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Santo Domingo, Dominican Republic, 14 – 17 November 2023

**Agenda Item 4: GREPECAS Work Programme**

# DEVELOPMENT OF A REGIONAL SBAS FOR LATIN AMERICA (CAR-SAM)

(Presented by Thales Alenia Space)


| **EXECUTIVE SUMMARY** | |
|---|---|
| SBAS is a Space ambitious program for regional economic dynamism, safety and environment. CAR-SAM is one of the last region not being equipped despite SBAS is a standard in civil aviation.<br>TAS has developed a technology ready now, compatible with ionosphere hard conditions affecting CAR-SAM region, relying on extensive use of Galileo, and compatible with existing aircraft equipment.<br>SBAS is by nature a regional integration project and a perfect topic for technological cooperation,<br>A wide TEST BED with all the CAR-SAM countries involved, should be initiated quickly for civil aviation but also in other areas of economic interest (agriculture, maritime, oil & gas, etc.) | |
| **Action:** | • Raise the interest of the region to test SBAS<br>• Identify a sponsor in each country<br>• Support a federative and regional shared test bed<br>• Get the support of regional organizations |
| *Strategic Objectives:* | • Air Navigation Capacity and Efficiency<br>• Economic Development of Air Transport<br>• Environmental Protection |
| *References:* | • N/A |


## 1. Introduction

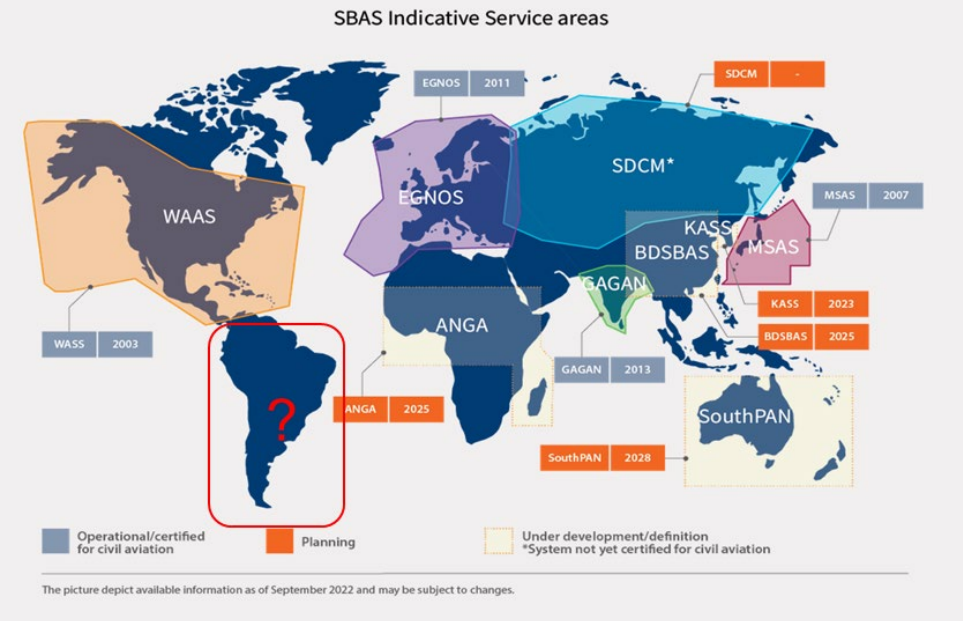
1.1 The development of air traffic transport is the first economic and social development factor in a continent like Latin America) LATAM. The European SBAS (Space based Augmentation System) called EGNOS is mainly used to augment the GNSS positioning signal for “Safety of Life” applications that need integrity, like civil aviation. Air safety is the first priority of the aeronautical context.

1.2 Europe is a leader in SBAS technology and Thales Alenia Space (TAS), as prime contractor of EGNOS system, is already exporting 2 SBAS, one in Korea called KASS and another one for Central Africa countries called ANGA.

## 2. Discussion

*Why a SBAS for CAR/SAM region?*

2.1 CAR/SAM is one of the last region in the world not covered (or not planned to be covered) by a SBAS which has become a standard for civil aviation, and is by the way also a key element of regional integration. The main obstacle up to now was the ionosphere specific conditions in the equatorial regions (geomagnetic Equator) that prevented previous SBAS generation to achieve the requested performances to bring improved services for air navigation compared to mid latitude regions achieving up to Category I performance level. But thanks to in depth studies and projects performed in collaboration with ASECNA, this concern was recently solved by Thales Alenia Space, with the development of new generation algorithms able to offer an improved resilience even under ionosphere very disturbed conditions. CAR/SAM region presenting very similar conditions as in Africa, this SBAS technology would offer better and safer navigation services than current procedures mostly relying on barometer aided vertical navigation. SBAS systems are the corner stones of aviation safety. They are also strategic for many economical domains, and therefore strategic to build international cooperation. It is the perfect timing for CAR/SAM region to raise interest in a regional SBAS, directly benefitting from the African experience and repeating the same success story.




