ICAO

Twenty-Second Meeting of the AFI Planning and Implementation Regional Group (APIRG/22)
(Accra, Ghana, 29 July – 2 August 2019)

Agenda Item 4.- Other Air Navigation Issues

4.4. Initiatives by States & Industry and other air navigation issues

SBAS for Africa and Indian Ocean initiative

(Presented by ASECNA)

SUMMARY	
SBAS services are key enablers to the Single Sky for Africa, an essential pillar of the operationalisation of the Single African Air Transport Market (SAATM), and to the implementation of the Space Policy and Strategy of the Africa Union which call for an indigenous continental level navigation augmentation system for Africa. In this regard, the "SBAS for Africa and Indian Ocean" initiative, recognised by ICAO, primarily aims to provide autonomously airspace users with mono-frequency (L1) initial services from 2021/022, with a potential progressive coverage of the continent. These services are intended to support en-route/NPA, APV-1 and CAT-1 operations, and thereby to enhance PBN and ADS-B operations in Africa for all phases of flight. **Action by the Meeting: Refer to Paragraph 10**	
Strategic Objectives	A – Safety, B – Air Navigation Capacity and Efficiency, D – Economic Development

1. INTRODUCTION

1.1 The use of enabling technologies constitutes a fundamental pillar of the operationalisation of the Single African Air Transport Market (SAATM). Indeed, space-based technologies, infrastructure and services, and especially satellite navigation services, provide new and innovative solutions to address today's technical and operational challenges of air navigation over the continent, helping to favour development and growth.

1.2 In this regard, the so-called "SBAS for Africa and Indian Ocean" initiative has been initiated for the continent, and pursues the autonomous provision of SBAS mono-frequency (L1) initial services from the 2021/2022 time-horizon for the benefit of the African airspace users.

1.3 Beyond the SAATM and its Single Sky component, the initiative aims also to contribute to the implementation the African Union Space Policy and Strategy, which call for an indigenous continental level navigation augmentation system for Africa. The initiative is also developed within the framework of the Africa-EU Strategic Partnership.

2. SBAS BENEFITS FOR AFRICA

2.1 SBAS does not require the installation or maintenance of local ground-based navigation aids or landing systems and the provision of related staff, and is particularly adapted to the African operational environment, where remote and isolated regions are vast and numerous. The benefits of its introduction in the continent are expected to be much more important than in any other part of the world.

2.2 SBAS is intended to enhance performance-based navigation (PBN) and automatic dependent surveillance - broadcast (ADS-B) operations in Africa for all phases of flight, from en-route down to approach, and thereby to increase significantly flight safety and efficiency.

2.3 In the navigation domain, the SBAS services will improve availability for all area navigation (RNAV) routes and flexibility for new and more efficient routes. They will provide an effective solution for CAT-I equivalent operations “everywhere every time”, especially in the very large number of runways ends of the continent, in international, regional and domestic airports, not served by precision approaches today. They will thereby enable to ensure service continuity during instrument landing system (ILS) maintenance and renewal periods, and overcome the known safety and operational performance limitations of lateral navigation (LNAV) / vertical navigation (VNAV) operations, through lower minima, geometric guidance, and no linkage with QFE setting.

2.4 The main expected safety benefits include the reduction of Controlled Flight Into Terrain (CFIT), which represented 20% of the fatalities in the world over the 2011-2015 period, most of them occurring in the approach/landing phase and being often associated with imprecise approaches, according to the IATA Annual Review 2016. The main expected efficiency benefits include shorter flight time, reduction of delays, deviations and cancellations, reduction of fuel consumption and Co2 emissions, lower fuel load requirements due to closest alternates availability, and elimination of the requirement for RAIM check before departure.

2.5 In the surveillance domain, SBAS provides, as primary navigation system, positioning source to meet the most stringent ADS-B requirements in support of advanced ATM operations, as enhancing the quality of the position information reported, compared to GPS/RAIM only. In particular, it improves the availability of ADS-B operations.

3. FEASABILITY OF SBAS IN AFRICA

3.1 Feasibility studies were performed from 2011 to 2015, in the field of ionosphere characterisation and optimisation of SBAS correction algorithm for the African equatorial region.

3.2 With the support of the French Space Agency (CNES) and of the European Space Agency (ESA), a dedicated network of GNSS stations, so-called SAGAIE, was deployed to collect and process real GNSS data from core constellations.

