



*International Civil Aviation Organization*

**MIDANPIRG Communication, Navigation and Surveillance Sub-Group**

**Seventh Meeting (CNS SG/7)**

**(Cairo, Egypt, 31 May - 02 June 2016)**

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**Agenda Item 4: CNS Planning and Implementation in the MID Region**

**CONSIDERATION OF GAGAN FOR PROVISION OF SBAS SERVICE FOR THE MID REGION**

*(Presented for Airports Authority of India)*

**SUMMARY**

This paper presents the performance attributes of GAGAN- Indian SBAS, the only SBAS system to have the unique capability to function in the Equatorial Anomaly Regions for the provision of Approach with vertical Guidance (APV1).

GAGAN is the fourth certified SBAS of the world and the third to have the capability of GNSS LPV approaches after WAAS of USA and EGNOS of Euro Control.

Many states of the MID Region, like the Asia Pacific region including India, are at lower latitudes and are affected by high Ionospheric activity. There is a very high potential for cost effective GAGAN adoption by states within GAGAN footprint covering most of the MID Region states, to derive the benefits of SBAS to meet the GNSS planning and implementation as per ICAO ASBU block upgrades.

India urges MID regional states to consider the GAGAN SBAS service within their states GNSS planning and implementation.

Action by the meeting is at paragraph 4.

## 1. INTRODUCTION

### **GAGAN (GPS Aided Geo Augmented Navigation)**

(Joint development by ISRO and AAI)

#### **GAGAN system realized in two phases**

##### **GAGAN-TDS (Technology Demonstration System) : 2004 – 2007**

- Implemented to demonstrate the proof of concept over Indian region
- Minimum set of ground and space elements used
- **No regional specific iono model**



##### **GAGAN-FOP (Final Operational Phase) : 2009 – 2013**

- Realized a certifiable SBAS over the Indian FIR
- Built over the TDS elements with additional ground and space elements on spiral deployment methodology
- Developed suitable iono model and implemented in the operational system to achieve APV-1/1.5 service over Indian land mass as per ICAO specification

**RNP 0.1 Service : Certification:30-Dec-2013 Commissioning:14-Feb-2014**

**APV 1.0 Service : Certification:21-Apr-2015 Commissioning:19-May-2015**

**Successfully Completed ONE year of operation on 19-May-2016**

1.1 GAGAN – GPS Based GEO Augmented Navigation is India's first Navigation Infrastructure for transition from Ground Based to Space Based Navigation. The certification of GAGAN on the 21<sup>st</sup> April 2015 has taken India into an exclusive club whose members being US, Japan and Europe having developed Wide Area Augmentation System (WAAS), Multi Satellite Augmentation System (MSAS), and European Geo Navigation Overlay System (EGNOS) respectively.

1.2 GAGAN is the first system in the world that is developed to operate in the equatorial Ionospheric Region, where Ionospheric activity is very high. The largest errors in position accuracy of GPS occur due to IONO activity. India has developed the Multi Layer Data Fusion algorithm after a decade of IONO data collection and analysis. GAGAN has robust system architecture to meet stringent requirements of aviation with sufficient redundancies for space and ground segments.

1.3 GAGAN is a GPS satellite-based augmentation system (SBAS) which provides the necessary accuracy and integrity enhancements to perform RNAV GNSS approaches (APV SBAS) to LPV DH minima in the IAC chart, the so-called LPV approach procedures. These procedures provide vertical and lateral guidance to the aircraft potentially down to as low as 250ft above the runway threshold (initial goal of LPV in India) without the need of airport infrastructure.