*Civil aviation benefits of a SBAS for CAR/SAM region*

2.2 There are many SBAS benefits for CAR-SAM in a very similar way of what was observed in Europe, which are highlighted hereafter**:**

**Aviation safety benefit**: The main reason of SBAS adoption around the world is due to the improved performances brought by the system offering similar geometrical guidance compared to ILS, leading to highly improved air navigation safety, in particular during approaches phases of airplanes when more accidents occur. Being a region with sometimes very bad weather conditions, safety of air transport is a real interest for CAR-SAM countries. More safety for air traffic also encourages the development of economy, and people exchanges support economic growth.

**a) SBAS is ready and already compatible with aircraft deployed receivers.**

**b) Support of economic exchanges:** SBAS allows a quick evolution of the numbers of airports at a low cost without the necessity to deploy specific navigation infrastructures for those airports.

**c) Economic benefit:** In all regions where it was studied, and recently in Africa, and Australia, the Cost Benefit Analysis was always very positive, achieving a Return On Investment in between 5 to 8 years, and justifying that SBAS was not a only cost but rather an investment.

**d) National and regional integration benefit:** In lots of CAR-SAM countries, the air navigation infrastructures lead to a strong concentration in big airports, central hubs, and very little direct regional flights between regional towns. SBAS will allow to decongestion main central airports and promote direct and safe regional flights. A regional SBAS will also be a strong integration factor between CAR-SAM countries like the unique sky was for Europe, as it was also a key factor for Africa. Moreover, the sharing of investment and benefits of such systems is much more interesting for a pull of countries rather than only one. This is why Space is a wonderful tool for integration.

**e) Environmental benefit:** SBAS system allows aircrafts to have much more direct routes, more direct airports approaches and avoids rerouting them to others airports in case of bad weather conditions. This results in a substantial fuel savings for a very beneficial ecological balance sheet.

*First simulations results for an SBAS implementation in SAM region for civil aviation*

2.3 To support previous argumentation, some preliminary analyses using real data collected in SAM region have been performed under various ionosphere conditions, using equatorial SBAS algorithms designed by Thales. The analyses have been performed using GNSS ground stations belonging to IGS network complemented by some Brazilian IBGE GNSS stations for a total of 35 ground stations (very similar number of stations compared to WAAS 38 and EGNOS 38).

2.4 Under nominal ionosphere condition (about 70-75% of the time), SBAS performances achieved are very similar to those obtained by WAAS or EGNOS.

2.5 According to Figure 1, SBAS service allowing aircraft vertical guidance (APV-I) up to a minimum descent altitude of 250ft is achieved with a very good availability over most of SAM countries. One can notice, that using an optimized reference station network (which is not really the case using currently available GNSS stations), full coverage of SAM countries will be achieved.

2.6 In these conditions, SBAS corrections integrity analyses demonstrated a full compliance to ICAO Annex 10 (SARPS) requirements with nominal margins (similar to EGNOS).

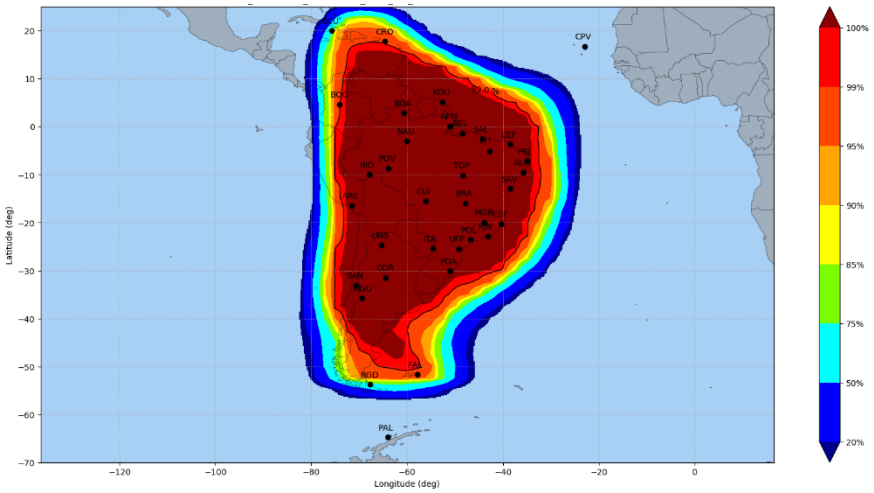



*Figure 1 : LPV / APV-I service level availability under nominal ionosphere conditions (selected day 2021-08-16)*