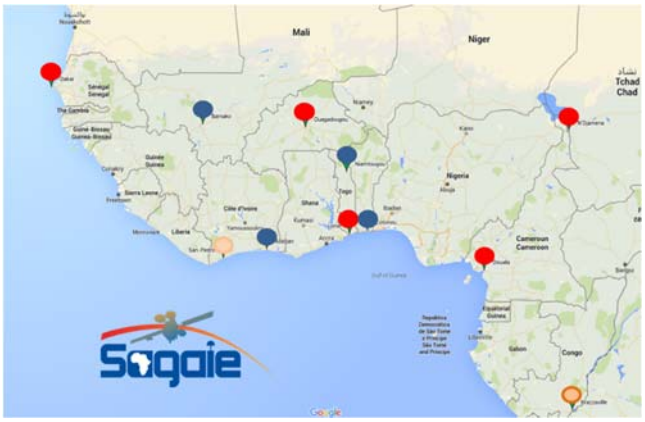

Figure 1: Network of SAGAIE GNSS stations

3.3 The studies undertaken included analysis of scintillations, plasma's bubbles and Total Electronic Content to characterise the physical phenomena of the equatorial ionosphere, and SBAS emulation using a representative test platform and an advanced tuning of SBAS correction algorithms and processing set.

3.4 They demonstrated the feasibility of SBAS APV-1 service level provision in compliance with corresponding SARPs contained in ICAO Annex 10, including during high ionosphere activity periods.

4. SERVICES PROVISION AND INFRASTRUCTURE

4.1 The "SBAS for Africa and Indian Ocean" initiative is recognised by ICAO for SBAS services provision in Africa under the SBAS identifier n°7 as per the provisions of the Annex 10.

4.2 It primarily aims to provide autonomously Safety of Life (SoL) service for safety critical applications in aviation, to support en-route/NPA (RNP 0.3), APV-1 and CAT-I operations according to three separate services level.

4.3 The services provision overall strategy is to meet user needs with an incremental approach in terms of coverage and performances, considering expendability towards the next generation of DFMC (Dual-Frequency Multi Constellation).

4.4 More specifically, the services provision plan is to provide airspace users with mono-frequency (L1) initial services from 2021/2022, with a potential progressive coverage of the continent, and then DFMC services beyond 2028-2030.

4.5 The signal-in-space will be compliant with corresponding SARPs from ICAO Annex 10, and with Minimum Operational Performance Standards (MOPS) published by RTCA (Radio Technical Commission for Aeronautics) and EUROCAE (European Organisation for Civil Aviation Equipment).

4.6 The infrastructure to support such an autonomous services provision will be developed using EGNOS technology and assets, and will be owned and operated by African stakeholders, as a solution deployed by Africa for the benefit of Africa.

4.7 It will comprise a network of Reference Integrity Monitoring Stations (RIMS), Mission Control Centre(s) (MCC), Navigation Land Earth Stations (NLES), SBAS wide area transport network(s) supported by AFI VSAT networks, and a space segment.

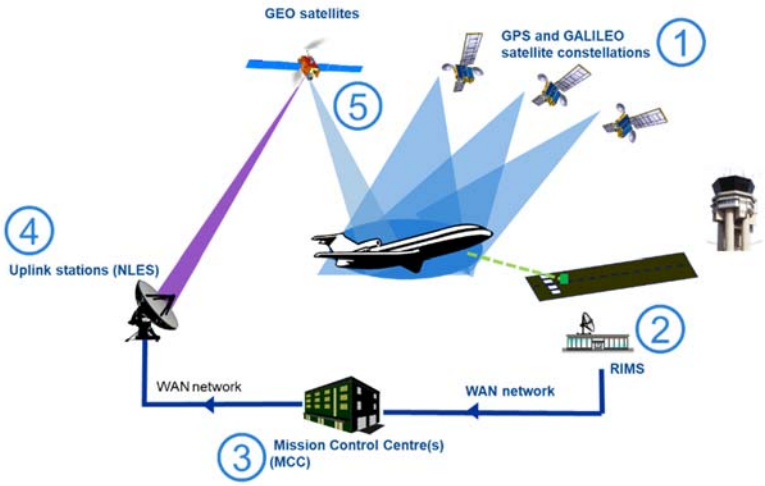

Figure 2: System architecture concept

4.8 For the development of the infrastructure, a contract for the conduct of a so-called "phase B" study was recently awarded to a consortium led by the Thales Alenia Space France company. The essential objectives of this phase B study are to:

- Define the best infrastructure architecture options, and proceed to the preliminary design of the selected architecture
- Provide a clear view on the implementation (C/D) and exploitation (E) phases, including detailed development, qualification and deployment plans, and on L1 services evolutions and transition towards DFMC services
- Provide pre-operational service and undertake field demonstrations

4.9 In this regard, System Requirements Review (SRR) and Preliminary Design Review (PDR) are scheduled in October 2019 and summer 2020. Critical Design Review (CDR) and Acceptance Review (AR) will follow in 2021 and 2022, these timelines for phases C/D will be refined as the development and qualification plan is endorsed during the phase B.

