFT are shown in the table below:

S/N	Problem description	Possible mitigation(s)	Affected Document(s)	Affected Section(s)	Remarks / Limitations	Regulatory aspects
1	Inconsistency of RF measurement methodologies and results reporting	Add RF measurement guidance material to Doc 9924	Doc 9924	Appendix M	–	**Doc 9924 3rd Edition 2020**
2	Use of uncertified transponder or NT/ES devices for small UAS	Add guidance material to Doc 9924	Doc 9924	Appendix S, section 1 to 3	–	**Doc 9924 3rd Edition 2020** –
3	High number of Mode A/C/S All-Call replies (DF11) due to P4 misinterpretation of the XPDR near MTL	Complete removal of long P4 processing from the XPDR	Annex10V4 AMD 90	– 3.1.2.1.5.1.1.1	The long/wide P4 is not used in civil radars.	**Annex10V4 AMD 90** **Effective date 01/01/2020**

And AAnd Appendix 5 provides the guidance for describes the radio frequency measurement and analysis.

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~~ of an Airborne Collision Avoidance System (ACAS) Resolution Advisory (RA), the ATM system ~~is able to~~can 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~~5.1 ~~e~~h).

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~~altitude but forgot to set barometric pressure setting. At that time, the airport QNH was 1013, while the crew barometric pressure setting was ~~1118~~1018.5. An alarm system notified the controller of this situation. The error was corrected after the controller prompted the pilot preventing a dangerous situation.

*NOTE: Issues can also occur between an area QNH and a local aerodrome QNH and when a pilot changes. This could generate a loss of separation if the two are significantly different.

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.

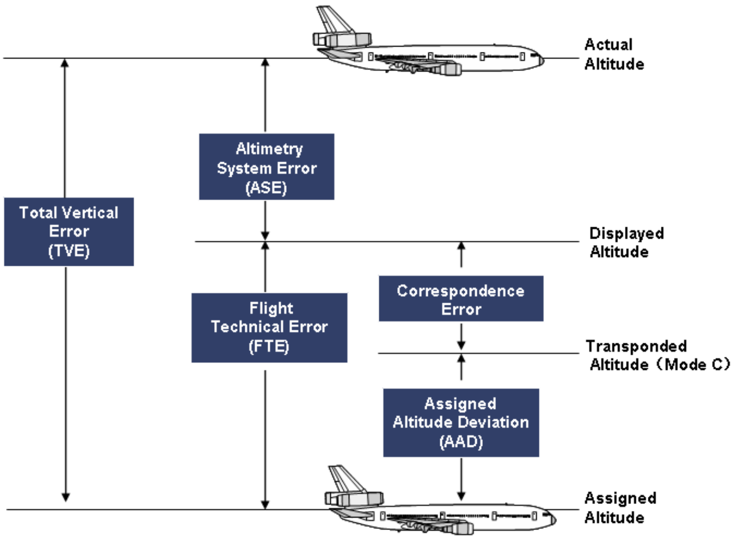

Figure 9-1: Relationship between the vertical errors

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.

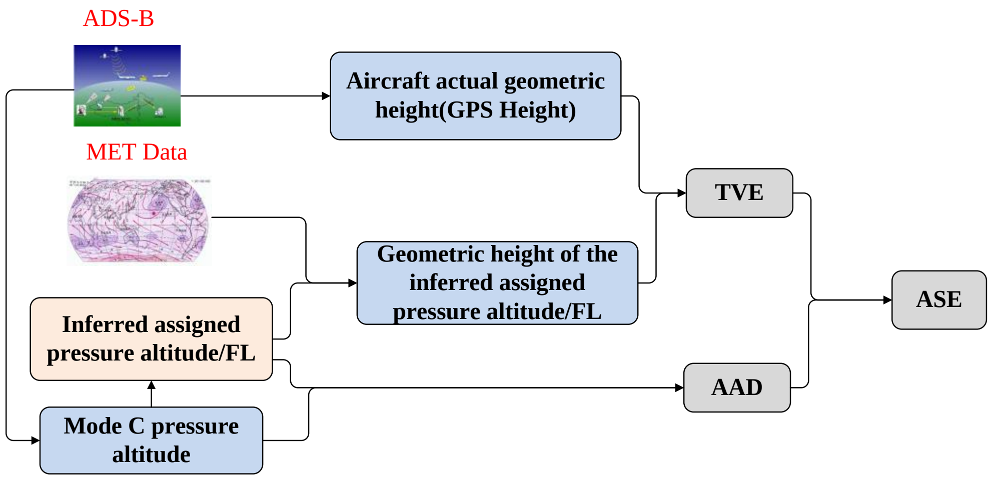

Figure 9-2: Calculation process of TVE, AAD and ASE based on ADS-B

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..~~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.

