INTERNATIONAL CIVIL AVIATION ORGANIZATION

FINAL REPORT OF THE SIXTH MEETING OF THE ICAO ASIA/PACIFIC GBAS/SBAS IMPLEMENTATION TASK FORCE (GBAS/SBAS ITF/6)

ICAO RO BANGKOK, 7-9 MAY 2024

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

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

1. INTRODUCTION

Meeting

1.1 The sixth Meeting of the ICAO Asia/Pacific GBAS/SBAS Implementation Task Force (GBAS/SBAS ITF/6) was held in ICAO Regional Office, Bangkok on 7-9 May 2024.

Attendance

2.1 A total of 59 participants from Australia, China, Hong Kong China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Philippines, Republic of Korea, Singapore, Thailand, USA, Vietnam, IFALPA and ICAO were registered for the GBAS/SBAS ITF/6. A list of participants is provided at Appendix B to this report.

Officers and Secretariat

3.1 Mr. V. K. Mishra, Regional Officer, PBN, ICAO APAC RSO was the Secretary of the meeting. He was supported by Mr. Xu Zhi Feng, Regional Officer, ATM, ICAO APAC RSO.

Opening of Meeting

4.1 Mr. V. K. Mishra, RO PBN welcomed all the participants. The meeting was conducted by the incumbent Co-Chairs of the ITF Mr. Susumu Saito, ENRI Japan, and Mr. George Wong, CAD, Hong Kong China.

Documentation and Working Language

5.1 The working language of the meeting and all documentation was in English.

5.2 A total of eight (8) Information Papers (IPs) and seven (7) Working Papers (WPs) were presented in the meeting. The list of papers and presentations is provided in Appendix A to this report. The papers are available on the webpage of the meeting; icao.int/APAC/Meetings/Pages/2024-GBAS-SBAS-ITF6.aspx

6. List of Decisions/Conclusions and Draft Conclusions/ Draft Decisions

6.1 The Sub-groups of APANPIRG record their actions in the form of Draft Conclusions, Draft Decisions, Conclusions and Decisions with the following significance:

1) Draft Conclusions deal with matters which, by the Sub-Group's Terms of Reference, require the attention of States or actions by ICAO following established procedures.

2) Draft Decisions relate solely to matters dealing with the internal working arrangements of APANPIRG and its contributory bodies.

3) Conclusions: Those Conclusions adopted by the Sub-group on behalf of APANPIRG on technical matters; and

4) Decisions relate solely to matters dealing with the internal working arrangement of the Sub-group only

6.2 List of Draft Conclusions

Draft Conclusion GBAS/SBAS ITF 6/01 - Draft Guidance Document for Implementation of GBAS in the Asia/Pacific Region.

6.3 List of Draft Decisions

Nil

6.4 List of Decisions

Nil

6.5 List of Conclusions

Nil

REPORT ON AGENDA ITEMS

Agenda Item 1: Adoption of Agenda

1.1 The following proposed agenda was adopted by the meeting.

Agenda Item 1: Adoption of Agenda

Agenda Item 2: Progress on the work of Expert Group constituted to:

- Draft Guidance Document on Implementation Process for GBAS & SBAS.

Agenda Item 3: Updates on GBAS-SBAS & States's Implementation status

Agenda Item 4: GNSS Interference and its impact to GBAS & SBAS

Agenda Item 5: Review of Action Item List

Agenda Item 6: Any Other Business

Agenda Item 7: Date and Venue of Next Meeting

Agenda Item 2: Progress on the work of Expert Groups

2. Progress on the work of Expert Groups

2.1 WP 01- Updates on Draft Decisions of GBAS-SBAS ITF-5 -Secretariat

The Secretariat informed the meeting status of the draft Conclusion taken in GBAS-SBAS ITF 5:

