



ICAO

**INTERNATIONAL CIVIL AVIATION ORGANIZATION
WESTERN AND CENTRAL AFRICAN OFFICE**

**Workshop on SBAS implementation in the AFI Region
Virtual Meeting, 04-05 March 2021**

Report

Prepared by ICAO Secretariat

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1 Introduction

Background

The twenty-third meeting of the AFI Planning and Implementation Regional Group (APIRG/23) held in November / December 2020 considered the status of implementation of the conclusions and decisions of the previous meetings of the Group, pertaining to the introduction of GNSS services in the AFI Region. It particularly recalled its Conclusion 22/39 adopted in 2019, calling upon the African Civil Aviation Commission (AFCAC), in coordination with the ICAO Regional Offices to convene a Regional Workshop on AFI GNSS/SBAS, and therefore urged AFCAC and ICAO Regional Offices to implement this conclusion by January 2021.

The APIRG/23 meeting also noted that the African Union Commission (AUC) was preparing to conduct a Cost Benefit Analysis (CBA) for a continental SBAS to be completed by June 2021, and further recommended the timely delivery of the study for its subsequent submission to the APIRG/24 in November 2021 for consideration in line with the regional GNSS strategy.

In view of the above, the APIRG Secretariat convened the recommended Regional Workshop on AFI GNSS/SBAS, which was virtually held from 4 to 5 March 2021.

Attendance

The workshop was attended by 258 participants from 30 States and seven (07) organizations.

Chairperson and Secretariat

The workshop was chaired by Mr. Magueye Marame Ndao, Director General ANACIM Senegal and Chairperson of the APIRG. Mr. François-Xavier Salambanga, Regional Officer CNS WACAF provided secretarial services for the workshop. He was assisted by Mr. Harvey Gabriel Lekamisy, Regional Officer CNS ESAF and Mr James Danga, Safety Expert, AFCAC.

Opening

Mr. Barry Kashambo, Regional Director ESAF and Secretary of the APIRG addressed the workshop with his opening remarks through which he welcomed the participants and expressed the gratitude of the APIRG Secretariat to the participants for their commitment in attending this workshop.

He provided the participants with background information on the evolution of GNSS evolution from core GNSS constellations to GNSS augmentations and ICAO policy on introduction of DFMC GNSS recommended by the ICAO 13th Air Navigation Conference (ANConf/13, 2018).

Furthermore, he stated the objectives of the workshop which were to facilitate the exchange of information and capacity building on SBAS developments amongst all supporting stakeholders, namely the AUC, AFCAC, airspace users, ANSPs, the EGNOS Joint Programme Office (JPO), to ensure the necessary alignment while preparing for the collaborative decision-making (CDM) on SBAS implementation in the AFI Region, in accordance with the AFI GNSS Strategy.

Mr. Tefera Mekonnen Tefera, the Secretary General of AFCAC gave his opening remarks, highlighting the prevailing downturn in economic activities and reduced air transport activities due to the COVID-19 pandemic. He indicated that AFCAC has continued to work with regional and international partners towards the development, through the AUC HLTF, of recommendations to support the restart and recovery of the aviation industry, including advocacy for relief measures to aviation service providers.

He further recalled APIRG/23 meeting's recommendation calling upon AFCAC and ICAO WACAF/ESAF Regional Offices to coordinate and convene a Regional Workshop on AFI GNSS/SBAS, and AUC to complete the independent Cost Benefit Analysis (CBA) for a continental SBAS by June 2021.

In his preliminary statement, Mr. Magueye Marame Ndao Director-General of ANACIM, Senegal and President of APIRG, welcomed the participants and called for a spirit of collaboration and consensus during the workshop. He reiterated that the main objectives of the workshop were to promote sharing of knowledge, experience and achievements, and provide updated information on developments related to the implementation of GNSS/SBAS in the AFI Region. He also recalled APIRG expectations with respect to the outcome of the Cost Benefit Analysis (CBA) currently being conducted by AFCAC and the AUC.

