



International Civil Aviation Organization

**NINETEENTH MEETING OF THE COMMUNICATIONS/NAVIGATION
AND SURVEILLANCE SUB-GROUP (CNS SG/19) OF APANPIRG**

Bangkok, Thailand, 20 – 24 July 2015

Agenda Item 5: Navigation

5.5 Other radio navigation issues

**CERTIFICATION OF GAGAN, INDIAN SBAS SYSTEM
FOR APV 1.0 PROCEDURES**

(Presented by India)

SUMMARY

GPS Aided Geo Augmentation Navigation (GAGAN) – The Indian Satellite Based Navigation System (SBAS) programme has obtained required certifications for RNP 0.1 and APV 1.0 Service over Indian Airspace. APV1 service, is well on its way to provide APV approaches for select runways within India.

The GAGAN service volume is susceptible to the ionospheric variations that are very predominant and affect the GPS as well as GEO signals. In order to meet the set objective of APV1.0 over the Indian land mass, India has developed an appropriate region specific ionosphere model for GAGAN.

This paper provides update on GAGAN and also urges the SBAS service providers in the world to encourage aircraft operators for utilization of SBAS technology.

1. INTRODUCTION

1.1 GAGAN is the Indian Satellite Based Navigation System (SBAS) programme

1.2 GAGAN is the first system implemented in the equatorial Ionospheric region in the world. GAGAN system was earlier certified for RNP0.1 enroute services on 30th December 2013 and recently APV 1.0 certification has been obtained.

1.3 As per ICAO Recommendation 6/5 (Adopted by AN-CONF/12) – “ICAO work programme to support global navigation satellite system evolution” ; GAGAN is interoperable with other Satellite Based Augmentation Systems (SBAS) namely the Wide Area Augmentation System (WAAS) in USA, the multi-functional transport satellite (MTSAT) satellite-based augmentation system (MSAS) in Japan and the EGNOS system in Europe.

1.4 GAGAN Signal-in-space is available on 24x7 basis through two satellites GSAT-8 (PRN-127) and GSAT-10 (PRN-128)

1.5 Raw data captured through INRES is transported through robust GAGAN communication network comprising of four circuits, using terrestrial / space media, established to ensure 99.999% availability.

2. DISCUSSION

2.1 GAGAN, SBAS Programme is unique because of the implementation of **ISRO-MLDF IONOSPHERIC ALGORITHM (IGM-MLDF 1.4)** to meet the ionospheric challenges posed in Indian sub-continent and other Equatorial Ionospheric Anomaly regions.

2.2 Continued work for mitigating identified hazards and fine tuning unique Ionospheric algorithm culminated in achieving APV 1 certification by India on 21st April 2015 and making available the certified GAGAN signal from 19th May 2015 to both civil Aviation and Non-Aviation Users.

2.3 With this, India became the first country in the world to establish Satellite Based augmentation system that can provide Approach with Vertical Guidance services namely, APV1 for landing at qualified runway ends in equatorial ionospheric anomaly region.

2.4 Performance of GAGAN is being continuously monitored (Reference Attached Annexure-I). India is continuously collecting and analyzing the ionospheric TEC and scintillation data from the GAGAN-TEC network consisting of 23 stations.

2.5 It is observed during data analysis that GAGAN performance was not affected by the recent geomagnetic storm of 22-23 June, 2015. It was one of the strongest storms of the current solar cycle which is declining now.

2.6 India has acquired Long Term Ionospheric Anomaly Monitoring (LTIAM) tool from FAA through ISTF for gradient analysis. AATR (Along Arc TEC Rate) analysis methodology has been adopted for data mining and irregularity detection.

2.7 India is now in the process of development of LPV procedures for select airports, for which the initial GNSS based Aeronautical Survey is completed and the procedures for some of them are ready. These procedures will be available for ground validation by the end of December, 2015.

2.8 GAGAN will provide direct as well as indirect benefits to civil aviation with respect to accuracy, fuel savings, emission reduction and ATM harmonization.

2.8.1 GAGAN shall provide capability for increased accuracy in position reporting, thereby making possible high-quality Air Traffic Management (ATM).

2.8.2 GAGAN shall also enhance reliability and reduce delays by defining more precise terminal area procedures that feature parallel routes and environmentally optimized airspace corridors.

2.9 The advantages of GAGAN can also be derived by neighboring states like Bangladesh, Myanmar, Nepal, Indonesia, Sri Lanka etc.

