



*International Civil Aviation Organization  
Eastern and Southern African Office*

**Joint Meeting of the APIRG Performance Based Navigation and  
Global Navigation Satellite System Implementation Task Forces (Joint  
PBN & GNSS/I TFs)**

**First Meeting**  
*(Nairobi, 8 - 10 September 2009)*

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**Agenda Item 8: AFI GNSS Strategy**

**The potential role of SBAS in AFI**

(Submitted by the European Space Agency)

**SUMMARY**

This Working Paper gives a summary of the potential role that SBAS can play in AFI to achieve PBN requirements. This is principally based on study results from the USA.

**1. OVERVIEW**

- 1.1. The FAA have 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.
- 1.2. SBAS-capable onboard avionics is steadily becoming more widespread and is becoming the de facto standard in some large aircraft like the A350.
- 1.3. GPS-RAIM and GPS-RAIM-INS are not robust to GPS satellite failures. WAAS (SBAS) has been shown to improve the GPS availability to 100% for use in RNP 0.1 procedures.
- 1.4. FAA studies have shown that SBAS is needed to ensure robustness against GPS satellite failures even for NPA.

**2. HIGHLIGHTS**

- 2.1. Due to EGNOS operations, SBAS NPA coverage already extends far into the AFI region.
- 2.2. Upon modification of MSG 27, SBAS-capable aircraft can already exploit this performance.

- 2.3. Initial US studies (Stanford University) indicated that RNP 0.3 coverage of AFI may be completed without additional EGNOS infrastructure.
- 2.4. ESA have launched studies to assess whether implementing MT28 is sufficient for such coverage or if additional EGNOS RIMS need to be deployed in Southern Africa.
- 2.5. SBAS can enable LPV operations in the many aircraft that do not yet have barometric vertical guidance (Baro-VNAV).
- 2.6. US studies (Stanford University) indicated that LPV coverage over northern and central AFI can be obtained by dual frequency L1-L5 users by implementing MT28. A small number of additional EGNOS RIMS in southern Africa are needed to complete the coverage.
- 2.7. Upon implementation of MT 28 in EGNOS and additional RIMS in southern Africa, dual frequency SBAS-capable aircraft can exploit LPV-200 performance over AFI.

