International Civil Aviation Organization

THE FOURTH MEETING OF THE ASIA/PACIFIC GBAS/SBAS IMPLEMENTATION TASK FORCE (APAC GBAS/SBAS ITF/4)

(Video conference, 11-12 May 2022)

Agenda Item 3: Updates from States/Administrations about GBAS/SBAS Implementation

UPDATE ON GBAS PROOF-OF-CONCEPT PROJECT

(Presented by Japan and Thailand)

SUMMARY

This paper presents an update of the GBAS Proof-of-Concept (PoC) Project between Japan and Thailand focusing on the update of installation progress and the ionospheric threat model development for the GBAS PoC equipment at Suvarnabhumi International Airport in Bangkok, Thailand.

1. INTRODUCTION

1.1 The GNSS-based navigation for aeronautical applications was officially initiated in Thailand in 2007 when Thailand's National Working Group for PBN and GNSS Implementation was established. After that, the Thailand PBN implementation plan was developed and approved in 2009. This plan corresponded to the APAC regional PBN implementation plan developed by the ICAO APAC regional office. Consequently, the instrument flight procedures (e.g. En-Route, Terminal and, Approach) were officially published. In January 2017, the Thailand PBN implementation plan was revised to be in line with the current Regional APAC Seamless ATM Plan. In this plan, the GBAS is planned to be installed at selected airports (Phuket International Airport first and then Suvarnabhumi International Airport). However, the project has been delayed due to the financial impacts of the COVID-19 pandemic.

1.2 Since Thailand is located in the low geomagnetic equatorial region which is affected by the ionospheric irregularities (e.g. equatorial plasma bubble (EPB) and equatorial ionization anomaly (EIA)), the assessment of its impact is necessary for approving GBAS operations in Thailand. In early 2019, the Ministry of Internal Affairs and Communications (MIC) and the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) of Japan has initiated a joint technical collaboration between Japan and Thailand called the "GBAS Proof-of-Concept (PoC) Project". The main objective of this collaboration project is to install GBAS PoC equipment at Suvarnabhumi International Airport and conduct an experiment for the deployment of GBAS at low geomagnetic latitude area, of which the performance is affected by the ionospheric irregularities. The expected outcome of this collaboration project would be beneficial for both sides as well as to facilitate other member states for the effective implementation of GBAS in the Asia-Pacific region.

2. PROJECT OVERVIEW

2.1 The GBAS PoC project is supported by the MIC through the industrial promoting program that supports Japanese industries' activities to solve the social problems/challenges in Asian countries by using Japan's cutting-edge wireless technologies. The NEC Corporation is contracted by the MIC to provide the GBAS PoC equipment and technical support for this project to assist the host countries with familiarization on GBAS and can move forward for a decision of GBAS implementation in the future.

2.2 The timeframe of this project is during2020-2023. The summary of annual plan activities is shown below,

Year	Key Activities
2020	- initial ionospheric threat model preparation - construction and installation preparation - equipment preparation
2021	- ionospheric threat model preparation (continue) - equipment construction and installation work
2022	- equipment evaluation - flight demonstration preparation - training and technical transfer - flight demonstration and performance evaluation
2023	- flight demonstration and performance evaluation (continue).

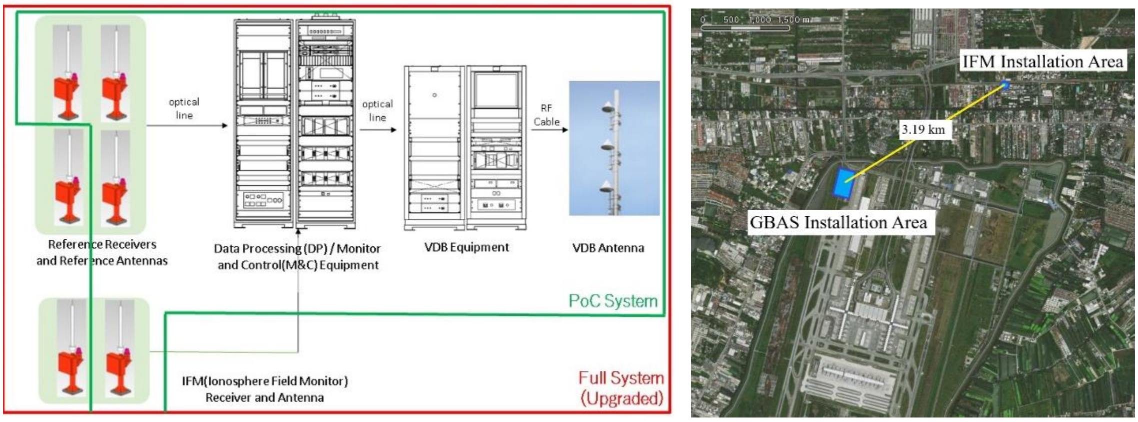

Figure 1. The GBAS PoC system configuration (left) and installation location (right)

2.3 Figure 1 shows the GBAS PoC system configuration and installation location. Whereas Figure 2 shows the construction layout of the reference receivers and VDB. Three reference receivers (RR), data processing, and VDB (VHF Data Broadcast) transmitter have been installed above the end of runway 19R of Suvarnabhumi International Airport. In addition, the IFM (Ionosphere Field Monitor) has been installed at the King Mongkut's Institute of Technology Ladkrabang (KMITL) campus to detect ionospheric disturbances.

