



International Civil Aviation Organization

**THE FIFTH MEETING OF IONOSPHERIC STUDIES TASK FORCE (ISTF/5)**

16 – 18 February 2015, Ishigaki, Japan

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**Agenda Item 3: Review of status of States' activities**

**GNSS IMPLEMENTATION IN INDIA: ACTIVITIES AND STATUS UPDATE**

(Presented by Airports Authority of India, India)

**SUMMARY**

This paper presents the activities and status update on GNSS implementation for navigation over Indian Region including GAGAN and GBAS. It also highlights the Operational Test & Evaluation (OT&E) tools developed by AAI, GAGAN team.

**1. Introduction**

1.1 Following the recommendations of ICAO on Future Air Navigation Systems, India is actively involved in implementing the GNSS based navigations systems-SBAS and GBAS over the Indian FIR. Satellite Based Augmentation System (SBAS) provides the navigation aid to aircraft over wide area where as Ground Based Augmentation System (GBAS) is suitable for precision approach guidance over a localized area/airport.

1.2 GAGAN (GPS Aided GEO Augmented Navigation), an Indian SBAS system has been developed jointly by Airports Authority of India & Indian Space Research Organization. It consists of 2 Indian Master Control Centers (INMCCs) (comprised of an Operation & Maintenance Subsystem (OMSS), Service Monitoring Subsystem (SMSS), and a CVSS/DCSS), 3 Indian Land Uplink Stations (INLUSs) (comprised of a Signal Generator Subsystem (SGS) and a Radio Frequency Unit (RFU) subsystem), 15 Indian Reference Stations (INRESSs) (with each INRES consisting of three strings of antennas, receivers, and processors), 2 operational GEO satellites (PRN 127 & PRN 128), and a Data Communication Subsystem (DCSS) connecting all of the ground sites.

1.3 Honeywell Smartpath SLS4000 has been installed at Chennai airport for Cat-1 operation. System is under performance evaluation pending finalization of iono threat model.

**2. Discussion**

2.1 GAGAN was certified for RNP0.1 service in December 2013 by the Director General of Civil Aviation (DGCA) and consequently declared commissioned for RNP0.1 to support for en route operations on 14th February 2014.

2.2 Work on certification for APV1 service is being carried out & it is likely to be completed by second quarter of 2015.

2.3 Recent activities of GAGAN includes the successful completion of the Deployment Readiness Test in December 2014 for the APV 1.0 build incorporating updated GIVE model & Threat model. These updated GIVE Model & Threat Model mitigate the threats related to correlation between two IGM-MLDF layers, elevation dependent bias in vertical delay, under sampled conditions in threat model, failed convolution analysis as part of PHMI analysis & negative IPP delay logic. Other activities undertaken are Flight Trials to validate GAGAN Signal in Space by AAI Flight Inspection Unit & successful conduct of Stability Test of APV 1.0 build in January 2015.

2.4 India has provided the GAGAN-TEC data for three seasons of the years- 2004, 2008 and 2012 representing moderate, low and high solar activity to the ISTF.

2.5 Honeywell has installed the GBAS system SLS4000 at the Chennai Airport. Ionospheric data collection and analysis is being carried out for this system.

2.6 AAI has developed the various Operational Test and Evaluation (OT&E) tools required for evaluation and monitoring of GAGAN system. These tools include - Range Error Bounding Analysis Tool, UDRE Bounding Analysis Tool, GIVE Bounding Analysis Tool, HMI Performance Verification Tool, Continuity Analysis Tool, Service Level Analysis Tool, GAGAN Message Analysis Tool, Loss of Lock Analysis Tool, GEO C/No Tool, and GAGAN Flight Trial Data Analysis Tool. These tools have been developed in different programming languages like 'C', Matlab, Java, etc.

2.7 OT&E (Operational Test & Evaluation) testing is an essential component of the approval process for the operational use of the GAGAN system. Its purpose is to evaluate the operational effectiveness and suitability of GAGAN and, in particular, verify that the GAGAN SIS (Signal In Space) performance is consistent with the accuracy, integrity, availability and continuity requirements.

2.8 Some of the sample plots produced by Range Error Bounding Tool, UDRE Bounding Analysis Tool & GIVE Bounding Tool are given below in Figure-1,2 & 3 respectively. All these plots show that various range residual errors generated after applying GAGAN corrections, are well bounded by their respective integrity bounds broadcast by GAGAN thus adequately meeting the integrity requirements.

2.9 Since GAGAN SIS is available over most part of Asia and Pacific, it can be effectively utilized by neighboring countries with minimum investment in the form of setting up the additional Reference stations. Hence, India is keen to partner with willing States for better harmonization of airspace.

### **3. Action required by the meeting**

3.1 The meeting is invited to do the following:

- a) to note the India's progress in GNSS implementation for civil aviation and continued support to ISTF.
- b) to discuss any relevant matters as appropriate.