2 Report on Agenda items

2.1 ICAO General Provisions

Under this Agenda item the workshop was provided with general provision and reference related to GNSS SBAS as baseline in order to set the scene.

2.1.1 Performance Based Navigation (PBN)

Under this sub agenda item, the AFPP provided a detailed presentation of the concept of performance-based navigation (PBN) as described in the ICAO Doc 9613 (PBN Manual) as well as the corresponding harmonized design criteria, pilot procedures, ATC separation, phraseology and airspace design principles.

The components of PBN and their interrelationships were presented to the workshop as follows:

- a) *Navigation infrastructure*, referring to ground-based navaids (VOR-DME, DME), space-based navaids (GNSS) and autonomous systems (INS, IRS);
- b) *Navigation specification* describing the operational approval process defined for each area of operation with focus on its two components:
 - Navspecification designator (RNAV or RNP);
 - Navspecification descriptor, a figure (X) that refers to the horizontal accuracy (Total system error or TSE required 95% of the flight time);
- c) *Navigation application*, the use of a navigation infrastructure and a navigation specification to fly into a given airspace, on a route or a procedure.

Figure 1 below summarizes the components and elements of the PBN concept:

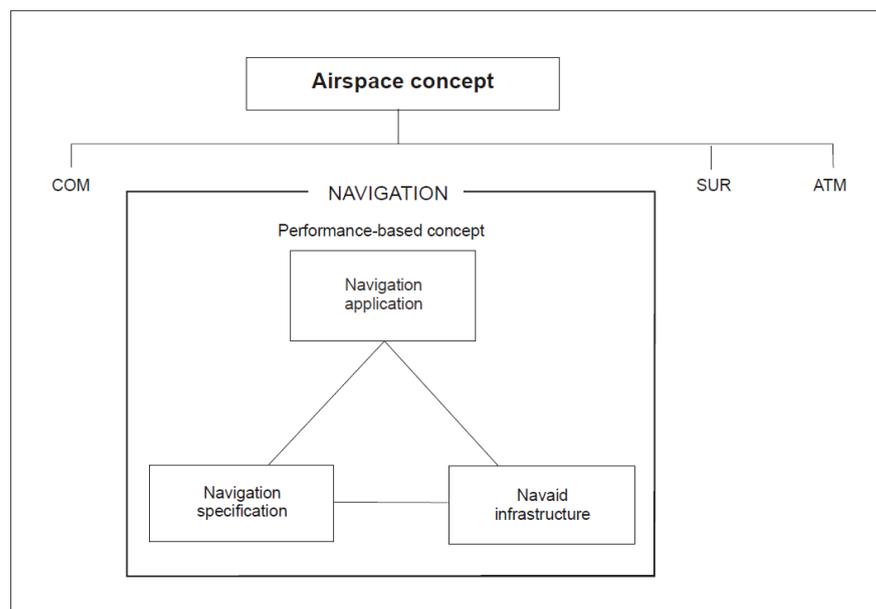


Figure 1: PBN concept

2.1.2 Global Air Navigation Plan (GANP) - Aviation System Block Upgrades (ASBUs) and Technology Roadmaps pertaining to Navigation

Under this sub agenda item, the Secretariat presented the provisions of the global Air Navigation Plan (GANP) and its technology roadmaps for communications, navigation, surveillance, information management and avionics.

With respect to the GANP (ICAO Doc.9750), the Secretariat presented the four layer architecture of its 6th Edition, including the global managerial, global technical, regional and national levels. The presentation also included a description of the ICAO Aviation System Block Upgrades (ASBUs), the related performance improvement areas (airport operations, global interoperable systems and data, optimum capacity and flexible flights, and efficient flight path) and associated block modules, with emphasis on Block 0 modules.

With respect to technology roadmaps, the Secretariat provided detailed information on performance-based navigation (PBN) and GNSS augmentation systems as summarized in the table below.