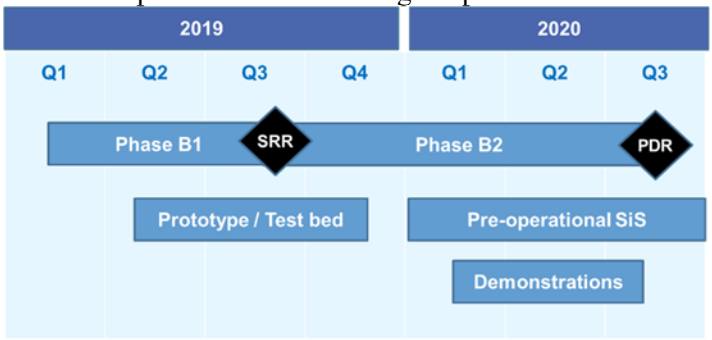

Figure 2: Phase B timelines

5. POTENTIAL COVERAGE AND PERFORMANCES

5.1 The potential coverage and performances are currently under assessment as part of the phase B study, using synthetic scenarios representative of the real ionosphere conditions and computation based on the advanced correction algorithm and processing called NACA (Navigation Advanced Chain of Algorithms), implemented in a representative system prototype.

5.2 The preliminary assessment undertaken so far provides the following indicative achievable performances for the en-route/NPA and APV-1 service levels, according to given infrastructure scenarios in terms of RIMS network:

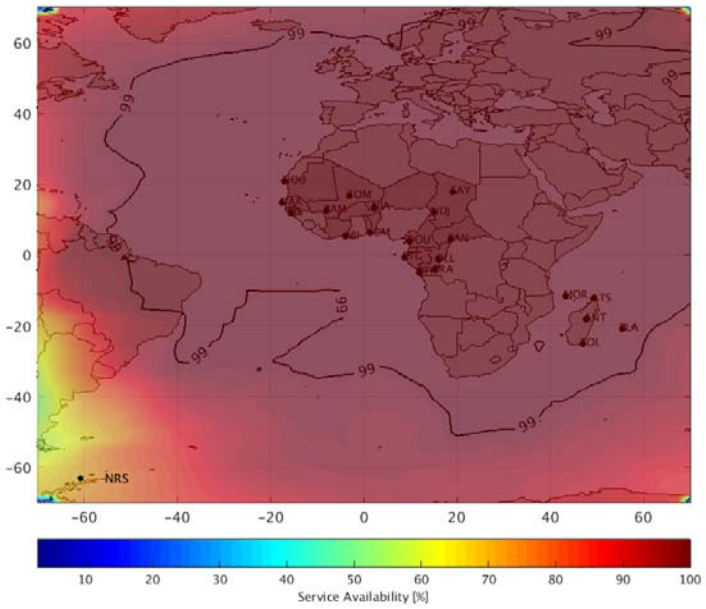

Figure 3: En-route/NPA service indicative availability map

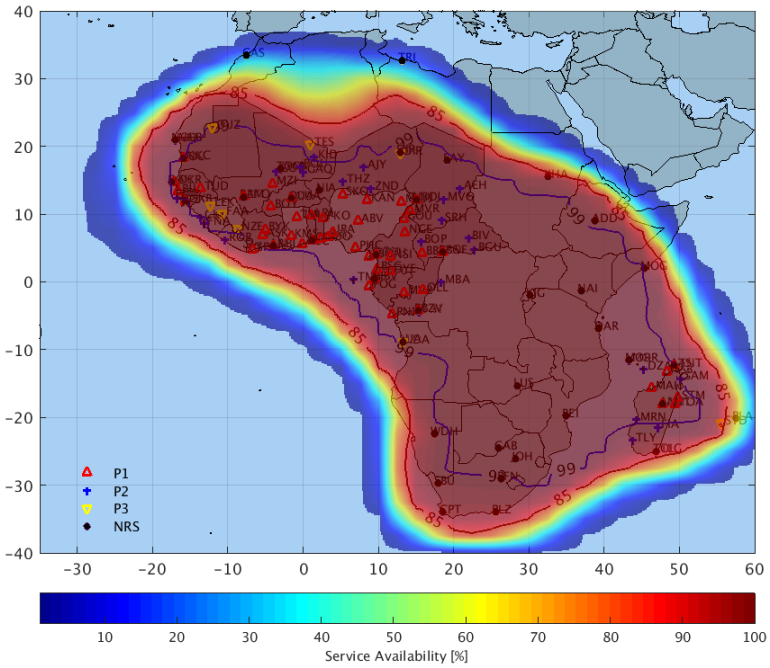

Figure 4: APV-1 service indicative availability map

6. PRE-OPERATIONAL SERVICE

6.1 Taking advantage of the legacy network of the SAGAIE GNSS stations and of new assets under development as part of the phase B study (representative system prototype using the NACA

correction algorithms and processing set), a pre-operational SBAS for Africa and Indian Ocean service will be deployed in western and central Africa in 2020.

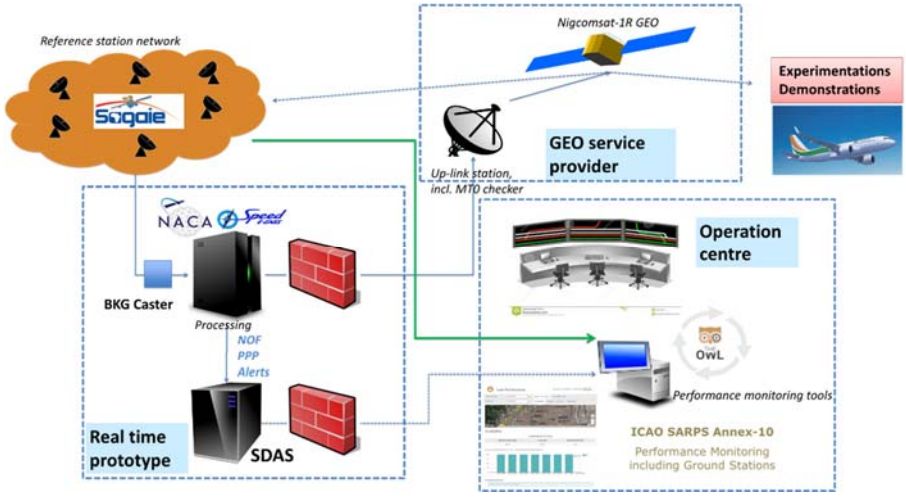

Figure 5: Pre-operational system architecture

6.2 The pre-operational service will provide a real-time SBAS signal-in-space transmitted by the Nigcomsat-1R geostationary satellite, operated by the Nigerian Communications Satellite Limited company.

Figure 6: Nigcomsat 1-R GEO coverage (PRN 147)

6.3 The pre-operational service will support on-the-job training of the operational staff and in-flight demonstrations with partner airlines (Air France, Emirates, Asky, Air Côte d'Ivoire…) to showcase the added value and the ease-of-use in Africa of SBAS approaches for aircraft, and of low altitude route and navigation 'Point in Space' (PinS) for rotorcraft.

7. USERS

7.1 The SBAS benefits are today widely acknowledged by airspace users, thanks to the global expansion of SBAS services over the world. An important number of airlines have integrated or plan to integrate SBAS in their navigation strategy, based on their own assessment of the positive benefits/costs ratio. For instance, over 125 000 SBAS equipped aircraft are today operating in the US National Airspace System.

7.2 In Africa, several airlines, such as Air France, are supporting the development the SBAS to improve the safety and efficiency of air navigation over the continent. Other airlines are also assessing the possibility to adopt SBAS, considering the growing number of SBAS capabilities

offered by aircraft at very acceptable costs. In this frame, some African airlines, such as Ethiopian Airlines for their A350, has already acquired the SBAS capability.

7.3 It is indeed expected that the number of forward-fit or retrofit SBAS avionics will significantly increase in the 2020-2025 timeframe. Almost all the new aircraft models from now will offer SBAS capability, at least as a costumer option.

7.4 In that respect, the SBAS Interoperability Working Group, which is the platform of the SBAS providers from over the world (US, Europe, Indian, Japan, Russia, China, South Korea, Australia and ASECNA), has recently compiled information from main aircraft manufacturers (Airbus, Boeing, Embraer, ATR and Bombardier) on the current SBAS capabilities and plans for their aircraft portfolio.

