



ASSEMBLY — 40TH SESSION

TECHNICAL COMMISSION

Agenda Item 30: Other issues to be considered by the Technical Commission

EXTENSION OF INDIAN SATELLITE BASED AUGMENTATION SYSTEM FOOTPRINT TO NEIGHBOURING COUNTRIES

(Presented by India)

EXECUTIVE SUMMARY

This paper describes the architecture of Indian satellite-based augmentation system (SBAS)-GAGAN (GPS Aided Geo Augmented Navigation) and its geographic (GEO) coverage area. The GAGAN has sufficient capacity to add more reference stations to expand the GAGAN services to the neighboring countries. The neighboring countries can take the advantage of utilization of GAGAN infrastructure for implementation of SBAS services in their regions in a short period of time for aviation and non-aviation sectors. The paper also describes about the major activities involved for expansion of GAGAN services in Asia Pacific Region.

<i>Strategic Objectives:</i>	This working paper relates to Strategic Objectives : Air Navigation Capacity and Efficiency.
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<i>Financial implications:</i>	NIL
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<i>References:</i>	Doc 9750, <i>Global Air Navigation Plan</i>
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1. INTRODUCTION

1.1 Indian SBAS called as GAGAN has been certified by Directorate General of Civil Aviation (DGCA) of India and declared operational for required navigation performance (RNP) 0.1 services in the year 2013 for the Indian flight information region (FIR) and for approach procedure with vertical guidance (APV) I services in the year 2015 covering the Indian land mass.

1.2 Subsequent to the system certification for RNP 0.1 & APV 1 operations, GAGAN system has been made more robust by adding redundancies in ground and space segments. Provided geographical redundancy to INMCC operations by establishment of third INMCC at Delhi. Also third GEO satellite has been integrated into the GAGAN system and at present GAGAN signals are available to the users from three GEO satellites.

1.3 Additional performance monitoring tools are installed at both Delhi and Bangalore master control centres for real time monitoring and analysis of GAGAN system performance parameters.

1.4 Airports Authority of India (AAI), the Indian air navigation service provider (ANSP), in collaboration with Indian National Center for Ocean Information Services (INCOIS), developed and implemented a unique concept called GAGAN Messages Service (GMS) for broadcast of emergency and informative messages through GAGAN GEO satellites for safety of life applications. India is the first country in the world for utilization of SBAS for broadcast of emergency messages through SBAS GEO satellites.

2. DISCUSSION

2.1 The present architecture GAGAN comprises of following subsystems:

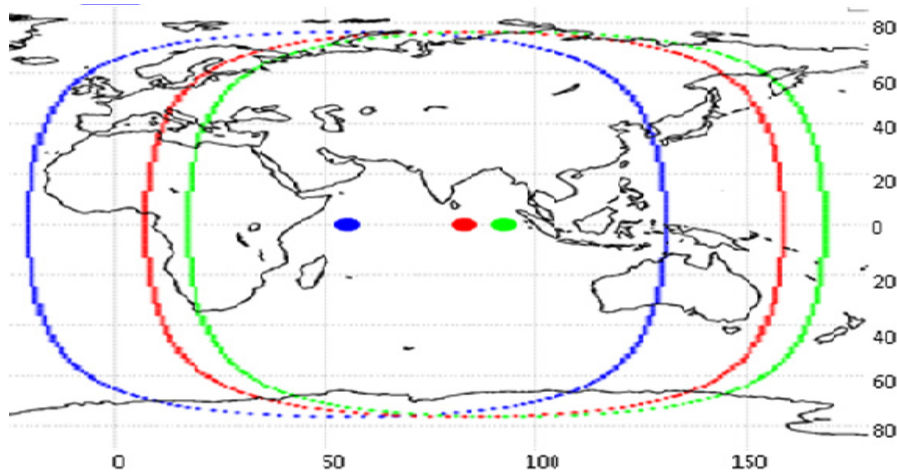
- a) 15 ground reference stations installed at different locations within India;
- b) two operational master control centres (one each at Bengaluru and Delhi);
- c) three uplink stations (two at Bengaluru and one at Delhi);
- d) three GEO satellites; and
- e) one INMCC at Bengaluru act as a basic shadow system to test and validate software builds before its operationalization. During the prolonged failures of any one of the operational INMCC's, the basic shadow system can be made operational.

2.2 Each one of the uplink station is connected to one GEO satellite and GAGAN signals are being broadcasted simultaneously from all three Indian GEO satellites GSAT-8 (PRN-127), GSAT-10 (PRN-128) and GSAT-15 (PRN-132) with common coverage area transmitting the SBAS messages for L1 signals of GPS constellation.

