



International Civil Aviation Organization

THIRD MEETING OF THE APIRG CNS SUB-GROUP (CNS/SG/3)
(Nairobi, Kenya, 26-30 April 2010)

Agenda Item 6: Aeronautical radio navigation service (ARNS)

USE OF SBAS FOR APV OPERATIONS

Submitted by the European Commission

SUMMARY

This Working Paper gives an overview of the status of SBAS implementation, procedure development and equipage world-wide, as well as the actual status of EGNOS. It also presents the plan for the provision of SBAS over the AFI region that would be supported by European funds in the context of the EU-Africa Strategic Partnership. This is justified by a robust cost benefit analysis for the civil aviation sector, for which the updated approach and results are presented.

1. USE OF SBAS FOR APV OPERATIONS

- 1.1. The PBN requirements issued by the 36th GA (2007), states that APIRG should have completed a PBN implementation plan by 2009 to achieve implementation of APV (Baro-VNAV and/or augmented GNSS) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016.
- 1.2. Many aircraft do not and never will have barometric vertical guidance (Baro-VNAV) capabilities. By limiting the strategy to Baro-VNAV implementation only, this PBN objective by 2016 for all instrument runway ends and all operators cannot be met. In addition to that, Baro-VNAV is less reliable under certain climatic circumstances and more prone to human errors than SBAS.
- 1.3. For all aircraft, SBAS can enable APV/LPV operations.
- 1.4. GPS-RAIM and GPS-RAIM-INS solutions are very sensitive to the number of healthy satellites currently available in the constellations and can have degraded availability under constellation maintenance scenarios. WAAS (SBAS) has been shown to improve the GNSS availability to 100% for use up to RNP 0.1 procedures.

- 1.5. FAA studies have shown that SBAS is valuable to ensure robustness against GPS satellite outages even for NPA.
- 1.6. The FAA has included SBAS in their GNSS Strategy for RNP and ADS-B in radar airspace, more specifically for LNAV/RNP 0.3, RNP 0.1 and LPV-200.
- 1.7. A number of aircraft manufacturers have completed aircraft STC (Supplemental Type Certificates). These have been completed for Boeing B-737-200 and in progress for the Airbus A350 and A400.
- 1.8. Airbus plans to implement their Satellite Landing System on the A350 XWB by 2013. This SLS will rely on use of SBAS (EGNOS and WAAS) for LPV 200 procedures.
- 1.9. EGNOS (over the ECAC region), WAAS (over CONUS, Canada and Mexico) and MSAS (over Japan) are already operational. GAGAN (over India) is being implemented, and Russia is also developing its own SBAS system, called SDCM¹. Extensions of these regional systems will ensure almost world-wide SBAS coverage.

2. SBAS IN EUROPE AND AFRICA

- 2.1. EGNOS started tests over ECAC in late 2006. From the end of 2007 onwards, the EGNOS Signal in Space (SIS) has been available nearly 100% of the time and has demonstrated that it delivers a robust integrity service compliant with ICAO SBAS SARPs. In October 2009, the open signal has been declared operational with the entry into service of the EGNOS Satellite Service Provider.
- 2.2. The EGNOS Service Provider will be certified by mid-2010 and the EGNOS will enter into operation for Safety of Life by the end of 2010. European ANSPs will accelerate publishing of landing procedures from that time onwards².
- 2.3. ECAC States are publishing new RNAV procedures also supporting SBAS vertical guidance (APV SBAS-LPV) in order to comply with the resolutions of the ICAO 36th Assembly (2007).
- 2.4. In addition to the 34 RIMS (Reference and Integrity Monitoring Stations) already in place, of which some are located already on the African continent, in Djerba (Tunisia), Nouackchott (Mauritania), Hartebeeshoek (South Africa), new RIMS will be brought online in Athens (Greece), Alexandria (Egypt) and La Palma (Spain). Further deployments are also planned in Tel Aviv, Agadir and Abu Simbel (Egypt).

¹ Currently, the Russian Space Agency is engaged with EU in a R&D project to test feasibility of integrating seamlessly SDCM with EGNOS

² At time of writing there are already around 100 EGNOS written landing procedures across Europe, developed initially for testing and research purposes, waiting for the declaration of service availability in 2010.