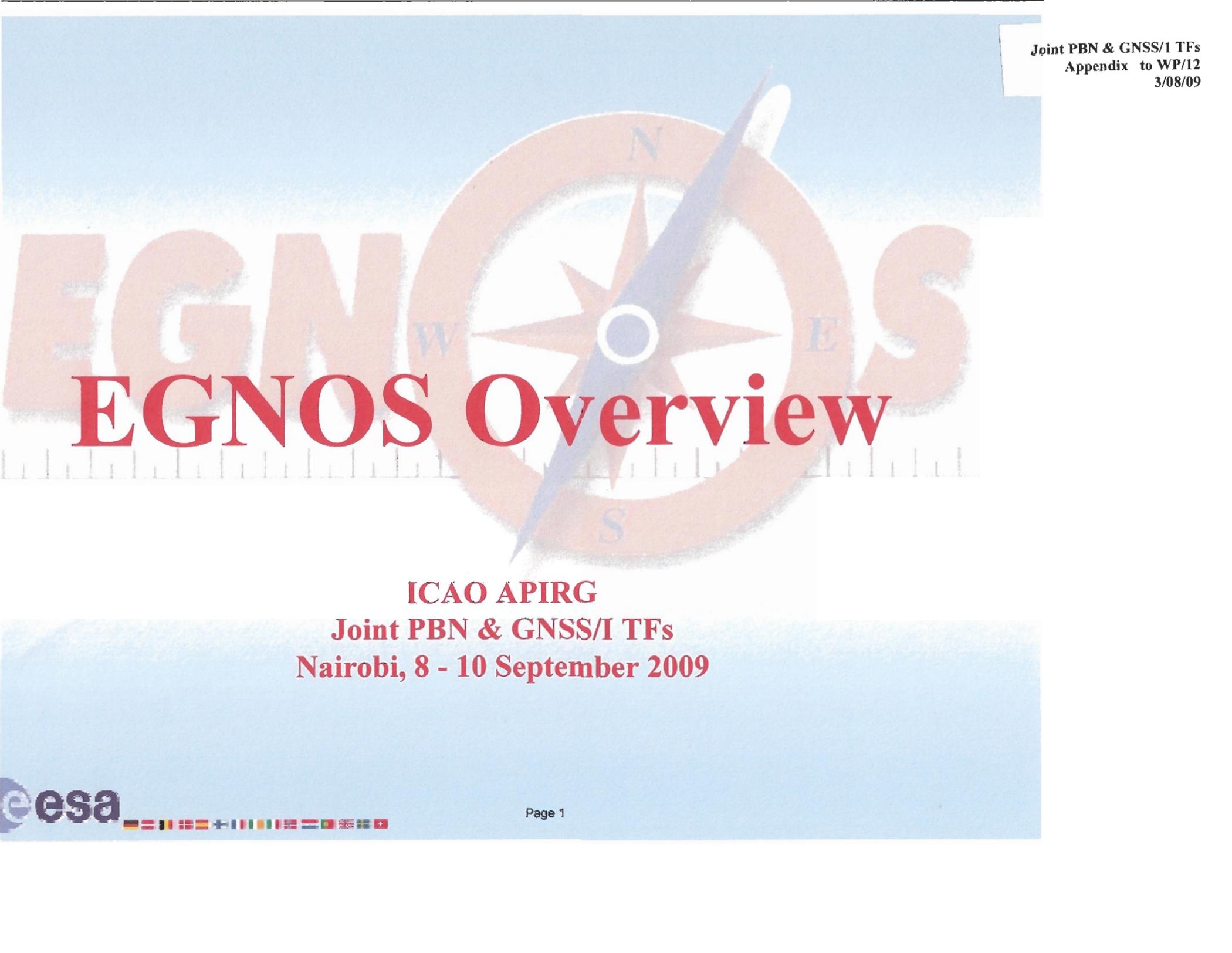
### **3. GNSS STRATEGY FOR AFI**

- 3.1. SBAS is the only GNSS technique that fully meets the relevant ICAO availability requirements for RNP 0.3 and RNP 0.1.
- 3.2. SBAS RNP 0.3 and RNP 0.1 functional capability should already be considered in Phase 1 of the AFI GNSS Strategy and PBN implementation plan.
- 3.3. SBAS LPV-200 functional capability should be considered for approach and landing operations in Phase II of the AFI GNSS Strategy and PBN implementation plan.

### **2. ACTIONS FOR THE TASK FORCE**

- 3.1. The task force is invited to:
  - a) View the accompanying presentations for further detail on the information presented in this WP. See
    - [sbas role 1di3.PDF](#)
    - [sbas role 2di3.PDF](#)
    - [sbas role 3di3.PDF](#)
  - b) Incorporate recommendations 3.2 and 3.3 in the AFI GNSS Strategy and PBN implementation plan.