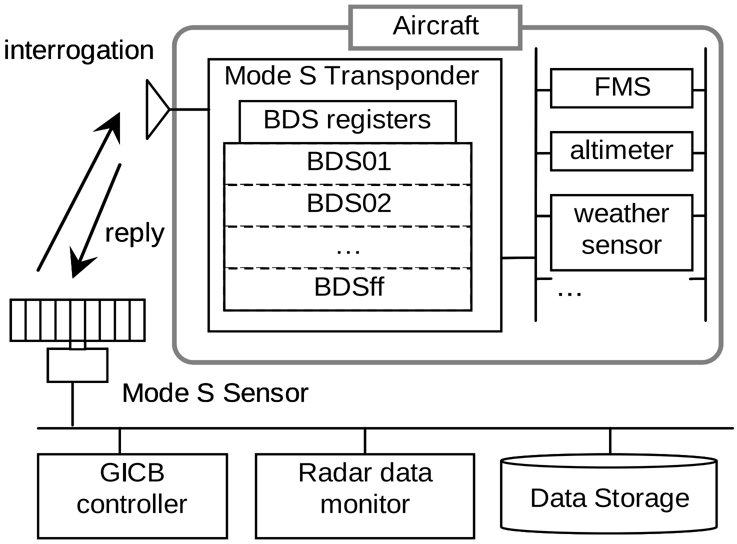

Figure1 - Example of Data Recording Configuration

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.

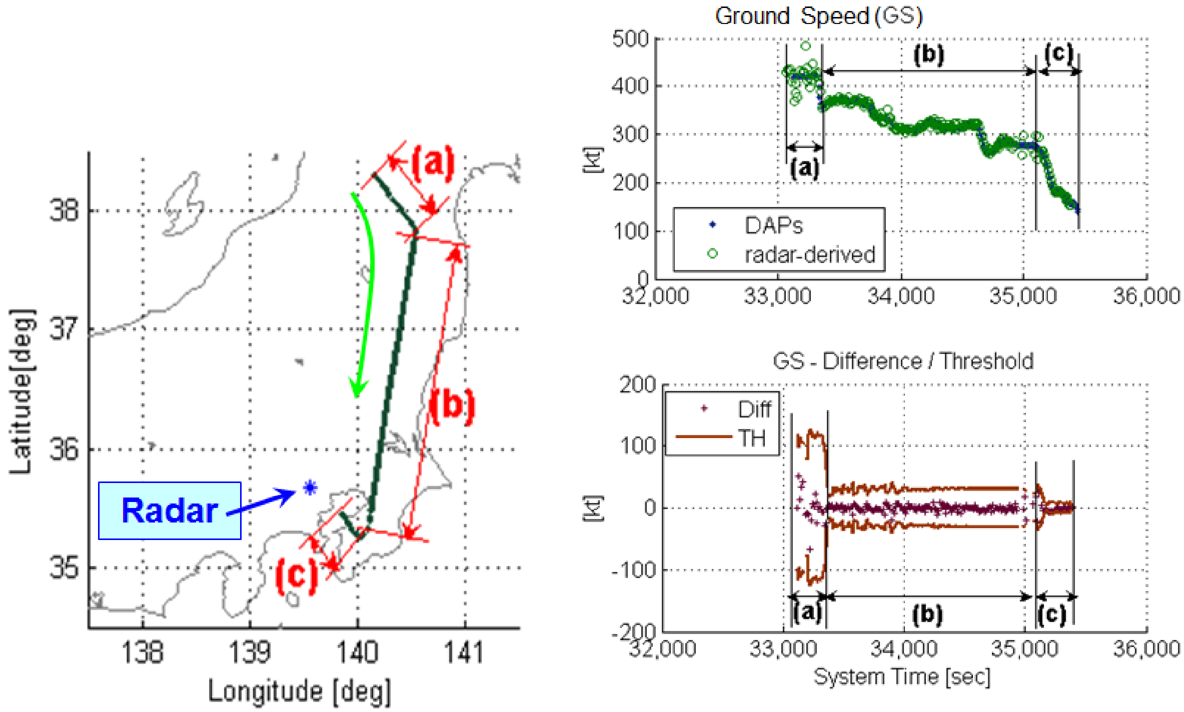

Figure 2 - Example of Dynamic Value Tests

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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~~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~~provide useful information on aircraft intentions 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~~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
		Selected Altitude (MCP/FCU)	2-13	ft	16	[0, 65520]
	BDS 4,0	Selected Altitude (FMS)	15-26	ft	16	[0, 65520]
		Barometric Pressure Setting	28-39	mb	0.1	[0, 410]
		Roll Angle	3-11	dg	45/256	[-90, +90]
		True Track Angle	14-23	dg	90/512	[-180, +180]
	BDS 5,0	Ground Speed	25-34	kt	2	[0, 2046]
EHS		Track Angle Rate	37-45	dg/s	8/256	[-16, +16]
		True Airspeed	47-56	kt	2	[0, 2046]
		Magnetic Heading	3-12	dg	90/512	[-180, +180]
		Indicated Airspeed	14-23	kt	1	[0, 1023]
	BDS 6,0	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.