- Draft Conclusion GBAS/SBAS ITF 5/01 - Draft GBAS safety assessment guidance document related to anomalous ionospheric conditions was reviewed and adopted by CNS-SG/27 through Conclusion CNS SG/27/06
- Draft Conclusion GBAS-SBAS ITF 5/02 - Draft SBAS safety assessment guidance document related to anomalous ionospheric conditions was reviewed and adopted by CNS-SG/27 through Conclusion CNS SG/27/07.
- Draft Conclusion GBAS-SBAS ITF 5/03 - GBAS and SBAS Elements in Revised Navigation Strategy for APAC was reviewed and adopted by CNS-SG/27 through Conclusion CNS SG/27/08, which was endorsed by APANPIRG Conclusion APANPIRG/34/10.
- Draft Conclusion GBAS-SBAS ITF 5/04 - Extension of the Asia/Pacific GBAS/SBAS Implementation Task Force to complete tasks as per TORs of GBAS/SBAS ITF. The GBAS-SBAS

ITF has been extended for another three-year term (up to 2026) by CNS SG/27 through Conclusion CNS SG/27/08 to complete the following remaining tasks for fulfilling the objectives stated in the Terms of Reference (ToRs) of the APAC GBAS/SBAS ITF:

- GBAS and SBAS implementation guidance documents.
- Workshop/Meeting for APAC airspace users and regulators; and
- Discussion and deliberation on technical issues in relation to GBAS/SBAS Safety Assessment and Performance Demonstration.

2.2 WP 02 – Expert group 3-2 – Guidance Document on Implementation Process for GBAS - Co-chair

Mr. George Wong, Co-Chair of the task force, presented the progress of Expert Group 3-2 in developing the guidance document for the implementation of GBAS. The first draft of guidance document for implementation of GBAS was presented in APAC GBAS/SBAS ITF/5 for seeking/collecting comments from States/Administration on the draft guidance document. Taking reference to those comments raised in APAC GBAS/SBAS ITF/5, multiple rounds of review were conducted through web-meeting and circulation by emails, involving Expert Group members and delegates of States/Administration, for discussion on those consolidated comments/proposed amendments after APAC GBAS/SBAS ITF/5. The revised version draft guidance document for GBAS Implementation after rounds of review was placed at Attachment A for members' final review and endorsement by the Task Force Meeting for onward referral to seek approval by CNS SG.

After thorough discussion on each paragraph of the draft guidance document, a draft conclusion was proposed for members' discussion and agreement for seeking further endorsement by CNS SG on the draft guidance document for implementation of GBAS in the Asia/Pacific Region:

<table>
<tr><td colspan="3">Draft Conclusion GBAS-SBAS ITF 06/01 - Draft Guidance Document for Implementation of GBAS in the Asia/Pacific Region</td></tr>
<tr><td colspan="2">What: the draft guidance document for implementation of GBAS in the Asia/Pacific Region developed by the APAC GBAS/SBAS ITF and provided in Attachment A of the Working Paper 02 (WP 02) is ready for endorsement by CNS SG</td><td>Expected impact:
☐ Political / Global
☐ Inter-regional
☐ Economic
☐ Environmental
☒ Ops/Technical</td></tr>
<tr><td>Why: To provide guidance to States for the implementation of GBAS</td><td colspan="2">Follow-up: ☐Required from States</td></tr>
<tr><td>When: 9th May 2024</td><td colspan="2">Status: Draft to be adopted by APANPIRG</td></tr>
<tr><td colspan="3">Who: ☒CNS Sub group ☐APAC States ☒ICAO APAC RO ☐ICAO HQ ☐Other:</td></tr>
</table>

2.3 WP 03 – Expert group 3-1 – Guidance Document on Implementation Process for SBAS - Co-chair

Mr. Susumu Saito, Co-Chair of the task force, presented the points of discussion on the SBAS implementation guidance document. Since the last meeting of the Task Force (GBAS/SBAS ITF/5) held in June 2023, the draft guidance document on SBAS has been uploaded to the ICAO SharePoint for review and modification by the Expert Group members. The Expert Group also met online three times (11 September, 17 October, and 5 December 2023) to discuss proposed modifications and address comments raised. However, the Expert Group could not finish considering and addressing all the modifications and comments. The draft SBAS implementation guidance document has not been matured yet, and still needs further revision. This working paper summarized the points of discussion on the SBAS implementation guidance document. Specific points for further discussion and consolidation are summarized in Table 1 of WP 03. The meeting was invited to consider the way forward to revise and finalize the guidance document with the proposed timeline given in Appendix A of WP 03 and urged States/Administrations to contribute to the guidance document development through the Expert Group.

