ELEVENTH AIR NAVIGATION CONFERENCE

Montreal, 22 September to 3 October 2003

Agenda Item 6: Aeronautical navigation issues
6.1 : Global navigation satellite system (GNSS) development status based on reports from States, service providers and industry organizations

INDIAN SATELLITE BASED AUGMENTATION SYSTEM — GAGAN FUNCTIONS AND CURRENT STATUS

(Presented by India)

SUMMARY

This information paper provides functions of GAGAN, its development plans and current status of the ground and space segments and ionospheric modeling for Indian airspace, which will be unique to this system.

The GAGAN system is planned to be made available to the Asia/Pacific States in support of the GNSS augmentation requirements for implementation of CNS/ATM.

1. INTRODUCTION

1.1 Airports Authority of India (AAI) and Indian Space Research Organisation (ISRO) have jointly undertaken a programme for the development and implementation of the satellite-based augmentation system (SBAS) over Indian Airspace called global positioning system (GPS) and Geo augmented navigation (GAGAN). This system is being developed to cater to the satellite navigation augmentation requirements for aircraft operators and air traffic services (ATS) providers in the Indian airspace, including the Indian oceanic airspace, as well as large parts of the Asia/Pacific Region.

1.2 India is situated in the equatorial region where the ionospheric variations are very pre-dominant which affect the GPS as well GEOS signals. To reduce the ionospheric effects, the data logging will be carried out at various locations for development of the unique ionospheric model and system will be designed to take care of the scintillation effects automatically.

1.3 "GAGAN" programme will be implemented in three phases viz.

a) 1st phase: Technology demonstration system;

b) 2nd phase: Initial operational phase; and

c) 3rd phase: Final operational phase.

2. GAGAN TDS CONFIGURATION

2.1 It is proposed to have eight reference stations (INRES), one master control centre (INMCC), one ground uplink station (INLUS) and a Geo stationery satellite with a L-band navigation payload for the TDS phase. As such, the TDS phase itself will have all the elements of the system for full testing of the level of accuracy achievable which would be further upgraded for full operational capability in the subsequent phases.

3. CURRENT STATUS OF GAGAN — TECHNOLOGY DEMONSTRATION SYSTEM

3.1 After completing a detailed design review of payload, ISRO is in the process of procurement of critical components for fabrication of the navigational payload which will be put in GSAT-4 satellite to be launched in 2005 and put in 82 degree East orbital slot.

3.2 In view of the in-house competence already available with ISRO, the navigation payload and RF portion of the uplink station (INLUS) would be done by ISRO.

3.3 Technical evaluation of the proposals received against the RFPs issued have been completed and contract for supply, installation, software development and integration of the system is expected to be awarded by September 2003.

3.4 API was filed by ISRO with ITU for the geo satellite. A revised API is however being filed which would reflect enhanced EIRP as well as inclusion of L5 frequency on the Nav payload.

3.5 ISRO also has placed order for some of the critical and long lead items for RF portion of land uplink station (INLUS) which is not included in the contract for implementation of TDS phase and would be done in-house by ISRO.

3.6 India being situated close to the equator ionospheric activities would have significant effect on received GPS signals over Indian airspace. To adequately assess the effect of ionosphere on GPS signals and to minimize its effect, development of ionospheric model has been initiated based on ionospheric data collected from a large number of locations over an extended period of time. Keeping this in view, it is planned to establish 20 Stations for collection of ionospheric data spread over the whole country. Total Electron Content (TEC) Receivers have been acquired and 4 TEC Stations have been established at Delhi, Jodhpur, Ahmedabad and Bhopal. Data collection at these four places is already in progress. ISRO and AAI are in the process of establishing the remaining TEC stations.

3.7 Ionospheric scientists in the country working in different universities and in research and development (R&D) institutions have also been involved and contracted for working on ionospheric data analysis and modeling.

4. IMPLEMENTATION TIMESCALE

4.1 **Technology demonstration systems (TDS)**: TDS phase requires the implementation of a minimum configuration system which would demonstrate the capability of the system to support up to precision approach Cat-I over a limited region of Indian airspace and would serve as a proof of concept. The TDS phase will be completed by 2005.

4.2 **Initial experimental phase (IEP)**: In this phase TDS would be expanded to cover the entire Indian airspace and requisite redundancies would be added to the system. Those elements not included in the TDS phase shall also be incorporated into the system along with their redundancies. The system would be available for trial operations and data collected by AAI during such trial operations would be analyzed to further improve the system, wherever necessary, to achieve compliance with ICAO SARPs. The IEP will be completed in a period of one year after the development of TDS.

4.3 **Final operational phase (FOP)**: During this phase GAGAN programme is expected to be matured. Extensive tests would be carried out to establish the stability of various elements and of the system as whole. The system would be put to extensive trial operation and would be evaluated with respect to ICAO SARPs before declaring the system operational. This phase is expected to be completed in one year after IEP.

5. CONCLUSIONS

5.1 "GAGAN" would have a capability to provide the augmentation service within GSAT-4 foot print, which covers most of the Asia/Pacific region. The coverage of GAGAN would ensure high reliability and availability for Asia/Pacific region, with over lap by European Geostationary Navigation Overlay Service (EGNOS) and multifunctional transport satellite-based augmentation system (MSAS).

5.2 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 quiet magnetic conditions and therefore, the ionospheric model being developed under the GAGAN project for this region would take care of such variations.

5.3 GAGAN has been designed to meet the ICAO global navigation satellite system (GNSS) SARPs and it would be interoperable with wide area augmentation system (WAAS), EGNOS and MSAS.

5.4 The GAGAN system is planned to be made available to the Asia/Pacific States in support of the GNSS augmentation requirements for implementation of CNS/ATM.

5.5 The conference is invited to recognize that GAGAN, being developed as a satellite-based augmentation system (SBAS), will have a foot-print covering most parts of the Asia-Pacific, including the equatorial region.

5.6 The conference may request ICAO to enlist the GAGAN augmentation system as one of the SBAS systems for the implementation of CNS/ATM.

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