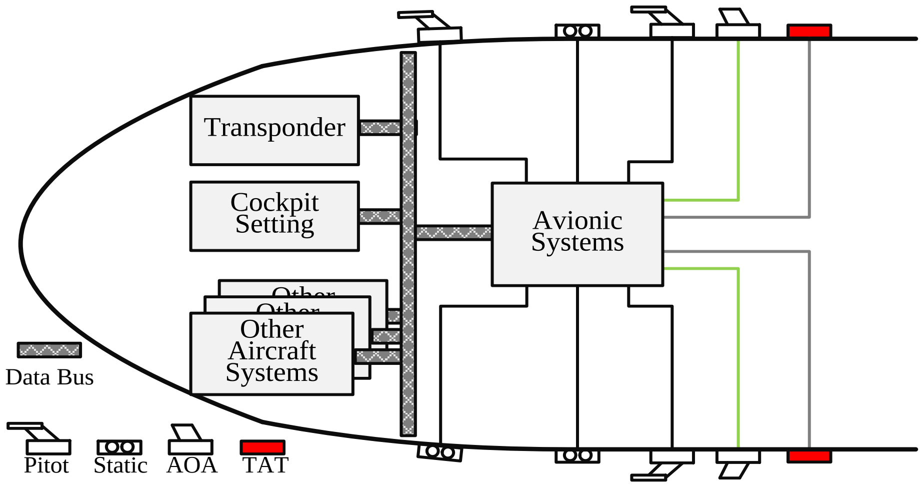

Figure 3.1 Typical DAPs Data Source Block Diagram

Transponder and TCAS Computer

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 .~~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).

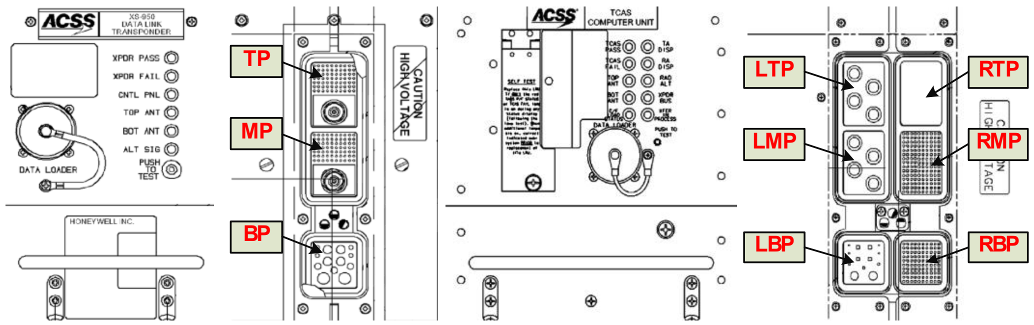

Figure 3.2 Transponder and TCAS Computer Examples from ACSS

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.

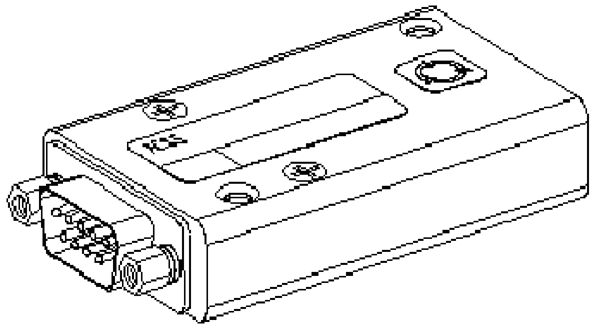

Figure 3.3 APM Example from ACSS

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.

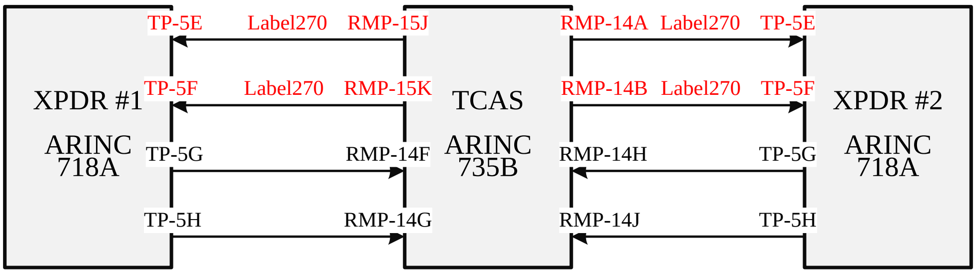

Figure 3.5 Illustrations of Datalink Capability and RA Report Transfer

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.