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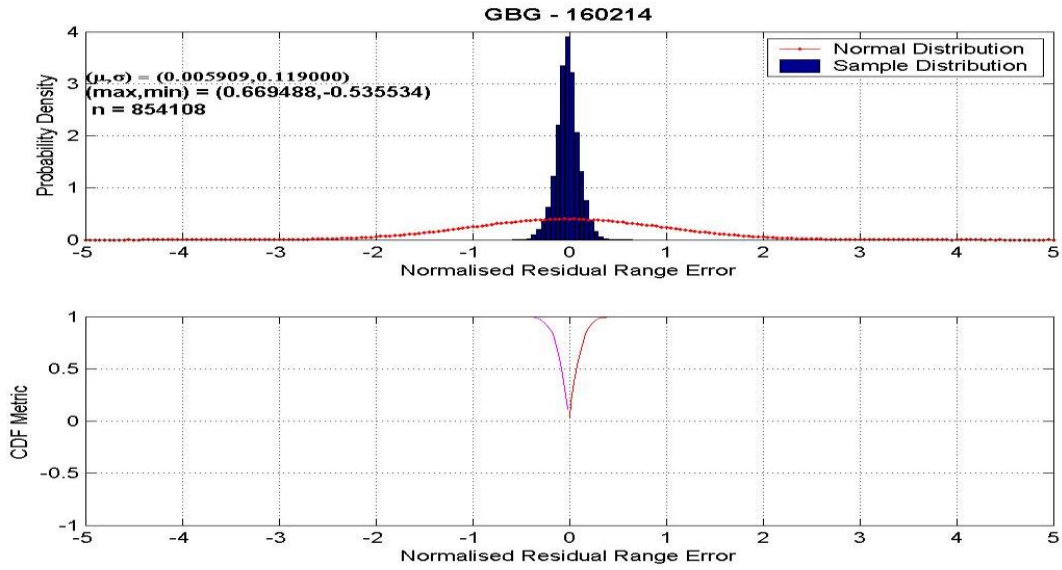


Figure-1

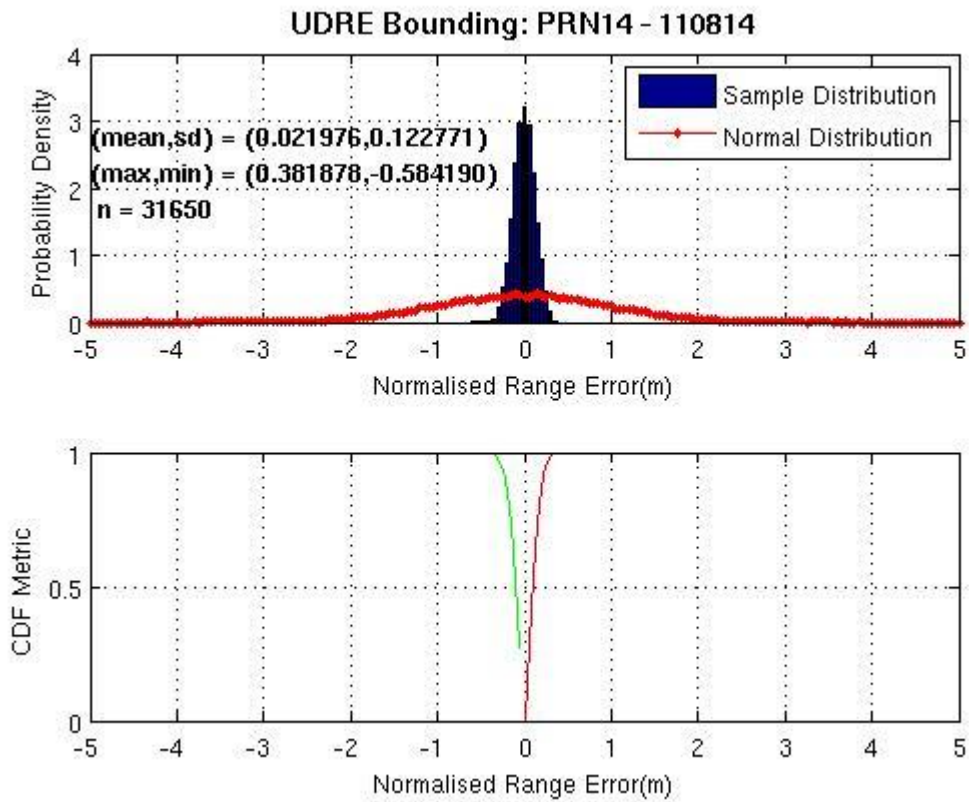


Figure-2

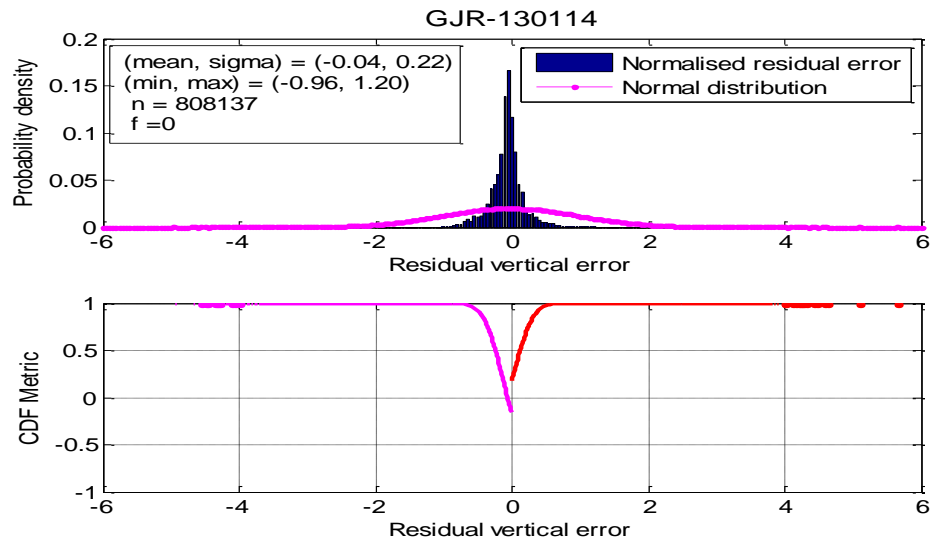


Figure-3

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