EXTENSION OF EGNOS IN AFRICA
<< CASE OF MADAGASCAR >>

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AMPTGNSS Madagascar - GNSS Technology for sustainable development
Contents

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- Case of Madagascar
- What is the need?
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**Introduction**

**NAVIGATION:**
The **key element of flight:** possibility to navigate from one airport to another one.

**TODAY:** techniques are based chiefly on terrestrial radionavigation aides.

**CNS/ATM concept:** GNSS implementation

**CONSTRAINT:** Integrity is not guaranteed and is of poor quality

- Augmentation systems are necessary for integrity monitoring
- **EGNOS** is one of the European contribution to GNSS
EGNOS: EUROPEAN SBAS

EGNOS
It aims to augment satellite navigation systems
  Provides correction

FONCTIONALITIES
✓ RANGING: GPS like pseudoranges
✓ INTEGRITY: Broadcast of GPS integrity messages
✓ WIDE AREA DIFFERENTIAL: Broadcast of GPS differential corrections valid over full Service Area.
CASE OF MADAGASCAR

AREA: 587,000km²

07 International scheduled Aerodromes
01 Main Custom Aerodromes
08 Main Aerodromes
29 National aerodromes
109 private and reduced used aerodromes
## What is the need?

### Total NAVAIDS in Madagascar

<table>
<thead>
<tr>
<th>Approach, landing, en-route</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>VOR</td>
<td>06</td>
</tr>
<tr>
<td>DME</td>
<td>04</td>
</tr>
<tr>
<td>NDB</td>
<td>12</td>
</tr>
<tr>
<td>Locator</td>
<td>04</td>
</tr>
</tbody>
</table>

### PA

- **PA runways**: 3
- **ILS CAT-II**: 3
What would be the benefits?

- EGNOS can replace ILS equipments which are costly, need maintenance and flight inspections
- New APV-1 procedures:
  - new routes between secondary and international airports
  - APV-1 could replace CAT-I when possible
- EGNOS (GNSS) will allow RNAV procedures:
  - distance and fuel savings
RNAV GNSS Approach Procedures:
- 2 Published RNAV GNSS Approach Procedures
- 1 Designed and tested RNAV GNSS Approach Procedures

WGS-84 Coordinate implementation:
- 07 International scheduled Aerodromes: 100%
- 01 Main Custom Aerodromes: 100%
- 08 Main Aerodromes: 50%
- 29 National aerodromes: 30%
GNSS EDUCATION

- **BASIC TRAINING**
  - Two short sessions every year from 2005
  - Participant: 90% Engineers

- **CONFERENCE/LECTURE** (every year)
  - Aim: the benefit of GNSS signals to the awareness of decision makers and technical from user institutions and private sector.
## ICAO GNSS AFI Strategy

<table>
<thead>
<tr>
<th>Phase I</th>
<th>2002 - 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Implementation of an AFI GNSS test bed</td>
<td></td>
</tr>
<tr>
<td>• GNSS as an augmentation to GPS from en-route to NPA operations</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase II</th>
<th>2006-2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Operation of SBAS with APV-1 capabilities</td>
<td></td>
</tr>
<tr>
<td>Had been shifted</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase III</th>
<th>2012-...</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Operation of SBAS with CAT-I capabilities</td>
<td></td>
</tr>
<tr>
<td>• Rely upon the availability of a civil satellite constellation (Galileo)</td>
<td></td>
</tr>
<tr>
<td>• CAT-I by SBAS or GBAS</td>
<td></td>
</tr>
</tbody>
</table>
# Civil Aviation Requirements for ISA

<table>
<thead>
<tr>
<th>Typical operation or facility performance</th>
<th>Accuracy 95%</th>
<th>Integrity</th>
<th>Continuity</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lateral</td>
<td>Vertical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>En Route oceanic</td>
<td>2.0 NM</td>
<td>N/A</td>
<td>10^{-7} /h</td>
<td>1.10^{-8} /h to 0.10^{-4} /h</td>
</tr>
<tr>
<td>En Route Continental</td>
<td>0.4 NM</td>
<td>N/A</td>
<td>10^{-7} /h</td>
<td>1.10^{-8} /h to 0.10^{-4} /h</td>
</tr>
<tr>
<td>En Route (terminal)</td>
<td>0.4 NM</td>
<td>N/A</td>
<td>10^{-7} /h</td>
<td>1.10^{-8} /h to 0.10^{-4} /h</td>
</tr>
<tr>
<td>Initial Approach, NPA, Departure</td>
<td>220 m</td>
<td>N/A</td>
<td>10^{-7} /h</td>
<td>1.10^{-8} /h to 0.10^{-4} /h</td>
</tr>
<tr>
<td>APV-I</td>
<td>16 m</td>
<td>20 m</td>
<td>2.10^{-7} / approach</td>
<td>1.8.10^{-6} in any 15 s</td>
</tr>
<tr>
<td>APV-II</td>
<td>16 m</td>
<td>8 m</td>
<td>2.10^{-7} / approach</td>
<td>1.8.10^{-6} in any 15 s</td>
</tr>
<tr>
<td>Category I</td>
<td>16 m</td>
<td>6 m to 4 m</td>
<td>2.10^{-7} / approach</td>
<td>1.8.10^{-6} in any 15 s</td>
</tr>
</tbody>
</table>
Test Bed Trials Objectives
(ESA – ASECNA cooperation)

- To verify the navigation performances over selected areas
- To analyze ionospheric impacts
- To evaluate APV1 procedure design
- To sensitize potential services providers and users
- To develop expertise in the view of the implementation of the AFI test bed and an operational system
Implementation Implications (1/3)

“Road Map”

Implementation of a stationary test bed dedicated to AFI region

Studies

Implementation of the operational system

Still a lot of work for the implementation
Implementation Implications (2/3)

**Test Bed Implementation**
- SBAS receivers on few A/C
- Validate SIS and performance criteria
- Better assessment of ionospheric effects
- Finalise SBAS architecture
- Special ionospheric model

**Economical Aspects**
- AFI 3% of worldwide traffic
- Airliners not inclined to invest in SBAS receiver although IATA Africa more interested than IATA Europe
- Investment in ground stations
- Cost/benefit analyses
Implementation Implications (3/3)

**Procedures**
- new flight procedure design
- new WP with coordinates in WGS84
- new rules for separation criteria
- GNSS NPA procedures
  - publication
  - design + test

**Staff Training**
- Pilots
- Civil aviation authorities
- Aeronautical professionals
- Air traffic controllers

Training provider

need to progress faster
SIS status information

• Forecast schedule for AOR-E and IOR SIS on web:
  • [http://www.esa.int/ESTB](http://www.esa.int/ESTB)
• ESTB FTP server available with rinex data
• ESTB Helpdesk available at: dstb@esa.int
  • For any questions on EGNOS and ESTB
  • For Login and password for ESTB FTP server
  • For Daily e-mail from ESTB MCC
Conclusion

EGNOS Implementation → still some more work

Future...

combined use Galileo+EGNOS

Other benefits from EGNOS for Africa...
Thank you!