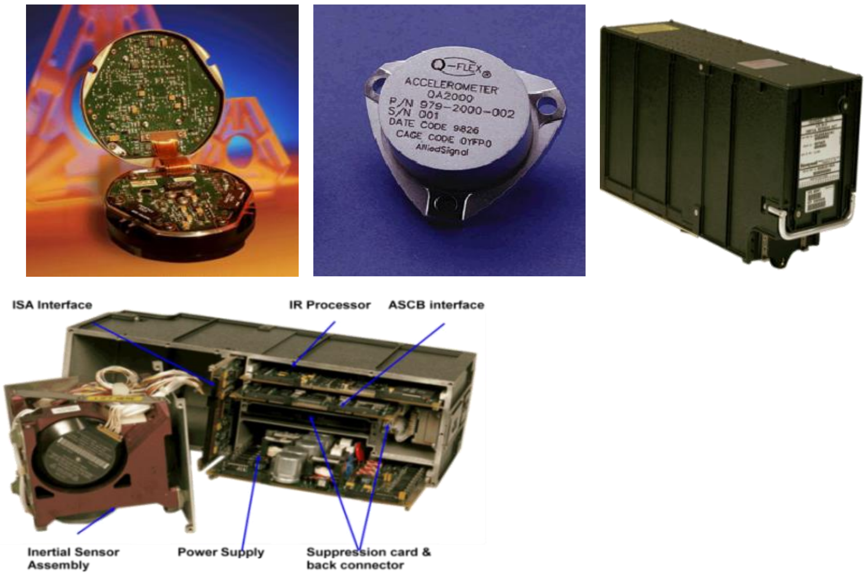

Figure 3.8 Gyro, Accelerometer and LASEREF IV IRU from Honeywell

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:

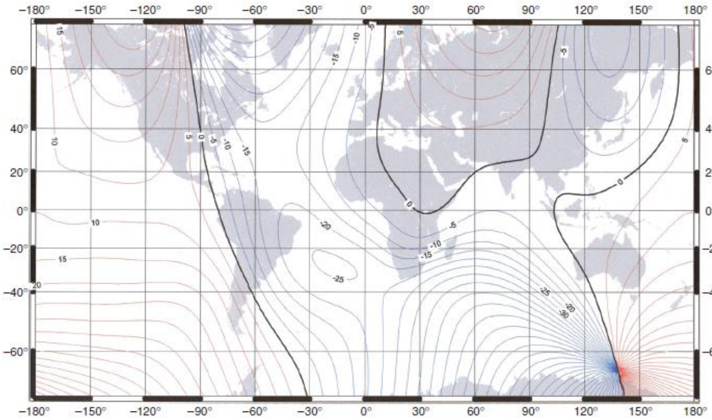

Figure 3.9 World Magnetic Model 2000

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.

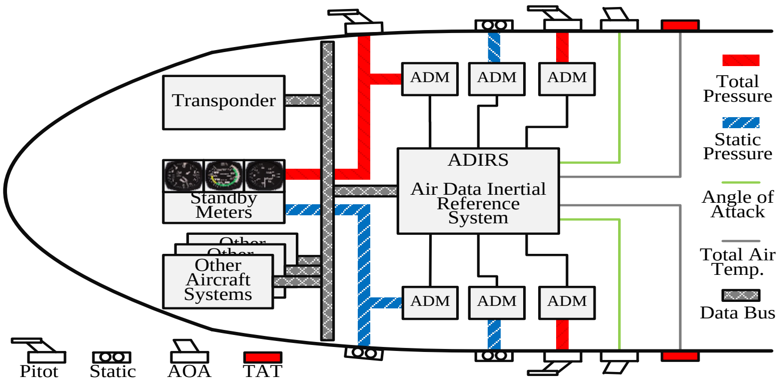

Figure 3.10 Typical ADIRS Architecture

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.

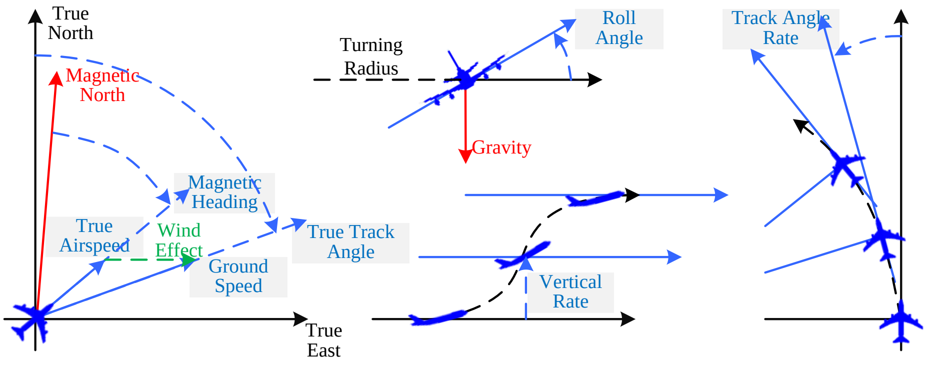

Figure 3.11 Illustration of Aircraft Dynamic

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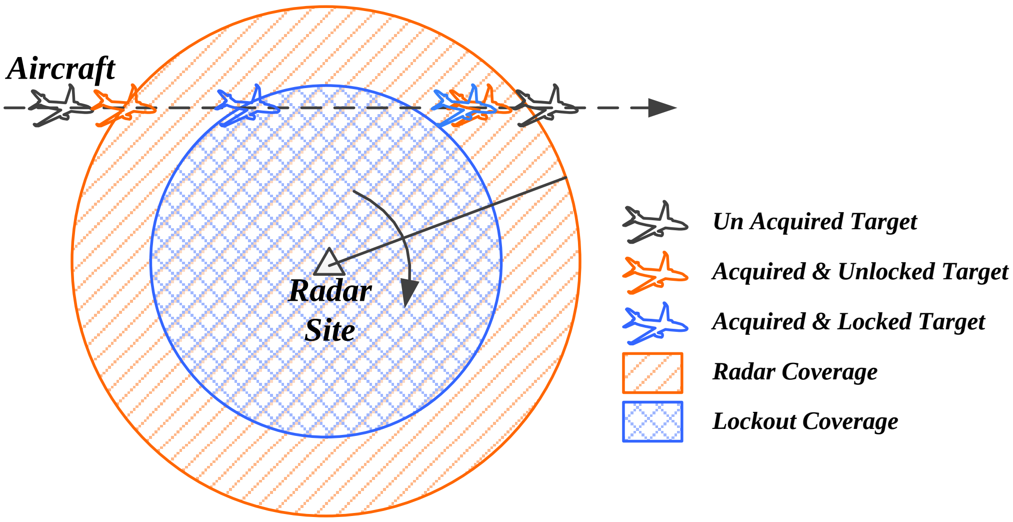
APPENDIX 4: Mode S Parameter Set

