INTERNATIONAL CIVIL AVIATION ORGANIZATION
NORTH AMERICAN, CENTRAL AMERICAN AND CARIBBEAN OFFICE

FIRST MEETING OF DIRECTORS OF CIVIL AVIATION
OF THE CARIBBEAN REGION (CAR/DCA/1)

(Grand Cayman, Cayman Islands, 8-11 October 2002)

Agenda Item 6 – Technical Cooperation Projects

DEVELOPMENT OF A REGIONAL GNSS AUGMENTATION TEST BED (CSTB)

(Presented by the United States of America)

SUMMARY

This information paper provides a general overview and status of the ICAO Regional Work Project for Latin America, RLA/00/009, whereby the U.S. Federal Aviation Administration (FAA), International Civil Aviation Organization (ICAO) and the member States of the ICAO Regional Planning and Implementation Group for the Caribbean and South American (CAR/SAM) Region (GREPECAS) are cooperating to implement a Global Navigation Satellite System (GNSS) Augmentation Test Bed (CSTB) to support a regional transition to a satellite-based air navigation infrastructure.

1. Introduction

1.1 The International Civil Aviation Organization (ICAO), along with its member States in the Caribbean and South American (CAR/SAM) region, have adopted as a high priority the transition from the current, aging, ground-based navigation systems to a future satellite-based infrastructure based on Global Navigation Satellite System (GNSS) technologies.

1.2 The CAR/SAM region has, through its GNSS Task Force, taken the initial steps in this transition by adopting the United Nations Development Program (UNDP) Regional Project for Latin America, RLA/00/009. This project establishes a GNSS augmentation test bed, called the CAR/SAM Test Bed or CSTB, throughout the region to support and facilitate research, development, acquisition, and implementation efforts associated with an operational transition to satellite navigation.

2. Project Objectives

2.1 Before States can transition to the operational use of satellite navigation technologies, many questions need to be answered. Some questions needing attention are:

- Can GNSS (and its augmentations) meet existing aviation requirements?
- What mix of GNSS technologies are needed to economically satisfy all requirements?
- How many TRSs will be needed to meet operational needs and where do these TRSs need to be situated for optimal service availability?
- How to achieve GNSS benefits by modifying existing route structures and procedures?
- What are the ionospheric conditions and other sources of system error in the region, and how to solve for these using GNSS?

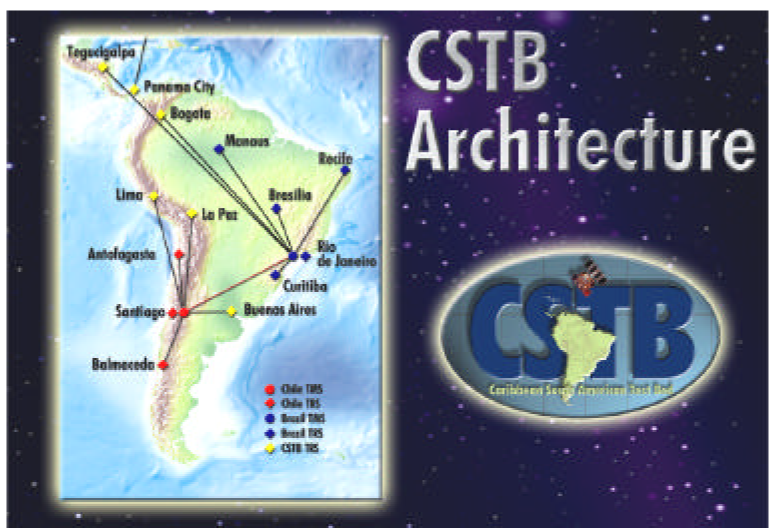
2.2 These are just a few of the many questions and issues that need to be addressed in a test bed environment prior to making a large monetary investment in new technologies. The CSTB provides the platform for each State, and the region as a whole, to analyze what an operational GNSS architecture should look like to meet existing aviation requirements.

2.3 In addition to the regional analyses, each State is also encouraged to use the CSTB to take a more in-depth look into its specific requirements and how State solutions fit into the overall CAR/SAM regional solution.

2.4 Through the course of this project, a cadre of expertise will be developed within the region that empowers all States to confidently design, plan for, implement and operate satellite navigation technologies in their airspace.

3. Project Overview

3.1 The CSTB consists of an initial wide area test bed capability based on Wide Area Augmentation System (WAAS) prototype technology. A network of CSTB Reference Stations (TRSs) are being installed throughout the region to monitor Global Positioning System (GPS) satellite signals, determine the health and accuracy of the GPS data, and forward this data to the heart of the system, the CSTB Master Station (TMS).



3.2 The TMS collects all TRS data and determines the amount of error associated with the GPS system in each respective geographic region represented by each TRS. This correction data is then formatted for broadcast and forwarded to either a VHF broadcast tower or Geostationary Communications Satellite (GEO) if available for transmission to the users.

3.3 The U.S. Federal Aviation Administration (FAA) has contributed five (5) TRSs to the project that are located in Buenos Aires, Argentina; La Paz, Bolivia; Lima, Peru; Bogotá, Colombia; and Tegucigalpa, Honduras. Additionally, three (3) FAA-provided TRSs and one (1) TMS are currently operating in Chile (Santiago, Antofagasta, and Balmaceda).