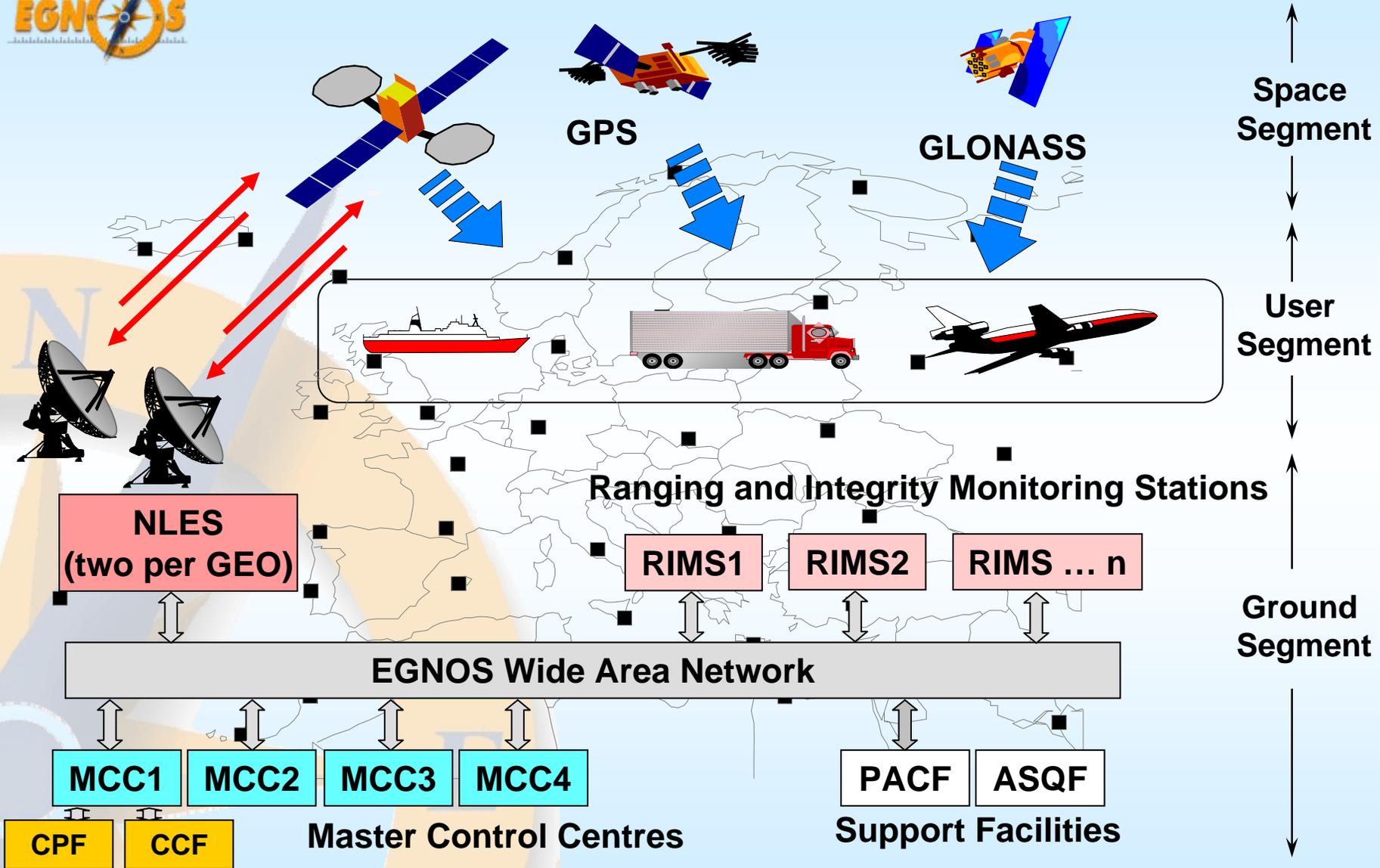
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The background features a large, semi-transparent orange compass rose with a blue needle pointing towards the top-right. The letters 'N', 'S', 'E', and 'W' are visible on the compass rose. Behind the compass rose, the word 'EGNOS' is written in large, semi-transparent orange letters. Overlaid on this is the main title 'EGNOS Overview' in a bold, red, serif font. Below the title, there is a horizontal white ruler with black markings.

