International Civil Aviation Organization
CAR/SAM Regional Planning and Implementation Group (GREPECAS)
Seventeenth Meeting of the CAR/SAM Regional Planning and Implementation Group (GREPECAS/17)
(Cochabamba, Bolivia (Plurinational State of), 21 to 25 July 2014)

Agenda Item 4: **Regional air navigation planning and implementation performance framework: Review of programmes and projects**

4.1 Projects of the ground-ground and ground-air communication infrastructure programme

PROGRESS OF THE RLA/03/902 PROJECT – "TRANSITION TO GNSS/SBAS IN THE CAR/SAM REGIONS – SACCSA – PHASE III

(Presented by the SACCSA Project)

EXECUTIVE SUMMARY	
Progress of the SACCSA Project, detailing activities, progress of the Work Packages, financial situation, results and conclusions.	
Strategic Objectives:	• Safety • Air Navigation Capacity and Efficiency • Environmental Protection
References:	• RLA/03/902 Project Document, Revision O • Report of the Ninth Meeting of Regional Project RLA/03/902 Coordination Committee (Lima, Peru, 1 to 4 July 2013)

1. Introduction

1.1 The trials carried out with the Wide Area Augmentation System (WAAS) and the European Geostationary Navigation Overlay Service (EGNOS) determined that their extension was not feasible in the CAR/SAM Regions due to the particular ionospheric behaviour experienced in these Regions. This suggested the development of a Satellite Based Augmentation System (SBAS) with algorithms adapted to the needs of the CAR/SAM Regions, known as the Regional Project RLA/03/902 "Augmentation Solution for the Caribbean, Central and South America" – SACCSA whose main purpose is to *Develop and Plan the Technical, Financial, Operational and Institutional aspects of a SBAS System for the CAR/SAM Regions*. As shown in Figure 1, the project has had several phases, currently developing Phase III, which will complete the execution of the Project.

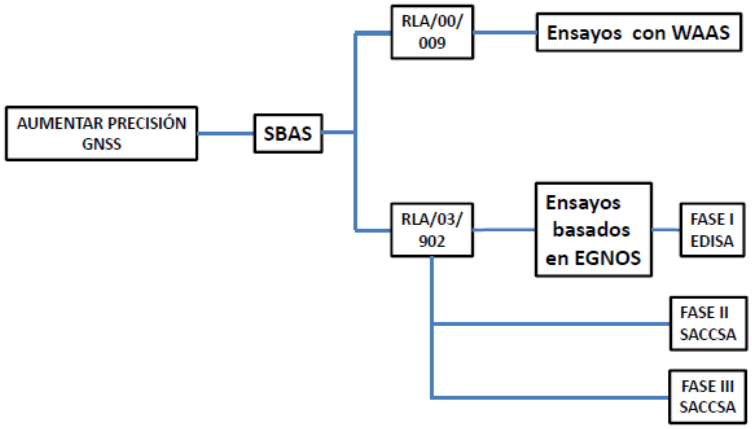


Figure 1
SACCSA Origin and Phases

2. Relevant Project Activities

2.1 During Phase III, several activities have been developed, which are presented graphically in Figure 2. The Work Packages (PT) already hired and finalized as part of the project are highlighted.