<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:

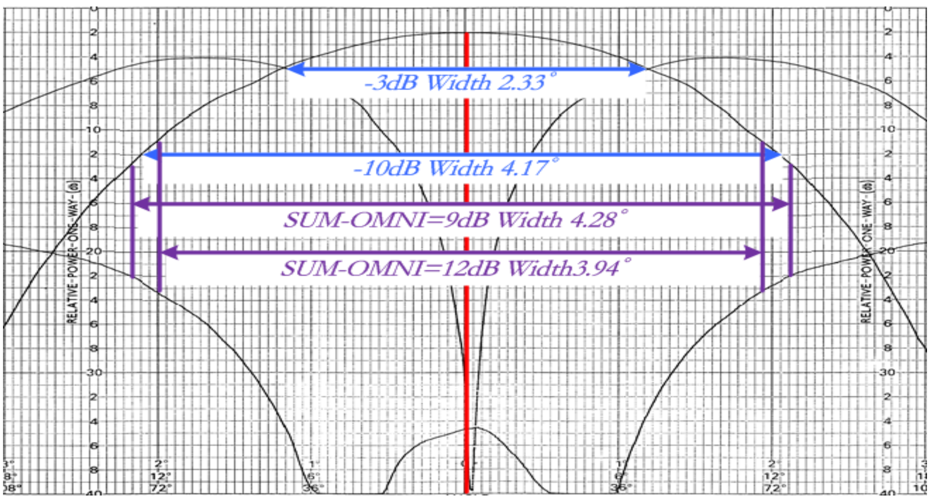
$$T \geq \frac{R * 2 * 1852}{3 * 10^8}$$

<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.



<u>*Time on Target **Tt***</u>

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:

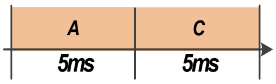
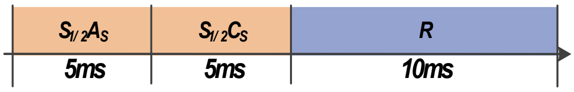
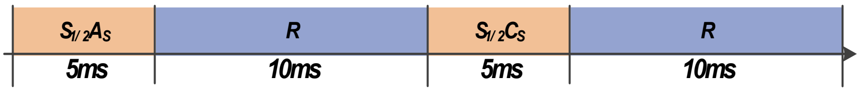
No.	Mode	Description	Pulse Used
1	A	Mode A interrogation	8µs between P1 and P3
2	C	Mode C interrogation	21µs between P1 and P3
3	A_S	Mode A Only All-Call	8µs between P1 and P3, and short P4
4	C_S	Mode C Only All-Call	21µs between P1 and P3, and short P4
5	S_L	Mode ACS All-Call	8µs, 21µs between P1 and 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]/......

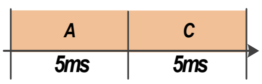
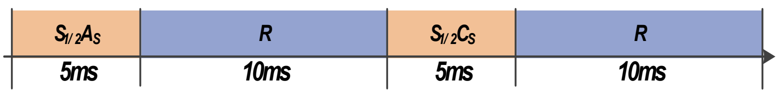
Note: The All-Call and Roll-Call periods are separated by "/", the "Mode" is one of the Modes listed above, and the "[Time]" stands for the duration of the periods.

6.4 An example is show as follows:

<table>
<tr><th>No.</th><th>Mode</th><th>MIP</th></tr>
<tr><td>1</td><td>Conventional</td><td>A[5.0]/C[5.0]

Mode A and Mode C repeat, both durations are 5ms</td></tr>
<tr><td>2</td><td>Mode S #1</td><td>$S_{1/2}A_S$[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</td></tr>
<tr><td>3</td><td>Mode S #2</td><td>$S_{1/2}A_S$[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</td></tr>
</table>

*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:

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

DAPs Extraction Strategy

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,~~registers; these registers should not be extracted periodically.

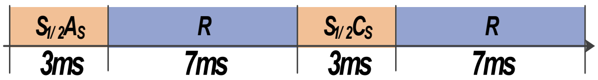
2) Extraction priority stands for the priority of each BDS when the radar is performing extraction, the priority should be in accordance ~~to~~with the user's needs;

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.