Figure 2. Construction layout of the GBAS PoC System at Suvarnabhumi International Airport

3. UPDATE ON CONSTRUCTION PROGRESS

3.1 The construction of the GBAS PoC equipment by NEC Corporation at Suvarnabhumi International Airport is now completed as can be seen in the Figure 3 and 4 below,

Figure 3. GBAS Shelter and VDB antenna (left) and RR antenna (right) installed at Suvarnabhumi International Airport

Figure 4. IFM Antenna and Receiver

4. UPDATE ON IONOSPHERIC THREAT MODEL DEVELOPMENT

4.1 To evaluate the impacts of ionospheric irregularities for GBAS, the ionospheric threat model will be developed by the Aeronautical Radio of Thailand (AEROTHAI) with the technical support by the Electronic Navigation Research Institute (ENRI) and King Mongkut's Institute of Technology Ladkrabang (KMITL). The collected GPS data since 2012-now will be analyzed to estimate the background residual ionospheric uncertainty during the ionospheric quiet and disturbed conditions. The ionospheric delay gradient, front velocity, and front width during the ionospheric disturbed conditions will be estimated for the ionospheric threat model development.

4.2 The preliminary ionosphere characteristics from the year of 2012 and 2020 (represented high and low solar activities, respectively) of Bangkok have been evaluated by AEROTHAI using the single-frequency carrier-based and code aided (SF-CBCA**)** method [1], courtesy of ENRI. The GNSS Data was collected from 3 receiver located at 3 different sites, Stamford International University, KMITL and in Suvarnabhumi International Airport (01L Localizer station) (Figure 5).

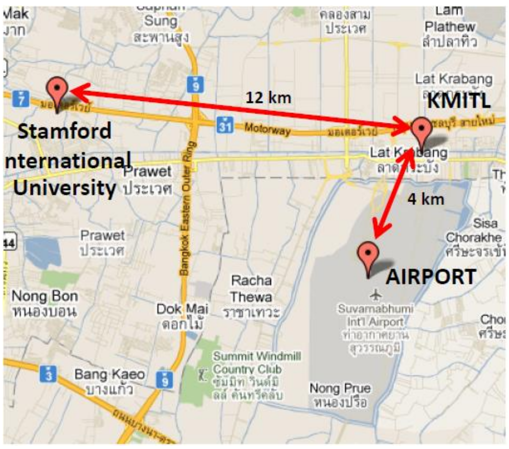

Figure 5. GNSS stations used for ionospheric threat model development

4.3 The SF-CBCA method estimates the single-difference of ionospheric delay between a pair of GNSS receivers of which relative positions are known. Float solutions are estimated using Kalman filtering then fixed using the double-difference of the integer ambiguity of carrier-phase measurements. The initial result of the method after validation of ambiguity resolution are summarized as follows in Figure 6 and Table 1.

