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- Agenda Item 3: Performance framework for Regional Air Navigation Planning and Implementation**
3.5 CNS/ATM/1 and CNS/ATM/2 meeting reports

IMPLEMENTATION PLAN FOR A TEST BED FOR THE SBAS / SACCSA IN THE CAR/SAM REGIONS

(Presented by the Secretary)

SUMMARY

This working paper presented the Implementation Plan for a test bed for the SBAS / SACCSA in the CAR/SAM Regions, complementing the Draft Conclusion CNS/ATM/2/1 and recommending its adoption.

1. Introduction

1.1 During the Seventh Meeting of the Coordination Committee (RCC/7) of Project RLA/03/902 – SACCSA, held in San Carlos de Bariloche, Argentina, from 11 to 15 October 2010, a demonstration in real time was performed through the broadcast of a SBAS / SACCSA signal by the GEO INMARSAT 3F4 PRN 122, and using the GMV SBAS processing center, magicSBAS; GPS observation data, from IGS type GPS receivers networks, SIRGAS (IGS, IBGE, UNESP, RAMSCA, PRSN, etc.). The result was highly satisfactory giving rise to steps towards the availability of a test bed for SBAS / SACCSA in these regions, as was expressed and agreed by the above-mentioned meeting through *CONCLUSION RCC/7/SACCSA/10 - IMPLEMENTATION OF A TEST BED FOR THE SBAS / SACCSA*

1.2 Conclusion RCC/7/SACCSA/10, recognizing the convenience and benefits of implementing a test bed for SBAS – SACCSA in the CAR/SAM regions that allow covering the objectives indicated under paragraph II.9 of its Report, directed Project RLA/03/902 to develop an implementation plan for a test bed for SBAS – SACCSA, defining the required infrastructure, costs and other associated aspects, and consequently, requested that ICAO urge States and International Organizations of these regions to participate in the mentioned test bed.

1.3 In this regard, ICAO requested the technical coordinator of the project to carry out an assessment on the possibility of implementing a test bed in the CAR/SAM regions, under a scalability concept and an estimated minimums and maximums.

1.4 Regarding Project RLA/03/902 – SACCSA, in view of the first results obtained by the SACCSA Phase III-A and its contribution to the PBN implementation and in order to support the completion of this Project, the Second Meeting of the CNS/ATM Subgroup, held in Mexico City, Mexico from 16 to 19 November 2010, agreed **DRAFT CONCLUSION CNS/ATM/2/1 “SUPPORT IN THE COMPLETION OF PROJECT RLA/03/902 SACCSA STUDIES AND PARTICIPATION IN THE TEST-BED IMPLEMENTATION”**, urging States/Territories/International Organizations of the CAR/SAM Regions to facilitate/coordinate with their corresponding national authorities, the access and provision of data to the SACCSA Project from networks with 1-second GPS receiving stations with FTP or NTRIP access and RINEX files; and participate in the implementation of a test bed SBAS-SACCSA. The text of this draft conclusion is presented in the **Appendix** to this working paper.

1.5 Additionally, the CNS/ATM/SG/2 Meeting took note and appreciated the contributions programme coordinated by Project RLA/03/902, which include offers from Project participant States and International Organizations contributing to promote implementation of the performance based navigation (PBN) and support the work of this CNS/ATM Subgroup. Likewise, the meeting supported the initiative of Project RLA/03/902 regarding the common strategy of information and diffusion of their programmes and results, and with the support of ICAO, continue presenting the SACCSA Project in the meetings of panels, users, international organizations and entities which follow-up on the GNSS development.

2. Discussion

Objectives of the test bed for SBAS / SACCSA

2.1 In the development of any SBAS system, it is required to have a test bed where solutions to be applied be tested and analyzed and necessary improvements to achieve the correct functioning of the system be introduced.

2.2 In the case of the CAR/SAM Regions, this is even more important if we take into account their peculiarities, compared to other regions with mid-latitude SBAS, for example, the behavior of the ionosphere and the impact on the SBAS in conditions of greater solar activity, including GEO satellite and the corresponding L1 signal reception which makes this a pioneer infrastructure in what has been done so far with the existing SBAS.

