International Civil Aviation Organization

Asia Pacific Second Meeting of the Asia/Pacific GBAS/SBAS Implementation Task Force

9-10 September 2020
(Video Teleconference)

FEASIBILITY STUDY AND VDB FREQUENCY ASSIGNMENT FOR GBAS IMPLEMENTATION

(Presented by Hong Kong, China)

SUMMARY

GBAS is one of the key satellite-based GNSS applications under ICAO Global Air Navigation Plan (GANP) to supplement and eventually replace the existing terrestrial-based Instrument Landing System (ILS). Recognizing the need to capture the characterization of ionosphere in the APAC Region and assess the potential impacts on GBAS due to ionospheric storm and scintillation around the airport, Hong Kong, China shares its strategy and experience in conducting a GBAS trial at the Hong Kong International Airport (HKIA) to assess the feasibility and identify potential impacts arising from local ionospheric effects and constraints induced by terrains/structures around HKIA. GBAS monitors the signals integrity of the Global Navigation Satellite Systems (GNSS) and broadcasts its differential correction information via a Very High Frequency (VHF) radio data link to provides precise navigational and approach services. The VHF radio data link uses the same VHF radio channels of ground based navigational systems. With increasing number of GBAS deployment in the region, there is a need for having a harmonized approach in coordinating navigational facilities frequency to facilitate implementation of GBAS.

1. INTRODUCTION

1.1 According to the ICAO ASBU Block 1 of GANP, GBAS is one of the key satellite-based GNSS applications to supplement and eventually replace the existing terrestrial-based ILS. Comparing with ILS, installation of GBAS is relatively easier and has less stringent siting criteria in terms of antenna system, equipment, protection for critical and sensitive areas requirements in the airfield. One GBAS could support precision curved-in approach using PBN procedures for multiple runways. However, ionospheric storm and scintillation are the ionospheric effects that have adverse impacts on the continuity, integrity and availability of this safety-critical precision landing system, especially for airports in low latitude/equatorial region.

1.2 Although a threat model (i.e. CONUS model) has been established with a view to overcoming ionospheric effect on GBAS, it was developed using the data collected in continental United States situated in mid-latitude region during solar peak in around 2001 - 2003. Most of the States in the APAC Region are at low latitude where both the ionospheric storm and scintillation are more prominent. According to the outcomes of ex-ICAO APAC Ionospheric Studies Task Force (ISTF), validity of the CONUS model

for GBAS operations in this Region is subject to further validation and an APAC Regional threat model has been developed by the ex-ISTF with the use of ionospheric data contributed by States in the Region. It is recommended that APAC members should conduct feasibility assessment on constraint(s) due to local environment prior to implementing GBAS.

1.3 Implementation of GBAS needs to install VHF radio station to broadcast correction signals to aircraft, via the same radio frequency spectrum that is already occupied by the VHF Omni-directional Range (VOR) and Localizer (LOC) of Instrument Landing System (ILS). In an area with multiple airports, VORs and ILS scattering around, it is required to have a harmonized approach in coordinating the frequencies to meet the challenges in assigning frequencies for GBAS implementation.

2. DISCUSSION

(I) Feasibility Study in Planning Phase

2.1 The Civil Aviation Department of Hong Kong, China (HKCAD) has realized the necessity for conducting feasibility assessment prior to local GBAS implementation. In addition to the establishment of a GPS and scintillation monitoring station at Hong Kong International Airport (HKIA), liaison has also been made with the local lands authority for collecting GNSS data covering the previous solar storm period, as well as different locations in Hong Kong. Those GNSS data collected in the past can shorten the time taken for ionospheric analysis required for GBAS implementation and has also been shared with the ex-ISTF for developing the regional ionospheric threat model.

2.2 For having a better feasibility assessment on GBAS deployment at HKIA prior to the actual implementation, HKCAD conducted a GBAS trial programme at the HKIA for the following purposes:

(a) Proof-of-concept in GLS flight procedures developed with consideration of existing terrains/building structures constraints around the HKIA

(b) Feasibility study for deploying GBAS and GLS flight procedures for the HKIA

(c) Assessment on potential constraint(s) for GBAS implementation due to local environment at HKIA

2.3 The GBAS trial was successfully completed to serve the aimed purposes for assessing the technical and operational feasibility of GLS operations at HKIA, with local airline's participation for aircraft landing at the HKIA with the use of GLS flight procedures during the trial. Positive feedbacks were got from pilots concerned. The results of ionospheric data analysis under the GBAS trial, with the use of GNSS/scintillation data collected in the past, have provided HKCAD insights on potential impacts due to the local ionospheric effects arising from ionospheric storm and scintillation, which are considered acceptable to meet the signal-in-space performance requirements specified in the ICAO Annex 10 to support GLS operations. Confident on future success in GBAS deployment is gained based on positive outcomes of the GBAS trial with potential constraints being realised. The observations and experience acquired from the GBAS trial are considered precious reference. The GBAS trial is considered as a cost effective and efficient approach for feasibility study on GBAS implementation.

(II) Issues Anticipated in Implementation Phase

2.4 In a typical GBAS installation, a VHF data broadcasting (VDB) radio shall be installed at the vicinity of the airport to broadcast correction messages to aircraft for the provision of precision approach service. According to the ICAO SARPs, the frequency spectrum and channel plan of the VDB is the same as the VOR and ILS LOC.

2.5 With reference to the ICAO Doc 9718, the channel spacing for a VDB shall have minimum of 1 MHz channel spacing from any existing VOR or ILS LOC within a defined range of 33 nautical miles, which is the range where no interference is anticipated. Based on this range and the plus or minus 1 MHz channel spacing requirement, the number of frequency channels available for GBAS installation is quite constrained.