# EGNOS Overview

**ICAO APIRG**  
**Joint PBN & GNSS/I TFs**  
**Nairobi, 8 - 10 September 2009**

# EGNOS System Architecture overview



# EGNOS Subsystems Deployment



- RIMS
- MCCs
- △ NLES
- PACF
- ASQF





# Signal Availability Improvement

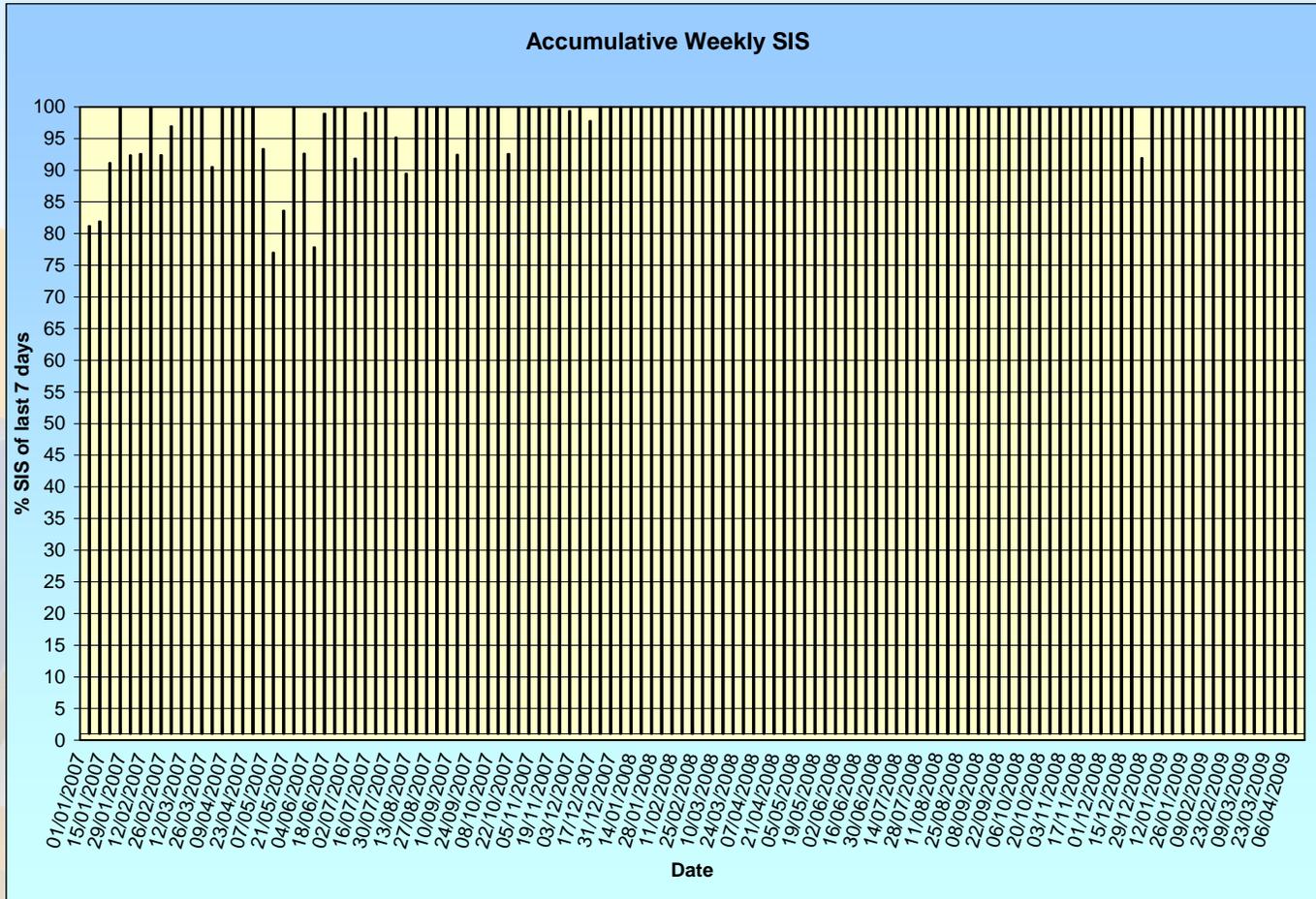
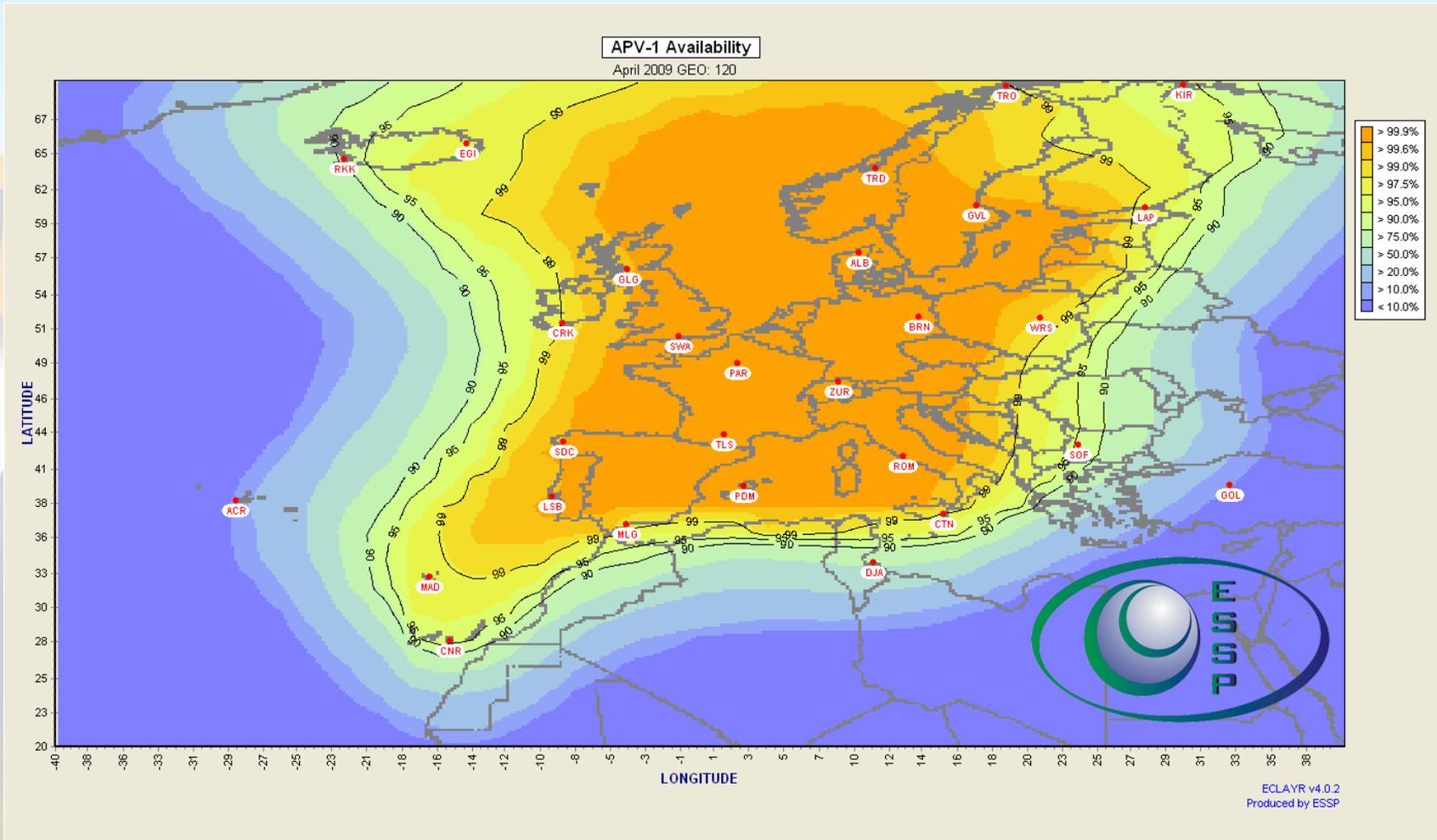