2.3 The basic objectives to be achieved are:

- a) Demonstrate the technical feasibility of the SACCSA solution.
- b) Analyze the performance of the algorithms and SACCSA solutions, performing the appropriate tests, corrections and/or modifications and demonstrate the technical feasibility of implementing the system.
- c) Have a infrastructure that allow analyzing in real the impact of the ionosphere on all elements of a SBAS system (reference stations, GPS, GEO, communications system), in complex situations such as those that will be seen in most active phase of this solar cycle, between 2012 and 2013, showing the extent of operation of the SACCSA ionospheric algorithm.
- d) Have a pre system that product of tests and analysis of its performance may give way to the final operational system.

- e) Provide an opportunity for States and International Organizations to become familiar with the system, developing open multimodal applications (non-SoL), which will start getting SBAS benefits, based on a non SoL open service for multimodal users, monofrequency and dual-frequency.
- f) Develop LPV aeronautical procedures, that can be flown with aircraft equipped in this regard (red label receivers).
- g) Minimize the risks of implementing the final system.
- h) Contribute to determine the best model for managing the system.
- i) Encourage the use of SBAS technologies in the CAR/SAM Regions, both at aviation level as well as at multi-modal level.
- j) Have a multi-frequency and multi-constellation infrastructure in order to analyze the advantages and comparison with different future technologies such as the multi-frequency (L1/L5) and multiconstellation.
- k) Take advantage of existing infrastructures in the CAR/SAM Regions to provide added value through the implementation of SBAS technology.
- l) Develop an improvement precision service based on SBAS.

2.4 In this infrastructure some of the most innovative solutions proposed by SACCSA could be integrated, as the use of multiconstellation at the ground segment level (use of GPS and GLONASS receivers), which represents a huge step in relation to the current SBAS systems in service or development.

Description of the test bed

2.5 To achieve these objectives, Project RLA/03/902 has proposed the implementation of a SBAS / SACCSA test bed representing the final system, and that allows guaranteeing the development and good functioning of the final system. This test bed should combine an operation and a service similar to a real system, but under the premise of the lowest possible cost, taking into account both the equipment and operational costs. Likewise, the distribution of costs would be consistent with a model of proportionality as a starting point, irrespective that States and International Organizations decide to increase their participation in a given time.

2.6 The test bed will be composed of:

- A navigation load in a GEO
- An access station to the GEO satellite
- An Central Process Unit (CPU)
- Communications network
- At least 24 reference stations, located in the sites defined for SACCSA or as close as possible to the same
- Collection and data recording centre for statistics analysis and studies
- Support center
- Operation for a period of two years

2.7 Since the test bed can be a wide range of prices, three possible solutions are proposed, which would allow selecting one or the other depending on the availability of budget, taking into account that the major costs of the operation are derived from the rent of the GEO navigation load and the operation of the CPU, which will always be the same regardless of the solution adopted.

Basic solution

2.8 This solution is based on using existing elements, both at receiver networks and GEO access stations level. It would start from the use of MagicSBAS and an INMARSAT access station (confirm availability) or an existing one within the satellite visibility footprint, using the receiver networks available in the CAR/SAM Regions. This solution would represent the lowest cost of all possible, but has the disadvantage of the data instability from some receiver networks and the lack of quality of the communications service, to which should be added that the data come from network servers and not directly from each one of the receivers. This will allow to analyze the performance and behavior of the system in real-time, while ensuring open service would depend on the performance of the receivers available and communications.

2.9 Depending on the performance of existing infrastructure in the region (monitoring stations and communications systems), this solution may be limited to the availability of service, for example, for flight tests and provision of services for the development of applications upon it. This solution would check the system behavior and the performance level that could be achieved, although the operational use (non-SoL) of the signal would depend largely on the region and/or state (performance level of the reference stations and communications) and the use you want to do of it.

