



International Civil Aviation Organization

**THE EIGHTH MEETING OF THE ASIA/PACIFIC GBAS/SBAS
IMPLEMENTATION TASK FORCE (GBAS/SBAS ITF/8)**

(Melbourne, Australia, 12-14 May 2026)

Agenda Item 4: Updates on GBAS/SBAS system and States' implementation status

RESEARCH ACTIVITIES RELATED TO GBAS AND SBAS IN JAPAN

(Presented by Japan)

SUMMARY

This paper presents the research and development activities related to GBAS and SBAS in Japan. For GBAS, GAST D performance enhancement, DFMC GBAS standardization, and advanced operations utilizing GBAS are being studied. SBAS message authentication schemes and utilization of SBAS in high latitude regions are the focuses of SBAS-related studies.

1. INTRODUCTION

1.1 Electronic Navigation Research Institute (ENRI), Japan has been conducting a research on the GBAS and SBAS for more than 30 years. The research focuses on GBAS include aspects of system development as well as advanced operations based on GBAS. ENRI has also deeply involved in development of SBAS including support for MSAS implementation and standardization of SBAS.

1.2 This information paper summarizes the current status of research and development activities on GBAS and SBAS by ENRI in Japan.

2. DISCUSSION

GAST D availability enhancement for low latitude regions

2.1 It has been shown that the availability of the GAST D service may not be sufficient in ionospheric active regions such as low magnetic latitude region. To improve the availability of GAST D service, it is proposed to use the ionospheric field monitor (IFM) which is an additional station to monitor ionospheric spatial gradient (Figure 1) and previously been proposed for use with GAST C.

2.2 Even with an ionospheric threat model equivalent to the APAC model (maximum gradient of 600 mm/km), exhaustive simulations showed that the IFM was effective in reducing residual differential errors (Figure 2) and high availability could be achieved. Furthermore, the locations of the IFM station to achieve high availability is flexible [1].

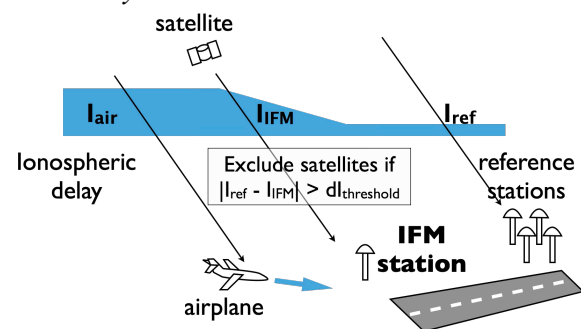


Figure 1. Concept of the ionospheric field monitor (IFM)

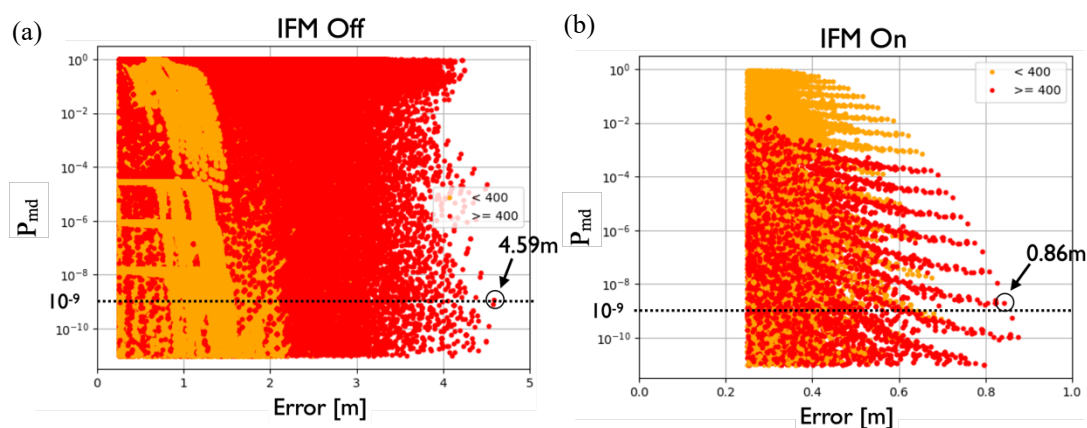


Figure 2. Example of simulation results of residual differential range errors (a) without IFM and (b) with IFM.