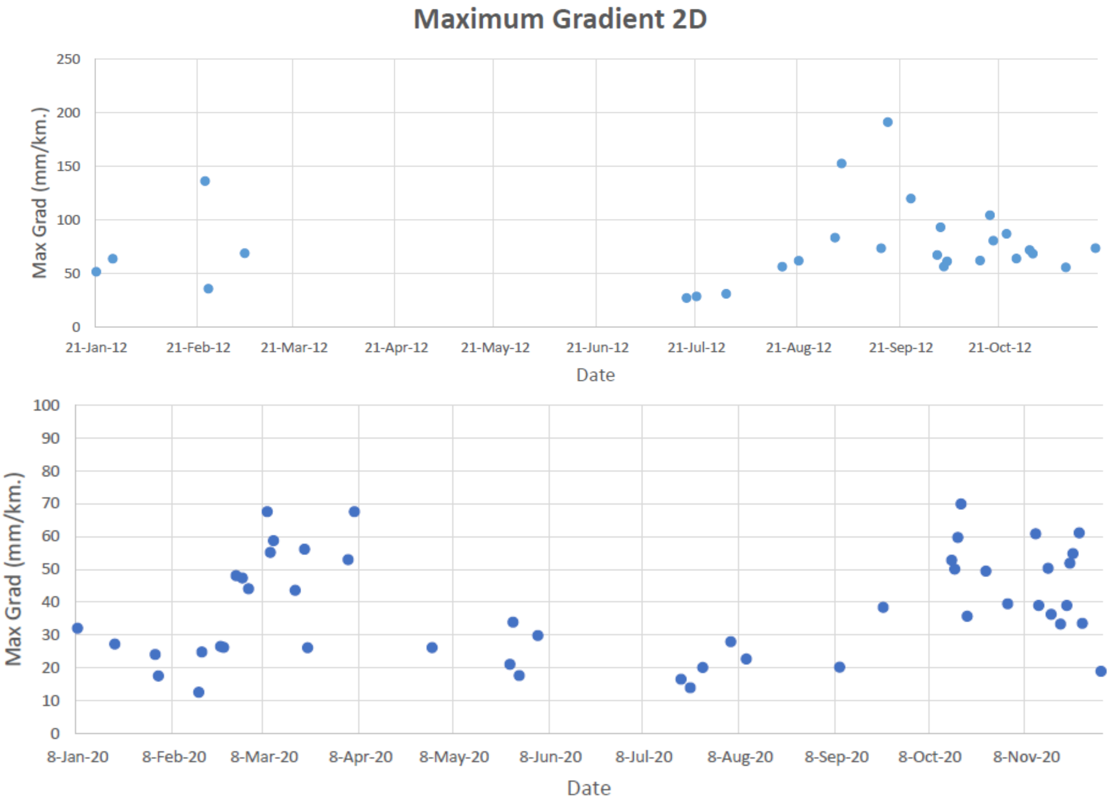

Figure 6. Maximum ionospheric delay gradients observed in 2012 (top) and 2020 (bottom)

Table 1. Preliminary ionospheric threat model of the year 2012 and 2020.

Initial Iono Model for 2012

Parameter	Range of values
Width (w)	2.7 - 100.8 km
Front speed (v)	7.4 – 190.9 m/s
Direction	40.7 – 110.4 degree
Slope (g)	Max. 191.1 mm/km

Initial Iono Model for 2020

Parameter	Range of values
Width (w)	0.9 - 159.3 km
Front speed (v)	3.9 - 233.3 m/s
Direction	20.4 - 289.5 degree
Slope (g)	Max. 69.8 mm/km

4.4 The final ionospheric threat model used for this project is during finalizing. In addition, the GLS approach procedures design has started and will be done by AEROTHAI with a technical assistance of JCAB with the target date of flight schedule in the last quarter of 2022. The expected GLS approach procedures are the GLS overlay ILS approach at all 4 runway ends to show that a single GBAS can cover multiple runways ends, and displaced threshold approaches to show the benefits on the reduction of aircraft noise without the modification of runways or hardware configurations. (Figure 7.)

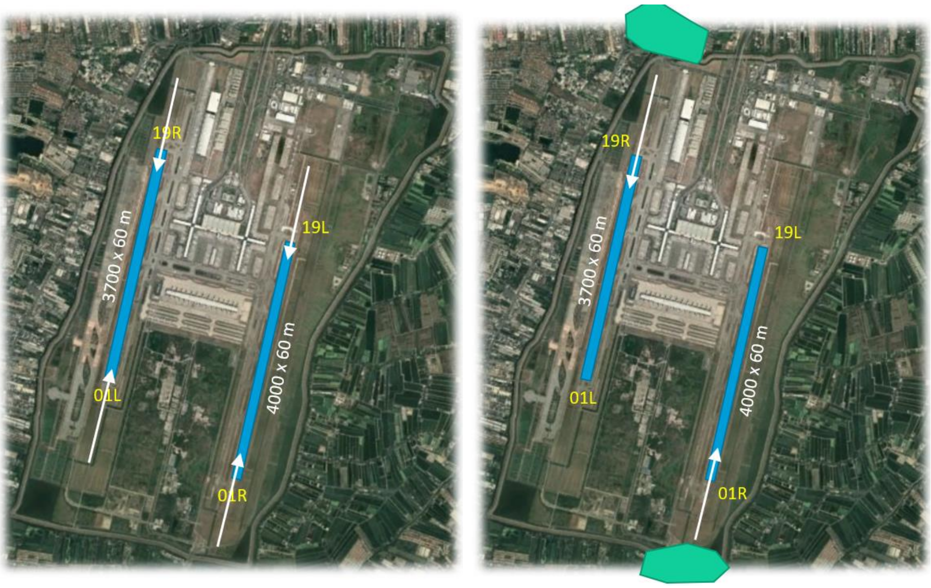

Figure 7. Expected GLS approach procedures for the GBAS PoC project

5. ACTION REQUIRED BY THE MEETING

5.1 The meeting is invited to:

a) note the information contained in this papers; and

b) discuss any relevant matters as appropriate.

6. REFERENCES

[1] WP/5 Ionospheric Delay Gradient analysis with the single-frequency carrier-based and code aided method presented by Japan at ISTF/5, 16-18 February 2015.

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