Agenda Item 6: Aeronautical Radio Navigation Service

Feasibility Studies on Ground Based Augmentation System (GBAS)

(Presented by: ASECNA)

**SUMMARY**

This paper provides information on actions conducted by ASECNA in the frame of its R&D activities and mainly for the first feasibility study on Ground Based Augmentation System (GBAS) implementation. This work was conducted during the last quarter of 2012 at the Leopold Sedar Senghor (LSS) airport, one of the most important airports in West Africa, in Dakar (Senegal).

Action: The meeting is invited to

a) Take note of information above;

b) Encourage States/Organizations to take benefit of this technology which is included in ASBU roadmap as an alternative short term solution for precision approach to ILS.

**REFERENCES:**

Doc 9750, ASBU technology roadmap

Related ICAO Strategic Objectives: A – Safety, B – Capacity

Related ASBU Bloc 0 Modules, Performance Improvement Areas and Applications: B0-65 , PIA 1

1 Introduction

1.1 ICAO Global Air Navigation Plan acknowledges that “GNSS centered Performance Based Navigation enables a seamless, harmonized and cost-effective navigational service from departure to final approach that will provide benefits in safety, efficiency and capacity.” As such, GBAS allows replacing or supplementing Instrumental Landing Systems (ILS).

1.2 Thus, GBAS-equipped aircraft operators can achieve safety and operational benefits and maximize the use of satellite navigation and automated systems. In comparison to ILS, GBAS has less critical and sensitive area protection requirement, has lower support and maintenance costs including less frequent flight inspections, it does not need to be installed at the end of runways and provides multiple path precision approach capability.

1.3 This note reviews activities conducted by the first GBAS study on the African continent performing a preliminary assessment of Static GBAS CAT-I system performances (accuracy, integrity, continuity, availability, satellites visibility, etc.) at Léopold Sédar Senghor airport. It included the sites installation, performance computation and analysis as well as training.

1.4 A Cost Benefit Analysis (CBA) assessment was also conducted to support the stakeholder decision on the future implementation of a GBAS system. A GBAS approach procedure was also designed and flown using a flight simulator system.
2. Discussion

2.1 The research of innovative solutions that contribute to the improvement of air navigation safety is defined in the ASECNA Strategic Orientations Plan (POS) as one of the strategic objective of the Agency.

2.2 The Engineering and Prospects Department of ASECNA, applying the guidelines of this POS plan, and in accordance with the Africa and the Indian Ocean (AFI) strategy regarding NAV means implementation, has included in its R&D activities, the operational evaluation and implementation of Ground Based Augmentation System (GBAS). This first feasibility study of GBAS in Africa has following objectives:

- Develop a good competence in the field of GNSS and in particular GBAS in order to create a technical and operational team necessary to support any potential future GBAS Programme;
- Assess the feasibility (opportunities, constraints, financial impact, etc. ...) of the implementation of GBAS within ASECNA area, and in particular Dakar International Airport;
- Sustain Agency’s position in the supply and implementation of new navigation systems in the region.

The study was made possible thanks to a partnership agreement signed in 2011 within PILDO and ASECNA to share experiences and R&D activities.

3. Results

3.1 Airport Siting activities for the installation of three GNSS receivers were performed by ASECNA local maintenance team:

- Identify suitable locations for the installation of three GNSS receivers
- Antenna and receiver installation;
- Geo-Position three selected positions based on 24 hours data collected;
- Validate the installation based on data analysis (multipath, shadowing effects...);

3.2 GBAS Ground Station Performance Results (1/2):

Two main tasks have been performed for performance assessment at GBAS station level:

1) Assess technical feasibility for the installation of a GBAS station at Dakar Airport (satellite visibility, signal to noise ratio C/No, number of satellites monitored by the station);

![Fig 1: Nominal number of GPS monitored satellites (>10 most of the time)](image1)

![Fig 2: Excellent Signal to Noise ratio around 45dB](image2)
2) Simulate GBAS messages with appropriate GAD parameter configuration computed based on measured data statistics.

Assessment of Ground Accuracy Designator (GAD) is to characterize the contribution of the ground station to the GPS measurements error. Measured values for Dakar receivers indicate excellent accuracy up to [C] level ground station type.

### 3.3 GBAS Airborne Performance Accuracy Results

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<tr>
<th>Horizontal Protection Error (HPE)</th>
<th>Vertical Protection error (VPE)</th>
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<tr>
<td><img src="image" alt="Horizontal Error Histogram" /></td>
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As required for CAT-I operations (ICAO Annex 10):
- HPL 95% < 16 m
- VPL 95% < 4 m

### GBAS Airborne Performance Integrity Results

As required for CAT-I operations (ICAO Annex 10):
- HPL 95% < 40 m (HPL95 = 2.568 m)
- VPL 95% < 10 m (VPL95 = 3.593 m)

### 3.4 GBAS Airborne Performance Summary

Table below summarizes the measured performance against CAT-I requirements:
Table comparing RNP CAT-I measured performance at Dakar Airport with SARPS Requirements
CAT-I Requirements taken from ICAO Annex 10 – Table 3.7.2.4-1

3.5 GBAS Approach Design and Simulation

GBAS approach on Dakar Airport RWY 36 was designed using PRODAN (in-house Pildo Labs tool) and verified with GeoTitan used by ASECNA, based on actual ICAO General Criteria from Doc.8168.

Initial segments are equal to actual RNAV GNSS procedure, while a new Final Approach Point so-called PILDO is included. Missed approach segment is proposed towards the IAF/IF because of the holding pattern.

Obtained minima is equivalent to 200 ft for all aircraft categories.

Procedure’s flyability was validated throughout PLATERO (*) coupled with the ESP Microsoft Flight Simulator.

3.6 Cost Benefit Analysis (1/2)

The Net Present Costs used, are computed for a set of scenarios mixing actual precision approach service with future additional GBAS or ILS ones.

- B1- Dual ILS on RWY36/18
- B2- GBAS by keeping ILS RWY36
- B3-GBAS by decommissioning ILS RWY36
GBAS initial investment is higher than for ILS (red line versus grey line in NPC graphic). However due to lower OPEX for the GBAS procedures, Net Present Cost is similar. Hypothetical ILS decommission would report economic benefits for GBAS exploitation after 5-6 years (grey line versus blue line in NPC graphic).

4. Conclusion

The static GBAS CAT-I study, conducted at LSS Airport in Dakar, showed that it is possible to reach the required CAT-I performances as per required in ICAO Annex-10. It confirmed LSS Airport as a very suitable scenario for the future operational implementation of GBAS services.

The next phase of the project to be executed in a near future includes the establishment of an automatic monitoring system for GPS and GBAS performances at LSS Airport; a longer data collection campaign (minimum of six months) in order to get a more complete visibility on the local GBAS performances taking into account all the seasonal effects of the atmosphere in particular in the equatorial region where the ionosphere is highly active and has a relevant impact in GNSS signals; analyse the possibility of installing an experimental GBAS Ground Station and perform an extended assessment for CAT II-III requirements.

5. Action by the meeting
   a) Take note of the above information
   b) Encourage development of studies and experimentations on this technology as an alternative solution to ILS and SBAS CAT I/II/III.