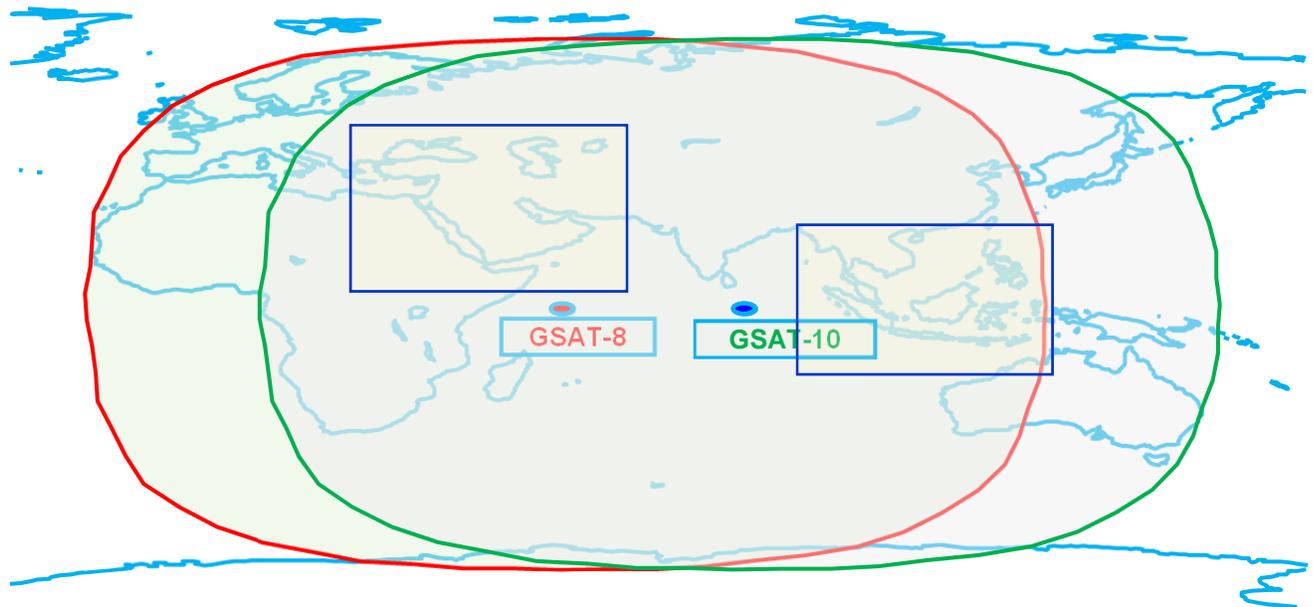
1.4 The system increases the airport accessibility especially if no ILS is available, but also providing a backup functionality in case of diversion or in case of instrument approach system failure. As a result, LPV operations are particularly beneficial to small and medium-size airports as it allows CAT-I like approaches under poor visibility conditions without the need for ground/airport navigation aids.

1.5 APV procedures for 6 Airports in India is in progress. The testing & validation of these procedures is expected to be completed by end of 2016. India plans to provide APV/LNAV/VNAV procedures for almost all operational airports in India within the next 5 years.

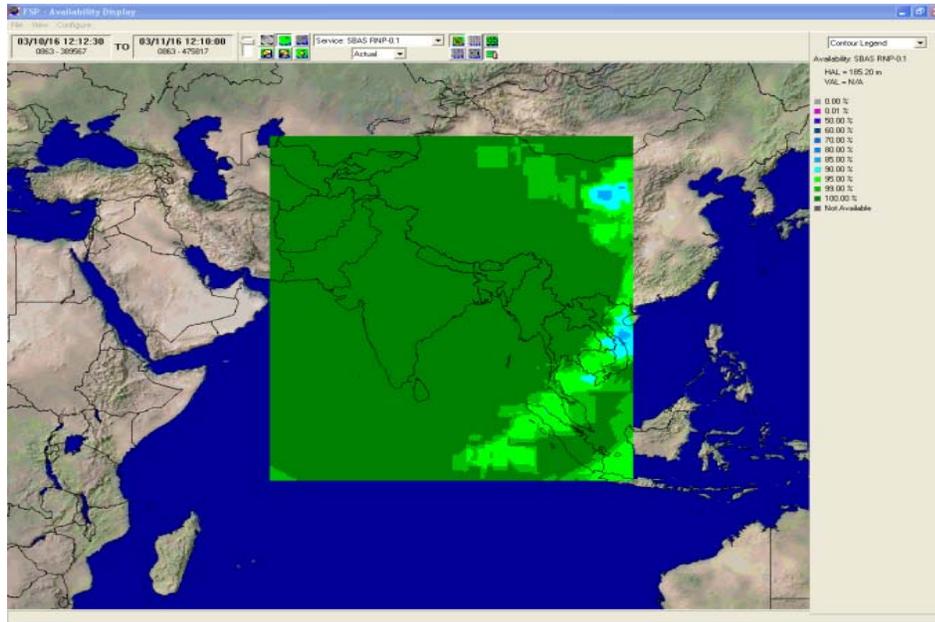
1.6 During the 52<sup>nd</sup> DGCA conference, GAGAN status was presented and the conference considered the following action plan for the use of available SBAS: **Quote:** “Taking note of the emerging GNSS technology and adoption of GAGAN/SBAS by India, the Conference urged States to: a) adopt SBAS in the Asia Pacific Region as an enabler for PBN operations; b) make use of existing GNSS/SBAS technology in the Region.” **Un-quote**