Fig. 1 EGNOS-OP Signal Availability improvements between January 2007 and March 2009

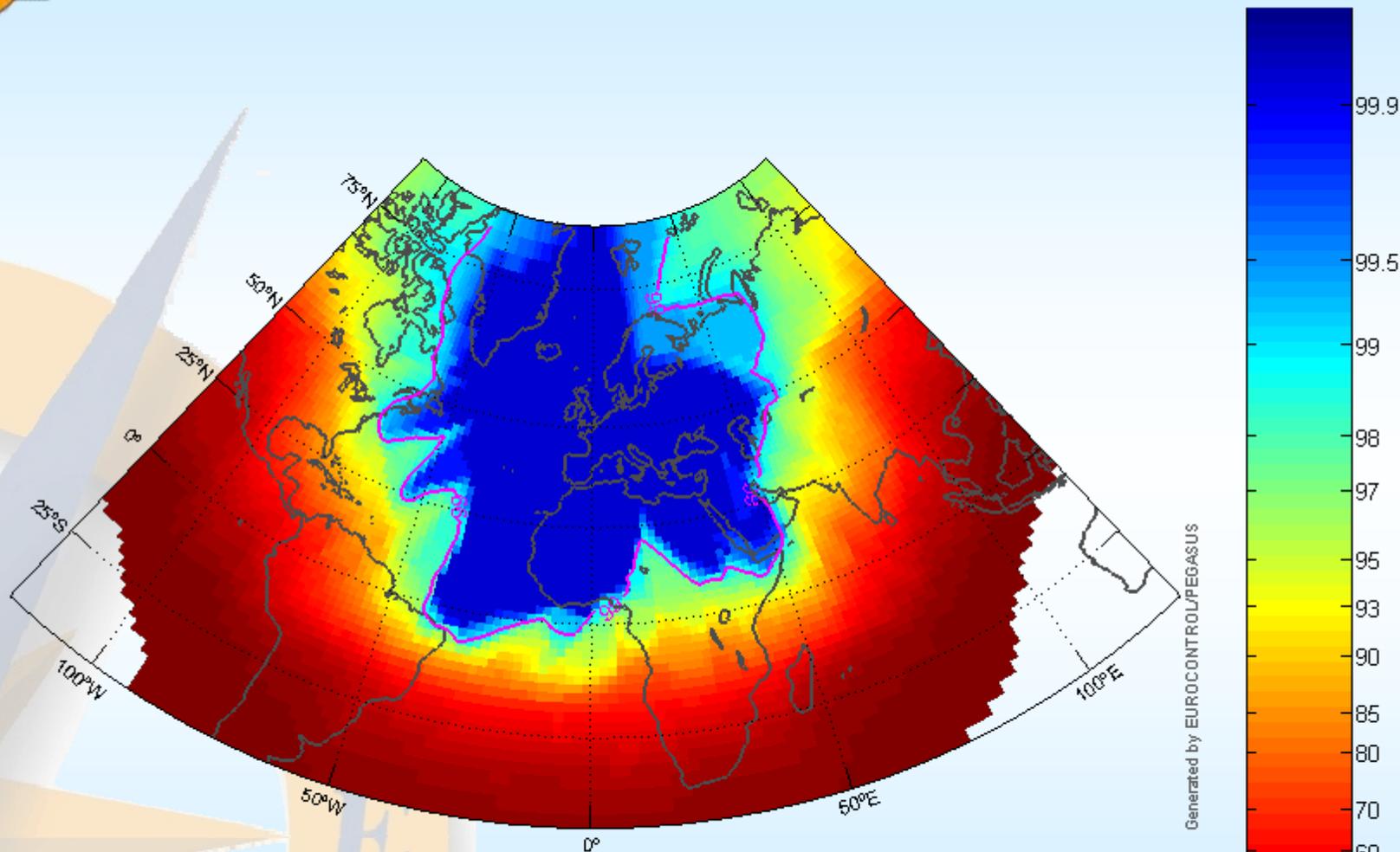


# EGNOS performance status in April 2009 (as measured by Operator)





# NPA Coverage with 29 GPS \*



08-Apr-2009 00:00 - 08-Apr-2009 23:59, step: 60s

**\* Upon planned MSG27 modification**



# New RIMS to be deployed

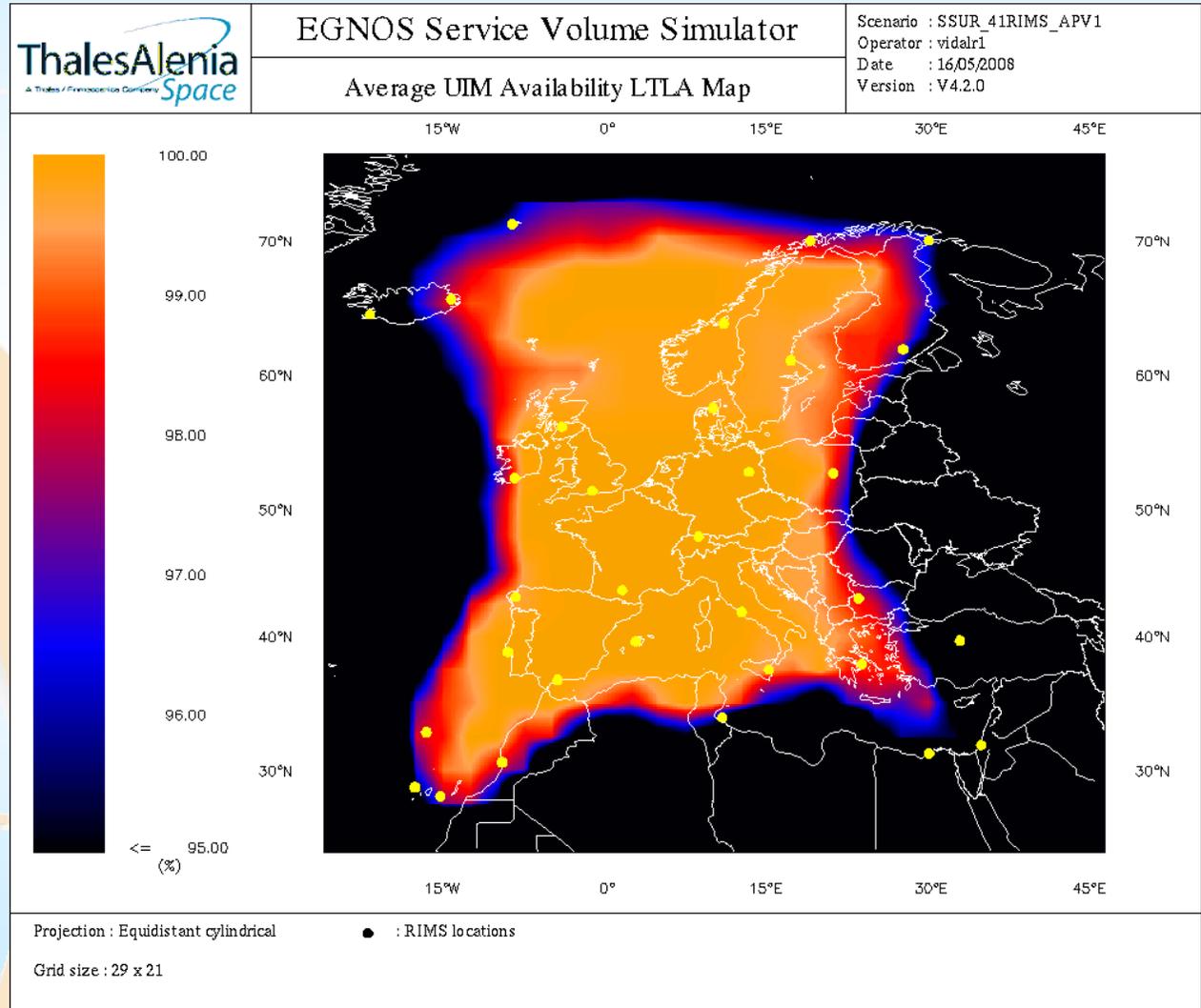




# EGNOS LPV performance status

## 41 Stations Prediction (Industrial Commitment)

- Target: End 2009  
– Q1 2010
- 41 RIMS ops
- Average as predicted



# SBAS Avionics Status

- **Garmin:**
  - 43,000+ WAAS LPV receivers sold
  - Currently sole GA panel mount WAAS Avionics supplier
- **AVIDYNE & Bendix-King:**
  - SmartDeck glass panel and KSN-770 projected to market summer 2009
- **Universal Avionics:**
  - Full line of UNS-1 Flight Management Systems (FMS) achieved avionics approval Technical Standards Orders Authorization (TSOA) in 2007/2008
  - 700+ units sold (est. 500+ aircraft configured)
- **Rockwell Collins:**
  - Multiple recent (fall '08) WAAS Sensor/Rcvr & FMS avionics Technical Standards Orders Authorization (TSOA)
- **CMC Electronics:**
  - Achieved Technical Standards Orders Authorization (TSOA) certification on both their 5024 & 3024 WAAS Sensors
- **Honeywell:**
  - Multiple FMSs to achieve WAAS acft cert. in 2009
- **NextNav:**
  - TSO-145c/DO-229D approved WAAS (mini) Beta1 and (Max) Beta 1,2,3 sensors



