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Agenda Item 6: Aeronautical navigation issues

STATUS OF THE BRAZILIAN TRIALS ON AUGMENTATION SYSTEMS

(Presented by Brazil)

SUMMARY

This information paper presents the status of the Brazilian Test Bed (BTB) program, its preliminary results and also raises some issues concerning ionosphere features along of the geomagnetic equator.

1. INTRODUCTION

1.1 Implemented since September 30, 2001, the Brazilian Test Bed (BTB) operates with one Master Station in Rio de Janeiro and five Reference Stations located in Manaus, Recife, Brasilia, Rio de Janeiro and Curitiba.

1.2 To carry out data collection and instrument approach procedures evaluation, BTB also utilizes a fully equipped Hawker 800XP aircraft.

1.3 Being a CAR/SAM Test Bed (CSTB) component, Rio de Janeiro Master Station will be connected to Santiago Master Station, besides being linked to at least two Reference Stations located in Honduras and Colombia.

1.4 Taking into consideration that the Brazilian concept establishes an integrated architecture of SBAS/GBAS systems, BTB comprises interoperability tests and evaluations of those systems.

1.5 In order to accomplish the objectives established for this integrated concept, Brazil has established an agreement with the United States Federal Aviation Administration (FAA) to perform an LAAS/GBAS Test. This cooperation includes a joint project whereby the FAA loaned a LAAS Test Prototype (LTP) system to the Brazilian Department of Air Space Control (DECEA) for installation at Rio de Janeiro International Airport (GIG).

(5 pages)

2. BTB PROGRAM PLAN

2.1 Execution

2.1.1 The program will be executed in a phase approach to reduce risk and allow adequate preparation.

2.1.2 Phased approach

a) Phase I: 1 October 2001 to 31 August 200 - Test bed implementation, requirements and architecture definition, flight test, site installation, and airport surveys.

b) Phase II: 1 August 2005 to 31 December 2007 - Aircraft installation, airspace design, software interfaces, flight evaluations and Proof of Concept.

2.1.3 Phase I will focus on definition of requirements and laying the foundation for the execution of Phase II. Phase II will focus on execution of the test plan, analysis and development of the end-state architecture. The program will utilize the Brazilian Test Bed and the LTP project as the foundation to support the project. The test bed will provide:

a) SBAS/GBAS implementation;

b) flight test support;

c) truth system;

d) highly accurate signal in space;

e) the opportunity to quantify operational benefits and human factor issues; and

f) SBAS/GBAS performance monitoring.

2.1.4 SBAS/GBAS transition implementation will be one of the primary areas of focus because it is an area that has not yet been addressed in other satellite navigation program. While DECEA will focus primarily on development of the architecture and procedures that are specific to Brazil and South America, the FAA will be participating in the project to glean any lessons learned that maybe applied to US airspace.

2.1.5 Flight test support will be accomplished in Phase I through the use of flight inspection aircraft provided by DECEA, and possibly through aircraft provided by other organizations involved in the project. It is desired to have aircraft that represents the user community to allow flight tests to be conducted using different categories of aircraft so as to insure adequate data is available to conduct analysis on system performance, operational procedures and traffic flow.

2.1.6 The test bed will provide DECEA with the ability to compare operational signals in space against a known and quantified signal. This will provide the basis from which to analyse system performance parameters and trace any anomalies in both GBAS and SBAS.

2.1.7 Performance monitoring is required not only to maintain an independent capability to assess GBAS and SBAS performance, but also to develop the capability to predict system performance for the issuance of NOTAMS and the storage of performance data for accident investigation, especially when satellite systems provide services covering more than one national airspace.

2.2 **Objectives**

2.2.1 In order to plan a full implementation of satellite navigation technologies, Brazil will have to address many issues. These issues can be broken down into two (2) primary areas: technical and operational.

2.2.2 The activities included under each of these areas are components of an overall transition effort. The establishment of a test bed capability is one of the primary activities under the "technical" arena, and one that will support the two areas as well. The test bed will provide the groundwork and function as the cornerstone of a satellite navigation transition effort within Brazil. For information purposes, a brief description of the areas has been included.

2.2.3 Technical activities will consist of analyzing the current navigation infrastructure and aviation requirements, identifying the desired capabilities to be achieved for an effective satellite-based navigation, and then deciding on the optimal architecture and mix of technologies that will meet all future needs and demands in a cost efficient manner. In order to arrive at the best solution to these issues, the test bed will be used as a foundational capability to exploit the research and development activities. The test bed will also be used to gain insight into the final operational configuration, interface issues, user considerations, and other technical system design, set-up, and operational aspects. It will also prove invaluable in concept feasibility studies, gathering political and users support, conducting capability assessments on proposed system architectures and providing for advanced technology familiarization and training.

2.2.4 A test bed will prove beneficial in other ways as well. It will allow for troubleshooting of other system interfaces and operational enhancements prior to system commissioning, provide a proving-ground for system and technical interface requirements, identify current infrastructure limitations, and more importantly, leverage operational implementation costs by developing a test and evaluation infrastructure that will be applicable to the operational environment (i.e. site selection and preparation, secure terrestrial communications links, operational procedure development, aircraft certification, training, etc.).

