**INTERNATIONAL CIVIL AVIATION ORGANIZATION**
**SOUTH AMERICAN REGIONAL OFFICE**

**Second Meeting of the Informal Coordination Group of the East Caribbean and North Eastern South America (E-CAR/SAM-NE ICG/2)**

**(Caracas, Venezuela, 01 to 05 December 2003)**

Agenda Item 2: **Review of CNS matters**

# GNSS AUGMENTATION TRIALS IN THE CAR/SAM REGION (CSTB)

(Presented by the Secretariat)

**Summary**

This working paper describes the architecture of the trial platform of the regional GNSS augmentation project, together with the objectives, current status and future of said trial.

**References:**
- RLA/00/009 Project document;
- Report of the Third Coordination Meeting on the GNSS augmentation trials of the RLA/00/009 Project (Rio de Janeiro, Brazil, 15-17 October 2003).

## 1. Introduction

1.1. In keeping with the ICAO policy, transition to the use of satellite technology in air navigation is a matter of high priority for the States/International Organisations of the CAR/SAM Regions. Logically, the first step in this transition is the establishment of a CAR/SAM regional trial platform to facilitate efforts to investigate, develop and implement an operational air navigation system.

1.2. The planning of the trials of the satellite-based augmentation systems (SBAS) to be conducted in the CAR/SAM Regions initiated during the eighth meeting of GREPECAS (Dominican Republic, 9 to 17 November 1998) through Conclusion 8/36 (SBAS systems tests in the CAR/SAM regions). On that occasion, information was provided on the offers of the European Tripartite Group (ETG) and the United States Federal Aviation Administration, to conduct tests of the EGNOS and WAAS systems, and their possible implementation through common agreement among the CAR/SAM States, thus contributing to the establishment of an operational SBAS model. It was also noted that the trials would be carried out through Technical Cooperation Projects, starting with the implementation of a WAAS-type SBAS system.

The FAA would contribute with the loaning, installation, training on and operation of the necessary equipment.

1.3. The aforementioned project is currently being implemented under the title *"Regional GNSS augmentation trials (CSTB)" (RLA/00/009 Project)*. Its main objective is to develop a plan for testing and assessment of the technical and operational benefits of the GNSS augmentation system in the CAR/SAM Regions, so that it may contribute to the establishment of the operational model of GNSS augmentation systems being developed by the GREPECAS ATM/CNS Subgroup. This UNDP-ICAO technical cooperation project was launched with the signing of Memorandum of Understanding Nat-I-9015 between the FAA and ICAO (4 June 2001). Its participants are States and Organisations in the CAR/SAM Regions (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Panama, Peru, Venezuela and COCESNA. The duration of the project is three years as of the aforementioned signing date.

## 2. Regional GNSS augmentation trial, RLA/00/009 Project

### Trial platform

2.1. The trial platform is made up of a ground segment and an air segment. The ground segment consists of reference stations, master stations, a satellite link station and a ground communications network for communications between reference stations and master stations, as well as between master stations and the satellite link station. The air segment consists of the avionics that will be used for the in-flight verification of the trials.

### Ground segment

### Trial reference stations (TRS)

2.2. The system consists of 13 TRS stations installed in the following States: one in Argentina, one in Bolivia, five in Brazil, three in Chile, one in Colombia, one in Peru and one in Honduras.

2.3. Each TRS is made up of a GPS receiver, a rubidium oscillator, a processing station and a communication router. The basic function of these stations is to determine any possible errors in the GPS signal (orbit, time, ionosphere).

### Trial master stations (TMS)

2.4. The trial platform also consists of two TMS stations, one in Santiago, Chile and the other in Rio de Janeiro, to which the reference stations are interlinked. The TRSs in Argentina, Peru and Bolivia are interconnected with the master station in Chile, while those located in Colombia and Honduras will be interconnected with the master station in Brazil.

2.5. The TMSs are made up basically of a processor, a server for disseminating the augmentation information, a recording device and a communication router. The basic function of the master station is to receive the signal with errors from reference stations, process it and make the corrections for the specific geographic area, as well as to determine the integrity in the use of signals from the GPS satellite constellation.

**Satellite link station**

2.6. The system will have a single Satellite Link station that will be located in Brazil. The satellite link station will receive the information processed by the TMS containing the corrected information for the GPS signal and will broadcast it over the same GPS frequency (L1), using the INMARSAT III geostationary satellite.

**Ground communication network**

2.7. The ground communication network is the network required for communications between the TRSs and the TMSs, as well as between the TMSs and the satellite link station. The links between the TRSs and the TMSs are established through 19.2 kbps circuits. Circuits with a 9600 bits/sec capacity will be required between the TMSs and the satellite link station.

**Air segment**

2.8. For in-flight trials, aircraft equipped with a GPS antenna capable of introducing to three subsystems, namely the user platform (CUP), the true reference station (CTR) and the navigation data acquisition platform (NAVDAC), will be used. The Aeronautical Authorities of Brazil, Chile and Colombia will supply the project with aircraft equipped with the necessary avionics to conduct the in-flight trials foreseen in the project.

