INTERNATIONAL CIVIL AVIATION ORGANIZATION

First Meeting of the Africa - Indian Ocean Aviation System Planning and Implementation Group (AASPG/1)

Libreville, Gabon, 3 - 7 November 2025.

Agenda Item 4: Implementation of air navigation goals, targets and indicators, including the priorities set in the regional air navigation plan

4.7. Other Aviation Safety and Air Navigation initiatives

ANGA SBAS programme update

(Presented by ASECNA)

SUMMARY
The flow of history is heading towards satellite-based augmentation services (SBAS) introduction over the world as baseline operations, as SBAS services are under development worldwide and the associated safety, efficiency and environmental protection benefits are today widely acknowledged by airspace users. The ANGA (Augmented Navigation for Africa) programme, recognised by ICAO under Annex 10, aims to provide the Africa and Indian Ocean (AFI) region with native SBAS services, to enhance navigation and surveillance operations for all phases of flight. This paper presents the development status of this programme, including the ANGA services roadmap, the users' perspectives, the demonstration services, and the on-going development of the version 1 (V1) of the ANGA system which will support operational services provision from 2030. It also presents a cooperative and inclusive approach for ensuring the access of any additional interested States/Organisations to the programme, which aims to be anchored to the African Union as a continental flagship programme as a basis for a continental SBAS solution. This could be done through the provisions provided by ICAO Air Navigation Services Economics Manual Doc 9161, concerning international cooperation in the establishment of international operating organizations. • Actions by the Meeting are outlined in section 7.

Strategic Objectives	A – Safety, B – Air Navigation Capacity and Efficiency, E – Environmental Protection

1. INTRODUCTION

1.1 Satellite Based Augmentation System (SBAS) provides the accuracy, integrity, service continuity and availability needed to rely on Global Navigation Satellite System (GNSS) navigation for all phases of flight, from en-route through Category I equivalent approach. It constitutes an essential element of the AFI Air Navigation Plan and of the revised AFI GNSS strategy adopted by APIRG/18 in 2012.

1.2 The ANGA (Augmented Navigation for Africa) programme aims to provide the Africa and Indian Ocean (AFI) region with native satellite-based augmentation services (SBAS), to enhance navigation and surveillance operations for all phases of flight, and to improve thereby the safety and efficiency of flights and reduce their environmental impact, in full alignment with airspace users' aspirations.

1.3 Further to the operational horizon, the programme carries a strategic vision for the future of aviation across the continent, in a growing competitive international environment where Africa should position itself as a key player in the global value chain and not be reduced to merely the consuming end of services provided by overseas entities.

1.4 The ANGA programme is recognised by ICAO Annex 10 for SBAS services provision with the assigned service provider identifier n°7, and by the U.S. authorities which has assigned thereto the PRN codes required for the broadcast of the ANGA signal-in-space.

1.5 The ANGA programme was initiated by ASECNA as per the decision of its Member States to develop SBAS services for the benefit of the continent, with an open, inclusive, and collaborative vocation. Beyond ASECNA member States, the programme membership also includes today the Seychelles Civil Aviation Authority (SCAA), and consultations are on-going with other States/Organisations to secure their access to the ANGA services.

1.6 As per this continental and inclusive approach, the programme has been proposed to the African Union Commission for consideration as the anchorage to develop the continental SBAS programme, as part of the flagship programmes of the African Union. Fully aligned with the vision and objectives of the African Space Policy, ANGA provides a unique key and comprehensive continental infrastructure and services solution, on which the Navigation & Positioning component of the African Space Programme can be built.

2. DISCUSSION

ANGA SERVICES ROADMAP

2.1 The ANGA services provision roadmap includes three essential steps:

a) Provision of L1 and DFMC demonstration services from 2020 and 2023 respectively, to support technical tests and to conduct fields demonstrations to showcase SBAS applications and benefits

b) Provision of L1 services from 2030, to support en-route down to APV-1 operations (and CAT-I (LPV-200) operations where possible), with a potential progressive coverage of the AFI region

c) Provision of next-generation of DFMC services beyond 2035, in a timely manner as airborne capabilities (under development) are available, to extend CAT-I (LPV-200) operations

2.2 ANGA services will complement the navigation services provided today. Existing conventional navaids, including ILS, will be maintained with an evolution towards a Resilient Operating Network (RON) to support back-up operations in case of GNSS outages.