Mode S Parameter Set Example

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 All-Call Period	ms	3.0	Equivalent Coverage Range $\frac{3*10^8*3.0*10^{-3}}{1852*2} \approx 243\text{NM}$
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~~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~~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 de-garbling 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~~For 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.

APPENDIX 6: GENERAL STRATEGY ON ASSIGNMENT OF AND MIGRATION TO SI CODE

~~Considering that, when formulating the general strategy:~~When formulating a strategy on the assignment of and migration to SI codes the following issues should be considered:

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

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 maybe subjected to error,~~;~~

e) The European region is reserving II codes 14 and 15 (and their matching SI codes) for special use (i.e. research/test and military purposes). However, the situation in the APAC region is different an~~ds~~ APAC –does not have the same conditions that allow the reservation of II 14 and 15 (and their matching SI code),~~;~~

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~~should be simple,

The following general strategy for ICAO APAC has been agreed 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-1, at the same time ensuring continued support for Mode S II-only ~~transponders;~~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~~;~~, and

e) The ICAO APAC regional office will not reserve II codes 14 and 15 (and their matching SI codes) for special use like the case of Europe region. Instead, ICAO APAC regional office will have the full flexibility to assign II 14 and 15 (and their matching SI codes) like the rest of the II and SI codes.

The following general strategy for migration has been agreed:

a) States with Mode S radars that can support II/SI code operation are encouraged to coordinate this functionality with the ICAO APAC regional 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

SN	Reference	Who	What	Due date	Status	Completed on	Result	Comment
35	D-3	Co-chairs and hosting States	Harmonization with air space users (in SURICG2)		close	Propose to close	The "Harmonization with airspace user" came from the objective of the dissolved Mode S DAPS WG, where the harmonization came from the ToR endorsed in SURICG/2. Since this is an ongoing item and has been re-merged back into the ToR of SURICG, I believe the item has already incorporated in the work of SURICG thus could be suggested for removal from the list.	Invite avionics manufacturers and airlines to share experience, where possible.
36	D-10	Co-chairs, ICAO	Reservation of II codes 14 and 15 for Research, Test and Military Purposes (DAPs WG/5)		close	Propose to close	COMPLETED New stategy adopted.	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.
37	D-11	China	Update IGD with the discussion outcome on IC planning and coordination (DAPs WG/6)	Target in 2025	close	Expected paper/IGD from China	The Edition 6.0 of the Mode S IGD was submitted last year. The main amendments to this version were the addition of some achievements from DAPs/6, such as the general strategy on the assignment of and migration to SI code that has been adopted during the 34th APANPIRG meeting. And there was also a change in the strategy to migrate from II codes to SI code in SURICG/9. The meeting finally decided to delay the update of the Mode S IGD to this year. This year only these related contents will be updated. I think there is no need for a paper to introduce the revised document. And the revised document will be submitted to you as soon as possible. Thank you	Revised IGD was presented in SURICG10
38	D-12	ICAO	Workshop on the use of Mode S and DAPs and Assignment of /migration to II/SI codes (DAPs WG/6)	Target in 2025	Open		Plan with FF SUR module	
39	9-1	Member States, ICAO Secretariat	Continue monitoring GNSS vulnerability issue and consider revising the regional surveillance strategy when necessary		Open		GNSS is a global issue. Continue to coordinate with HQ for global guidance.	
40	9-2	ICAO Secretariat	Incorporate updates from States during SURICG/9 into e-ANP Volume II Table CNS II-APAC-3 SURVEILLANCE through the PfA process.		close		replaced by action item from SURICG10	
41	9-3	Member States	Incorporate individual statistics and trend analysis on equipage similar to IP/20 of SURICG/9 for future meetings to see any need for another initiative on new equipage mandate in future.		on going			

SN	Reference	Who	What	Due date	Status	Completed on	Result	Comment
42	10-1	SURSG	SURSG will review final list of APAC Common SWIM Surveillance Information Services was prepared by the SURICG/10 meeting and provide further updates, if any, to publish in the next version of APAC Common SWIM Surveillance Information Services.		Open			
42	10-2	ICAO Secretariat	During the discussion of the next meeting date of SURSG, it was stated that the next Meeting will be planned before the SURICG/11 Meeting in 2026		Open			
43	10-3	USA	8.17 The Meeting noted that a Performance-Based Surveillance Sub-Group (PBSSG) is discussing using a cooperating surveillance system for separation, not for non-cooperative systems. However, the proposal to add non-cooperative sensors can be shared with the group by Alex from the USA during next week's Meeting from 28 – 30 April 2025		on going			

Asia and Pacific Ministerial Declaration on Civil Aviation (Delhi)

1) We, the Ministers from the Asia and Pacific States responsible for Civil Aviation, met in New Delhi, India, from 11-12 September 2024, on the occasion of the 2nd Asia Pacific Ministerial Conference on Civil Aviation and the 80th anniversary of the Convention on International Civil Aviation (Chicago Convention), organized by the International Civil Aviation Organization (ICAO), to reaffirm the obligations as the Contracting States to the Chicago Convention signed on 7 December 1944 to ensure the safety, security, efficiency and continuity of civil aviation;