The meeting agreed to work as per the proposed timeline so as to have the first draft presented in the GBAS-SBAS ITF/7 meeting for onward referral to seek CNS SG's endorsement.

Agenda Item 3: Updates on GBAS/SBAS and States' Implementation status

3.1 WP 04 - GBAS status update and further operational experiences (Australia)

Australia briefed the meeting on Australia's GBAS status, information on in-service observations and an update on the number of GLS capable aircraft operating in Australian airports. The meeting was informed that:

- Australia continues to experience incidences of a reduction in GLS Service Availability due to the prevailing Global Positioning System (GPS) satellite constellation in combination with the use of Ionosphere Threat Model. Furthermore, Australia continues to experience incidences of lightning induced damage to the GBAS equipment.
- Australia increased the Routine Flight Inspection interval for the GBAS from 12 months to 60 months. Since the introduction of the new interval, there has been no observable effect on GBAS performance.

USA asked about the GLS procedure allocation rate by ATC in view of equipage rate in Australia. Australia informed the meeting that the expected approach at Sydney and Melbourne was GLS. IFALPA observed that international pilots were seldom given GLS approach at Sydney and asked about percentage of domestic and international pilots operating in Australian airports using the GBAS. Australia informed the meeting that GLS remained the expected approach at Sydney and Melbourne. Singapore also asked whether it was planning to use GLS to replace the ILS. Australia informed that ILS would be maintained. Hong Kong China asked about the GLS loss risk mitigation measure. Australia informed that alternate procedures and visual approaches were the option. China asked whether the number of satellites was less than four, whether GBAS system would provide alert and whether there was status indicator of GBAS in tower. Australia informed that GBAS system is designed in such a way that it would issue alert in this case. Pakistan enquired whether the investigation and analysis of GLS loss resulted in any modification to the GBAS ground system, Australia informed that there was none so far.

3.2 IP 01 - SouthPAN status update (Australia)

Australia presented a summary of the SouthPAN program, which will provide a SBAS aeronautical radio navigation service to Australia and New Zealand by 2028 to support en-route, terminal, NPA, and APV flight operations across Australia and New Zealand. The service is currently broadcasting Early Open Services on the L1 and L5 navigation signals. A preliminary probabilistic analysis has identified potential challenges with meeting the ICAO Annex 10, Volume 1 Continuity of Service navigation performance requirements for specific types of approaches with vertical guidance enabled by SouthPAN. Australia is currently exploring available options to notify pilots of predicted periods when specific types of SBAS enabled approaches may be unavailable.

3.3 IP02- GBAS Status Update in Japan (Japan)

Japan presented the status of GBAS implementation in Japan. Japan Civil Aviation Bureau (JCAB) installed the first GBAS at Tokyo international airport (HND) and is conducting CAT-I trial operation. The goal of the trial operation will be achieved shortly. The Electronic Navigation Research Institute (ENRI) has contributed to the improvement of GAST-D performance in low latitude regions. Currently, ENRI is engaged in research and development activities related to GBAS, including the development of the DFMC GBAS concept and advanced operations with GBAS. The paper highlighted the following main points on GBAS in Japan:

- Japan developed ionospheric threat model in order to meet the requirements for CAT-I operations in the low magnetic latitude region.
- Japan developed IFM (ionospheric field monitor) to mitigate the navigation error due to the ionospheric abnormality.
- Two Japanese airlines, ANA and JAL, conducted GLS trial approaches.
- Pilots' feedback indicated that GLS provided a more stable approach, compared to ILS.
- JCAB observed that good flight inspection data was necessary for approach minimum reduction.
- JCAB is considering and coordinating the start of GBAS operations, including revisions to the final approach procedure.
- The future challenge is to establish the skills and procedures necessary to periodically validate and update the ionospheric model.
- Japan developed a CAT-III GBAS prototype for R&D in 2014.
- The testbed of DFMC GBAS developed and deployed at Ishigaki, Japan in 2019.

Pakistan asked when GLS Cat III would be published. Japan clarified that GBAS III project was experimental in nature for R&D purposes. Japan confirmed that GBAS position information would be used for Taxi guidance. In response to Singapore's query on whether there was any timeline for promulgation of GLS Cat I, Japan advised that updates would be provided in the GBAS-SBAS ITF/7 meeting.