Table of the workshop

Augmentation	Main Purpose	New Capabilities	Maturity Level
ABAS	<ul style="list-style-type: none"> Support non-precision (LNAV) and vertically guided (LNAV/VNAV) approaches with BaroVNAV and other terminal and en-route navigations. 	<ul style="list-style-type: none"> ABAS supports all PBN navigation specifications with the exception of RNP APCH down to LPV/LP minima. Specific ABAS configurations are required to support RNP AR APCH. 	<ul style="list-style-type: none"> Ready for implementation DF MC ABAS: Validation
SBAS	<ul style="list-style-type: none"> Support PBN in all phases of flight with an increased accuracy, integrity and availability compared to ABAS. Increases accuracy and integrity for the vertical guidance. 	<ul style="list-style-type: none"> Support all PBN navigation specifications, with a deployment emphasis over RNP APCH down to LPV or LP minima at 250 ft (APV I performance) or 200 ft /550 m (Category I performance) 	<ul style="list-style-type: none"> Ready for implementation DF MC SBAS: Validation
GBAS	<ul style="list-style-type: none"> Support Precision Approach and landing operations at a specific airport (one system may support all runway ends). As an option, may support arrival and departure phases of flight. 	<ul style="list-style-type: none"> Category I using GBAS Approach Service Type C (GAST-C). PBN in terminal area (RNAV 1 & RNP 1 operations) can be supported using GBAS positioning service. 	<ul style="list-style-type: none"> Ready for implementation DF MC GBAS: Validation

Furthermore, the presentation highlighted the strategy for the rationalization of conventional navigation infrastructure and for its evolution toward support of PBN included as Attachment H to Annex 10, Volume I, which is reflected in the GANP Navigation technology roadmaps.

Note : Attachment H to Annex 10, Volume I has been developed in response to Recommendations 1/8 (Rationalization of radio systems) and 6/10 (Rationalization of terrestrial navigation aids) made by the Twelfth Air Navigation Conference (ANConf/12). In planning for the implementation of PBN, States need to be able to assess opportunities for realizing economic benefits by reducing the number of terrestrial navigation aids, while at the same time ensuring that an adequate navigation infrastructure remains available to mitigate the potential loss of GNSS services.

2.1.3 *Air Navigation Services Economics*

Under this agenda sub item the Secretariat provided the participants with the economic and organizational aspects related to the Global Air Traffic Management Operational Concept (GATMOC) and System elements, including costs, benefits, cost-benefit studies, business case, funding, cost-recovery and organizational format.

The attention of the workshop was drawn on the necessity for States to strive for the efficient and cost-effective implementation of the GATMOC, using the GANP as the implementation planning document, through international cooperation and collaboration within the ATM community.

The workshop was also reminded that States should consider facilitating implementation of the global ATM operational concept by adopting, where appropriate, a regional approach in order to enhance transparency, efficiency, fairness, comparability and predictability of the costs of air transport infrastructure

In light of Resolution A32-19, guidelines on cost allocation issues were presented to the participants as well as general trend in the variation of the main factors of the ATM system and ICAO policies and guidance on funding air transport infrastructure.

The presentation highlighted the relevance of CBA studies and business case assessment in relation to resource mobilization, cost recovery and sustainability.

2.2 **Strategy for the introduction of Global Navigation Satellite System (GNSS) services in the AFI Region**

2.2.1 *APIRG GNSS Strategy and PBN Roadmap*

The Secretariat presented to the workshop the background APIRG provision for GNSS from APIRG/11 (Nairobi, 30 March - 3 April 1998) to APIRG/23 (Virtual, 23 November - 2 December 2020)

The objectives of the AFI GNSS Strategy were recalled to the workshop: define an evolution path for rationalizing ground-based navigation aids, i.e. VOR/DME/ILS/NDB, ensuring that operational and other concerns such as positive cost-benefit analyses are fully taken into account without analyzing GNSS systems configuration per se nor the advantages and disadvantages of various deployment strategies.