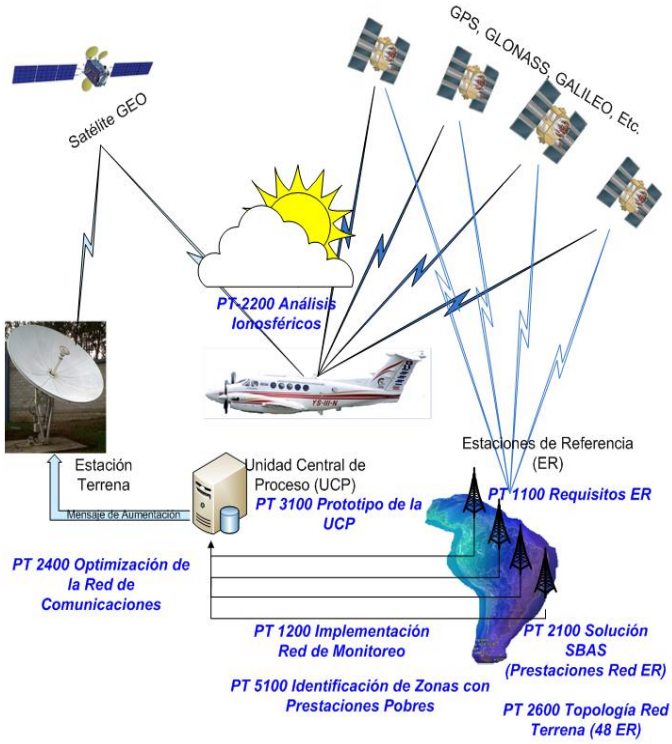


Figure 2
Phase III Scheme

2.2 The progress of activities is presented in detail in Section 3.

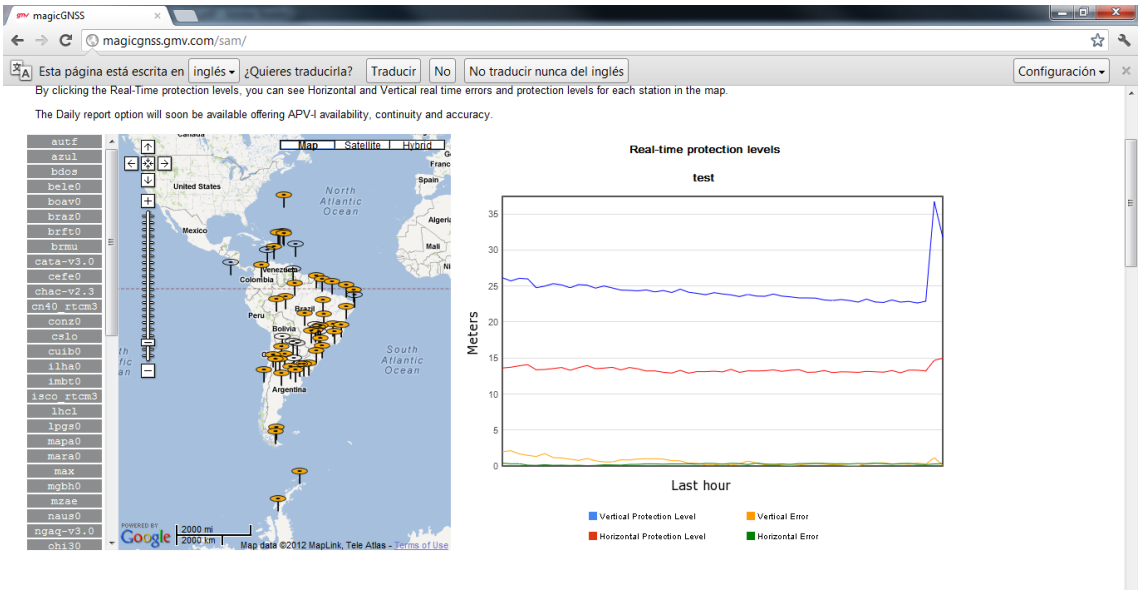
2.3 Regarding recommendations 6/5 *ICAO work programme to support global navigation satellite system evolution* and 6/9 *Ionosphere and space weather information for future global navigation satellite system implementation* of the Twelfth Air Navigation Conference (ICAO Doc 10007), SACCSA Project, in general, has performed the following activities:

a) Support was provided for Global Navigation Satellite System (GNSS) system implementation through courses and/or seminars held in Costa Rica and Mexico;

b) Hiring and implementation of several Work Packages for the elements of a SBAS system in the CAR/SAM Regions have been defined; information on ionospheric behavior and the definition of ionospheric algorithms to implement a SBAS system in the CAR/SAM Regions; the compatibility with other SBAS systems; the definition of communication needed to operate the system; and the definition of Reference Stations on the Ground Network. All this information is described in the work package progress section;

c) During the RCC/7 Meeting held in Bariloche, Argentina, a real SBAS signal was broadcast in the CAR/SAM Regions using SACCSA algorithms through the GMV MagicGemini platform and the Inmarsat geostationary satellite. More details are presented in Appendix 1 and in http://www.icao.int/publications/journalsreports/2012/6703_en.pdf; and

d) GMV, contractor for this Project, provided a platform for analysis of SACCSA benefits through the magicSBAS and the GMV MagicGemini tools in real time, using it for the effect of Reference Stations that are installed for other purposes by Universities, Geographical Institutes, etc. The results are available at the following link: http://magicgnss.gmv.com/sam/. The horizontal and vertical errors as well as the associated protection levels can be observed in real time (Figure 3).



