International Civil Aviation Organization

THE THIRD MEETING OF THE ASIA/PACIFIC GBAS/SBAS IMPLEMENTATION TASK FORCE (APAC GBAS/SBAS ITF/3)

(Video conference, 27-28 September 2021)

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

GAGAN COVERAGE EXTENSION TO NEIGHBORING STATES

(Presented by Airports Authority of India)

SUMMARY

This paper presents the current status of Indian SBAS – GAGAN (GPS Aided GEO Augmented Navigation) and its expansion plan in the Asia-Pacific region. Recognizing the benefits accruable through Satellite-based Augmentation System (SBAS) implementation and India's efforts towards implementation of SBAS based PBN operations, the states are invited to note the actions taken by India to extend the GAGAN services beyond Indian Flight Information Regions (FIR).

1. INTRODUCTION

1.1 The Indian SBAS- GAGAN (GPS Aided GEO Augmented Navigation), first in equatorial region, and has been certified by DGCA, India for RNP0.1 and Precision Approach with Vertical guidance (APV1) services on 21st April 2015 and since then it is in continuous operations meeting the operational criteria specified in the ICAO SARPS.

1.2 Presently GAGAN system consists of 15 Indian Reference Stations (INRES), 2 Indian Master Control Centers along with one Indian Master Control Center in minimum basic shadow system mode, 3 Uplink stations, and 3 geostationary satellites. Additionally, 25 dual- frequency GPS receivers are deployed for monitoring of the Ionospheric Total Electron Content and Scintillation. Figure 1 shows the locations of Reference stations and Ionospheric monitoring stations.

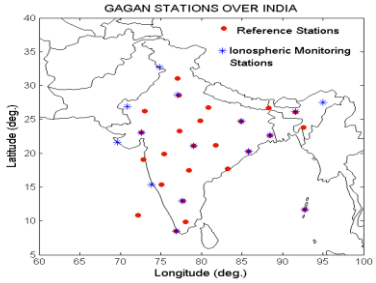

Fig. 1: Locations of GAGAN Reference stations and Ionospheric Monitoring stations

1.3 Recognizing the benefits accruable through SBAS implementation, Indian Government mandate SBAS equipage on new aircraft being procured after 1st July 2021. National Civil aviation Policy (NCAP) also encourages the retrofitting of the existing fleet by incentivizing airline operators. On

successful completion of the development of the business case and stakeholder consultation, India will strive for mandating the use of GAGAN in all eligible aircraft in upcoming years.

2. DISCUSSION

2.1 GAGAN reference stations are strategically located at the periphery of Indian boundary so as to cover large neighboring area in order to provide the RNP0.1 service over Indian Flight Information Region.

2.2 GAGAN system is capable of installation of total 45 INRES stations at various places for GAGAN system. AAI is working on installing INRES station out of Indian Territory and thus extending the RNP0.1 and APV1.0 services beyond present service area, to give advantage of SBAS to other neighboring nations.

2.3 Footprint of GAGAN GEO satellites are shown as below. The real time GAGAN performance is available on https://gagan.aai.aero/gagan/.

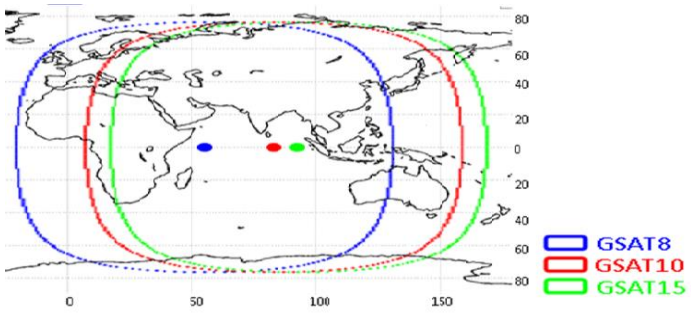

Fig. 2: Footprint of GAGAN Satellites

2.4 Following figure shows the coverage of GAGAN RNP 0.1 over the Asia-Pacific region states. All states within GAGAN coverage area can utilize GAGAN for seamless navigation over the Asia-Pacific region. India (AAI) being the GAGAN service provider ensures the availability of GAGAN signal-in-space as per ICAO standards to meet the defined requirement of availability, accuracy, integrity and continuity over the Asia-Pacific region.