2.3 As part of the navigation strategy, the on-going development of airborne EFVS (Enhanced Flight Visual Systems) capabilities is closely followed for consideration as enabler to straight-in landing operations below SBAS LPV DA/DH down to 100 feet.

2.4 Beyond aviation, open positioning service for mass market applications will also be available, benefiting the African economy in many areas.

USERS' PERSPECTIVES

2.5 At global level, the flow of history heads towards SBAS introduction over the world as baseline operations. SBAS benefits are today widely acknowledged by airspace users. The Position Paper on SBAS issued in 2021 by the Joint User Requirements Group (JURG), the forum coordinating airlines' positions on CNS issues, has confirmed further the interest of airspace users in SBAS operations, especially in the AFI region where benefits will be much more important than in any other part of the world.

2.6 This trend is resulting, among others, from the worldwide development of SBAS services, from the increasing availability of airborne SBAS/LPV capability at lower cost, in line-fit and retrofit (either through Service Bulletin or Supplemental Type Certificate), and from a set of positive economic studies on the use of SBAS services, especially in Africa.

2.7 Some individual business cases undertaken with partner airlines (Air France, ASKY, Air Côte d'Ivoire), with the support of the Satellite Navigation in Africa Joint Programme Office (JPO), to assess the business opportunities related to their future SBAS operations Africa showed very promising results in terms of net profits and return of investment.

2.8 As an illustrative result, the estimated results for a fictive airline of 18 aircraft with 8-year average age, operating 32 destinations in Africa with various types of airports in terms of ILS equipage, include a cumulated Net Present Value (NPV) of 2,5 M$ over 10 years, a Return on Investment (ROI) of 262% and a payback period of 5 years.

2.9 At continental level, the independent CBA study on SBAS implementation in Africa carried out by the African Union Commission, demonstrated the high economic attractiveness of SBAS implementation for the overall aviation sector. Taking a conservative approach, the individual financial results for the two main stakeholder groups are as follows:

- For airlines, the SBAS business case is highly profitable and attractive, with positive values in all the evaluated financial indicators:

NPV	ROI	F-IRR	Payback period
287 M$ (2045)	545%	36%	6 years

NPV = Net Present Value, ROI = Return on Investment, F-IRR = Financial Internal Rate of Return

- For ground-side users (ANSPs, airport operators and SBAS service provider), the business case is also profitable, considering the financial indicators values:

NPV	ROI	F-IRR	Payback period
59 M$ (2045)	21%	15%	6 years

2.10 The socioeconomic impact of SBAS has also been monetised and included in the economic results of the CBA, with emphasis on the environmental effect of the system's implementation. The carbon footprint is very positive, with 1,444 million of cumulated kg of CO2 saved during the analysis period versus a generation of 20 million kg of CO2. Combining the financial results and socioeconomic impact increases the overall results:

NPV	ROI	F-IRR
402 M$ (2045)	110%	28%

2.11 The ANGA services roadmap is therefore aligned with the aspirations of the airspace users. On one hand, some major aircraft operators are calling for expediting ANGA deployment to take timely advantage of the safety, efficiency, and environmental protection benefits. On another hand, the community of users which are not yet interested in the use of ANGA services will not be penalised by for their operations, as existing navigation services will continue to be delivered and no mandatory equipage will be applied.

ANGA SYSTEM DEVELOPMENT

2.12 The architecture of the ANGA system native infrastructure comprises:

- A network of Navigation Reference Stations (NRS) deployed at various locations to collect GPS and Galileo signals data, with a fine-tuned geographic distribution to optimise the observations of the satellites and the propagation conditions of their signals. This network is scalable to support incremental service areas extension.