3.4 IP03- MSAS Program Update (Japan)

Japan informed the meeting that the MSAS was declared operational in 2007 up to NPA due to ionospheric effect. Commercial flight-based trial operations of RNP approach procedures with LPV250 minima was ongoing within limited time at seventeen airports in Japan. The trial operations contributed to an increase in opportunities for landing at local airport and reduced CO2 emission. The feedback from the operators was to identify the need for improvement of system performance.

The Research and development activities on Dual Frequency Multi constellation MSAS (DFMC MSAS), including message authentication using L5 QPSK signals, were undergoing at the Electronic Navigation Research Institute (ENRI).

3.5 IP 04 - KOREAN SBAS (KASS) AIP and Operation (Republic of Korea)

The meeting was informed that:

- The Republic of Korea completed the Development and Implementation of Korean SBAS (KASS, Korea Augmentation Satellite System)
- KASS system comprises of seven KASS Reference Stations (KRSs), two KASS Processing Stations (KPSs), two KASS Control Stations (KCSs) and three KASS Uplink Stations (KUSs at 2 sites).
- KASS is augmenting the GPS L1 signal and providing the APV-I approach services at first in the Incheon FIR.
- KANSC has been analyzing the KASS signal performance of SIS (Signal in Space) since the APV-I class SoL service was first broadcasted on 28th December 2023. Long-term data accumulation is required. However, for the accuracy of the KASS system, the horizontal accuracy is within 1.2~1.7m and the vertical accuracy is within 2.2~2.7m (March 2024).
- KASS is certified by MOLIT with support from experts in certification, safety, and software domain.

3.6 IP 05 - GBAS IMPLEMENTATION STATUS IN MALAYSIA

Malaysia informed the meeting that:

- Ground-Based Augmentation System (GBAS) had been installed in Kuala Lumpur International Airport (KLIA) to support PBN approach procedures CAT 1 for all runways in KLIA.
- Based on the ionospheric analysis, it was recommended to schedule Kuala Lumpur GBAS operations between 10 PM and 6 PM.
- GBAS flight inspection and commissioning were carried out in November 2019.

ICAO clarified that GNSS was not a part of PBN. Malaysia asked when the guidance document for the implementation of GBAS would be available so that they could use that to reach out to their regulator. The co-chair replied that the guidance document would be ready after this meeting. Thailand asked the status of GBAS as it started in 2018. Malaysia informed that GBAS was on, and data was being collected.

3.7 IP 06- Report of GBAS Proof-Of-Concept Project at Suvarnabhumi International Airport (Presented by Japan and Thailand)

This paper presented the summary of the GBAS Proof-Of-Concept (PoC) Project between Japan and Thailand. The project successfully demonstrated that the GBAS equipment operated within ICAO standards using Thailand's Ionospheric Threat Model developed from local data collection. Throughout the project, issues regarding scintillation and RF interference occurred. While changing the antenna addressed scintillation issues, further work is required to mitigate the RF interference.

The GBAS PoC Project successfully demonstrated that GBAS operating in low geomagnetic latitude area affected by the ionospheric irregularities complied to ICAO standards. In achieving operation within the standards, local data should be collected and used to develop an ionospheric threat model that could signify the local ionosphere of the area of operations. This helps giving a more accurate bound (less conservative) of actual occurrences of the effects of the ionosphere thus providing a better performance of the installed GBAS system.

Malaysia asked how Thailand decided the location of antenna to mitigate the interferences. Thailand informed that the experiments were in progress and AEROTHAI would decide the best location available in the airport.

Singapore wanted to know how one change in antenna solved the RFI. Thailand informed the meeting that it was for limited period and that controlled trials were needed. Per Singapore's query, Thailand confirmed that conservative threat model was used.

Pakistan asked how unintentional interference could be solved. Thailand informed the meeting that they were still working on that and that Collaboration with the police, military, frequency regulatory department was needed. Some interference was unintentional to aviation but intentional for other purposes.

3.8 WP 05 - GBAS Siting Considerations at Changi Airport (Singapore)

Singapore aims to install GBAS at Changi Airport to enhance approach and landing flexibility. Singapore shared some GBAS Siting considerations which focused on multiple VDB coverage simulations, based on the antenna heights and locations, so to ensure continuous operations with minimum disruptions due to complex airport environment.