2.3 AAI has developed 65 localizer performance with vertical guidance (LPV) procedures for various airports in India. AAI is in the process to complete the flight simulator validation and creation of Nav-data base for flight validation of LPV procedures. AAI has also retrofitted its flight calibration aircraft for SBAS operations. It is planned to utilize this capability for conducting flight validation of SBAS-LPV procedures. AAI is planning to develop and validate around 200 LPV procedures for qualified runways of Indian airports by the end of 2020.

2.4 DGCA of India issued a revised mandate that the aircrafts being registered in India from 30 June 2020 will mandatorily have to be GAGAN enabled. This supersedes the earlier forward-fit mandate issued by DGCA regarding availability of GAGAN equipage in aircraft from 1 January 2019.

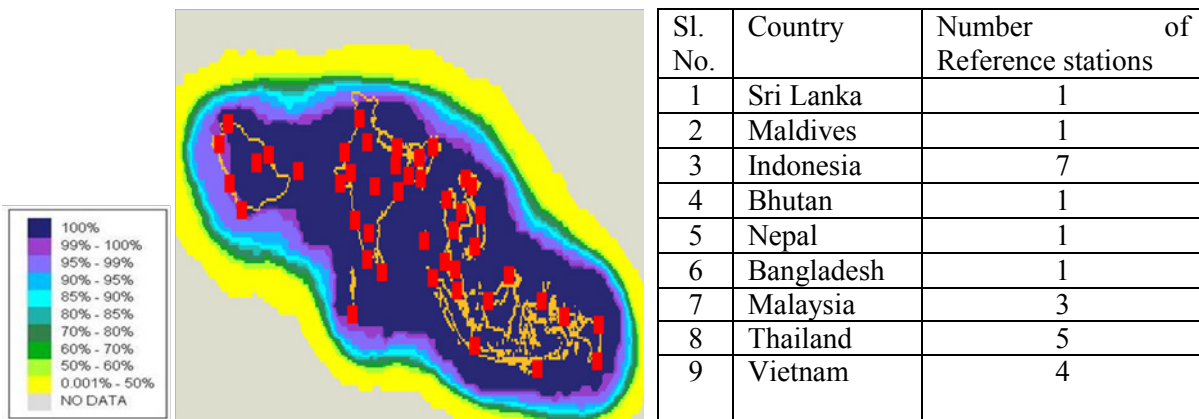
2.5 The coverage area of GAGAN GEO satellites GSAT-8, GSAT-10 & GSAT-15 is shown below.



2.6 GAGAN GEO’s foot print extends from Africa to Australia. GAGAN is the first SBAS system in the world certified for APV 1 operations in the equatorial region. GAGAN implemented a unique “iono algorithm” particularly suitable for equatorial/low latitude region. Hence countries in low latitude region and within the GAGAN GEO foot print can gainfully utilize the GAGAN system infrastructure for implementation of SBAS services in their regions.

2.7 Neighbouring countries of Indian can collaborate with AAI to implement SBAS service in the Asia Pacific Region by installing additional GPS reference stations and integrate the same with GAGAN system.

2.8 An initial simulation analysis indicating the number of reference stations that may be required to be installed in neighbouring countries for provision of APV 1 coverage is given below.



2.9 The GAGAN GEO satellite services is provided by Indian Space Research Organization (ISRO) and expansion of GAGAN services involves discussion among multiple stake holders viz. ISRO, Raytheon (GAGAN system software developer), ANSP’s, civil aviation regulators, airspace users etc.

2.10 The first step for GAGAN services expansion could be a technical feasibility study by GAGAN data collection for a period of two to three days at some selected locations and based on the data analysis, the required number of reference stations and their locations can be assessed for implementation of SBAS APV 1 services.

2.11 The following are the major activities involved for the provision of GAGAN services in order to implement the SBAS over the region of interested ANSP.

Sl. No.	Activities
1	Finalise the number of GAGAN Reference stations and its location(s).
2	Conduct obstruction clearance survey, multipath survey and radio frequency (RF) interference survey to assess technical suitability of each selected site.
3	Development of civil and electrical infrastructure at the identified site.
4	Procurement of required hardware, associated software and tools.
5	Installation of reference station and associated equipment.
6	Establish redundant data communication links between reference station and GAGAN master control centers.
7	Integration with GAGAN master control centers at Delhi/Bengaluru and GEOs.
8	Site acceptance test (SAT) with new reference equipment.
9	Static and dynamic evaluation of GAGAN SIS over the region.
10	Operations and maintenance training to ANSP personal.
11	Generation of certification documents.
12	Reference station and associated facility approval by regulator.
13	APV 1 procedures development and validation.
14	Service approval by regulator.
15	Commissioning of SBAS services .

3. CONCLUSION

3.1 The meeting is invited to take note of:

- a) the developmental activities undertaken by India for implementation of SBAS services over Indian region and its readiness to help neighbouring states to acquire SBAS services with a minimal cost; and
- b) the activities involved for provision of SBAS services over the respective ANSP region using GAGAN infrastructure.