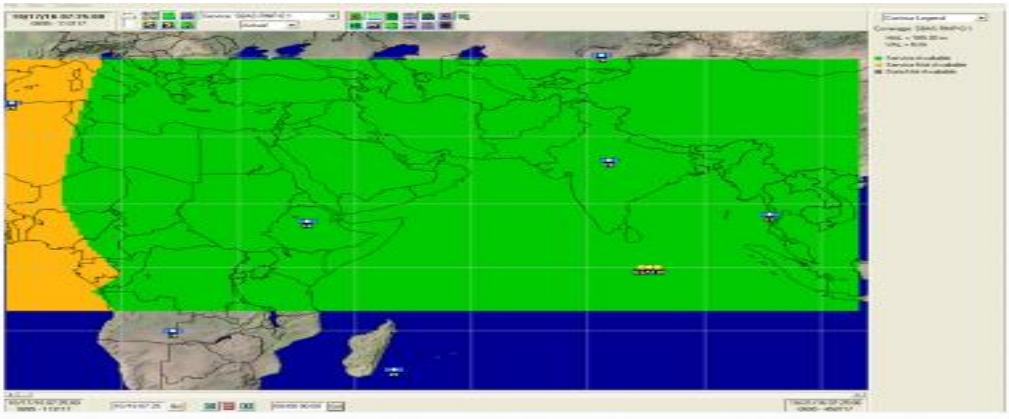

Fig. 3: Coverage of GAGAN RNP 0.1 over the Asia-Pacific Region States

2.5 All the neighboring countries lie in the anomalous ionospheric region as magnetic equator crosses the southern India and Sri Lanka. The region lying in the ±20° of magnetic equator possesses ionospheric anomaly. Fig. 4 shows the ionospheric electron density (in terms of TEC) illustrating the crest of

anomaly lying above 25° N at 0700 UT. This TEC map has been generated using data from ionospheric monitoring stations.

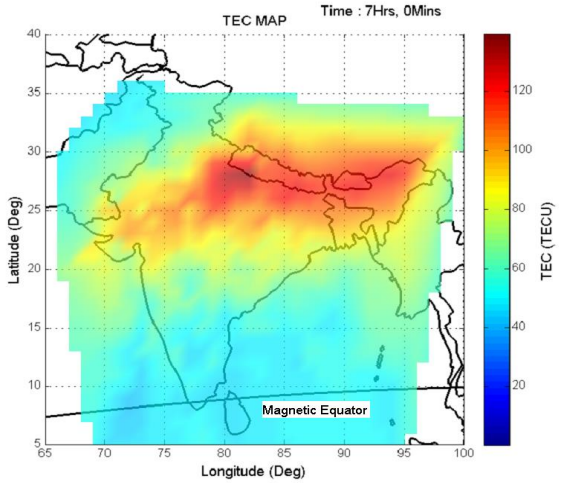

Fig. 4: Snapshot from the Ionospheric Total Electron Content map

2.6 Since the ionosphere is the biggest error source in GPS and it is more dynamic and unpredictable over equatorial and low latitude region, the region specific ionospheric threat model was developed by India. AAI has established an Ionospheric Research & development Centre at Ahmedabad to analyze the Ionospheric behavior over equatorial region.

2.7 GAGAN, employing the region specific Iono model, is broadcasting the ionospheric corrections over 102 grid points through Geostationary satellites as shown in the Fig. 5. These grid points cover almost all the neighboring States.

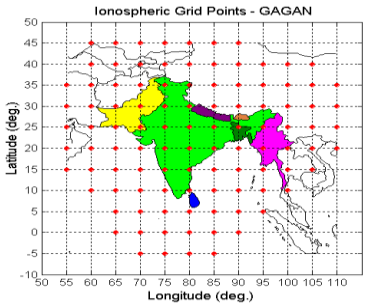

Fig. 5: Ionospheric grid points served by GAGAN (red circles).

2.8 The data from the GAGAN reference stations and ionospheric monitoring stations have shown enormous potential in host of applications other than aviation use. The ionospheric corrections broadcast from GAGAN can be used to interpret the large scale variations of ionosphere over Indian Sub-continent facilitating the space weather research.

2.9 The support from India is aimed to examine the availability of GAGAN signal-in-space through workshops, site/field surveys by data collection at various locations, identification and assistance in development of reference stations, certification & service level agreements within the jurisdiction of the state. As a result of the unprecedented pandemic situation and subsequent economic slowdown, particularly in the aviation industry, this activity has not gathered a pace as warranted.