The performance-based approach the workshop focusing on the infrastructure required to support PBN implementation and operations, was underscored.

The following criteria for the implementation of SBAS in the AFI Region were recalled to the workshop:

1. Availability of conclusive cost-benefit analysis (APIRG Conclusion 17/29 refers)
2. Full compliance with ICAO technical requirements (Standards and Recommended Practices);
3. Agreement between stakeholders on pre-implementation cost benefit analyses on case by case basis;
4. Application of the user pays principle across all sectors (SBAS users). National authorities shall prevent cross-subsidization of non-civil aviation users of SBAS.

2.2.2 *APIRG Regional NAV Project*

Under this agenda item, Cameroon, the Project Team Coordinator presented the status of development of the APIRG NAV Project aimed at assisting States/Organizations in coordinating harmonized provision of Aeronautical Radio Navigation Service (ARNS) through the effective implementation of:

- Aeronautical conventional Radio Navigation Systems (VOR, DME ILS);



- Global Navigation Satellite systems (GNSS-core and augmented), in accordance with the operational requirements of Annex 10 (Aeronautical telecommunications) to the Convention on International Civil Aviation, Volume I, Annex 11 (Air Traffic Services) and the relevant supporting guidance material contained in ICAO Doc 8071 (Manual on Testing of Radio Navigation Aid) and ICAO Doc 9849 (Global Navigation Satellite System (GNSS) Manual).

The APIRG Project Team developed a questionnaire in order to gather information on the deployed radio navigation and GNSS infrastructure, and to assist in identifying the availability and reliability of these systems in the AFI Region.

~~The workshop agreed to propose the revision of the mandate of the Navigation Project to include the update of the AFI GNSS Strategy in light of the outcome of the Cost Benefit Analysis (CBA) currently being conducted by AFCAC and the AUC.~~

2.3 Update on developments related to GNSS standardization

2.3.1 Under this Agenda sub item, ICAO presented to the workshop an update on GNSS

standardization through the work of the Navigation Systems Panel (NSP) and the relevant ICAO documentation on the matter.

The principle of GNSS augmentation systems were briefly presented with focus on Satellite Based Augmentation System (SBAS) as well as the current available technology worldwide.

The evolution of GNSS toward Dual Frequency Multi-Constellations (DFMC) was reviewed under the scope of the various technologies under development for the modernization of existing constellation (GPS, GLONASS) or the basic inclusion of DFMC functionality in future systems (Galileo, BeiDou).

The changes to the section of Annex 10, volume I that address common aspects of different GNSS elements (Core constellations and SBAS) were recalled to the workshop where the main intent was to extend the current provisions to include dual-frequency DFMC GNSS provisions;

The workshop was updated on the first version of joint DFMC SBAS MOPS which will be consistent with ICAO SARPs to be approved during NSP/6 and applicable from 2022 (Receiver Standards), after a formal approval by RTCA PMC and EUROCAE TAC and ICAO Council.

2.4 GNSS Regional Initiatives in Africa

2.4.1 AUC/AFCAC support to SBAS Implementation Strategy

Under this Agenda Item AFCAC presented to the workshop the updates of the conduct of the Cost Benefit Analysis (CBA) for the implementation of SBAS in Africa called upon by APIRG.

The specific objective of the CBA is to investigate the related public and industry benefits and costs/impact of SBAS/GNSS implementation in Africa as a whole, taking into account existing and planned initiatives related to SBAS provision on the continent. The CBA also intend to investigate the potential governance and institutional schemes for SBAS provision and use in Africa.

A summary of the scope and terms of reference (ToRs) of the independent CBA was provided to the workshop. Notably, the CBA shall cover all:

- Oceanic and continental airspace under African Union Member States jurisdiction;
- Operations: PBN, ADS-B, etc...;
- Phases of flight from En-route down to CAT-I;
- Airports, aerodromes, airfields and heliports;
- Aircraft and rotorcraft operators, including commercial, regional, business and general aviation.