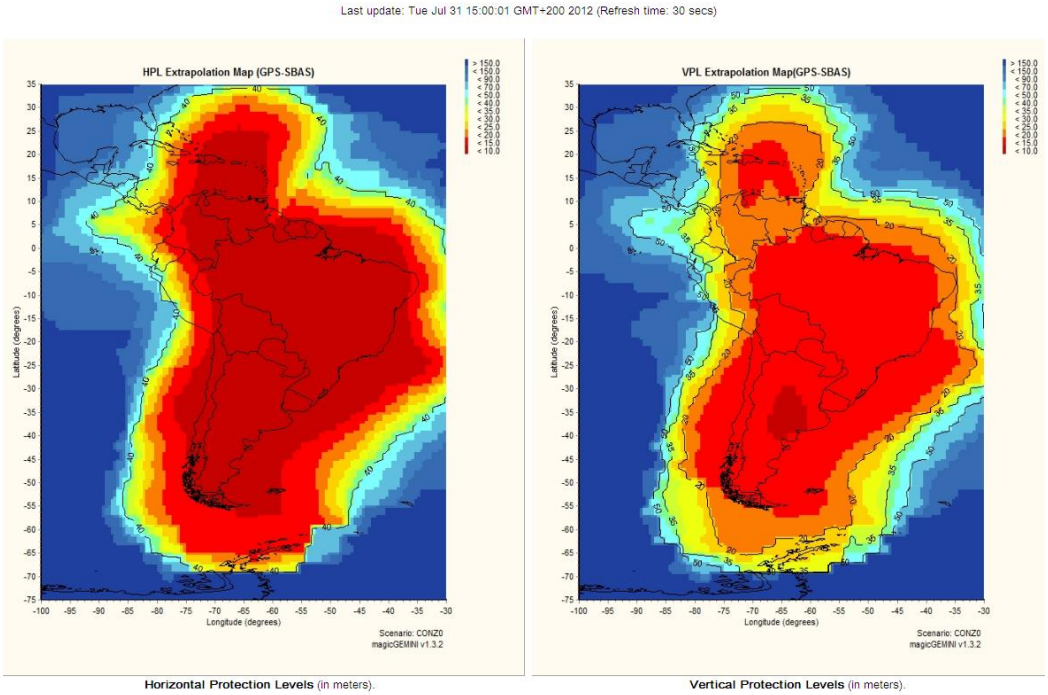


Figure 3

Note: benefits depend on the availability of existing data and there is no service guarantee because this platform has not been considered by the project.

2.4 The following activities have been finalized since the Ninth Meeting of the Project Coordination Committee:

- Transfer of the technical coordination. *Aeropuertos Españoles y Navegación Aérea* (AENA), in addition to the economical contribution that has provided, they have also provided an important support in-kind as the Project Technical Coordination. However, due to the fact that they can no longer provide this support, the Project approved to accept the generous support of Colombia for the development of this important task. To this end, the personnel designated by Colombia, in coordination with AENA personnel and GMV (project contractor), from 19 to 23 May 2014, transferred the technical coordination and covered the following topics:

  i. Project status and documentation
  ii. Updates carried out during the technical coordination of AENA
  iii. Review delivered and pending work packages
  iv. Financial status
  v. Institutional aspects

- Contracting of the next work packages. Once transfer had been formalized, Technical Coordination proceeded to approve the contracting of the following work packages:

- PT 1300: Monitoring Network Operation
- PT 3200: Processing Central Unit Prototype Operation
- PT 5000: Solution for zones of poor output
- PT 6300: Website portal operation and maintenance, among others.

- Complying with Conclusion RCC/9/SACCSA/2, the Project members were asked to consider the different scenarios for contracting Work Packages to finalize the Project considering budget availability. In accordance with the responses received, ***only the last group of tasks will be contracted and the Project will be closed at the Tenth Meeting of the Project Coordination Committee, which is tentatively scheduled for October 2014 in Colombia and will also include an Advanced GNSS Workshop and the Presentation of the Project Final Results.***

- In accordance with Conclusion RCC/9/SACCSA/10, the final version of the Project Document, Version O was submitted, which is adjusted to the current situation of the project and the conclusions of the last Coordination Committee Meeting.