2.10 The knowledge and expertise gained in development of GAGAN project may be useful for the neighboring states as they lie in the same ionospheric region. The States have been invited for collaborative development of applications based on Indian SBAS-GAGAN.

2.11 Airports Authority of India being GAGAN service provider is in the process to obtain required approvals from concern Ministries in Government of India (GOI) to establish a MOU with the neighboring countries for provision of GAGAN services in their regions for aviation/non-aviation applications.

2.12 India is keen to expand the coverage of GAGAN services for harmonization of air space management in the neighboring States.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) Note the information contained in this paper;

b) Discuss any relevant matters as appropriate.

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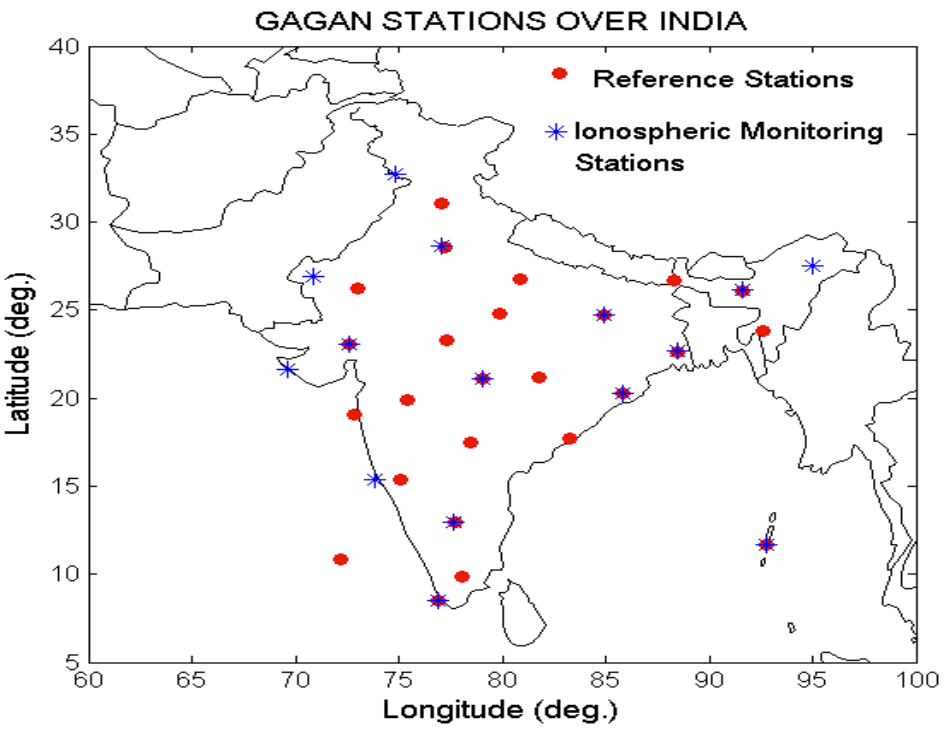
ANNEXURE - I



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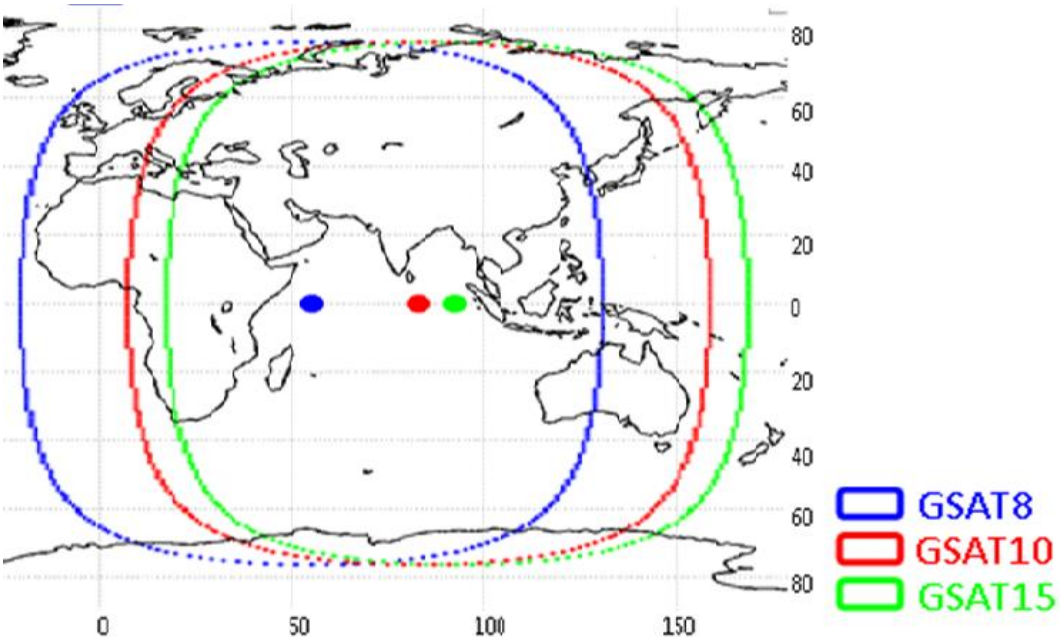