2.9. The CUP consists of a GPS/WAAS receiver, a processor and a storage device. The CTR has two differential GPSs, one in the aircraft and the other on the ground, and the NAVDAC is made up of a processor and a storage unit.

2.10. It is through this segment that the augmented GPS signals and their effectiveness in the different navigation phases (initially en-route and non-precision approach) will be tested.

## 3. Main objectives of the GNSS regional augmentation trial

3.1. The main objectives of the trial are the following:

a) To acquire and store GPS signal data through the reference stations and the equipment used for in-flight trials, in order to analyse its behaviour in the ionosphere in the CAR/SAM Regions under study.

b) To try out the precision of the system in operation, based on a previously designed service volume model, initially for en-route and non-precision approach applications, above all in the CAR/SAM Regions, using for this purpose:

- long-term data acquisition and storage at all reference stations;
- non-precision approaches at selected airports;
- terminal area manoeuvres at selected airports and SID and STAR procedures;
- en-route over land areas; and
- en-route over oceanic areas.

c) To conduct a training programme to become familiar with the operation of the different elements that comprise the system and the corresponding procedures to be used, in order to be able to understand the new satellite-based navigation systems.

d) To foster international cooperation and contribute to the safety of the global transportation system through the sharing of information, technology, technical assistance and training among the countries.

e) To encourage future trials with other satellite-based augmentation systems.

## 4. Current project phase

4.1 The current status of the Project in each of the States involved is as follows:

### Argentina

4.2 The TRS station is installed and operational since December 2001. Communications with the Chilean Master Station was completed in March 2002. Since the most important activity carried out was data collection from the TRS, this activity has been carried out in a continuous manner and all information recorded is in the FAA's data base.

### Bolivia

4.3 Since November 2002, upon not having available a communications line with the Chilean master station, all data obtained in the TRS station were recorded in CD, sent on a monthly basis to the ICAO Regional Office in Lima and then sent to the FAA for processing. In addition, some of these CDs were sent to Colombia (June 2003) since a processing unit was available and in operation. From the analyses of the data processed by the FAA, it was determined that the Millenium GPS receiver was having problems and the FAA sent a new GPS receiver.

### Brazil

4.4 Brazil equipped a Hawker 800 property of the GEIV with a flight trial console with capacity to collect GPS L1, L2 and WAAS data. Since April to October 2003, 40 flight trial hours have been carried out. Flight trials consisted in approach procedures to the Santos Dumont airport (Rio de Janeiro), to verify precision at the approach modes, and in 40-mile square flights at 31.000 feet after sunset hours, to see the ionosphere behaviour at its worst condition. Important initial studies on the ionosphere in the equatorial area and its impact on GPS signals have been effected.

### Chile

4.5 The information obtained by the Chilean reference stations is continuously transmitted for storage and processing, since 1998, to the FAA NSTB facilities at the Atlantic City Technical Centre, through a 64 Kbits/Sec direct digital circuit established between Santiago and Atlantic City. The connection of the master station to REDDIG will be implemented by the end of November.

*Colombia*

**Colombia**

4.6 Colombia, since June 2003, has started operation of a processing unit of GPS data obtained by the reference stations and, for this purpose, uses GPS Solution Software to be in the capacity of obtaining archives such as PDF Site Name Ext (Position Domain Navigation Error), SV Tatus Range and SV Domain, as well as geostationary satellite event data archives.

4.7 In addition, has developed a programme in C language, which statistically analyzes the data in the PDF output of the PDF Site Name ext archive. The programme's objective is to provide availability, integrity, continuity and coverage values for NPA operations and APV/1 and APV/2 approaches. A technical and operational guidance manual for the RLA/00/009 CAR/SAM Test Bed has also been elaborated. A Colombian network VSAT station has been installed in Tegucigalpa, Honduras, to be able to take the information from the Honduras TRS to Bogota, and from Bogota to Rio de Janeiro, via REDDIG. The link with the Brazilian master station is pending. It is expected to be implemented and operational through REDDIG at the end of November 2003. The GPS data recorded from the reference station are uploaded in the Colombian aeronautical administration's web page, with a weekly updating.

**Panama**

4.8 This reference station is part of the United States satellite augmentation trial platform (NTSB). The information of the data is recorded directly at the Atlantic City Technical Centre's NSTB.

**Peru**

4.9 The TRS station is installed and operational since December 2001; communications with the Chilean master station was completed in the beginning of 2002. Since the most important activity carried out was data collection from the TRS, this has been continuously carried out and all information recorded is in the FAA's data base.

4.10 Likewise, the Peruvian administration has purchased a work station and installed the GPS Solution data processor, provided by the FAA. The unit is still unable to process the information in its totality and currently, technical personnel is making coordinations with FAA for its operation.

**COCESNA**

4.11 COCESNA records since 2002 and in CDs the information obtained in its reference station, and sends the information to the FAA Atlantic City Technical Centre.

4.12 During the data analysis, it was determined that the station had a failure and the FAA replaced the GPS receiver and the processing unit, but the fault continues. Coordinations between FAA and COCESNA continue, with the aim of solving the problem.

5.. **Suggested action**

5.1 The meeting is invited to take note of the information contained in this information paper.