- Two Mission Control Centres (MCC) composed of Navigation Processing Systems (NPS) to compute SBAS corrections and associated integrity bounds, and of Centralised Control Systems (CCS) for system control and monitoring

- Two Navigation Broadcast Stations (NBS) for the uplink of the signal carrying the SBAS messages to the navigation payload of the GEO satellite(s)

- A wide area secure internal communication network to ensure data communication between the various sub-systems

- A space segment composed of up to 3 GEO satellite(s) to broadcast the signal-in-space to the users

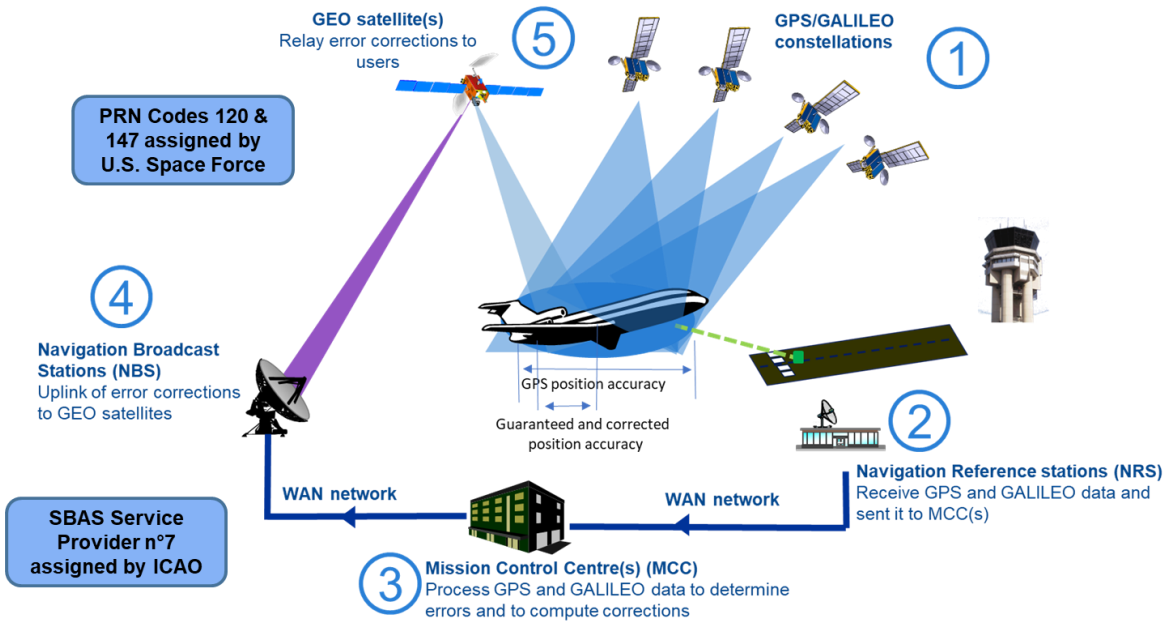
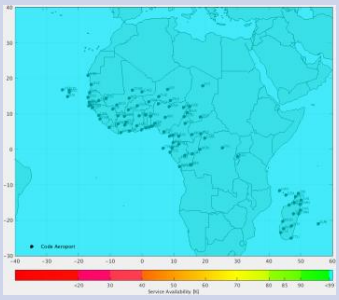
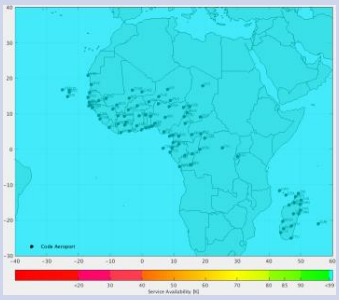
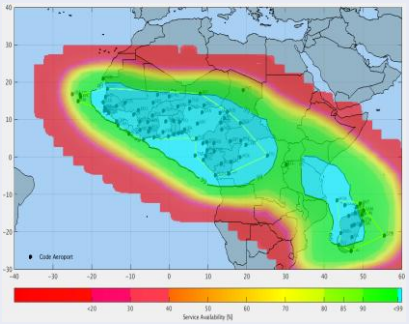
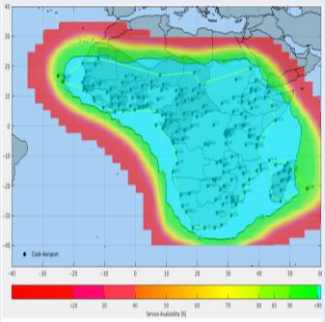


Figure 1: ANGA system native architecture

2.13 The ANGA system roadmap is based on the development of the version 1 (ANGA V1) to support the SBAS L1 services provision from 2030, and on its subsequent future evolutions (ANGA V1+) to extend L1 services and introduce DFMC services as follows:

Versions	ANGA V1	Evolutions (ANGA V1+)
En-route/NPA service level (L1)	 Service area	 Service area
APV-1 service level (L1)	 Service area	 Progressive extended service area

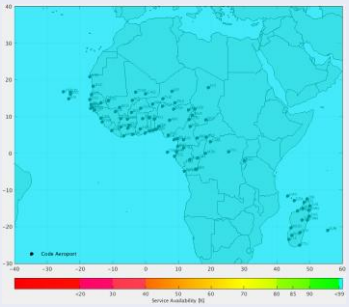
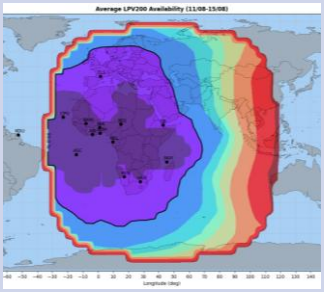
LPV-200 service area (L1)	Where possible	Where possible
En-route/NPA service level (DFMC)	-	 Service area
APV-1 and LPV-200 service levels (DFMC)	-	 Minimal service area
Entry into operations	2030	To be defined (from 2035)

Table 1: ANGA system roadmap

2.14 The ANGA Version 1 (V1) will primarily support from 2030 en-route/NPA operations in all the FIRs of the AFI Region, and APV-1 operations in the ANGA members' airspace, and in the neighbouring area depending on the capability to deploy some Navigation Reference Stations at the required locations.

2.15 The definition (SRR) and preliminary design (PDR) reviews of ANGA V1 are completed. The next steps include the ANGA V1 development, deployment, qualification, and entry into exploitation phases which are under procurement. The corresponding contract is expected to be awarded to the industry by end of 2025. As part of the development plan, Critical Design Review (CDR), System Qualification Review (SQR), and Operational Readiness Review (ORR) are scheduled in Q1 2027, Q4 2029 and Q2 2030 respectively.

2.16 The ANGA GEO-1 service, which will support ANGA V1 development and qualification, and then services provision, is under procurement. Infrastructure hosting sites preparation activities are also under procurement, for completion by 2027.

2.17 ANGA V1 has the capability to provide SBAS services beyond the airspace of the current members of the ANGA programme, providing a window of opportunity to integrate additional airspace in the service area. The window is open until end of 2025, to ensure the timely integration of the required elements in the ANGA V1 technical baseline which will be frozen through the contractual commitment with the industry.

ANGA DEMONSTRATION SERVICES

2.18 ANGA L1 and DFMC demonstration services were provided, in full compliance with the ICAO SARPs, from 2021 and 2023 respectively until 2024.

2.19 The signals-in-space were generated and broadcasted from a test-bed infrastructure composed of a network of GNSS stations, a representative system prototype, an uplink station deployed in Abuja (Nigeria) and the navigation payload of GEO satellite NigComSat-1R.

2.20 ANGA L1 demonstration service was provided in Western and Central Africa and were very instrumental to confirm the performances of the ANGA signal-in-space and to showcase the SBAS applications and benefits through field demonstrations, conducted for commercial aircraft in Togo and Nigeria, and for rotorcraft in Cameroon.