2.10 This approach is one that has been used during the demonstration held during the RCC/7 where it was noted that in Brazil and Argentina the performance was stable, but there were availability problems in the area of Colombia - Ecuador - Peru due to connections and latency data in the reference stations, and the lack of some that would be necessary.

2.11 From a representative view of the system, this is the less desirable for the lack of control over the monitoring stations.

Intermediate solution

2.12 This solution is based on using only the receivers whose performance benefits in data transmission and communication are sufficient, installing where needed dedicated reference stations. The connection antenna to the GEO could be in any area of the GEO visibility footprint (in the Americas or Europe). This alternative will provide a minimum guaranteed service, but always depending on others, because the number of active reference stations is limited.

2.13 This solution is more solid than the basic, because it incorporates dedicated stations with service warranty, therefore, mitigating the risks associated to the basic solution, but remains dependent on the performance of the existing infrastructure in order to provide high service availability in all the coverage area. It would allow provision of SBAS information to users who wish to study the system for experimental use.

2.14 It is important to note that the reference stations placed under this concept could be re-used in the SACCSA system as part of the monitoring network within the Support Segment.

Advanced solution

2.15 In this case a totally dedicated test bed and with high service availability would be installed. A dedicated reference stations network would be used, with an access antenna to the satellite located in the CAR/SAM Regions. The number of stations would depend on the coverage and provisions to be achieved, but in principle would be of a minimum of 50% (24), up to the total of 48 reference stations designed by the SACCSA Project. This solution would guarantee the service for no SoL users, and would open the door to aeronautical users to experiment with the system and flight procedures using "red label" receivers or non-aviation receivers, Novatel or Septentrio type, in a wide coverage area.

2.16 From a system standpoint, this is the best and most desirable solution, because it avoids relying on third parties and the Test Bed is constituted as a real approximation to the final system in its entirety, which allows gaining knowledge on the operation, maintenance and institutional implications of a system of these characteristics. Also, it is the best solution to LPV in flight testing.

2.17 The Monitoring Stations could be used beyond the tests, because after these they may be used as performance monitoring stations, both GPS/GLONASS and SACCSA (if implemented). These stations will be essential for PBN implementation based on GNSS navigation, as will allow States and air navigation service providers to know the infrastructures provided by GPS/GLONASS at all times. Therefore, the best thing would be that each State/International buys their stations within the overall process, remaining under their ownership. Naturally, the station model would be unique, and would be based on the award resulting from their provision, so their acquisition could be made through the ICAO-TCB, because all stations could be bought to be distributed later, which would be cheaper than the independent acquisition of one or two stations by each contracting State/International Organization

Test bed financing

2.18 SACCSA test bed is a necessary and important step before deciding the launching of the final system implementation, and is a consequence of the work that has been developed in Phase II and those that are being developed in Phase III. In this infrastructure, the operation of the proposed solutions and of the developing algorithms could be checked.

2.19 This makes that the infrastructure be a result of the SACCSA project, and therefore, is a complementary activity, linked to the work currently under development, but with an independent budget and additional to the one ongoing in Phase III.

2.20 When financing the test bed, we must separate the costs of equipment or capital expenditures (CAPEX – CAPital EXpenditure) and operating expenses (OPEX). Lets analyze both costs:

2.21 **CAPEX:** These costs refer to the cost of equipment necessary for the implementation of the test bed, and basically include hardware/software (HW/SW) elements and infrastructure installation, if necessary

2.22 In this section, the elements to consider are:

- Reference stations for the test bed
- UCP prototype
- Support center
- Access stations to the satellite
- Data collection and distribution unit
- Tools user license

2.23 For the intermediate and advanced solutions, the reference station model will be unique, so engineering costs are diluted and impact less in the final CAPEX cost. In view that these stations would be owned by the Administrations, it would be suggested that each State/International Organization acquire their corresponding stations based on their own resources and budget external to the Project. This would apply to system monitoring tools licenses, in case a State/International Organization wishes to have some from outside of the Project.