2.9.1 GNSS augmented services can be extended to the states where GAGAN service volume is contiguous with Indian service volume with the inclusion of a few reference stations using GAGAN GEOS and the capabilities of monitoring signal-in-space.

2.9.2 The benefit of additional reference stations will in turn increase availability and continuity within the APV service volume.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

3.1.1 Take note of the GAGAN developments as a viable SBAS solution within Equatorial Ionospheric Anomaly Region capable of providing RNP0.1 service and APV 1/LP services at selected airports.

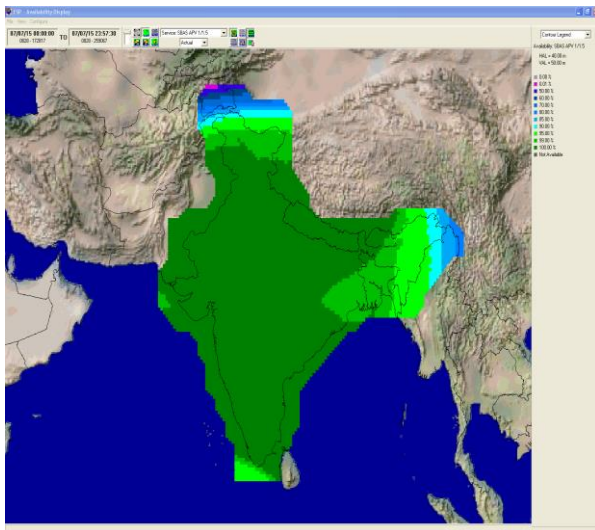
3.1.2 In view of regional harmonization of systems and provision of seamless navigation, states may consider use of GAGAN signal for SBAS services with assured coverage so that the states can mutually benefit from India's efforts in launching GAGAN services.

3.1.3 Urge states to consider SBAS implementation to achieve the Global GNSS transition plans.

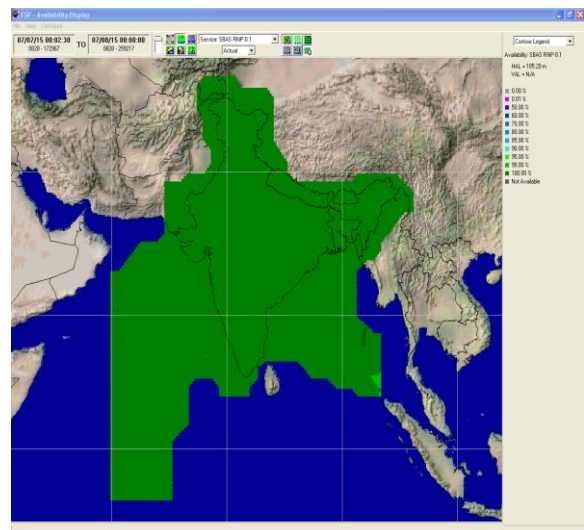
ANNEXURE-I

GAGAN Performance Analysis

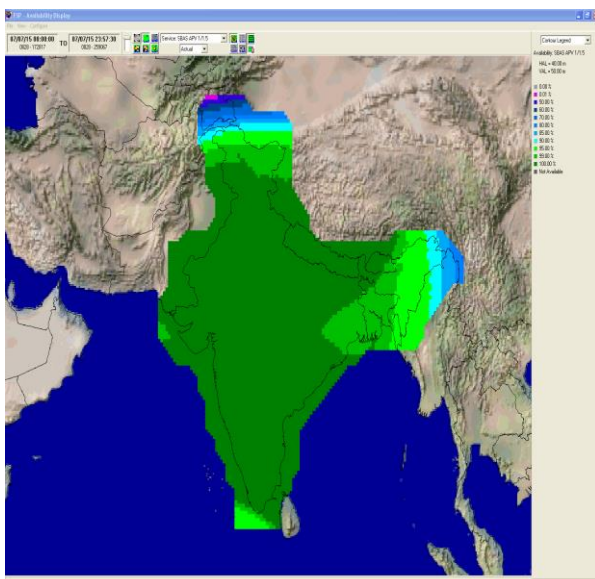
**PRN-127
GAGAN Service APV 1
Over Indian Landmass**



**PRN-127
GAGAN Service RNP 0.1
Over Indian FIR**



**PRN-128
GAGAN Service APV 1
Over Indian Landmass**



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GAGAN Service RNP 0.1
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