## 2. GAGAN PERFORMANCE ATTRIBUTES

### GAGAN foot print

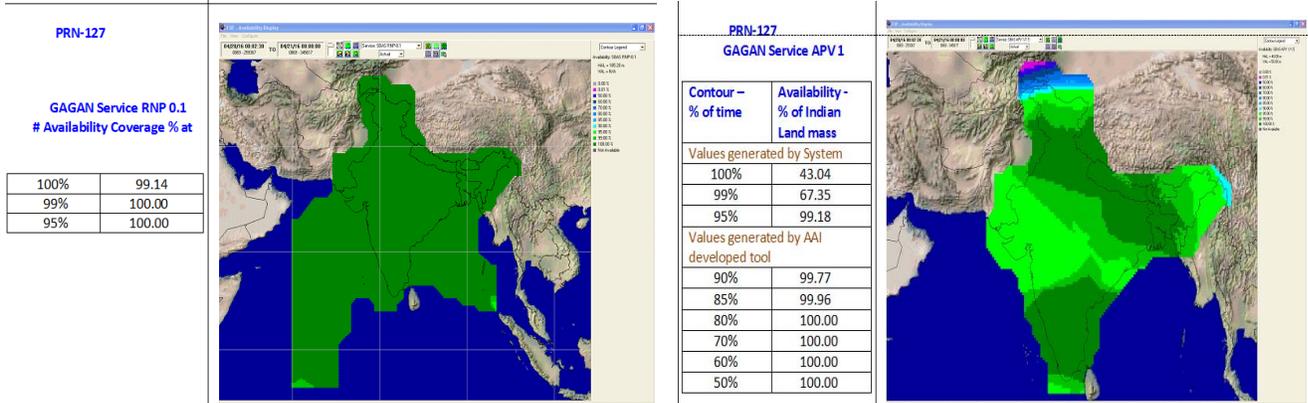


### Current RNP0.1 footprint



**Current GAGAN Performance**

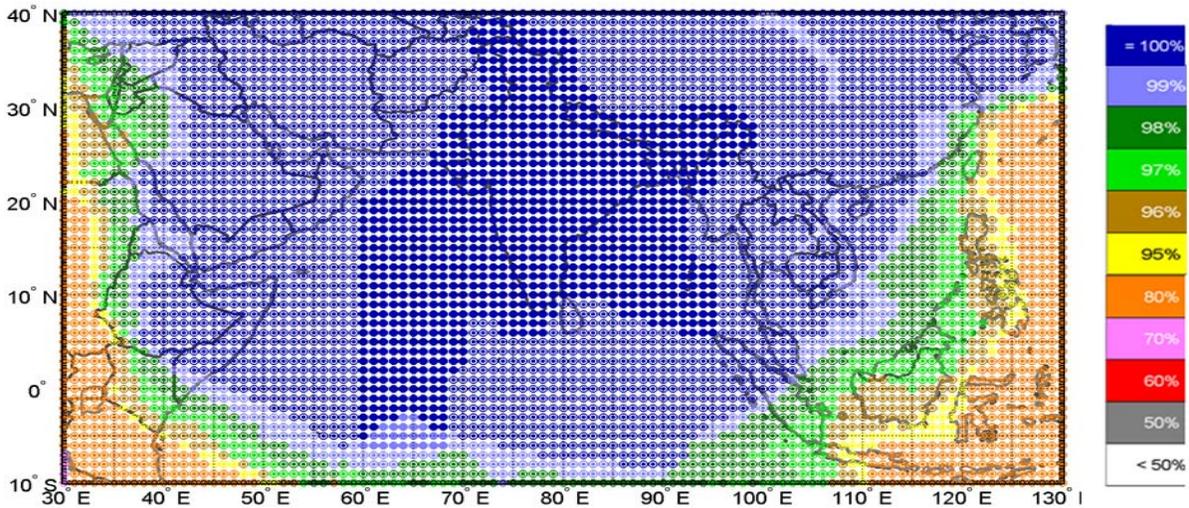
Live GAGAN performance can be viewed at <http://gagan.aai.aero>