2.2.5 Operational activities will ensure that the planned satellite navigation system architecture meets all operational requirements prior to its integration and public use in State-controlled airspaces. These activities will ensure a timely transition to new satellite navigation services by making sure all operational issues are addressed prior to final system development, test, and integration. The main goal is to have all aspects of an air traffic control system prepared ahead of time and ready to support the introduction of new satellite navigation capabilities and maximize the benefits throughout Brazil. A number of these activities need to be initiated and addressed concurrently with the technical test bed activities.

2.2.5.1 For example, the test bed will be used to:

a) perform operational analyses of prototype system performance and reliability;

b) gain experience with procedure design/development issues;

c) gain experience with flight inspection of procedures;

d) test prototype avionics and system modernization features prior to their operational debut; and

e) provide an operational training capability for pilots, ATC personnel, and maintenance technicians.

2.2.5.2 In addition, operational activities will focus on the governmental actions necessary for the introduction of GNSS-based navigation systems and services. These items are designed to resolve all issues relating to overall program support, as well as build a consensus for accelerated implementation with the existing air traffic management system. Some of the high level considerations to be addressed include the establishment of a satellite navigation program and an interagency operational implementation team (air traffic controllers, certification specialists, procedures specialists, maintenance specialists, etc.). Civil aviation interest groups (commercial, general aviation, cargo, helicopters, service providers, equipment manufacturers, and academia) that must be involved from the very beginning to ensure all user needs and requirements are taken into account and addressed in the early stages of system design and development. These groups could also be from outside the aviation field, which stand to benefit from the availability of a precise GNSS-based navigation system throughout Brazil (e.g. surveying, agriculture, maritime, emergency services, ground transportation, railways, precise timing, etc.).

2.2.6 The project objectives are to:

a) establish the service requirements for the use of CNS/ATM elements in the Brazilian airspace;

b) demonstrate integrated SBAS/GBAS operations;

c) conduct Proof of Concept as a transition to an operational environment;

d) conduct Proof of Concept of safety enhancements identified by DECEA and FAA;

e) demonstrate and quantify operational benefits and human factor issues;

f) demonstrate capability to certify and approve operational procedures;

g) identify optimum satellite up-links and operational frequency spectrum;

h) transition enhancements from R&D to limited implementation; and

i) contribute to the CSTB in order to establish a regional system.

2.3 GBAS/LAAS TEST

2.3.1 This joint GBAS/LAAS research and development project will permit the FAA and DECEA to gain many mutual benefits. Brazil (DECEA) will be able to conduct site survey, validation, and preparation work in advance of an operational GBAS/LAAS installation at Rio de Janeiro International Airport. Jointly, both parties will be able to validate the potential applications of GBAS/LAAS at adjacent airports, the use of the GBAS/LAAS PVT (Position, Velocity and Time) signal for long-range aircraft guidance, and the integration of SBAS and GBAS/LAAS operations in the terminal environment using multi-mode receiver (MMR). The flight data collected by DECEA will also provide many operational insights into the use of GBAS/LAAS for complex procedures that will provide significant operational, safety, capacity, and efficiency benefits to the airlines flying in Brazilian airspace.

2.3.2 LTP Project Joint Activities:

a) analyse GBAS/LAAS coverage on all runway ends at the primary airport;

b) analyse GBAS/LAAS coverage up to 20 NM at all qualified runway ends (multiple airports);

c) analyse potential GBAS/LAAS applications at the edge of the service volume;

d) provide positive guidance in all missed approach areas;

e) analyse use and benefits of advanced procedures;

f) validate the use of GBAS/LAAS to conduct curved approaches around an obstacle at an adjacent airport (LTP at GIG and procedure at Santos Dumont Airport);

g) validate the GBAS/LAAS siting criteria that have been established by the FAA Technical Center and academia;

h) collect flight data from different types of aircraft on procedures for straight-in approaches and terminal area operations at the primary airfield and adjacent airports that will be used to validate GBAS/LAAS procedure criteria;

i) cooperate in gaining international acceptance of the GBAS/LAAS TERPS criteria and SARPS that will be developed and proposed to ICAO for global acceptance; and

j) determine any effects of the geomagnetic ionosphere conditions (including scintillation) on the operation of GBAS/LAAS for Category I and II operations.

3. BTB PRELIMINARY RESULTS

3.1 The preliminary results of BTB operation, from October 1 on, have exposed significant ionospheric features along of the geomagnetic equator; these include geomagnetic anomalies, plasma bubbles, and scintillation, with prejudice to the use of ionosphere models conceived from the environmental characteristics of the Northern Hemisphere.

3.2 Those preliminary results have caused the need to data collecting, which was undertaken by a FAA B-727 aircraft in January 2002. Also, an Ionosphere Seminar was organized in March 2002 in order to involve the scientific community (Brazilian and international) in this matter. At this opportunity a working group was established to study and suggest a technical and operational solution to the problem.

3.3 During this year, DECEA has collected data from 22 to 24 of April showing some evidence that the fluctuation in Signal to Noise Ratio (SNR) level was due to scintillation and "bubbles", even though small fluctuations and scintillation are not a problem for the systems, but larger SNR fluctuations can cause carrier measurement dropouts and sometimes code measurement dropouts. Dropouts of satellites in the position solution can affect the moment-by-moment accuracy of the system.

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