Fig. 2: Footprint of GAGAN Satellites

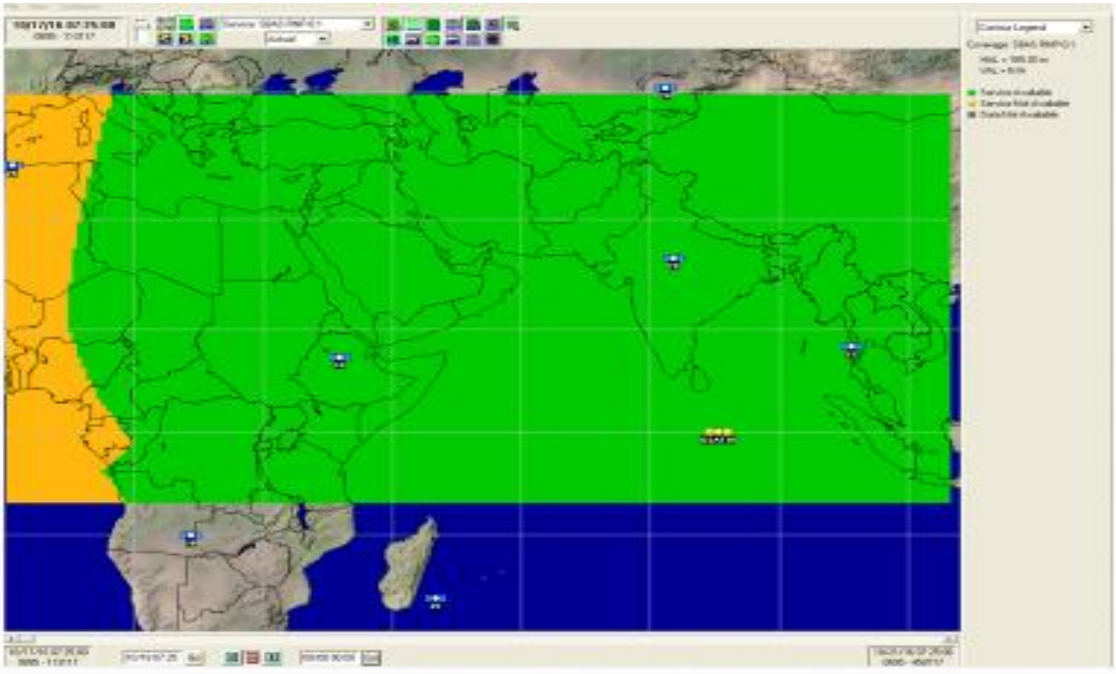
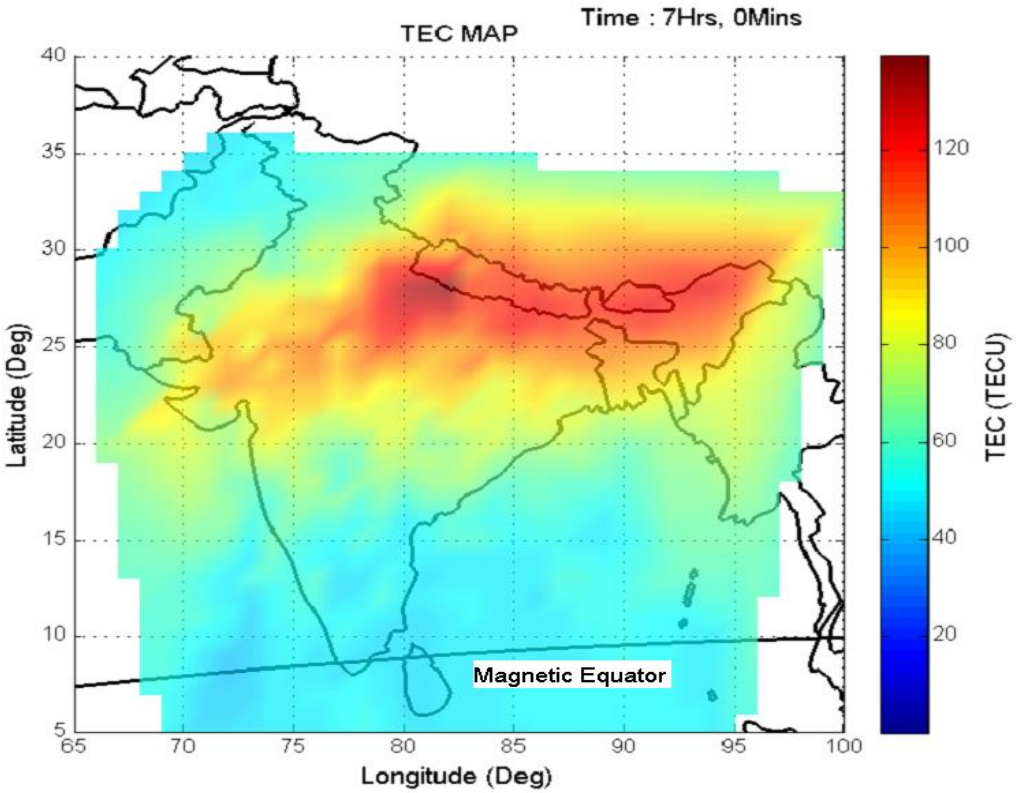