2) Recalling that Ministers met at the 1st Asia Pacific Ministerial Conference on Civil Aviation in Beijing, China, from 31 January to 1 February 2018, and endorsed a landmark declaration (Beijing Declaration) underpinning the importance of air transportation for social and economic development and the shared commitments and vision of Asia and Pacific Ministers to build Regional momentum to realize the implementation of Aviation Safety priorities and targets and Asia/Pacific Seamless Air Traffic Management (ATM) Plan (now renamed as the Asia/Pacific Seamless Air Navigation Service (ANS) Plan) with the collaboration of States/Administrations and active participation of the aviation industry;

3) Acknowledging the extraordinary circumstances during COVID-19 pandemic which impeded States/Administrations from effectively implementing the Beijing Declaration commitments while noting updated safety and air navigation targets have emerged to better support States/Administrations in the Asia and Pacific Region;

4) Recognizing that the recovery of air transportation is progressing and that passenger and freight demand in the Asia and Pacific Region is forecast to regain higher growth rates requiring a concerted effort of States/Administrations and the aviation industry to meet the increasing demand while enabling a safe, secure, efficient and a more resilient aviation sector, and minimizing the adverse effects of international civil aviation on the global climate, which supports the realization of United Nations 2030 Agenda for Sustainable Development;

5) Identifying that key priorities exist in the Asia and Pacific Region requiring collaboration and that States/Administrations need to develop capabilities to improve safety, security and building of additional capacity to address emerging Regional and global challenges to sustain the Regional civil aviation growth forecast;

6) Noting that over half of the States/Administrations in the Asia and Pacific Region which have had an ICAO audit under the Universal Safety Oversight Audit Programme – Continuous Monitoring Approach (USOAP – CMA) have an effective implementation (EI) of the critical elements (CEs) of a State safety oversight system lower than the global average;

7) Noting that over half of the States/Administrations in the Asia and Pacific Region which have had an ICAO audit under the Universal Security Audit Programme (USAP) have an EI of the CEs of a State aviation security oversight system lower than the global average;

8) Acknowledging that the ICAO Assembly 41st Session endorsed the Global Aviation Safety Plan (GASP) 2023 – 2025 edition and the Seventh Edition of the Global Air Navigation Plan (GANP) as the global strategic directions for safety and air navigation respectively, and urged Member States to demonstrate the political will necessary to implement remedial actions to resolve safety concerns and air navigation deficiencies in a timely manner as well as integrate aviation in the national development plans;

9) Appreciating that HR development strategies combined with adequately funded and quality assured training and accompanying investment in training infrastructure is essential for developing and maintaining a qualified and competent workforce to manage all aviation activities and to meet ICAO's strategic objectives;

10) Realizing the benefits of working in partnership with ICAO and aviation stakeholders through interactive platforms for closer coordination to identify opportunities for innovation and the adoption and integration of new technologies, such as Advanced Air Mobility (AAM) to keep pace with global advancement in information technology, artificial intelligence, etc. and future evolving technologies and sciences;

11) Recognizing that only universal participation in the international air law treaties adopted under the auspices of ICAO would secure and enhance the benefits of unification of the international rules which they embody, with particular priority to be given to the Protocols of Amendment to the Convention on International Civil Aviation which have not yet entered into force;

12) The Second Asia Pacific Ministerial Conference, therefore, agrees to the Asia and Pacific Ministerial Declaration on Civil Aviation (Delhi) and the Ministers commit to the following:

1.0 Reaffirming Asia and Pacific Ministerial Declaration on Civil Aviation (Beijing)

1.1 Support and continue efforts towards the realization of the Beijing Declaration commitments, especially pursuing cooperative progress on commitments relating to aviation safety oversight capability, State Safety Programme (SSP) implementation, certification of aerodromes used for international operations, the timely implementation of the Asia/Pacific Seamless Air Navigation Service (ANS) Plan, and supporting the establishment of independent accident investigation authorities.

2.0 Effective Implementation of ICAO Global Plans

2.1 Undertake to support the effective implementation of the ICAO Global Aviation Safety Plan (GASP), Global Air Navigation Plan (GANP) and Global Aviation Security Plan (GASeP) and associated Regional plans, which include detailed guidance to assist States/Administrations in complying with ICAO's Standards and Recommended Practices (SARPs).

3.0 Aviation Safety

3.1 Continue efforts and cooperation to uphold aviation safety as a key priority, carrying out effective safety oversight and safety management activities, joining forces to share safety information and fostering a strong and positive safety culture.

3.2 Strive to achieve the current GASP, in particular, prioritize and commit resources to achieve the following goals:

a) Improve scores for the effective implementation (EI) of the critical elements (CEs) of the States/Administrations safety oversight system;

b) Work towards an effective SSP;

c) Endeavour not to have any Significant Safety Concerns (SSCs) under the USOAP Continuous Monitoring Approach (CMA) and to resolve any future SSCs within the time frame agreed with ICAO;

d) Collaborate with States/Administrations and the aviation industry through the Regional Aviation Safety Group (RASG) to organize capability-building events for the Region and implement Safety Enhancement Initiatives (SEIs) as stipulated in the Regional Aviation Safety Plan (RASP); and

e) Develop and publish a National Aviation Safety Plan (NASP).