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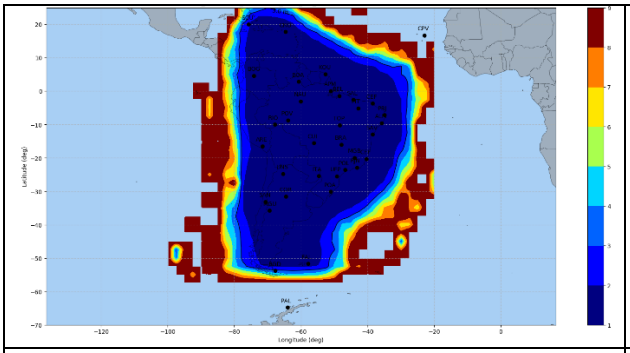
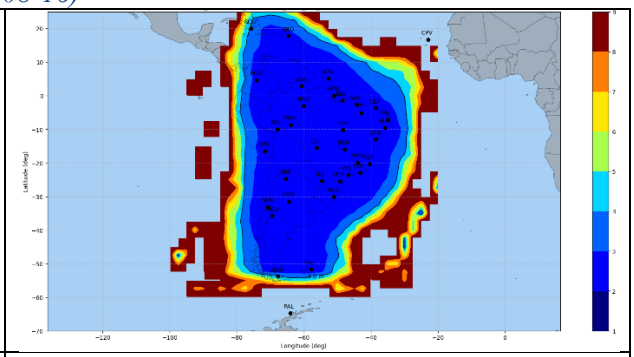
|  |  |
| HNSE < 2m in most of SAM covered area | VNSE<3m in most of SAM covered area |

2.7 Regarding measured position accuracy performances, obtained results are in the same level as required for the minimum performances for Category I approaches.

2.8 Under active ionosphere conditions (less than 20% of the time), SBAS service is kept with a very good resilience level.

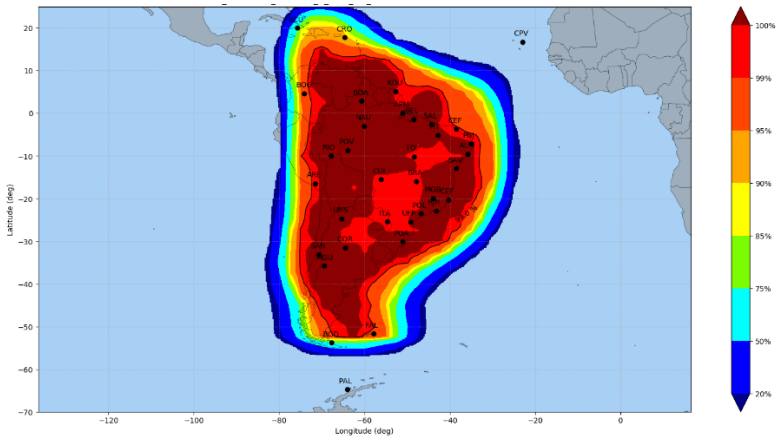



*Figure 2: LPV / APV-I service level availability under active ionosphere conditions (selected day 2023-01-09)*

2.9 Similar APV-I availability performances are obtained under active ionosphere conditions, compared to the nominal case.

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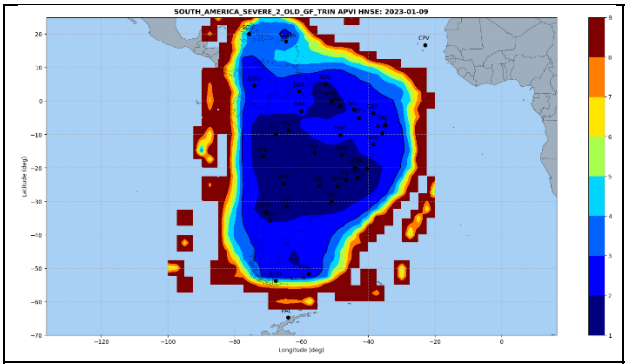
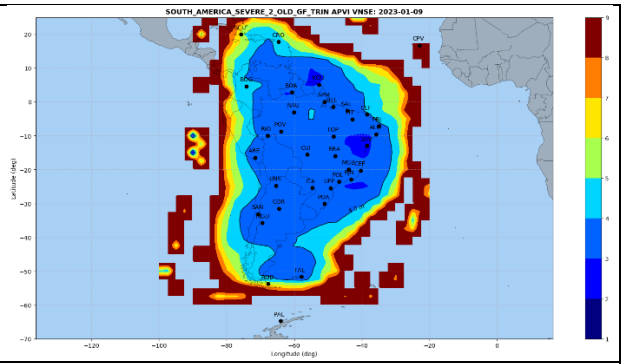
|  |  |
| HNSE < 3m in most of SAM covered area | VNSE<4m in most of SAM covered area |