2.21 ANGA DFMC demonstration service was available in the whole continent, in the Middle East and in Europe:

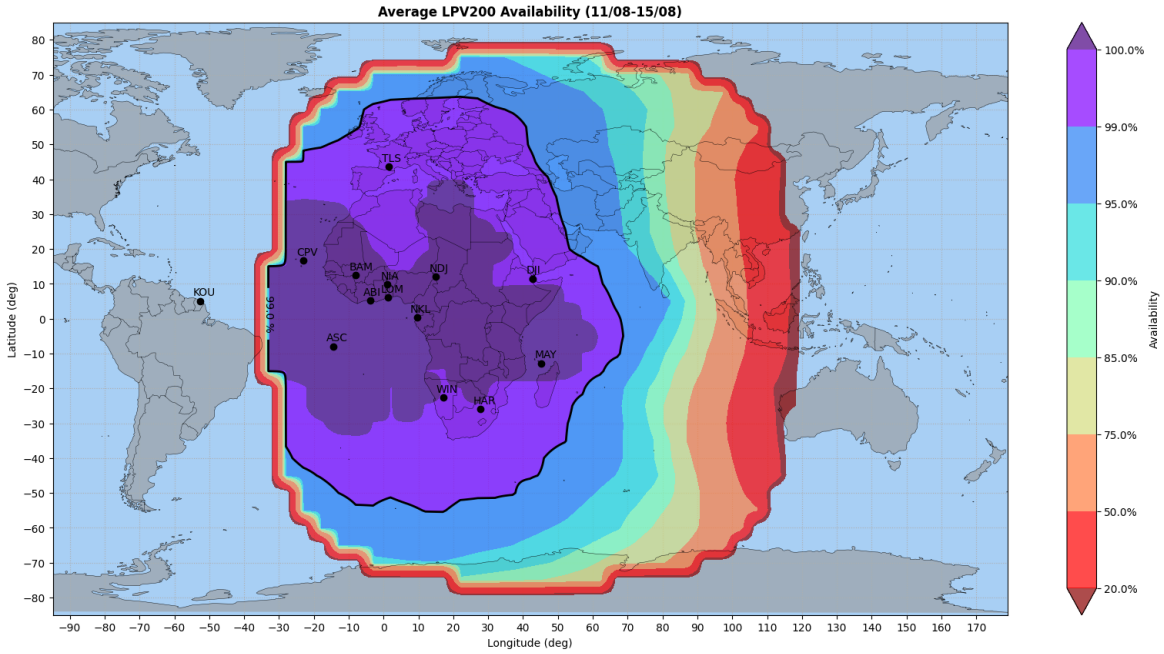


Figure 2: ANGA DFMC demonstration service (LPV-200 availability)

2.22 This DFMC service was the first ever to be broadcasted in the world and was notably used by the avionics industry for the standardisation and prototyping of the future DFMC airborne receivers.

2.23 The provision of these L1 and DFMC demonstration services is expected to be resumed in 2026 in parallel with the ANGA V1 development. On this occasion, the L1 demonstration service could be extended to Eastern Africa, through the deployment of additional GNSS stations.

JOINING THE ANGA PROGRAMME

2.24 The ANGA programme aims to provide a continental SBAS solution, taking maximum benefit of the SBAS regional dimension, and ensuring a cost-efficient deployment, avoiding unnecessary duplication.

2.25 SBAS services provision is indeed regional by essence, as crossing the natural borders of States and organisations, and relies on a cooperative approach for the deployment and exploitation of the infrastructure. Providing SBAS services at a given location requires the deployment of navigation reference stations in the neighbouring area, often beyond the considered airspace.

2.26 Initiated by ASECNA, the ANGA programme is inclusive and open to any States or organisations which would like to contribute to and benefit from the ANGA services. In this vein, the Seychelles CAA has already joined the programme, and consultations are on-going with other States/Organisations to secure their access to the programme.

2.27 The membership to the ANGA programme is proposed through a cooperation framework, based on the guiding principle of multilateral partnership, and not on provider/consumer relationships. This framework covers services provision, infrastructure hosting, users' adoption and promotion, capacity building, regulation, and other aspects of the programme. It aims to be complemented by a multilateral governance scheme, to be developed with the interested stakeholders with an anchorage as a flagship programme of the African Union. This could be done through the provisions provided by ICAO Air Navigation Services Economics Manual Doc 9161, concerning international cooperation in the establishment of international operating organizations.

2.28 States/groups of states/organisations interested in exploring their participation to the programme, including those interested in seizing the window opportunity (until end of 2025) to secure their access to the ANGA V1 services (from 2030), are invited to liaise with ASECNA to discuss the implementation of the proposed cooperation framework.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the development status of the ANGA programme, including its full alignment with airspace users' aspirations, the significant achievements made in the development of the version 1 (V1) of the ANGA system which will support SBAS services provision from 2030 and the milestone of end of 2025 for securing the access of additional stakeholders to the ANGA V1 services;

b) support the cooperative and inclusive approach for SBAS deployment in the continent, to take maximum benefit of the SBAS regional dimension, and ensure a cost-efficient deployment, avoiding unnecessary duplication; and

c) encourage ASECNA member States to continue discussions with the African Union and the other interested stakeholders to develop the cooperation framework and the governance scheme for a continental SBAS based on ANGA.