The workshop noted that delays were expected in the completion of the continental SBAS/CBA which was initially scheduled by end of June 2021, mainly due to AUC internal procurement mechanisms. The workshop commended the efforts made by the AUC and AFCAC and encouraged States/Organizations to actively participate in the collection of data and information needed for the conduct of the SBAS/CBA.

AFCAC took the opportunity to provide the workshop with information on the establishment of a Platform of African Air Navigation Service Providers, to be launched in first quarter 2021, with the main objectives to:

- Enable and facilitate a forum for discussions and coordination, to promote efficiency on air navigation services and a uniform level of safety for air navigation service providers in Africa;
- Recommend a framework for establishment of a continental ANSP Master Plan;
- Foster enhanced quality of service in air navigation as adopted by previous regional meetings of African ANSPs;
- Recommend a framework for establishment of a seamless airspace in Africa in accordance with the relevant AFCAP provisions and AU Assembly decision

AFCAC also highlighted current efforts towards development of the Continental Air Navigation Master Plan to support implementation of the Single African Air Transport Market (SAATM). This is being implemented under Pillar 4 (Aviation Infrastructure) of the Joint Prioritized Action Plan (JPAP) on the operationalization of SAATM.

2.4.2 *EGNOS Africa Joint Programme Initiative*

Under this agenda item, the mission of the Joint Programme Office (JPO) was presented to the workshop as a Pan African specialized ‘entity’, to coordinate and support the implementation of seamless and sustainable satellite navigation solutions in all sectors with aviation as a main driver.

The coordination of SBAS development in Africa for aviation was outlined with focus on the inter actions between key stakeholders: Avionics Manufacturers, Aircraft Manufacturers, Air Navigation Services Providers, SBAS Services Providers and Airlines / Aircraft Operators.

The JPO presented to the workshop its intervention areas for beneficiaries including support to GNSS/SBAS services implementation, GNSS/SBAS applications development, promotion and communication of GNSS/SBAS services, training and capacity building on GNSS/SBAS, R&D and specific supporting services.

The JPO reported the outcome of the communication & outreach events held in Lomé, Togo from 28 to 29 February 2021 with the aim at fostering multilateral dialogue with all stakeholders including airlines, aircraft/avionics, manufacturers, SBAS providers and institutional/technical stakeholders:

- Awareness of the readiness and achievements leading to SBAS use over the world;
- Capture information on SBAS benefits and opportunities in Africa;
- Continuous exchange on “nice to know” information on SBAS/LPV in Africa;
- Share and learn SBAS development plans with an end-to-end perspective;
- Assert inclusive strategic vision towards SBAS use in Africa;

The workshop commended the capacity building work done by the JPO and took note of its readiness to further assist stakeholders in the coordination and development of GNSS/SBAS in Africa.

2.4.3 *SBAS for Africa and Indian Ocean Initiative– Operational Trials*

ASECNA provided the workshop with an update on the SBAS for Africa & Indian Ocean (A-SBAS) initiative being implemented through a project.

The presentation outlined a background on SBAS operations operational benefits in CAT-I operations complimentary to ILS, geometric guidance capability, increased RNAV and RNP capabilities and accurate position source for most-stringent ADS-B requirements.

The feasibility of SBAS implementation as well as the service provision strategy and plan were presented to the participants in light of the coverage and level of performance of the A-SBAS system.

The A-SBAS pre-operational service was reported to be successful provided in view of the results of flight demonstrations conducted in Lomé, Togo on 27 January 2021.

Moreover, it was indicated that the above benefits expected from the A-SBAS services would be provided with no specific increase of air navigation charges and no penalties to airlines not yet interested to use SBAS services.

The workshop commended the successful initiative of A-SBAS and encouraged the ANSP to advance the project continue to contribute to the APIRG as the regional mechanism.

