INTERNATIONAL CIVIL AVIATION ORGANIZATION

AFI PLANNING AND IMPLEMENTATION REGIONAL GROUP SEVENTEENTH MEETING (APIRG/17) (Burkina Faso, 2 to 6 August 2010)

Agenda Item 3.3: Communications, Navigation and Surveillance (CNS)

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 provided.

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 Some IATA and many non-IATA aircraft do not, and never will, have barometric vertical guidance (Baro-VNAV) capabilities[1],[2]. 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 In contrast, SBAS can enable APV/LPV operations for all aircraft.

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.

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[1] EUROCONTROL – 45% of aircraft and 52% of flights in Europe will never be Baro-VNAV capable, see viewgraph in Annex

[2] MITRE – 50% of FMS in USA will never be Baro-VNAV capable. Among these, 18% of the 10 major airlines cannot fly Baro-VNAV procedures, see viewgraph in Annex.

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 SDCM[3]. 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 complaint 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 is being certified during July 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 onwards[4].

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 EGNOS 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 Agadir (Morocco), Tamanrasset (Algeria) and Abu Simbel (Egypt) to enable the SBAS coverage of the Mediterranean and North African region.

2.5 The provision of SBAS over AFI has been considered by European Union (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 trials[5] have been undertaken in Africa in recent years, showing the technical feasibility and the interest from the user communities.

2.6 An AFI EGNOS test bed was implemented across the entire continent between 2003 and 2006. The three regional reports from this testbed, that were compiled by ASECNA, ATNS, and ICAO ESAF office respectively, have been submitted to the ICAO Secretariat of the AFI GNSS Implementation Task Force.

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

[4] 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 EGNOS Safety-of-Lifeservice availability in 2010.

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

2.7 Ionospheric effects over the equatorial region are a challenge for single frequency SBAS. However, the detailed architecture design for SBAS in AFI has been defined by the European Space Agency (ESA), and the technical feasibility shown, for the equatorial region in Africa as well. These results have been presented to ICAO in a number of dedicated workshops (Cairo, 2005 and Toulouse, 2006).

2.8 Certain regions (CARSAM) have opted to wait for the availability of dual-frequency constellations (GPS and/or Galileo) that will be available by 2018 onwards, before considering SBAS implementation. Thus AFI States will have the choice to implement mono-frequency SBAS at sub-regional or continental level in order to fully comply with PBN requirements by 2016, or alternatively wait for dual-frequency SBAS which may be available by 2020 onwards.

3. EU-AFRICA COOPERATION AND FUNDING OF SBAS IN AFRICA

3.1 European Development Funds have been already allocated for the extension of the EGNOS coverage to the MEDA[6] countries, with deployment of EGNOS stations, trials and other activities related to training, certification and application development.

3.2 Deployment of stations for the provision of SBAS services over Southern Africa is being planned in the frame of the EU-South Africa Space Dialogue, in cooperation with the South African ATNS and the Council for Scientific and Industrial Research.

3.3 Further specific research activities, involving African organizations (notably ASECNA and the South-African CSIR), are already funded[7] and are being carried out for the definition of the SBAS services and infrastructure in West/Central Africa and Southern Africa.

3.4 The implementation of SBAS in Africa is also part of the EU cooperation policy with Africa on transport[8] and of the First Action Plan (2008-2010) for the Implementation of the Africa-EU Strategic Partnership[9]. The Second Action Plan is being prepared jointly by the EU and the AU and will be adopted at the upcoming Africa-EU Summit in November 2010, and a plan for the implementation of the SBAS services over AFI is intended to be shared with the African Union Commission and concerned stakeholders on that occasion.

3.5 The implementation of SBAS in Africa could be funded through European Development Funds and other co-operation funds[10]. In this case, no mechanism shall be put in place by the European Union to recover such costs from ANSPs, airlines and airspace users in Africa. 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.

3.6 The implementation of Basic GNSS procedures (e.g. for GPS NPA) and APV Baro-VNAV, will be beneficial to AFI, as a precursor and facilitator to implementation of future SBAS LPV procedures, which will ultimately be fully compliant with the PBN requirements for APV.

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[6] Euromed GNSS-I and Euromed GNSS-II projects
[7] through the Seventh Framework Programme for research and technological development (FP7)
[8] Communication from the Commission to the European Parliament and to the Council "Partnership between the European Union and Africa. Connecting Africa and Europe: working towards strengthening transport cooperation" (COM(2009) 301 final, dated 24 June 2009)
[9] Africa-EU Summit in Lisbon, December 2007
[10] e.g. Africa-EU Infrastructure Trust Fund of the European Investment Bank

4. ECONOMIC BENEFITS OF SBAS IN AFI

4.1 Studies have shown that 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.

4.2 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 an Inter-regional SBAS for AFI (ISA) have taken a more pragmatic approach and only considered benefits than can be measured in financial terms accruing to the civil aviation sector.

4.3 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." The EC has supported numerous revisions of the CBA and commissioned a final update in 2009 to take account of concerns raised by this forum, e.g. the costs of aircraft equipage and procedure development have been included.

