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ASSEMBLY — 37TH SESSION

TECHNICAL COMMISSION

Agenda Item 46: Other issues to be considered by the Technical Commission

UPDATE ON GAGAN-INDIAN (SBAS)

(Presented by India)

EXECUTIVE SUMMARY

As a major step towards transition to satellite-based navigation, India has developed a space-based augmentation system "GAGAN". Technical demonstration system (TDS) and final system acceptance test (FSAT) has been successfully completed in August 2007. GAGAN signal-in-space is available for flight validation. Flight inspection carried out and results are found to be satisfactory. Final operational phase (FOP) has already commenced.

The GAGAN service volume, being at lower latitudes, is susceptible to ionospheric variations that are very predominant in the equatorial region which affect the global positioning system (GPS) as well geostationary earth orbit (GEO) signals. An appropriate algorithm is being developed to mitigate the ionospheric effects to ensure GAGAN system support various phases of flight operation throughout the service volume.

This paper provides an update on the progress of GAGAN-FOP and certification process.

The Assembly is invited to note the commitment of India to implement SBAS to provide seamless satellite air navigation service across regional boundaries; and that India would extend support to neighbouring States to plan the use of GAGAN signal in space for providing SBAS service volumes in their flight information regions (FIRs).

Strategic Objectives:	This working paper relates to Strategic Objectives A, D and E on safety, efficiency and continuity.
Financial implications:	N/A

1. INTRODUCTION

1.1 In accordance with ICAO global plan initiatives for the transition to satellite navigation, India has developed, a space-based augmentation system “GAGAN” indigenously.

1.2 Implementation of GAGAN is a major step towards transition to satellite navigation and the primary objective is to achieve APV1.0 / APV 1.5 navigation capability over the entire Indian land mass.

1.3 In order to overcome the ionospheric variations that are predominant in the equatorial region which affect the GPS as well GEO signals, Iono-Tropo model is being developed through collection of real-time TEC data over an extended period of time from twenty-six TEC stations, which have been established for this purpose.

1.4 As the footprint of the GAGAN space segment covers large portions of the airspace beyond India, GAGAN can be extended to other States by also setting up ground stations at strategic locations.

2. GAGAN IMPLEMENTATION STATUS

2.1 Technical demonstration systems phase (TDS)

2.1.1 The technical demonstration phase is to demonstrate the capability of the system to support the precision approach over a limited region of Indian airspace to serve as proof of concept with minimum configuration. The performance objective was to meet the ICAO Standards and Recommended Practices (SARPs) requirements.

2.1.2 The TDS system consisted of eight Indian Reference Stations (INRES) at Delhi, Kolkatta, Guwahati, Port Blair, Ahmedabad, Bangalore, Jammu and Trivandrum, an Indian Mission Control Center (INMCC), Indian Land Uplink System (INLUS) at Bangalore.

2.1.3 The INMARSAT 4F1 navigation transponder (space segment) was hired for integration of GAGAN ground segment, to complete the final site acceptance test (FSAT) and also to conduct the user level testing of GAGAN SIS. Flight inspection was carried out and results were found to be satisfactory. The TDS and final system acceptance test (FSAT) were successfully completed in August 2007. GAGAN signal-in-space is available for flight validation.

2.2 Final operational phase (FOP)

2.2.1 After the successful completion of the TDS phase, the final operational phase (FOP) has already commenced.

2.2.2 The GAGAN-FOP is a multi-phase programme of India used to deliver a space-based augmentation system (SBAS) for GNSS over Indian flight information regions (FIRs). GAGAN-FOP will provide a certifiable Indian SBAS over its service volume.

2.2.3 GAGAN–FOP is being deployed in a spiral deployment methodology, building incrementally on the TDS phase equipment and architecture, using lessons learned, and data generated from the TDS phase to guide the deployment of the FOP.

2.2.4 The ground-based elements (GBE) of the GAGAN-FOP will consist of all subsystems established in TDS phase and additional 7-INRES, redundant INMCC and Indian land uplink station-signal generation subsystem (INLUS-SGS).

2.2.5 The deliverables include ionospheric modeling and implementation on the operational system as per software standards, final RNP 0.1, APV 1.0 or APV 1.5 certification data preparation, safety design and HMI assessment documentation/reports.

2.2.6 An algorithm review team (ART) will review and finalize the recommendation made by the algorithm working group (AWG). The objective is to develop a single frequency user-based method for characterizing ionospheric delays that provides mitigation to the depletion problem. The format and resolution of the data will be determined by the AWG and algorithm review team (ART).

2.2.7 The above process may require new SBAS messages not currently defined in ICAO SARPs or RTCA 229D to support the new ionospheric algorithms. One of the major tasks would be to define evaluation criteria based on backwards compatibility with the existing certified SBAS receivers and identify modifications required to the ICAO SARPs and Radio Technical Commission for Aeronautics (RTCA) Minimum Operational Performance Standards (MOPS) to support the new SBAS messages. However, efforts are on to look for a way forward without MOPS change. During the GAGAN-FOP the AWG and ART will collaborate on a plan for implementation and certification of the equatorial GIVE (grid ionospheric vertical error) identified on the operation of GAGAN and provide the details and objectives for the parameters of the ionospheric scintillation model.

2.2.8 GEO *Navigation payload*: Initially, GSAT-4 was planned to be positioned in the Indian Ocean region between the orbital arc 60 to 110°E longitude. The failure of the launch in April 2010 has had a slight impact on the planned schedules. However, the next payload, GSAT-8 is scheduled to be launched by October 2010 and it is anticipated that GAGAN SIS will be available for preliminary site acceptance tests (PSAT) by year's end.

3. THE GAGAN FOP SYSTEM PARAMETERS

3.1 The first milestone is to deliver an RNP0.1 capability provided over the Indian FIRs.

3.2 The second milestone is to deliver APV1/APV1.5 service as specified in ICAO's specification over 90 per cent of the Indian land mass. A certification package to demonstrate the service requirements associated with this milestone will be delivered with the APV1.5 service milestone.

4. CERTIFICATION

4.1 *Certification by regulatory authority*: DGCA (India) officials are involved in the training process for certification of the system. The draft certification plan is being prepared and is in the process of evaluation.

4.2 The process of certification has started concurrently with GAGAN-FOP and will proceed as a parallel activity in coordination with all concerned participants and appropriate assistance from FAA, the authority who has certified WAAS is being sought.

5. TECHNOLOGY SUPPORT OF DEVELOPMENT AND MAINTENANCE OF GAGAN

5.1 Indian Space Research Organization (ISRO) in association with the Airports Authority of India (AAI) will be developing the entire system through all the stages of TDS, 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.

6. TIMELINE FOR COMPLETION OF GAGAN-FOP

6.1 The system with its entire space segment of three GEOs (GSAT 8, GSAT 10 and GSAT 9), ground segments, and uplink stations shall be ready by 2011. However, GAGAN SIS will be available with the integration GSAT 8. The same is planned to be accomplished by November-December 2010. However, the certified GAGAN system for aviation users within the defined service volume will be available with availability of the entire system including appropriate redundancies and safety assurance mechanisms by June 2013.

7. CONCLUSION

7.1 GAGAN has a capability to provide the augmentation service within its footprint, which covers a large portion of the airspace beyond Asia-Pacific Region, Africa to Australia.

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 shall meet the ICAO GNSS SARPs and would be interoperable with other SBAS systems WAAS, EGNOS, MSAS and GRAS.

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