2.24 The remaining elements are common to the test bed, so they have to be paid on the project budget.

2.25 **OPEX:** This includes the operational costs of the system, and will course on a regular basis over its useful life with the corresponding annual changes as set forth in the appropriate contracts. Among others, this would include:

- Rent of the GEO load
- Operation and rent of the access station to the satellite
- Operation of the UCP prototype
- Operation of the Support Center
- Operation of the data collection and distribution unit
- Communications network
- System Management & Engineering

2.26 These are current OPEX costs, which should be charge directly to the Project.

Warranties and service protection

2.27 Participation in Project RLA/03/902 SACCSA and/or the Test Bed is opened to all States and International Organizations. For those not interested in participating and obviously in not receiving their signals, the IGPs of non contracting States could be nullified in the process central unit (UCP), so they would only see the GEO L1 signal, but not the corrections given by the system, so they could not use it. This constitutes an element of warranty and protection of the service, since it will only be available on participating States.

Request for PRN code assignment for the SBAS / SACCSA test bed

2.28 It is suggested to ask the ICAO Navigation Systems Panel (NSP) to consider the possibility of allocate PRN codes (codes of pseudo-random noise) for SBAS testing. Thus, the assignment of one of them would be necessary for the SBAS/SACCSA test bed.

Implementation strategy

2.29 Taking into account that one of the major goals is to maximize the cost-benefit balance of the test bed, we recommend the gradual implementation of this SACCSA infrastructure, and therefore, minimize the risks of the investment. Thus, it is recommended to start implementing the basic solution and gradually progress to the intermediate solution depending on the provisions observed regarding the availability of data and communications and the use that each State/International Organization wants to make of the SACCSA test bed. The ultimate goal of implementation is the advanced solution, as it is what allows addressing with more warranty all the identified objectives.

3. Conclusion

3.1 The implementation of the SBAS/SACCSA test bed will allow States and International Organizations an early familiarization with the SBAS signals being able to develop applications and non SoL services, based on SACCSA, so they could get a return on investment, as services are traded, as well as applications, so non aeronautical users could benefit promptly.

3.2 At aeronautical level, LPV procedures can be designed and flight with "red label" receivers (remember that the message MT0 must be activated), which will allow to design procedures and see the improvements obtained. Likewise, it would represent an additional support for States that develop GBAS implementation projects.

4. Action by GREPECAS

4.1 GREPECAS is invited to:

- a) take note of information presented in this working paper;
- b) adopt the Draft Conclusion CNS/ATM/2/1 presented in the Appendix to this working paper, urging States and International Organizations to assess the desirability of participating in the implementation of a SBAS / SACCSA test bed by signing the implementation plan of this infrastructure presented in this working paper and participating in the development and execution of this Plan;
- c) encourage States and International Organizations to develop multimodal uses and applications based on the infrastructure, obtaining the benefits from such use; and
- d) recommend that the ICAO Navigation Systems Panel (NSP) consider the possibility to allocate PRN codes for the SBAS testing

APPENDIX

**DRAFT CONCLUSION ON PROJECT RLA/03/902 – SACCSA FORMULATED BY THE
CNS/ATM/SG/2 MEETING**

**DRAFT
CONCLUSION CNS/ATM/SG/2-1**

**SUPPORT IN THE COMPLETION OF PROJECT
RLA/03/902 SACCSA STUDIES AND
PARTICIPATION IN THE TEST-BED
IMPLEMENTATION**

In view of the first results obtained by the SACCSA Project – Phase III-A, and its contribution to the implementation of PBN and in order to support the completion of this Project, CAR/SAM States/Territories/International Organizations are urged to:

- a) facilitate/coordinate with their corresponding national authorities, the access and provision of data to the SACCSA Project from networks with 1-second GPS receiving stations with FTP or NTRIP access and RINEX files; and
- b) taking into consideration the objectives indicated in Appendix B to this part of the report, consider participation in the SACCSA-SBAS test-bed implementation by notifying ICAO by **30 June 2011**.

— END —