Fig. 3: Coverage of GAGAN RNP 0.1 over the Asia-Pacific Region States



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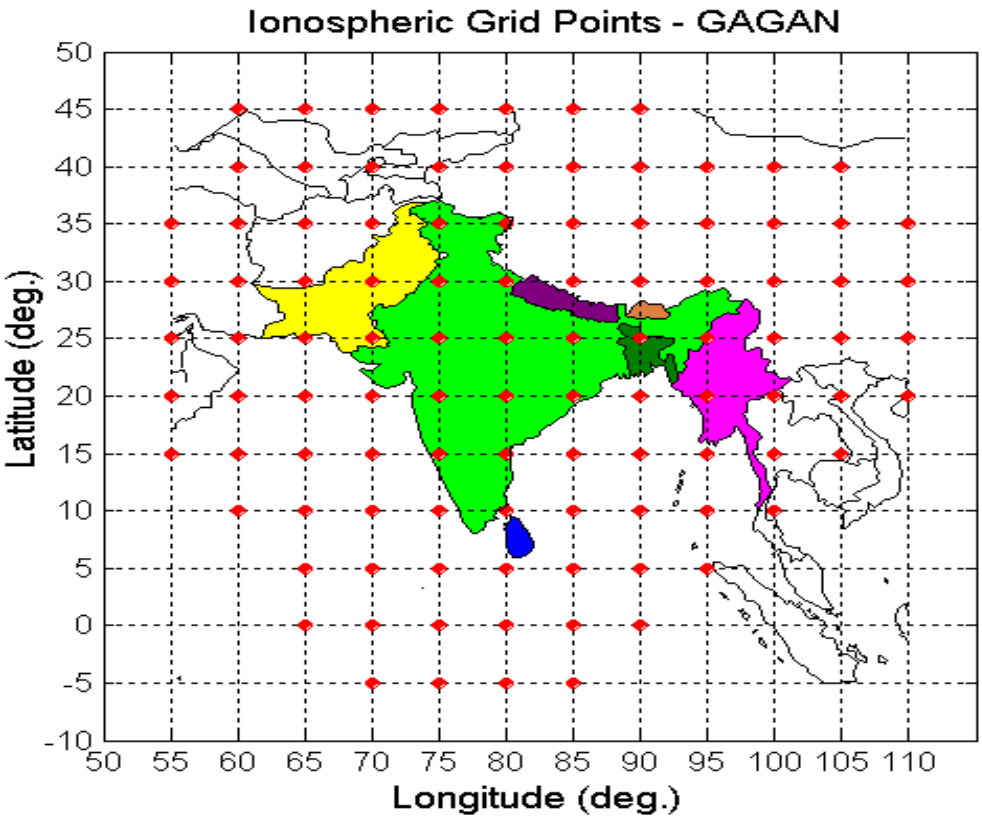

Fig. 5: Ionospheric grid points served by GAGAN (red circles)