4.4 The 2009 ISA CBA is comprehensive, conclusive and inclusive of contribution from major African airlines. It was presented at the Joint PBN/GNSS TF and provided as an IP at the CNS/SG/3. Member States were invited to provide comments on the CBA before APIRG/17, however comments were only received from IATA, and these have been addressed in this WP. It should be noted that the CBA includes social benefits that will accrue to African citizens as well as financial benefits to the airlines and ANSPs.

4.5 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). This study used the latest, available flight statistics (taken from 2007 and 2008) for the AFI region. A conservative assumption was made that by 2020, with a 100% penetration of LPV procedures on IFR landings, 46% would use SBAS. In addition, a sensitivity analysis was carried out to counteract the usual uncertainties in the base assumptions and statistics used.

4.6 The main benefit for aviation due to ISA roll-out in the AFI region will be the foreseen CFIT reduction (therefore benefiting citizens by increasing safety of flight in the region), while ground infrastructure represents the highest investment required. Airlines and ANSPs are also beneficiaries due to reduced accidents and DDCs, and reduced ground navaids and improved ADS-B, respectively.

4.7 ISA cumulated benefits for aviation in the AFI region over a 30-year period will amount to c. €1,700m versus expected investments of c. €359m (which could come from European cooperation funds). Discounted net benefits amount to c. €211m, which makes a hugely positive case for SBAS implementation in AFI. A sensitivity analysis has shown that even in the worst case, the discounted net benefits will reduce by a maximum of €75m and therefore that the overall net benefits will still be positive with a value of over €135m.

4.8 In an analysis that focussed solely on the costs borne by and benefits accruing to 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 as a total of €10m over the first five years).

5. ACTIONS FOR APIRG/17

5.1 APIRG/17 is invited to:

a) Take account of the information presented in this paper when concluding on the AFI GNSS Strategy document (Appendix H to AFI CNS/ATM implementation plan Doc. 003).

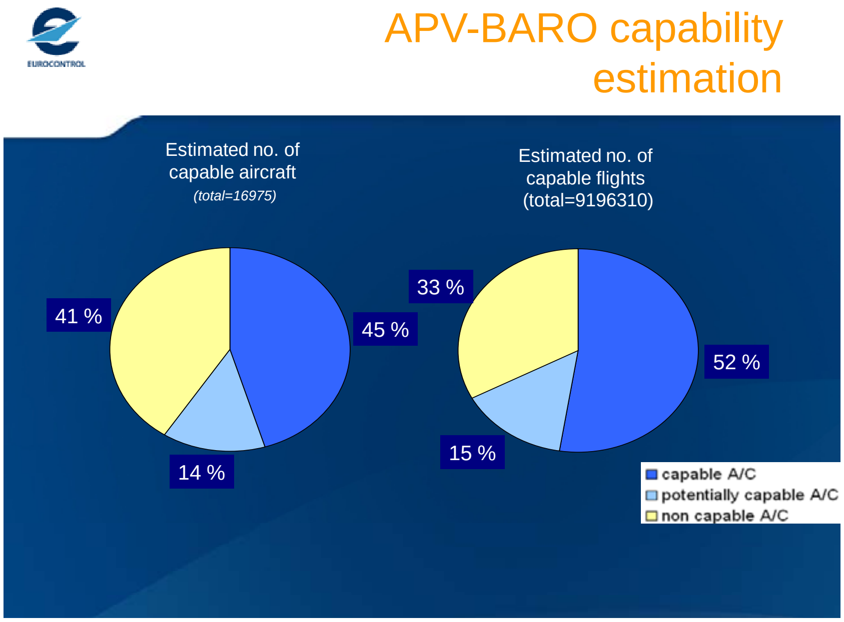
b) Take note of the details of the final EC CBA analysis provided as an Information Paper, and that no further CBA studies will be supported by the EC in this context.

c) Take note that, in further developments of SBAS infrastructure in Africa, 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) Recognise that the PBN requirements will only be partially met without the availability of SBAS services, and that it is necessary to define and agree a work plan for SBAS implementation to fully meet these PBN requirements at the earliest date and in the most cost-effective manner.

e) Urge AFI Member States to also consider the needs of their non-IATA airlines and to encourage discussion between regional groups of MS on how best to proceed with the implementation of SBAS infrastructure in AFI.

ANNEX



Baro-VNAV Capable Operations

MITRE Estimates

Airline Classification	Number of Aircraft	Number of FMS	Number of VNAV Capable FMS	FMS (%)	Baro-VNAV Capable (%)
10 Major Airlines	3642	3466	3003	95%	82%
Regional Airlines	2325	2151	179	93%	8%
Other Part 121 Airlines	405	316	262	78%	65%
Part 121 Cargo Airlines	1077	610	538	57%	50%
Business Jet Operators	709	640	135	90%	19%
Summary	8158	7183	4117	88%	50%

*** CAASD does not have a comprehensive avionics database of Business Jet Operators. These data reflects a very small portion of this classification, and may not accurately depict the capability of this classification.**