DFMC GBAS (GAST E)

2.3 Research on the DFMC GBAS has been conducted since 2015. The main objective of the research is to enhance performances of GBAS under ionospheric active conditions such as the low magnetic latitude region. ENRI contributes with the research to the DFMC GBAS SARP's development activities by ICAO. ENRI is working on defining GBAS messages (Message Types 23, 50, and additional data blocks of Message Type 2) as a member of ICAO NSP GWG DFMC GBAS SARP's drafting group [2].

2.4 The research on DFMC GBAS is conducted with the DFMC GBAS testbed installed at Ishigaki (24.4°N, 124.3°E, 19.7° in the magnetic latitude) (Figure 3) and the DFMC GBAS airborne mockup. 8 flight data collection campaigns have been conducted since February 2020 including the last campaign in September 2025. 58 flights were conducted and 14 of them were under strong or moderate ionospheric activities.

2.5 ENRI will continue operating the DFMC GBAS testbed to collect data as much as possible while the solar activity is high. The next flight data collection campaign is planned in October 2026.

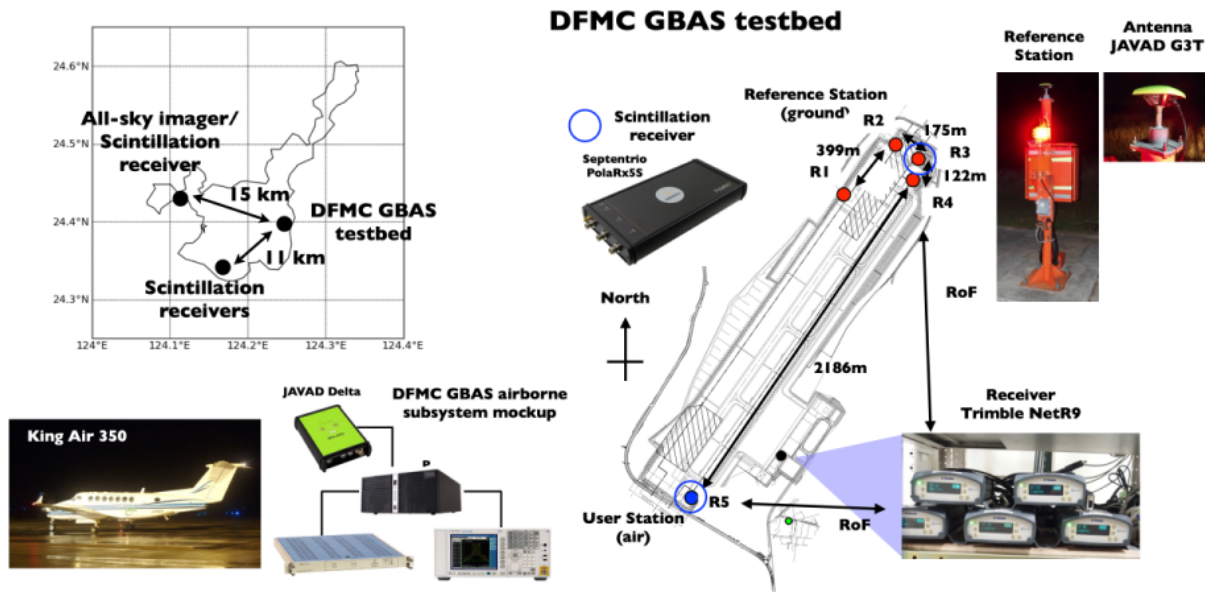


Figure 3. DFMC GBAS testbed at Ishigaki and DFMC airborne mockup.

