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

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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
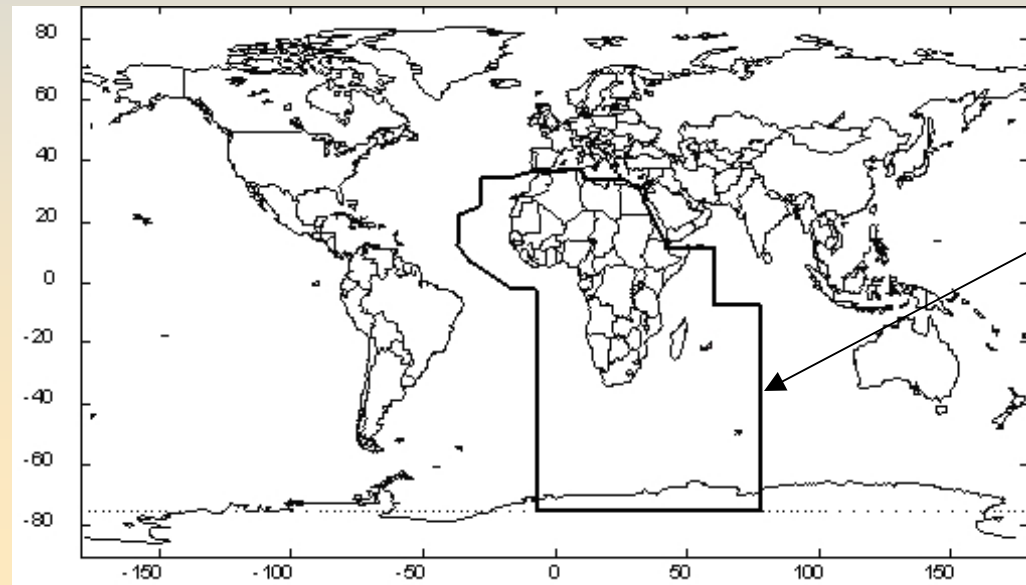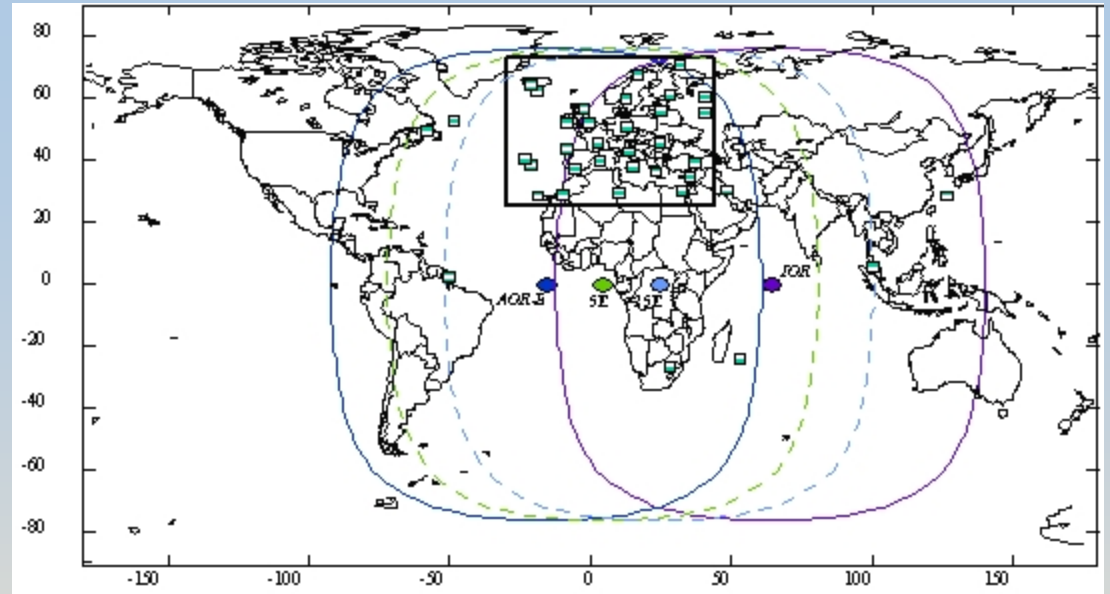
EGNOS: EUROPEAN SBAS

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.