# Aircraft Supplemental Type Certificates (STC): Completed & In-Work



## Completed:

- Bombardier: Challenger CL-600/601, CL-604, CRJ-200
- Cessna Citation Jet: CJ-1+, CJ-2+, CJ-3
- Beechcraft: King Air-300 (FAA Fit Inspection aircraft)
- LEAR : 40, 40XR, 45, 45XR, 60
- Boeing: B-737-200



## In-Work:

- Agusta: A-109
- ATR-42
- Beech: Be-200, Be-300, Premier-1, King Air-200/300
- Boeing: B-727, B-737
- BELL 412
- Cessna Citation: II, 550, 560/XL/XLS, 650, VII, Bravo, Encore
- C-9
- Northrop Grumman T-38
- Gulfstream G-II, G-III, G-IV, G-150, G-200
- DeHaviland: Dash-8
- Falcon: 10, 20, 50, 2000
- Hawker: 125-700B
- King Air: 300, 350, RC-12
- LEAR: 31A, 35A, C-21A
- Lockheed Martin: C130J
- McDonnell-Douglas: MD-87
- PC-12
- Bombardier: Global 5000/Express, Q-Series, Q-400, CL-300, CL-605
- Sikorsky: S76, S76-B, S-76C++
- Bombardier: CRJ-700/900
- Hawker: 400XP, 800XP
- Dassault Falcon: 50EX, 2000EX
- Piaggio: P-180
- Airbus: A-350, A400

IWG 18 Meeting  
June 17, 2009



Federal Aviation  
Administration

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# Satellite Landing System

Allows to fly RNAV (GNSS) approaches with vertical guidance down to 200ft without any xLS ground station

## First step: A350XWB EIS

- ▶ Targeted procedures: RNAV GNSS with LPV minima (down to 200')
- ▶ Technical enabler: GPS+SBAS
- ▶ Coverage: multi regional
- ▶ Cockpit integration (HMI, NDB, ..)