- 2.5. The provision of SBAS over AFI has been considered by EU since the early phase of development of EGNOS, and initial system architecture definition and architectural trade-offs have been already performed in the past. Real-life operational trials³ have been undertaken in Africa in the past recent years, showing the technical feasibility and the interest from the user communities.
- 2.6. The extension of EGNOS in Africa is identified in the First Action Plan of the Africa-EU Strategic Partnership and in the Commission communication (COM(2009)301) on partnership with Africa on transport. A plan for the implementation of the SBAS services over AFI is intended to be shared with the African Union Commission before the upcoming Africa-EU Summit in November 2010
- 2.7. The implementation could be funded through European Development Funds and other co-operation funds. No cost-recovery mechanism, that charges airlines and airspace users in Africa, is planned. The implementation would include development of infrastructure but also other activities, such as development of GNSS procedures, which will support African MS in their implementation of PBN, and training to Air Traffic Management Service providers in Africa.
- 2.8. The implementation of basic GNSS procedures (e.g. GPS NPA) will be beneficial in AFI, as a precursor and facilitator to implementation of SBAS LPV procedures.

3. ECONOMIC BENEFITS OF SBAS IN AFI

- 3.1. Studies have shown that augmented GPS (SBAS) in AFI could have significant social and economic benefits accruing in the transport sector (aviation, rail and maritime), but also in other areas such as land management, agriculture and precision surveying.
- 3.2. In the civil aviation sector, SBAS will inter alia improve regional integration by the opening up of new routes and by facilitating access to airports in remote regions, even if this type of benefit is hard to quantify. The cost benefit analyses (CBA) for ISA (Inter-regional SBAS for AFI) have taken a more pragmatic approach and only considered benefits than can be measured in financial terms.
- 3.3. At CNS/SG/2 in May 2007, a recommendation was made to delay ISA implementation until "...further cost benefit analysis in coordination with users demonstrates a conclusive need."
- 3.4. The ISA CBA was reviewed and revised in 2009, with the contribution of major African airlines, presented at the Joint PBN/GNSS TF and at the CNS/SG/3. Costs of aircraft equipage and procedure development have been included.

³ Eurocontrol and ASECNA in Senegal and Kenya for aviation, in South Africa for rail and through Suez canal for maritime

- 3.5. The updated CBA (which assesses the delta from a base line scenario of Baro-VNAV without SBAS) considers a timeframe of 30 years (from 2011 to 2041). A conservative assumption was made that by 2020, with a 100% penetration of LPV procedures on IFR landings, 46% would use SBAS.
- 3.6. The main benefit for aviation due to ISA roll-out in the AFI region will be the foreseen CFIT reduction (therefore increasing safety of flight in the region), while ground infrastructure represents the highest investment required.
- 3.7. ISA cumulated benefits for aviation in the AFI region over a 30-year period will amount to c. €1.7b versus expected investments, which could come from European cooperation funds, of c. €359m. Discounted net benefits amount to c. €211m.
- 3.8. In an analysis that focussed solely on the costs and benefits borne by AFI IATA members, the cumulative net benefit for such companies amounts to c. €82.5m. Their key benefits accrued from DDC reduction and with ADS-B improvement, while retrofitting of equipment represented the highest investment item (quantified in a total of €10m over the first five years).

4. ACTIONS FOR THE CNS SUB-GROUP

- 5.1. The sub-group is invited to:
 - a) Take account of the information presented in this paper when reviewing the AFI GNSS Strategy document (Appendix H to Doc. 003) for APIRG/17.
 - b) Take note that details on the ISA programme proposal will be presented by the EC at APIRG/17, and the full ISA CBA analysis will be provided for information.
 - c) Take note that, in further ISA developments, EC will take into account ICAO's stated interest in achieving early benefits from GNSS in AFI by implementation of Basic GNSS procedures (e.g. for GPS NPA) and APV Baro-VNAV as a precursor and facilitator to implementation of SBAS LPV procedures.
 - d) Initiate discussion on how best the African aviation community can be associated to the steering of future ISA implementation activities.