AFI Region
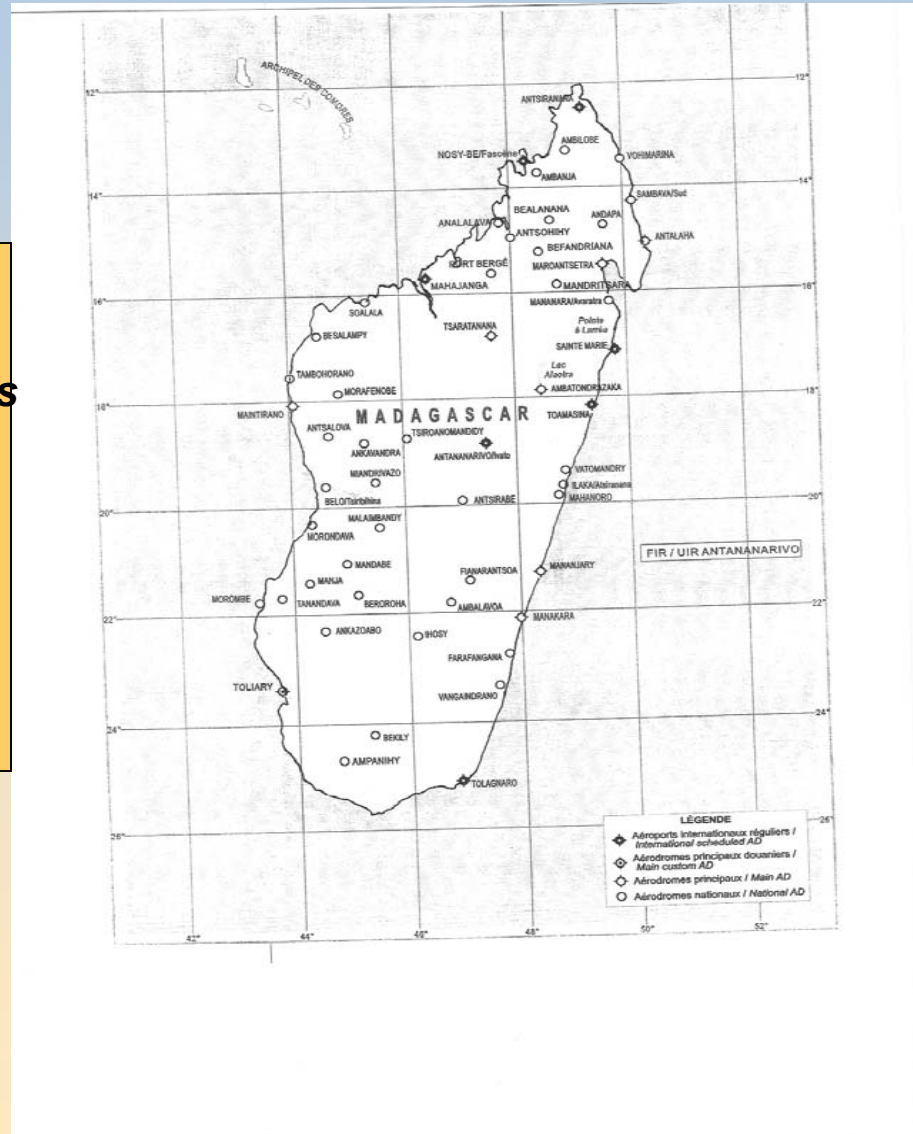
CASE OF MADAGASCAR

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AREA: 587.000km^2

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	
approach, landing, en-route	
VOR	06
DME	04
NDB	12
Locator	04

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**

States ATS

IATA Airliners ATS

IATA Airliners ATS

GNSS IMPLEMENTATION

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

Phase I **2002 - 2005**	**Phase II** **2006-2012**	**Phase III** **2012-...**

• Implementation of an AFI GNSS test bed

• GNSS as an augmentation to GPS from en-route to NPA operations

→ (arrow) **Had been shifted**

• Operation of SBAS with APV-1 capabilities

• Operation of SBAS with CAT-I capabilities

• Rely upon the availability of a civil satellite constellation (Galileo)

• CAT-I by SBAS or GBAS

Civil Aviation Requirements for ISA

Typical operation or facility performance	Accuracy 95%		Integrity				Continuity	Availability
	Lateral	Vertical	Integrity risk	Time To Alert	Horizontal Alert Limit	Vertical Alert Limit		
En Route **oceanic**	2.0 NM	N/A	10^{-7} /h	5 min	4 NM	N/A	$1-10^{-8}$ /h to **10^{-6}** 10^{-4} /h	0.99 to 0.99999 **0.999**
En Route **Continental**	0.4 NM	N/A	10^{-7} /h	15 s	2 NM	N/A	$1-10^{-8}$ /h to **10^{-6}** 10^{-4} /h	0.999 to 0.99999 **0.9999**
En Route (terminal)	0.4 NM	N/A	10^{-7} /h	15 s	1 NM	N/A	$1-10^{-8}$ /h to **10^{-6}** 10^{-4} /h	0.999 to 0.99999 **0.9999**
Initial Approach, NPA, Departure	220 m	N/A	10^{-7} /h	10 s	0.3 NM	N/A	$1-10^{-8}$ /h to **10^{-5}** 10^{-4} /h	0.99 to 0.99999 **0.9999**
APV-I	16 m	20 m	2.10^{-7} / approach	10 s	40 m	50 m	$1-8.10^{-6}$ in any 15 s	0.99 to 0.99999 **0.9999**
APV-II	16 m	8 m	2.10^{-7} / approach	6 s	40 m	20 m	$1-8.10^{-6}$ in any 15 s	0.99 to 0.99999 **0.99999**
Category I	16 m	6 m to 4 m	2.10^{-7} / approach	6 s	40 m	15 m to 10 m	$1-8.10^{6}$ in any 15 s	0.99 to 0.99999 **0.99999**

Test Bed Trials Objectves
(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 incline 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

need to progress faster

Staff Training

- Pilots

- Civil aviation authorities

- Aeronautical professionals

- Air traffic controllers

training provider

SIS status information

- Forecast schedule for AOR-E and IOR SIS on web:
  - 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!