2.5 Stakeholders’ Perspectives

2.5.1 Air Navigation Service Providers

Under this agenda item, CANSO provided the workshop with a communication on the initiatives taken in the matter of the implementation of ASBU modules including those related to GNSS/SBAS.

2.5.2 Airspace Users

IATA reminded the workshop on its position on Navigation avionics with focus on the conditional neutral’ position for the implementation of SBAS, as summarized in the table below:

Technology	Support	Maintain	Neutral	Do not support
PBN	X			
NDB				X
DME		X		
VOR		X		
TACAN				X
ILS	X			
MLS				X (See Note 3)
GNSS	X			
ABAS	X			
GBAS	X			
SBAS			X (See Note 4)	

Note 4: Airlines who are equipping with SBAS are doing so based upon their individual operational requirements and business case. IATA member airlines who are not planning to utilize SBAS are concerned that they may be adversely impacted by its implementation. Three essential requirements for SBAS implementation are:

1. no mandatory requirements by regulatory authorities to fit SBAS equipment to aircraft;
2. no unjustified restrictions to operations due to a lack of SBAS equipment; and
3. no costs related to SBAS being imposed directly or indirectly to airspace users who do not use such technology.

SBAS Implementation in AFI Region: IATA Position (Navigation)

IATA also provided the workshop with its views on GNSS / SBAS Implementation in the AFI Region that should take into consideration the following:

- Global/Regional Harmonization/ standardized regional framework;
- Vision and CONOPS document CNS/ATM Airspace
- National (State) Implementation Strategies
- APIRG Conclusions / Requirement for Cost-Benefit Analysis (CBA) in light of the APIRG Decision 23/01

IATA outlined the challenges in the implementation of SBAS such as:

- Ionospheric errors/study
- Cost of investment/Return on investment
- User pay principle/non-aviation users
- Regulatory certification
- Regulatory operational approval
- GNSS Interference/vulnerabilities.

IATA also expressed concerns on:

- Aircraft equipage/readiness
- Additional crew training e.g., sim.
- Cost of investment
- User pay principle/User charges
- Airline financial position post-COVID
- Mandates.

IATA renewed its support to the AFI SBAS Cost-Benefit Analysis (CBA) and willingness to collaborate with AFCAC for the data collection and post-analysis workshop to ensure regional ownership of the deliverables of the CBA.

The African Airlines Association (AFRAA) presented to the workshop the Airline's Perspectives on GNSS SBAS with focus on the state of the aviation industry in Africa adversely affected by the COVID-19 pandemic. AFRAA also expressed concerns at some challenges in SBAS implementation, such as the infrastructure deployment in the entire African continent, the retrofit cost for member airlines fleet of aircraft.

The AFRAA presentation put the spotlight on degree of SBAS equipage of the current fleet operating in the continent, highlighting the importance of the required SBAS infrastructure for entire Region be set with the cost assessed. AFRAA also pointed out the increasing number of airline bankruptcy worldwide and in Africa while many States' borders remain closed and increasing number of grounded aircraft (high percentage of non-SBAS capable).

As the entire Aviation sector is affected by the COVID-19 pandemic, AFRAA expressed its reservations as to whether Africa should undertake SBAS implementation in the near future and at the same time confirmed to stand ready to work with the stakeholders on the continental CBA for a sound SBAS infrastructure in the space, on ground and onboard the aircraft.

AFRAA also shared its view on the opportunity for strategic aviation innovation to overcome the COVID-19 devastating effects through the application of the lab approach to innovate through Africa Aviation Revamp-LAB.

In this regard, AFRAA proposed that the relevant aviation stakeholders including Airlines, ANSPs, Airports, airport service providers and CAAs should innovate to make African air transport safer, competitive and efficient enough to support the industrialization, trade, tourism, and other key economic sectors anchored on the AfCFTA and SAATM.