- On January 14, 2014, through a teleconference, the Project Members discussed items related to the Current Status of the Project, the status of the Transfer of the Technical Coordination and the Timetable of the Project, reaching the following agreements:

  1. Send comments or sign the RLA/03/902 Project Document – Rev O by 31 January 2014.
  2. Update the activities timetable and inform the Members/ICAO Regional Offices for the corresponding arrangements.
  3. Preparation of the Project Information Paper.

3. Review of the Work Packages

3.1 Figure 2 highlights the packages that have already been contracted and finalized; however, Table 1 shows those that have been contracted and finalized in detail, those contracted and pending finalization and those that will not be carried out by the agreement of the Project Members.

				Impacto
Actividad	**PT**	**Sub-Actividad**	**Situación Actual**	
Red de monitorización y control de la misma	1100	Definición de la Red de Monitorización	Contratado y Terminado	Se determinaron los requisitos de Estaciones de Referencia.
	1200	Implementación de la Red de Monitorización		Se definió el centro de Captura de los datos que serán obtenidos a través de la Estaciones de Referencia.
	1300	Operación de la Red de Monitorización	Pendiente Finalizar.	Pendiente Contratar
Profundización en la definición del sistema	2100	Análisis Técnico de la Solución SBAS	Contratado y Terminado	Aprovechando resultados de fases anteriores se completaron los estudios, se estudiarion las difentes opciones y a partir de ello se plantea la Solución SBAS más adecuada a la Región para cumplir los requisitos de precisión Horizantal y Vertical para APV-I, con niveles de confianza entre el 95% y el 99% en aspectos de precisión.
	2200	Análisis Ionosféricos		En armonía con la Recomendación 6/9 sugiere "coordinar actividades a nivel regional y mundial en materia de caracterización ionosférica para la implantación armonizada del sistema mundial de navegación por satélite", se analizó de forma detallada el comportamiento ionosférico en escenarios con pérdida de señal GPS, la distribución de Burbujas (depleciones) Ionosféricas, la hipótesis de ionósfera monocapa en Sistemas SBAS y el impacto inosférico en futuros sistemas SBAS.
	2300	Verificación de las Especificaciones del Sistema	No se Realizará	No será posible verificar especificaciones y soluciones de SACCSA
	2400	Optimización de la Red de Comunicaciones	Contratado y Terminado	Se analizaron diferentes topologías de red determinando que la que la solución para SACCSA se debería basar en lo siguiente: o Subred entre las ERS y los CPCS: una red satelital basada en tecnología MF-TDMA, con terminales integrados en cada ERS, con una topología en dos estrellas, una cubriendo el área CAR y otra el área SAM. o Sububred entre las EAS y los CPCS: una red terrenautilizando tecnología MPLS, que está disponible en el área SACCSA. Podría prescindirse de esta subred si las EAS se ubicasen en el mismo emplazamiento que los CPCS. o Subred entre los CPCS: una red terrena utilizando tecnología MPLS
	2500	Comportamiento de la UCP con Datos Reales	Pendiente Finalizar.	Pendiente Contratar
	2600	Topología de la Red Terrena	Contratado y Terminado	SE determinó que necesario optimizar la red de Estaciones de Referencia (ERS) para que sin exceder las 48 estaciones (***Figura 4***), se logre una distribución homogénea de las mismas dentro del área de servicio.
	2700	Actualizaciónd el Mapa Interactivo	No se Realizará	Mapa Interactivo no Actualizado
	2800	Servicio de Consultoria sobre la Solución SBAS	Contratado y Terminado	Recomendación 6/5 sugiere un plan para "atender la interoperabilidad entre constelaciones y los sistemas de aumentación actuales y futuros de los sistemas mundiales de navegación por satélite":
Prototipo de la UCP de SACCSA y su operación	3100	Desarrollo y Preparación del Prototipo de la UCP	Contratado y Terminado	Se definió el Prototipo de la Unidad Central de Proceso (UCP) que se encargará del cálculo de los mensajes SBAS, además, se determinó el Segmento de apoyo de SACCSA.
	3200	Operación del Prototipo de la UCP	Pendiente Finalizar.	Pendiente Contratar
Definición de actividades de soporte a la validación y certificación del sistema	4000	Definición de actividades de soporte a la validación y certificación del sistema	No se Realizará	No se dispondrá de referencia ni guías para validar SACCSA
Análisis de opciones complementarias en zonas de prestaciones pobres o limitadas	5100	Identificación de Zonas con Prestaciones Pobres	Contratado y Terminado	Se determinó que SACCSA puede cumplir los requisitos de Precisión, Integridad y Disponibilidad llegando al APV-I tanto en condiciones nominales como degradadas por actividad solar, sin embargo, se identificaron regiones en el Sur de Argentina y la Región costera del Noreste de Brasil para las cuales el requisito de Disponibilidad se ve limitada para APV-I, principalmente debido a la falta de monitorización ionosférica en dichas regiones.
	5200	Aprovisonamiento Herramienta de Simulación	Pendiente Finalizar.	Pendiente Contratar
	5300	Comparar soluciones en Zonas con Prestaciones Pobres	Pendiente Finalizar.	Pendiente Contratar
Mejoras a la Página WEB de SACCSA	6100	Definición de requisitos del portal WEB	Contratado y Terminado	Se definió el portal en el URL http://www.rlasaccsa.com, incluyendo requisitos de acceso. El portal incluye Documentos de OACI, Contenidos de SACCSA, Contenidos de EDISA, enlaces, Etc.
	6200	Implementación del portal WEB	Contratado y Terminado	Se plantearon los requisitos para Implementación del Portal WEB que permitirá difurndir información de SACCSA a través de Internet.
	6300	Operación y Mantenimiento del Portal WEB	Pendiente Finalizar.	Pendiente Contratar
Documentación			No se Realizará	La información se recibirá solo en formato electrónico.
Gestión			Pendiente Finalizar.	El proyecto es Gestionado desde su inicio hasta su finalización.
Aspectos institucionales	7000	Aportación en Especie de AENA	Sin Información	Sin Información.
Tareas:				
Contratadas y Finalizadas				
Pendientes de Finalizar				
No se realizan por Acuerdo de los Miembros delProyecto.				