- Multiple VDBs may increase redundancy of the GBAS coverage for different runway ends.
- The increased VDB antenna height will improve service coverage for CAT I GLS operations.

Co-chair, Mr. Saito, asked about the need for multiple VDBs. Singapore explained that this was for redundancy purpose. Singapore informed that it was collecting data for the study and research. In response to Malaysia's query on timeline of GBAS implementation Singapore informed that it was planned to implement by 2027.

Agenda Item 4: GNSS Interference and its impact to GBAS & SBAS

4.1 WP 06 - ICAO Recommendations and Guidance on GNSS Vulnerability (Secretariat)

The Secretariat presented an overview of ICAO's Recommendations and Guidance on Global Navigation Satellite System (GNSS) vulnerability, including the following:

- Recommendation 6/2 of 11th Air Navigation Conference
- Electronic Bulletin, EB 2011/56 on Interference to GNSS Signals
- Recommendation 6/8 of 12th Air Navigation Conference
- Memorandum of Cooperation with the International Telecommunication Union (ITU)
- ICAO NSP Liaison Statements to RTCA and EUROCAE on Increased Protection of GNSS Receivers
- Guidance on GNSS vulnerability & mitigation provided in GNSS Manual (DOC 9849)

- 40th Session of the Assembly / State Letter 2020/89 / ITU Circular Letter 488
- ICAO APAC Office issued State Letter T 8/5.10 : AP099/22 (CNS) dated 21 July 2022
- Appendix C to Assembly Resolution 41-8
- Resolution on prevention and mitigation of harmful interference to GNSS (Resolution COM 5/5 (WRC-2023)
- APANPIRG Conclusion 8/43 - GNSS Frequency Based Interference (1997), Conclusion 9/32 - GNSS Frequency Protection (1998), Conclusion 22/28 - Protection of aviation utility of GNSS (2011), Conclusion APANPIRG/27/36: Protection of GNSS signal against jamming (2016).
- Forms for GNSS Interference Reporting in APAC

Japan observed that spoofing was very difficult to identify and whether there was any guidance available. Co-chair, Mr. Saito, informed that some guidance on spoofing could be found in ICAO GNSS Manual.

4.2 WP 07 - Experience with the effect of GNSS Radio Frequency Interference to GBAS operations in Australia

Australia shared experience on Global Navigation Satellite System (GNSS) Radio Frequency Interference (RFI) events observed in Australia, their impacts to the Ground Based Augmentation System (GBAS) and measures in place in Australia to mitigate the effect of GNSS interference to GBAS Landing System (GLS) operations. Since the deployment of GBAS, there has only been one instance for the GBAS ground station stopped broadcasting pseudo-range corrections due to GNSS RFI. This resulted in a momentary loss of GLS service. A summary of measures in place in Australia to mitigate against GNSS interference is given below:

• the GBAS siting process assesses the likelihood of interference from the environment that may impact Reference Receiver performance. This will include the collection of GPS data at candidate sites to identify any potential interference sources.

• the GBAS ground station Reference Receivers are sited as far as practicable away from public roadways to minimize the likelihood of interference from any Personal Privacy Devices.

• prior to the introduction of GBAS at a site, aircraft ADS-B FOM PA data is analyzed to identify any potential interference along approach paths that will be supported by the GBAS.

• Australia has a robust regulatory framework in place to protect the Aeronautical Radio Navigation Service band. All devices operating within this band must be appropriately licensed by the Australian spectrum management authority. Furthermore, Personal Privacy Devices (e.g. jammers) are prohibited in Australia; and

• the Australian spectrum management authority conducts awareness campaigns.