3.4 Brazil has also made a strong commitment to the project and has purchased and installed five (5) TRSs in Rio de Janeiro, Brasilia, Curitiba, Recife, and Manaus; and one (1) TMS in Rio de Janeiro as its contribution to the establishment of the CSTB architecture. Brazil has also equipped a Hawker 800 aircraft to perform regional flight tests, and is investigating the acquisitions of a GEO uplink and broadcast capability to support the transmission of the CSTB correction signal throughout the CAR/SAM region.

3.5 A communications link between the Rio de Janeiro and Santiago TMSs is being coordinated to allow for data sharing throughout the region. A TMS-to-TMS communications link already is operational between the Santiago and FAA Technical Center TMS to provide the CSTB with access to more than eighteen (18) U.S. TRSs, one (1) Panama City, Panama TRS, three (3) Mexico TRSs, and three (3) Canadian TRSs.

3.6 The last component of this project is the addition of a Local Area Augmentation System (LAAS) Test Prototype, or LTP. Brazil is currently investigating the potential installation of an LTP in Rio de Janeiro. This LTP will allow the project to conduct regional integration testing for wide area and local area systems, as well as tests and data collection to support operational LAAS facility siting and installation, advanced procedure development and approval (curved approaches), and research on extreme terrain and multi-path interference generated by having airports located in close proximity to mountains and bodies of water.

4. **Project Status**

4.1 The CSTB Project Plan document was approved in June 2001 and implementation began soon thereafter.

4.2 The FAA conducted a TRS Installation and Operation Training Course in Buenos Aires, Argentina from December 5-7, 2001. At this course, all attendees were given detailed instruction on installation procedures for a TRS, including equipment set-up and operation and GPS receiver antenna site survey, installation, and verification. Instruction was also provided on the various troubleshooting procedures to ensure continuous TRS operation. At the conclusion of the training, the Argentina TRS installation was complete and operational. The communication line between Argentina and the Santiago TMS was completed on February 5, 2002, thus initializing access to Argentina collected data.

4.3 In January 2002, Peru completed the installation its TRS and initialized a communication link to the Santiago TMS. The Bolivia TRS was also installed in May 2002 and is awaiting initialization of the communications line to Santiago. The Honduras (COCESNA) and Colombia TRS installations are in progress and investigations continue on securing final communications lines to the Rio de Janeiro or FAATC TMSs.

4.4 The FAA and Brazil completed technical ionosphere flight tests from January 14-24, 2002 in the Rio de Janeiro area. The data collected, both from the Brazil TRSs and the FAA B727 aircraft, will be used to determine conclusions about the geographic ionosphere challenges that the CAR/SAM region has to address when planning for and implementing an operational GNSS. The flight test report is currently being finalized and should be available in mid 2002.

4.5 From February 18-22, 2002, the CSTB project hosted a training course at the FAA Technical Center for CSTB participants. This training instructed all States on the operation of the CSTB and how to collect and analyze data, and conduct flight testing in support of operational transition initiatives. This training provided the necessary instruction to complete all CSTB infrastructure set-up and initialization, and prepared all State representatives for the execution of regional data collection flight tests to be performed in mid 2002.

5. Initial CSTB Flight Tests and Data Collection

5.1 The primary objective of the CSTB project, as agreed to and finalized in the August 1-3, 2001 GNSS Task Force Meeting, is to develop a wide area GNSS augmentation test bed to conduct research and development activities in support of an operational implementation of an SBAS in the region for enroute through non-precision approach (NPA) operations. It was agreed that the individual States would then provide any precision approach (PA) operations at their airports requiring this level of service.

5.2 To support the development of an operational SBAS NPA service with high availability (0.99+), the CSTB project has to address the threat from the ionosphere and associated threats of scintillation and bubbles. This requires the collection and analysis of both “static or ground” and “airborne” data. The static and airborne data collection and analysis, as well as any flight tests that are performed, needs to be designed to validate the integrity, accuracy, continuity, availability, and coverage requirements for this desired operational capability.

5.3 To support this project objective and collect the required airborne GPS data, the CSTB project planned and executed airborne data collection flight tests from May 12-26, 2002. For this test, a Chilean Citation II aircraft recorded airborne GPS data (non-precision approach phase) in Santiago, Chile; Buenos Aires, Argentina; La Paz, Bolivia; Lima, Peru; and Antofagasta, Chile. The aircraft also recorded enroute GPS and ionosphere data while flying between the aforementioned cities. Ground TRS data was also recorded at the TRSs in the same geographic area during this same timeframe.

5.4 Both airborne and ground TRS data logged during the flight timeline are currently being collected for post-processing to be analyzed specifically to determine, at a minimum, the following parameters:

- GPS satellite loss due to scintillation

- GEO message loss (from either or both GEO satellites: AOR-W and/or AOR-E)
- Potential improvements due to algorithm or tracking loops
- Continuity and Availability under simulated or Test bed SBAS NPA service
- Continuity and Availability with RAIM as a back-up integrity source
- Accuracy and Integrity of NPA service (both with and without clock and ephemeris corrections provided by the TMS)
- Vertical Accuracy resulting from the actual state of the ionosphere in the region

5.5 Regional flight tests and data collection and analysis exercises will continue throughout 2002 and be summarized and reported at subsequent ICAO regional meetings. In late 2002 and throughout 2003, the CSTB project coordination team will begin to focus more on specific State flight tests and operational scenarios throughout the region.

6.0 Recommendation

6.1 The meeting is requested to note the material presented in this information paper. For additional information on the CSTB project, please contact either the ICAO South American Regional Office in Lima, Peru or Mr. David S. Burkholder, FAA CSTB Project Coordinator, at (202) 267-7274 / David.S.Burkholder@faa.gov

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