**RNP Coverage**

**APV1 Coverage**

**RNP Coverage over neighbouring Countries**



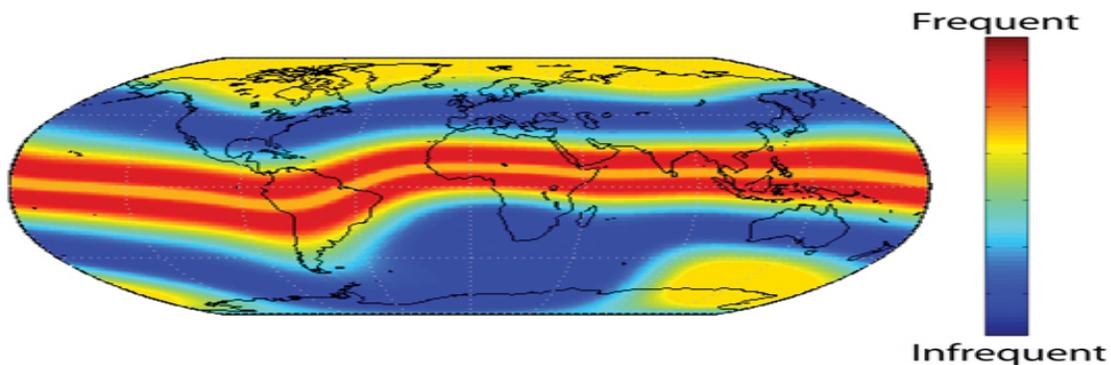
Above availability is optimistic as it is based on user geometry based on the satellite constellation and the UDRE is modelled by the satellite geometry as opposed to the broadcast UDREs

**3. GAGAN a cost effective solution for Mid Region states**

3.1 The footprint of RNP0.1 services through GAGAN is as shown in the figure above.

3.2 States intending to use GAGAN may need to carry out a feasibility study to put ground reference stations connected to GAGAN Master Control centre. Using the GAGAN uplink stations the correction data can be uploaded to be received by the user.

3.3 Many countries of MID Region lie in the anomalous Ionospheric region. GAGAN would be the most appropriate SBAS solution for two reasons. One, All GAGAN satellites are high elevation and give wider coverage and second the algorithm is specific to handling Equatorial Anomaly of lower latitudes.



3.4 The knowledge and expertise gained in development of GAGAN in India may be very useful for member States. The States are invited for collaborative development of applications based on Indian SBAS-GAGAN

3.5 India is keen to expand the coverage of GAGAN services for harmonization of air space management in the low latitude States within its footprint. GAGAN is interoperable with EGNOS and WAAS. This will also provide a platform for harmonization of developments and deployments of CNS facilities and procedures within Region and inter regional;

#### **4. ACTION BY THE MEETING**

4.1 The meeting is invited to:

- a) note the information contained in this paper;
- b) urge MID Asia states to consider the India's GAGAN/SBAS in their states GNSS planning and implementation programs; and
- c) consider India's willingness to assist in the SBAS implementation programs.