2.10 Measured position accuracy performances remain very efficient. In particular, concerning VNSE (Vertical Navigation System Error) achieved performances are compatible with Category I performances (<4m) and some areas are slightly above (about 5m) which remain in any cases very good performances compared to the minimum required VNSE for APV-I (20m).

2.11 Again, in depth integrity corrections analyses have been performed, using ionosphere reference data (IONEX) complemented by verifications using 19 independent GNSS ground stations spread in Brazil (which undergoes the most significant ionosphere effects).
Even under these conditions, SBAS corrections integrity analyses demonstrated a full compliance to ICAO Annex 10 (SARPS) requirements with margins (similar to EGNOS under degraded ionosphere conditions).

2.12 At the end, even under worst ionosphere conditions (similar to worst cases observed in other SBAS like WAAS and EGNOS) representing less than about 3-4% of the time, SBAS performances are achieved with a very good resilience level, preserving in any cases corrections integrity.

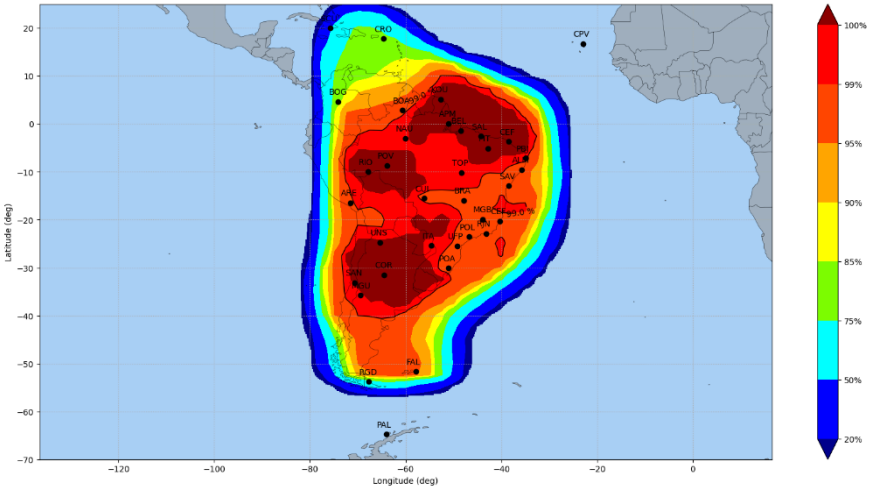
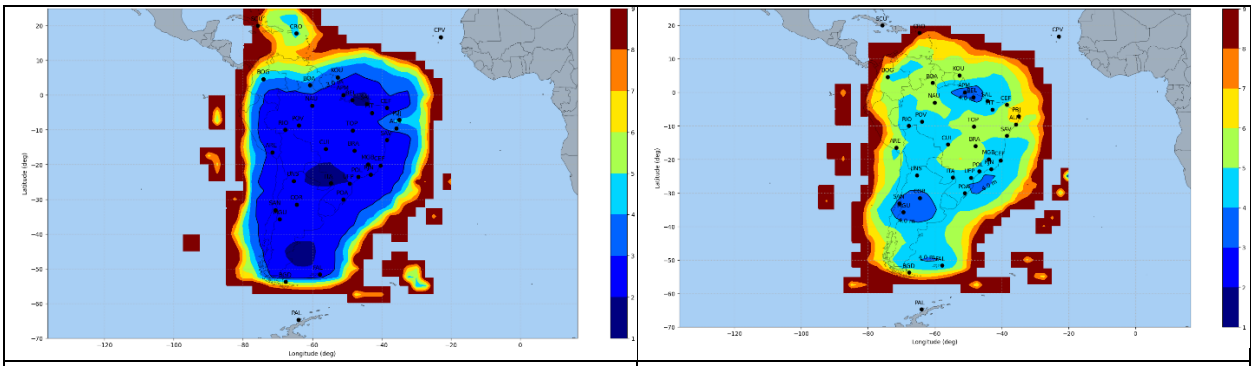



*Figure 3: LPV / APV-I service level availability under very strong ionosphere conditions (selected day 2023-02-11)*

2.13 Under such very strong conditions, APV-I service level availability can be kept to more than 95% in most of SAM region.



| HNSE < 3m in most of SAM covered area | VNSE<6m in most of SAM covered area |
|---|---|

2.14 Measured position accuracy performances remain very efficient and fully compatible with APV-I vertical guidance approaches.

