



WORKING PAPER

TWELFTH AIR NAVIGATION CONFERENCE

Montréal, 19 to 30 November 2012

Agenda Item 1: Strategic issues that address the challenge of integration, interoperability and harmonization of systems in support of the concept of “One Sky” for international civil aviation

**1.1: Global Air Navigation Plan (GANP) – framework for global planning
c) Navigation roadmap**

**GAGAN REDEFINING NAVIGATION - ENABLER FOR SEAMLESS
AIR TRAFFIC MANAGEMENT**

(Presented by India)

EXECUTIVE SUMMARY

This paper presents GAGAN implementation as a regional SBAS system and provides an update on the development activities of GAGAN systems and presents contours of the signal-in-space. States within the Asia Pacific Region can optimally utilize for mutual benefit the GAGAN SBAS architecture to provide for harmonized introduction of satellite navigation for the entire region.

Action: The Conference is invited to note the progress made in the development of only the Fourth SBAS in the world and encourage other States within the GAGAN footprint to dovetail their navigation implementation strategy in order to achieve ICAO Assembly Resolution 36-23 for provision of APV services to all runway ends.

1. INTRODUCTION

1.1 GAGAN is a reality with the signal-in-space providing service to non-aviation users while India continues its efforts for the certification of GAGAN for aviation.

1.2 India endorsed the Global Satellite Navigation Strategy Plan and embarked on the ambitious plan of implementing the space based augmentation system for the region in order to pave way for the implementation of harmonized air traffic management to air traffic traversing large volumes of oceanic and continental airspace and provision of LNAV, LNAV/VNAV and LPV approaches to all runway ends.

1.3 GAGAN (referred to as “The Sky” in Sanskrit) is the acronym for the GPS Aided Geo Augmented Navigation System being developed by India. GAGAN is an outcome of India’s vast experience in space research lead by the Indian Space Research Organization (ISRO) that has recently recorded its hundredth launch and is preparing itself for the Mars mission in 2013 and later Chandrayan-II, work done by many research institutes for capturing the behaviour of the equatorial anomaly of the Appleton region, the majority of which falls

in India and the Ministry of Civil Aviation's commitment to lead the air traffic management harmonization programme of the region to meet the challenges posed by increasing air traffic within the region.

1.4 India has its GNSS policy based on attaining the ability to monitor the performance of GPS/GNSS signals and augment it suitably to compensate for various error budgets through the provision of GAGAN.

1.5 Operationalization of GAGAN for aviation will provide India the required platform for implementing GNSS-based operations in the APAC Region and beyond as a primary means of navigation and thereby increasing airport capacity, safety, reduce emissions and most importantly, reduce dependency on ground-based navigation aids.

2. BACKGROUND

2.1 GAGAN implementation progress update

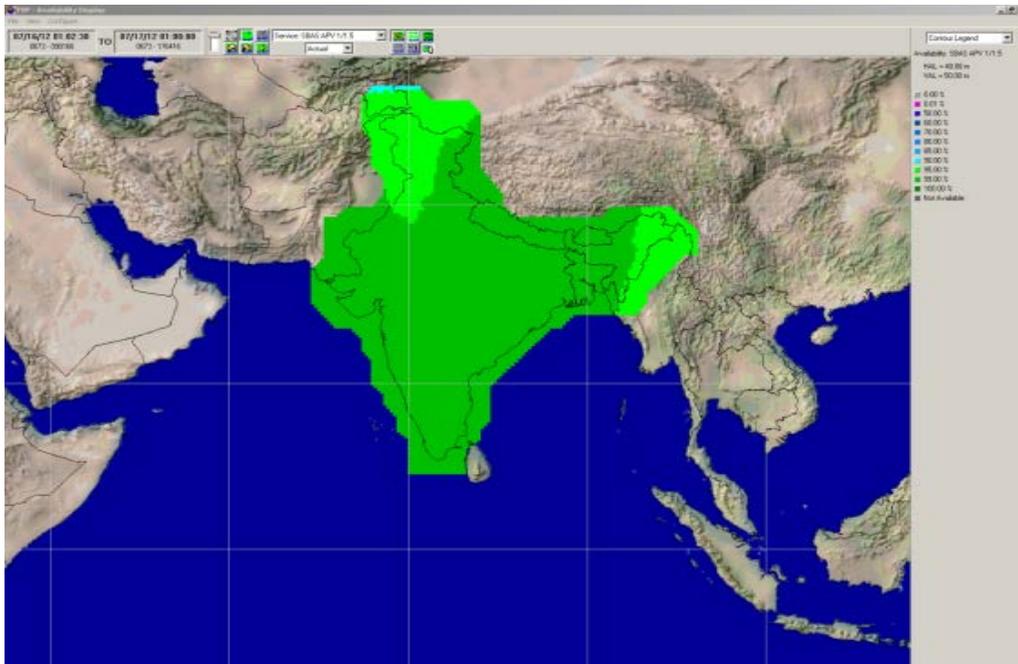
2.1.1 Ground segments for GAGAN have been installed, tested and integrated with GEO satellite GSAT-8. GAGAN signal-in-space is available from December 2011 and has provided sufficient evidence of achieving the set objectives of APV 1 service within the agreed GAGAN service volume. India has designed and developed its IGM- MLDF (ISRO GIVE Model- Multi-layer Data Fusion) algorithm to achieve APV 1.0 service availability over land mass.

