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GPS Aided GEO AUGMENTED NAVIGATION (GAGAN) - INDIA

SUMMARY:

Airports Authority of India (AAI) and Indian Space Research Organization (ISRO) jointly executing the GAGAN project. GAGAN will provide augmented information for satellite navigation to the aircraft flying within Indian FIRs, which consist of seven boundaries. India is situated near the vicinity of equator. In the equatorial region the ionospheric variations are very predominant which affect the GPS as well GEO signals. It has therefore been decided to go for Iono - Tropo modeling over Indian airspace after collecting TEC data over an extended period of time from 20 TEC stations, which have been established for the purpose. The TDS phase has been completed and Preliminary Site Acceptance Test (PSAT) results are as per prerequisite set for the project. GAGAN TDS has been integrated with INMARTSAT 4F1 navigation transponder, which has been hired by ISRO and Signal-In-Space (SIS) will be available for testing, certification and validation in the month of May 2007. After completion of initial validation of SIS, FOP will be taken up to complete the project all respect by end of year 2010.

1. Introduction

1.1 GAGAN will provide augmented information for satellite navigation to the aircraft flying within Indian FIRs, which consist of seven boundaries.

1.2 Total airspace area controlled by AAI is 6 million Square Km. Majority of the Indian airspace falls in oceanic region, where difficult to provide navigation signal through conventional Navigational aids.

1.3 India is situated near the vicinity of equator. In the equatorial region the ionospheric variations are very predominant which affect the GPS as well GEO signals. It has therefore been decided to go for Iono -Tropo modeling over Indian airspace after collecting TEC data over an extended period of time from 20 TEC stations, which have been established for the purpose.

2. Implementation Plan

2.1 **Technology Demonstration Systems – Extended (TDS-Extended):** This phase requires implementation of a minimum configuration system which would demonstrate the capability of the system to support up to precision approach over limited region of the Indian airspace and will serve as proof of concept. The performance objective of this system is to meet the ICAO SARPs requirements. The TDS –extended will consist of eight Indian Reference Stations (INRES), an Indian Mission Control Center (INMCC), two Indian Land Uplink System (INLUS), space segment, required communication links and necessary software for navigation and communication during the TDS-extended phase. A GSAT-4 will carry the navigation payload of C and L-1/ L-5 band and be placed at 82°E.

2.2 **Final Operational Phase (FOP):** during this phase, the GAGAN program will be matured. Extensive tests would be carried out to establish the system stability of various elements of the system as a whole. The system will be put in extensive use for its evaluation with respect to ICAO SARPs. Certification and validation of the system will be completed before declaring the system operational.

3. Current status of GAGAN:

3.1 Infrastructure for installation of INRES at Delhi, Kolkatta, Guwahati, Portblair, Ahmedabad, Banglore, Jammu and Trivanthapuram is in place.

3.2 The installation of GPS-TEC at all 20 stations has been completed at 5° x 5° grid size. Ionospheric data from 20 TEC stations is being analyzed by number of Indian universities and R&D institutions involved in ionospheric studies for development IONO-TROPO model that is suitable for Indian airspace.

3.3 As per current analysis results, 5 more TEC station is recommended for equatorial anomaly region which will from 2° x 2° gird size, to achieve better IONO model for Indian airspace.

3.4 Infrastructure for INMCC and INLUS at Banglore is in place for installation of GAGAN equipment.

3.5 GAGAN ground segment integration and connectivity test with seven INRES with INMCC is completed. The INRES data is being received through fiber optic cable at INMCC Banglore for corrections and validation checks of the erroneous data. PSAT of GAGAN ground element was conducted in May 2006 with help of satellite emulator.

3.6 The INMARSAT 4F1 navigation transponder has been hired by ISRO in month of January 2007 for integration of GAGAN ground segment, to complete of Final Site Acceptance Test (FSAT) and also to conduct the user level testing of GAGAN SIS in May-2007

3.7 Total cost of the GAGAN project is Rs 644.00 Crores (140 m USD)

4. TDS- Extended Results

4.1 The TDS phase is to demonstrate the expected vertical and horizontal positional accuracies over 95% of the time with the associated Time-to-alarm (TTA) capability.

4.2 Results were better than 7.6 meters accuracies in both vertical and horizontal over 95% of the time within the perimeter of the reference stations.

4.3 Using type 62 (test) message, the TTA was better than 6.2 seconds

4.4 Results were well within the exit criteria of PSAT Perimeters of INRES sites too exhibited good performance.

5. Certification

5.1 Flight trials: Flight trials are scheduled in month of May 2007 to check the integrity of the up linked GAGAN signals. Training for this purpose has to be conducted at the earliest.

5.2 **Certification by regulatory authority:** DGCA (India) officials are involved in the training process for certification of the system. The certification documents are under preparation.

5.3 In the Month of 13th Novmber-2006 FAA and AAI has signed MOC for GAGAN Project in certification and validation of SIS.

6. Technology support of development and maintenance of GAGAN

ISRO in association with the AAI will be developing the entire system through all the stages of TDS-Extended, and FOP. ISRO will continue to provide technology support, maintenance and replenishment of the space segment of the system, as and when required, to maintain the system as a robust system.

7. Conclusion:

7.1 GAGAN has a capability to provide the augmentation service within GSAT-4 footprint, which covers a large portion of the Asia-Pacific region.

7.2 Necessary Ionospheric and Tropospheric (IONO-TROPO) models for GAGAN are under development. GAGAN system takes into account the fact that in the equatorial ionosphere the spatial and temporal variability is much greater, even during equate magnetic conditions and therefore a model specifically for this region has to be developed to take care of the variations.

7.3 GAGAN would be developed to meet the ICAO GNSS SARPs and it should be interoperable with WAAS, EGNOS, MSAS and GRAS.

8. Action taken by the meeting

The meeting is requested to take note of the information.

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