4.0 Air Navigation Services

4.1 Commit to resources in modernization and innovation in Air Navigation Services, in tandem with developments in the airport and airline capacity, to support recovery and meet future demand for air travel and new entrants.

4.2 Commit to implement the ICAO Standards and Procedures for Air Navigation Services (PANS), and the Asia/Pacific Seamless ANS Plan (including prioritized GANP elements) and its subsidiary plans to enhance ANS capacity and harmonization in the Asia and Pacific Region focusing on as a matter of priority:

a. Phase I, II and III of the Asia/Pacific Regional Aeronautical Information Management (AIM);

b. Improved Airspace Safety and Capacity through the implementation of more efficient Air Traffic Control (ATC) separation minima;

c. Performance Based Navigation (PBN) implementation in accordance with ICAO Assembly Resolution A37-11 on Global PBN Goals;

d. Common Ground/Ground Telecommunication Infrastructure to support ANS applications;

e. Expediting the implementation of ICAO provisions related to System Wide Information Management (SWIM);

f. Enhanced civil/military cooperation;

g. Enhanced Surveillance capability for improved Safety and Efficiency;

h. Air Traffic Flow Management (ATFM) and Airport Collaborative Decision Making (A-CDM) implementation;

i. Air Traffic Management (ATM) contingency planning, in coordination with neighbouring States/Administrations;

j. Air navigation in national planning frameworks such as National Development Plans (NDPs) supported by National Air Navigation Plans (NANP); and

k. Enhancement of safety risk assessment capability.

4.3 Share best practices, resources and capability in the provision of ANS, including Aeronautical Search and Rescue (SAR), Meteorological Services for International Air Navigation (MET) and Air Traffic Flow Management (ATFM) through Regional cooperation and enhanced coordination.

4.4 Work collaboratively through ICAO and Regional collaborative platforms towards Seamless ANS, including Flight and Flow Information for a Collaborative Environment (FF-ICE) and Trajectory-Based Operations (TBO) to support future traffic growth and sustainability.

5.0 Aviation Security

5.1 Commit to continuing efforts and cooperation to uphold aviation security as a key priority, carry out effective aviation security oversight, enhance compliance with relevant ICAO aviation security and security-related Standards, joining forces to share security information as appropriate and foster a positive security culture.

5.2 Strive to achieve the aspirational goal of the GASeP as established, in particular, prioritize and commit resources to achieve the following objectives:

a) Improve score for the effective implementation (EI) of the critical elements (CEs) of the States/Administrations security oversight system;

b) Endeavour not to have any Significant Security Concerns (SSeCs) under the USAP Continuous Monitoring Approach (CMA) and to resolve any future SSeCs within the time frame agreed with ICAO;

c) Collaborate through Regional multilateral Forums such as; the Regional Aviation Security Coordination Forum (RASCF) to assist States/Administrations to achieve compliance with the relevant aviation security and security-related Standards.

6.0 Facilitation

6.1 Consistent with the facilitation-related Decisions of the ICAO 41st Assembly Session in October 2022 and the outcomes of ICAO's High-Level Conference on COVID-19 in 2021, strive to ensure coordination between civil aviation and various stakeholders, including the health authorities, to allow seamless implementation of ICAO Annex 9 — *Facilitation* and the ICAO's Facilitation Programme, including relevant health related provisions and the five key elements of the ICAO Traveller Identification Programme Strategy, and taking into account a multi-layered risk-based approach to establish national health and other facilitation measures.

7.0 Gender Equality

7.1 Demonstrate States/Administrations commitment to promote and encourage the aviation sector to take the necessary measures to strengthen gender equality by supporting policies, as well as the establishment, development and improvement of strategies and programmes to further women's careers within the aviation sector.

8.0 Resourcing for Civil Aviation

8.1 Commit to providing Civil Aviation Authorities/Administrations in the Region with the necessary autonomy and powers, sustainable sources of funding and resources to carry out effective safety and security oversight and regulation of the aviation industry or alternatively, as may be appropriate, consider establishing and delegating responsibilities to an RSOO (Regional Safety Oversight Organization) that can effectively support regulatory oversight for aviation safety and security.

8.2 Urge Asia and Pacific States /Administrations, other ICAO Member States, international assistance and donor partners, as well as financial institutions to enhance cooperation and provide technical expertise, resources and funding support for technical assistance, capacity-building initiatives and the implementation of the above commitments/actions in the Asia and Pacific Region.

9.0 Aviation Environment Protection

9.1 Encourage Asia and Pacific States/Administrations to continue their efforts and work together to reduce emissions and other environmental impacts of aviation.

10.0 Ratification of International Air Law Treaties

10.1 Encourage Asia and Pacific States, which so far have not done so, to ratify the Amendments to the *Convention on International Civil Aviation*, in particular, the amendments to Articles 50 (a) and 56 adopted by the ICAO Assembly 39th Session in 2016, as soon as possible.

10.2 Encourage Asia and Pacific States to consider becoming parties to the international air law treaties that they have not yet ratified.

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