2.1.2 The GSAT-10 launch on 29 September has provided an end-to-end redundant configuration of all elements. The same will be integrated with the GAGAN ground segments after undergoing in-orbit-testing by the end of February-March 2013.

2.1.3 The Final System Acceptance Test (FSAT) of the GAGAN system was successfully completed on 16 July 2012 as per planned schedule. The results on FSAT day 16 July 2012:

GAGAN FOP FSAT Objective and Results date of test: 16 th July, 2012			
Service Level	Parameters	Requirement	Observed Performance/Results
RNP 0.1	1. Availability 2. Horizontal Accuracy 3. Vertical Accuracy 4. Time to Alarm 5. Vertical Alert Limit 6. Horizontal Alert Limit	>0.99 over the Indian FIR <72 m 95% bound N/A 10 s N/A 185.2m	99.8% 0.7m Average 1.52m Average 6.2S - Not Provided
APV1/1.5	1. Availability 2. Horizontal Accuracy 3. Vertical Accuracy 4. Time to Alarm 5. Vertical Alert Limit 6. Horizontal Alert Limit	99% over 76% of India <7.6 m 95% bound <7.6 m 95% bound 6.2 s 50 m 40 m	86.57 % 0.7m Average 1.51m Average 6.2s VPL<50 HPL<40

2.1.4 GAGAN APV 1.0 service volume on FSAT day:



2.2 GAGAN certification process has been initiated through establishment of Technical Review Team (TRT) and association with Mitre Corporation providing technical assistance. On certification, the system will be commissioned by July 2013.

2.3 India has been participating in the ICAO Navigation Systems Panel – GNSS SARPS-Work Group 2 and WG2 meetings and has continually updated the progress. Similar actions have been done at the ICAO CNS-MET Subgroup, ISTF and APANPIRG meetings. APANPIRG in its 23rd meeting endorsed India's efforts towards provision of a regional SBAS system and through a State letter encouraging States to examine the feasibility for utilization of GAGAN signal-in space.

3. DISCUSSION

3.1 It may be seen that the GAGAN footprint extends to a large portion of the Asia-Pacific Region, and many States are sharing common boundaries with India wherein GAGAN service expandability and usability can easily be achieved with optimum cost and efforts.

3.2 The Future Indian Air Navigation Systems (FIANS) acknowledges ICAO Assembly Resolution A36-23 which resolved that approach with vertical guidance (APV) should be implemented as either a primary approach, or as a backup for precision approaches, at all runway ends of all aerodromes serving aircraft with a maximum certificated take-off weight of 5 700 kg or more. This resolution included an implementation timing of 30 per cent completion by 2010, 70 per cent by 2014, and 100 per cent by 2016.

3.3 India plans to implement APV (SBAS) and APV (Baro-VNAV) approaches in a phased manner. Initially six airports have been identified for implementation of APV (SBAS) procedures once the certification process is complete for GAGAN.

3.4 India is committed to the efforts in the development of GAGAN to meet the standards set with a planned expenditure of over USD 100 million in the period 2012-2017.

3.5 The revenue base for aviation infrastructure funding comes predominately from commercial airlines. Aircraft operators will additionally require retrofitting SBAS avionics equipment in their aircraft to use such services. India understands that aviation is unlikely to entirely self-fund a complex system such as SBAS. However, existing SBAS in North America and Europe (WAAS and EGNOS) are used extensively by non-aviation users including marine and land transport, agriculture and the geospatial industry. For example, the EU estimates that of the 240 000 agricultural tractors expected to be fitted with GNSS by 2012 nearly 70 per cent will be EGNOS capable. The economic benefits of EGNOS to agriculture alone are estimated at €6 billion by 2030. India is initiating efforts to realize the potential of GAGAN both for aviation and non-aviation use.

3.6 The possible reduction of terrestrial radio-navigation aids has not been determined in the context of GAGAN. However, as newer airports come on the horizon, the possibilities of not increasing the ground navigation aids are being considered. That would need to a certain degree mandating regional airlines procuring new aircraft to forward fit with certified SBAS receivers. As a process of developing the transition plan from the year 2025, India has envisaged to maintain minimum requirements of Ground systems by not attempting to replace some of the existing ones.

3.7 GAGAN would enable the Indian sub-continent to meet international obligations for performance-based navigation (PBN). Shared benefits will be possible, if States within the region harmonize the resources that will redefine the navigation of the future leading to increased airspace capacity, reduced separation, increased fuel efficiency, reduced emission, meeting the objectives of seamless air traffic management.

3.8 However, it is essential to examine the availability and usability of GAGAN signals received across borders. It may require data collection, analysis, adding additional reference stations and planning data communication to master control centres for increasing APV service availability beyond India.

4. CONCLUSION

4.1 The Conference is invited to note:

- a) the progress made in the development of GAGAN - the fourth SBAS in the world and encourages other States within GAGAN footprint to dovetail their navigation implementation strategy in order to achieve ICAO Assembly Resolution A36-23 for provision of APV services to all runway ends; and
- b) India's commitment to support other States within APAC and beyond within the GAGAN footprint to explore the feasibility to utilize GAGAN signal-in-space to achieve seamless ATM across borders for global harmonization.

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