4.3 IP 08- GNSS RFI monitoring service by JCAB in Japan

Japan Civil Aviation Bureau (JCAB) established the Network Performance Assessment Center (NPAC) in 2020 for the mission of centrally monitoring, analyzing, and assessing service levels of CNS as the core of CNS performance management. This paper introduced the performance monitoring of GNSS conducted by NPAC. NPAC collected GNSS signals by GPM system and provided the following three services to users.

a) GNSS Performance Prediction Service providing availability forecasts for ABAS and SBAS

b) GNSS Performance Monitoring Service providing information on the impact on operations utilizing GNSS

c) GNSS Performance Analysis and Evaluation Service conducting analysis and evaluation of GNSS performance for safe and continuous utilization of GNSS

The Co-Chair asked whether the problem report form mentioned only ADS-B but not GNSS. Japan informed that SBAS and GBAS were not included in the problem report, and it had a plan to include those.

Agenda Item 5: Review of the Action list

5.1 The Action List of the task force is a collection of technical matters identified during the first meeting of the task force. It provides description, relevance, ownership, and priority to be assessed in each meeting. A review of the status of tasks in the Action List was conducted in the meeting and the follow-up actions, as well as revised target dates, of outstanding tasks were discussed and deliberated in the meeting. Some of the action items had been closed as those actions had been completed and new target dates had been assigned for the remaining ones per the discussion among members in the meeting. The updated Action list as concluded in the meeting is attached as **Appendix C**.

5.2 As per latest status in the updated Action List, the following tasks in high priority are still outstanding:

(a) Organize a workshop with airspace users of APAC Region

(b) Organize a specific meeting with APAC regulators interested in GBAS/SBAS

(c) GBAS and SBAS Safety Assessment

(d) GBAS/SBAS Performance Demonstration

(e) Develop SBAS Implementation Guidance Document

The meeting after deliberation considered these remaining tasks essential for fulfilling the objectives of the Terms of Reference (TORs) of the Asia/Pacific GBAS/SBAS Implementation Task Force (APAC GBAS/SBAS ITF).

Agenda Item 6: Any Other Business

6.1 IP 07 - Current Status of GBAS-SBAS Discussion in Navigation Systems Panel - Co-Chair

Co-chair of ITF, Mr. Susumu Saito, presented the status of discussion in the ICAO Navigation Systems Panel on GBAS and SBAS including standards for DFMC GBAS and its advantages, such as deemed to be able to provide availability even under severe ionospheric conditions. The meeting was also informed that:

- The GBAS Working Group is developing a baseline airborne MOPS and a baseline development DFMC GBAS to be delivered by Q4 2024.

- To support deployment of existing GBAS (GAST C and D), updates and maintenance of existing ICAO standards, guidance materials, and manuals, Doc8071 Vol. II are being updated and will further be discussed in the next NSP JWGs/12 meeting.
- GWG will work on creating a GBAS manual.
- A mature version of the SBAS authentication concept of operations document is planned to be delivered by November 2024.

Pakistan asked whether there was any guidance material regarding the certification of SBAS by the states(regulators). Co-chair informed that some guidance would be part of the guidance document for SBAS implementation.

Agenda Item 7: Date and Venue of Next Meeting

The Co-chairs proposed to conduct the 7th Task Force meeting in the first half of 2025. ICAO proposed that the States willing to host the next meeting should write to the Secretariat APAC-RSO@icao.int

Closing of Meeting

Co-Chairs and Mr. V K Mishra thanked all participants for their fruitful contributions and closed the meeting.

Appendix A

List of Papers

Information Papers

IP-01- SouthPAN Program Status Update - Australia

IP-02- GBAS Status in Japan

IP-03- MSAS update - Japan

IP-04- KOREAN SBAS (KASS) AIP and Operation - Korea

IP-05- GBAS Implementation Status - MALAYSIA

IP-06- Report of GBAS Proof-Of-Concept Project at Suvarnabhumi International Airport - Thailand

IP-07- Current Status of NSP discussion related to GBAS-SBAS- Co-chairs.

IP-08- GNSS RFI monitoring service by JCAB in Japan

Working Papers

WP-01- Updates on Draft Decisions of GBAS-SBAS ITF-5 -Secretariat

WP-02- Draft GBAS Implementation Guidance Materials – Co-chairs

WP-03- Draft SBAS Implementation Guidance– Co-chairs

WP-04- GBAS Status update and Operational Experiences- Australia

WP-05- GBAS Siting Considerations by CAAS-Singapore

WP06- ICAO Recommendations and Guidance on GNSS Vulnerability- Secretariat

WP 07- GNSS Interference observations in Australia