7.5 Airbus has clear plans for SLS (SBAS Landing Systems) deployment over most of its fleet. The A220/350 SLS is already available. A320 family will propose the capability by 2020. A330/380 capability is planned by 2021. Retrofit solutions are also getting more available through OEM or aftermarket solutions.

7.6 Boeing has SBAS receiver customer solutions now or soon available for several aircraft types, to comply with US ADS-B mandate. SBAS capability will be available over 777X by 2020, and is currently under study for 777, 787, 737MAX, 737NG. Retrofit solutions are also progressing.

7.7 An increasing number of Embraer, ATR and Bombardier aircraft are also proposing SBAS as customer options and retrofit solutions as well.

7.8 The trend of aircraft SBAS solutions is therefore very positive, and the International Coordinating Council of Aerospace Industries Associations (ICCAIA) considers that SBAS L1 operations will be baseline operations, as GPS is today, from 2025-2028 when DFMC will be introduced.

8. SBAS IN THE WORLD

8.1 In recent years, implementation of new SBAS systems has indeed flourished over the world leading to the expansion of SBAS services provision globally. At this date, nine (09) operational and under-development SBAS have been recognised by ICAO through the assignment of service provider identifiers as follows:

Identifier	SBAS
0	WAAS (US)
1	EGNOS (Europe)
2	MSAS (Japan)
3	GAGAN (India)
4	SDCM (Russia)
5	BDSBAS (China)
6	KASS (South Korea)
7	**SBAS for Africa and Indian Ocean**
8	AUSBAS (Australia)

8.2 The status (as of end of 2018) and plans for SBAS procedures deployment are the following:

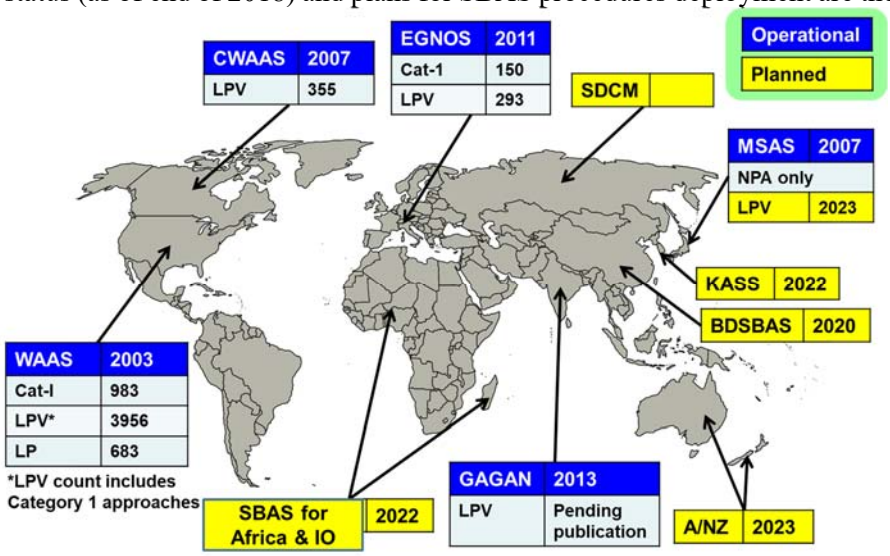

Figure 7: Status and plans for SBAS procedures development in the world

9. WAY FORWARD

9.1 The flow of history heads towards SBAS introduction over the world as baseline operations, as GPS is today, and the "SBAS for Africa and Indian Ocean" aims to ensure that the AFI region is not left behind thereof.

9.2 "SBAS for Africa and Indian Ocean" constitutes a fully-fledge African initiative developed for the benefit of Africa, and need to be further developed under the coordination of AFCAC.

9.3 From a planning perspective, SBAS shall be positioned as a high priority of the AFI GNSS strategy, and its introduction shall be expedited to improve air navigation services safety and efficiency and to respond to airspace users' requests. This would not be in contradiction with the need impact analysis requested by APIRG conclusion 19/29, as this analysis shall consider the SBAS initiatives under development, as requested by the African Union Ministerial Specialised Technical Committee TTIEET.

10. ACTION BY THE MEETING

10.1 The meeting is invited to:

- consider the "SBAS for Africa and Indian Ocean" initiative as a flagship programme for the benefit of the continent, to be further developed jointly by all interested stakeholders under the coordination of the African Civil Aviation Commission (AFCAC) with the Joint Programme Office (JPO) under the aegis of the African Union Commission
- position SBAS services as a high priority of the AFI GNSS strategy