Table 1

3.2 As **Appendix 1** to this information paper, a description of the SACCSA Project at the world environment is presented.

4. Project Closing Activities

4.1 The Tenth and last Meeting of the Project Coordination Committee (RCC/10) is tentatively scheduled to be held in Colombia in October 2014. During this meeting and as indicated in para 2.4, the project will be closed and through a workshop, Members will be informed of the final results.

5. Conclusions

5.1 The studies performed through the Project, allow establishing that **with a specific adjustment to the equatorial regions, a SBAS (APV-I) system would be feasible in the CAR/SAM Regions in accordance with the specifications indicated in the ICAO Annex 10, Volume I:**

- **APV-I (HAL=40m, VAL=50m)** requirements are achieved in most part of the CAR/SAM Regions
- **LPV-200 (HAL=40m, VAL=35m)** possibility, partial with some risk
- There are zones of limited benefits in deteriorated conditions (solar maximum) **where different solutions have been evaluated as contingency elements**.
- T Alert: 6 seconds; Integrity: 1.2 x 10 -7 approximation
- Precision: The precision requirements for aeronautical use Precision (95%): 16m(H)/20m(V); Availability: 99% - 99.999% are achieved with enough margin.

5.2 The implementation of a SBAS System in the CAR/SAM Regions in Band L1adequate to the particular ionospheric conditions of the equatorial latitudes will be feasible if the following recommendations are taken into account:

- Use of ionospheric models adjusted to the region
- Combined use of GPS and GLONASS/Galileo constellations to improve the region coverage and of the ionospheric estimation for the SBAS in L1 system. GLONASS/Galileo would be used internally in the system (ionospheric algorithms)
- Need of safety case for the next solar maximum. This is a clearly distinguishing element of other existing solutions in SBAS (WAAS, EGNOS, GAGAN)
- Redundancy of stations in equatorial zone (+4-5 stations) total 50-52 ERS
- Use of operational concepts associated to the inclusion of mechanisms to assure the system behavior in extreme ionospheric conditions as contingency elements that are necessary to evaluate
- In the long term, implementation of a double-frequency SBAS system with a mono frequency backup for ionospheric reasons (sparkling will affect more the double frequency than the mono frequency). Therefore, the best implementation strategy will be a mono frequency design scalable to multifrequency and multiconstelation.
- Evaluate the SACCSA test-bed prototype development for the next solar maximum in order to start getting benefits from the SBAS technology and mitigate risks.
- In view of the ionospheric analysis performed, it is important that States interested in implementing GBAS systems carry out a specific feasibility analysis.

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