2.15 Even under such degraded conditions, ionosphere corrections integrity is preserved with margins (in depth verification using 19 independent GNSS stations has been carried out for that purpose[1]).

[1] Use of IONEX reference is no more possible under such extreme ionosphere activity since the refresh rate of the associated data is not compatible at all with ionosphere dynamics in equatorial region.

2.16 From these first analyses using real conditions and real GNSS stations, exactly same conclusions as those allowing to decide SBAS development in Africa are obtained for CAR-SAM region. Thales Alenia Space is fully confident in its SBAS solution for CAR-SAM region allowing to achieve same level of performances as those targeted in Africa through the ANGA SBAS program.

*Benefits in others domains of application depending on the economy of a country*

a. The main applications for **agriculture** are the meccanization and automation in a safe way and the reduction of pollution during fertilizer spreading thanks to precise agriculture. It also allows law enforcement to respect for example the distance to habitations for fertilizer spreading

b. In the **maritime** domain, one of the main interest is the safety of navigation for an improved logistic, especially in the big ports with high traffic density

c. In the **Oil & gas** industry the price of drilling operation in safe conditions with precise and sure positioning is key to avoid worthless over expensive cost

d. In the **Railway**, SBAS can be used to improve a safe and efficient signalization

e. For automatic **road tolling**, SBAS is very useful for example to certify that a car is using a toll road and not a free one just aside

f. They are others applications to be discovered, tested and developed by CAR/SAM countries like in the **mining domain** but also in the future like the **exploding market of drones**

2. 17 **Benefit for CAR/SAM youth:** SBAS is high technology creating highly qualified employments, structuring the academic chain and paving the way for value creation through the development of downstream applications (new initiatives, startup, etc…) , while providing concrete perspectives to students.

*Proposed next steps*

**a) Identify a sponsor in each country**

The first objective would be to identify in each CAR-SAM country a sponsor to investigate SBAS benefits for its country and the region, whether it is an airline, an ANSP, a Ministry, an Industry other than civil aviation, which will agree and be able to support the initiative in its country.

**b) Propose a federative and shared test bed**

A large test bed could be deployed with every interested country, each one selecting the most 2 to 3 more relevant applications /use cases to demonstrate SBAS interest in civil aviation, rotorcraft transport but also others domains like, agriculture, Oil & Gas, maritime, mining, etc.. as it was done in Africa and it has started everywhere else in the world

The test bed will be done for the end users with the participations of the main stakeholders in each country.

In parallel, a Cost Benefit Analysis would be needed to justify the interest of other economic sectors than civil aviation and should be initiated by the countries themselves

**c) Get the support of regional organizations**
ICAO, COSESNA, ALCE , MERCOSUR and CELAC, as regional organizations could also support and federate such an initiative for political, economic or technical reasons.

## 3. Conclusion

3.1 Most of the regions in the world have chosen to deploy SBAS because of the safety and economic demonstrated benefits. It is now a standard. CAR-SAM is one of the last regions in the globe not being equipped.

3.2 European SBAS technology is the only one ready now, applicable in the CAR-SAM region because it is the only one capable to support the strong ionosphere conditions (as demonstrated in Africa), being ready and already compatible with aircraft deployed receivers. The technology developed by Thales Alenia Space relies on an extensive use of Galileo to model and correct the ionosphere effects.

3.3 A GNSS cooperation between CAR-SAM and Europe will fulfill many important priorities of both regions:

- Improvement of transport in terms of safety but also environmental impact;
- Develop the regional cooperation; and
- Technological partnership in one of the excellence domain of Europe,

3.4 Being prime of EGNOS system for more than 20 years, mastering the technology resistant to strong ionosphere conditions and only European industrial with export references (Korea and Africa), TAS is ready to support a regional Sbas opportunity

## 4. Suggested action

4.1 Meeting is invited to:

a) take note of the information in this paper;

b) discuss the proposal of a federative and shared test bed;

c) analyse the possibility of participation of other segments (maritime, agriculture, oil & gas, etc.), providing more resources for implementation; and

d) formulate such other actions as the meeting deems appropriate.

— END —