2.6 As an example, Appendix 1 shows that, within 33 nautical miles from HKIA, there are more than 20 sets of VOR and ILS. In view of the current situation due to lack of harmonized planning, it would not be feasible to assign a frequency for VDB at HKIA in the band from 108.025 MHz to 117.950 MHz without re-assignment of existing occupied frequencies. Likewise, it is also noted that similar constraints might be imposed on other airports close to HKIA, in case they have any plans to implement GBAS in the future.

2.7 The challenge in assigning VDB frequencies for GBAS implementation would impose constraints to states/administrations in meeting the ICAO initiatives in GANP/ASBU. It is recommended for this Task Force to deliberate a harmonized approach in ensuring frequency planning for VDB in place to facilitate GBAS implementation in the Region, as well as making collaboration with ICAO Spectrum Review Working Group for such harmonization. ICAO APAC Office is suggested to provide assistance in coordination with states/administrations on their plans for replacement/decommission/provision of VOR, ILS and GBAS, so that advance planning can be done for re-assignment of frequencies to facilitate future GBAS deployment. Accurate and updated records about frequency channels deployed for ground based navigational system maintained by ICAO would be helpful for coordinating among States/Administrations to facilitate the assignment of VDB frequencies in the Region.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the Hong Kong, China's strategy and experience for conducting a GBAS trial at the HKIA to assess feasibility and identify potential impacts arising from local ionospheric effects and constraints induced by terrain/building structures around the HKIA;

b) note the issue about VDB frequency channel assignment raised in this paper;

c) deliberate a harmonized approach in ensuring frequency planning for VDB in place to facilitate GBAS implementation for the Region, as well as making collaboration with ICAO Spectrum Review Working Group for such harmonization; and

d) seek assistance from ICAO APAC Office to coordinate with states/administrations on their plans for replacement / decommission / provision of navigational facilities, so that advance frequency planning can be done to facilitate GBAS deployment.

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Appendix 1

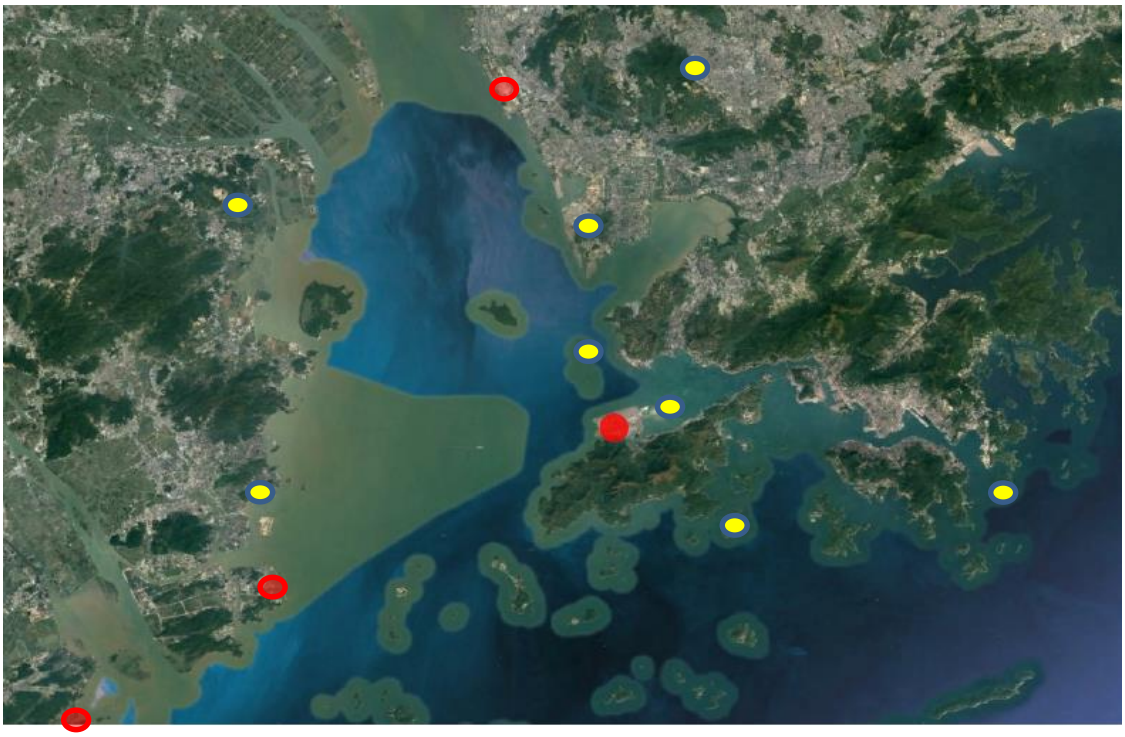

Figure 1

Location	Ground Based Navigation Facilities
Hong Kong International Airport	4 x ILS/DME (plus 2 x ILS/DME in future)
Cheung Chau	1 x VOR/DME
Lung Kwu Chau	1 x VOR/DME
Siu Mo To	1 x VOR/DME
Tung Lung	1 x VOR/DME
Shenzhen International Airport	4 x ILS/ DME
Guanlan	1 x VOR/DME
Shekou	1 x VOR/DME
Nanlang	1 x VOR/DME
Macau International Airport	2 x ILS/DME
Macau	1 x VOR/DME
Zhuhai International Airport	2 x ILS/DME
Jiuzhoudao	1 x VOR/DME

Table 1