2.5.3 *Aircraft Manufacturers*

AIRBUS provided the workshop with a presentation on his Fleet Readiness for SBAS/LPV. SBAS technology that requires a new generation of Multi-Mode Receivers (MMR) was presented as a key enabler technology for airborne functions such as ADS-B where required (US Mandate) and LPV approaches-SBAS Landing System (SLS)

The Multi-Mode Receivers (MMRs) implementation was reported to address major hardware obsolescence affecting some aircraft, support today and future approaches (SLS / LPV, GBAS CAT II/III), and provide SBAS capability required by mandates.

The presentation gave an overview of MMRs equipage for A320 / A330, A380/A350 aircraft families.

AIRBUS informed the workshop that the SLS technology based on differential GPS, enables to fly RNAV (GNSS) approaches in an ILS look-alike way:

- With geometric vertical guidance (no issue with QNH setting error and Baro-VNAV in cold temperature)
- With LPV minima (performance equivalent CAT I ILS: down to 200 ft)
- Pilot Training limited to level A

AIRBUS also provided an overview of SBAS constellations worldwide with a mandate in Europe by 2030+, ILS Cat I decommissioning and with reference to A-SBAS in the WACAF airspace by 2025+ and updated the workshop with LPV implementation status in Europe (EGNOS): 1067 LPV procedures serving 809 airports including 276 LPV200 as of January 2020.

The workshop took note of the information provided that should be considered for the CBA and the post analysis exercise.

2.5.4 *States*

Participants representing States commended the presentations provided to the workshop. The questions raised and comments made by the participants were related (but not limited) to the following:

- Cost/Benefit of SBAS system compared to ILS's;
- Recommendation to AFCAC to include the environment issues in the ToRs of the CBA;
- Request to have comparative outcome of CBA of other augmentation systems (i.e GAGAN);
- Accuracy of the SBAS system and possible drawbacks;
- Limitation of LNAV, B/VNAV.

These questions and comments were duly addressed by the presenters.

2.6 **Way forward and Conclusion**

In consideration of the deliberations on the above agenda items, the workshop agreed on the following recommendations and key action items as the way forward:

- 1) Support AFCAC and AUC in the conduct of the CBA on SBAS implementation in Africa;
- 2) The outcome of the AFCAC and AUC cost benefit analysis (CBA) for continental SBAS implementation for aviation must include all architectural options as per the terms of reference of the study;
- 3) States/Organizations States/Organizations take advantage of a strong inclusive regional CDM network for the implementation of SBAS;
- 4) States/Organizations/Industry to cooperate by providing to AFCAC, the raw data that will be collected by the consultant to conduct the CBA;
- 5) Update of the AFI GNSS Strategy to align with the GANP Technology Roadmaps related to Navigation systems, and based on the outcome of the GNSS/SBAS CBA when available;
- 6) States/Organizations to implement the GANP Technology Roadmap related to Navigation in developing GNSS/SBAS initiatives;
- 7) APIRG to serve as the common umbrella for the development and coordination of GNSS/SBAS initiative through the AFI Navigation Project,
- 8) Support to States for the establishment of GNSS related regulations;
- 9) Organization of a regional workshop for GNSS certification;
- 10) Applying the lab approach to innovate through Africa Aviation Revamp-LAB;



- 11) Airlines, ANSPs, Airports services providers and CAAs urged to innovate to make the African air transport safer, competitive and efficient enough to support the industrialization, trade, tourism, and other key economic sectors anchored on AfCFTA and SAATM;
- 12) Conduct of similar workshops/seminars on specific matters related to GNSS/SBAS, intended States and AFI operators (ANSPs, Airlines, Airports,...); and
- 13) States/Organizations to support the work of APIRG on GNSS providing relevant data and information to surveys conducted by its Navigation Project in a timely manner.

Appendix B to this report provides an Action Plan based on the above recommendations, with stakeholders' roles, responsibilities, and timelines, to support related implementation and monitoring.