Advanced operations by using GBAS

2.6 The research program on the advanced operations by utilizing GBAS including the following three major objectives.

- (1) Development of fundamental operational concepts for increased glide path (IGP) approaches and secondary runway aiming point (SRAP) operations utilizing GBAS.
- (2) Development of an operational concept and a testbed of pilot support tool for runway exit and taxi guidance using GBAS functions.
- (3) Evaluation of reduced runway occupancy time with GAST D where ILS equivalent critical and sensitive areas is not required in congested airports.

2.7 Details of the program and major outcomes are provided in the separate IP to this meeting.

Research topics related to SBAS

2.8 ENRI has developed a prototype of DFMC SBAS [3]. The DFMC SBAS prototype has been used for validation of DFMC SBAS standards. It is continuously running at ENRI, and sometimes DFMC SBAS experimental messages are broadcast from QZSS satellites.

2.9 One of the current focuses of SBAS standardization is the SBAS message authentication schemes. ENRI has developed a prototype software for SBAS message authentication. ENRI is working on integrating it into the DFMC SBAS prototype for final validation of SBAS message authentication SARPs.

2.10 In the DFMC SBAS, SBAS messages can be broadcast not only from geostationary satellites (GEOs) but also from non-GEO satellites. ENRI is studying possible SBAS services in very high latitude regions where signals from GEOs cannot be received. Experiments in northern Europe have been conducted to evaluate the performance of DFMC SBAS in the arctic region by using DFMC SBAS messages broadcast from QZSS satellites in non-GEO orbits [4,5].

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to:

- a) note the information contained in this paper; and
- b) discuss any relevant matters as appropriate.

REFERENCES

- [1] Saito, S., & Yoshihara, T. (2026). Enhancing GAST D availability by using an ionospheric field monitor. NAVIGATION, 73(1). <https://doi.org/10.33012/navi.731>
- [2] Saito, S., Tuffaha, M., Topland, M., Lavik, L., Murphy, T., McGraw, G., Wichgers, J., "Utilization of Full-Resolution Ground Code and Carrier-Phase Measurements in DFMC GBAS (GAST E)," Proceedings of the 38th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2025), Baltimore, Maryland, September 2025, pp. 250-262. <https://doi.org/10.33012/2025.20301>
- [3] Kitamura, M., & Sakai, T. (2019). DFMC SBAS prototype system performance using global monitoring stations of QZSS. Proc. of the 2019 Pacific PNT Meeting, Honolulu, HI, 382–387. <https://doi.org/10.33012/2019.16789>
- [4] Takahashi, T., Saito, S., Kitamura, M., & Sakai, T. (2025). Performance evaluation of DFMC SBAS messages broadcast by the Japanese Quasi-Zenith Satellite System (QZSS) and received in Oslo, Norway. NAVIGATION, 72(2). <https://doi.org/10.33012/navi.692>
- [5] Takahashi, T., Nishiyama, T., Kitamura, M., Saito, S., Hashimoto, T., & Sakai, T., “Performance of DFMC SBAS Broadcast from non-GEO Satellites in the Arctic Region,” ION Pacific PNT, Honolulu, Hawaii, April 2026.

Executive Summary for consideration for inclusion in the Meeting Report**RESEARCH ACTIVITIES RELATED TO GBAS AND SBAS IN JAPAN**

This paper presents the research and development activities related to GBAS and SBAS in Japan. For GBAS, GAST D performance enhancement, DFMC GBAS standardization, and advanced operations utilizing GBAS are being studied. The ionospheric field monitor (IFM) was shown to be effective in implementing GAST D in the low latitude regions. The DFMC GBAS testbed at Ishigaki, Japan is used for DFMC GBAS standardization to make it available under active ionospheric conditions. Advanced operations utilizing GBAS is an important topic to accelerate implementation of GBAS. The DFMC SBAS prototype has been developed by ENRI and used as a core system of its researches. ENRI is contributing to validation of the SBAS message authentication schemes. Extending services to very high latitude by using SBAS messages broadcast from non-GEO satellites are being exploited.