## Future steps:

- ▶ Technical enablers: all new GNSS means capable of LPV200'
- ▶ Coverage: worldwide



**A350XWB EIS**



# EGNOS Certification

## •Certification requirements baseline - Single European Sky Regulatory package

- Interoperability Regulation (EC No 552/2004)
- Service Provision Regulation (EC No 550/2004) – Provision of air navigation services in the Single European Sky
- Commission Regulation (EC No 2096/2005) – ANSP certification process
- Safety Oversight Regulation (EC No1315/2007)

# Status of EGNOS Certification

- **Design Safety Case (part A)**

- Based on technical inputs from European Space Agency (design agent for EGNOS) and industrial documentation

- Last version (v4.2) issued in May 09

- **Operations Safety Case (part B)**

- produced and maintained by EGNOS Operator (ESSP)

- Last version (v3.0) issued in March 09

- **Application Safety Case for En-route through NPA operations**

- Argument to be developed by ESSP

- Target Level of Safety is met

- Safety is at least equivalent to already approved GPS-based operations

- **Application Safety Case for LPV operations**

- Argument to be developed by local Air Navigation Service Provider





# Schedule

- Establishment of Quality, Safety and Security management systems by ESSP:  
MID 2009
- NSA Auditing:  
END 2009-EARLY 2010
- NSA reviewing safety case:  
MID to END 2009
- ESSP Certification:  
MARCH-APRIL 2010
- ESSP Declaration of Verification and Technical File:  
MAY 2010
- EGNOS Safety of Life entry into service:  
MID 2010
- Publications of Procedures by National ANSP:  
from MID 2010



# EUROCONTROL projects

## - Work Description -

- Identification of airport(s) where the EGNOS APV procedures can provide benefits
- Identification of aircraft operator(s)
- Design SBAS APV procedures
- Implementation Safety Case
- Equipping aircraft with SBAS avionics
- Airworthiness certification and operational approval
- Flight demonstration of the procedures
- Business case for the airport(s) and the operator(s)
- Awareness and dissemination of results

# EUROCONTROL projects

## - UK -

- **Partners :**
  - NATS
  - Aurigny Airlines
  - Anglo Normandy Engineering
  - Pildo

With the support of:

- States of Guernsey
  - UK CAA
- **Nb Aircraft:** 1  
Britten Norman Trislander
- **Airport/Procedures:**
    - Southampton
    - Alderney
- **Receiver:** Garmin 430



# EUROCONTROL projects

## - France -

- **Partners :**
  - EGIS AVIA
  - DSNA
  - Airbus Transport Industry (ATI)
  - Pildo
- **Aircraft:** 1 (+4)  
Beluga – Airbus A 300-600ST
- **Airports/Procedures:**
  - (Clermont-Ferrand)
  - Pau
- **Receiver:** CMC Electronics  
both FMS and sensor.



# Eurocontrol Projects Poland

- **Partners :**
  - Pildo
  - PANSA
  - Royal Star-Aero
  - ANS Czech
  - Helios
  - ADV Systems
- **Aircraft:**
  - Piper PA-34 Seneca II
- **Airport/Procedures:**
  - Mielec
  - Katowice
- **Receiver:**     Garmin 430



# GSA projects

## HEDGE

- **Partners :**

|         |                   |
|---------|-------------------|
| Helios  | TAF Helicopters   |
| REGA    | Royal Star        |
| PANSA   | Capital High Tech |
| Helileo | Aeroclub de       |
| Pildo   | Sabadell          |

## HElicopters Deploy GNSS in Europe



- **High Level Objectives**

- To develop the helicopter SOAP (SBAS Offshore Approach Procedure) procedure (and necessary avionics) and then to successfully demonstrate it to the user community
- To develop helicopter PINS (Point in Space) procedures for mountain rescue and HEMS (Helicopter Emergency Medical Services), and to then successfully demonstrate them to the user community
- To develop and demonstrate an integrated navigation/surveillance concept

# National PBN Strategies

## France (1)



direction générale  
de l'Aviation civile

direction des services de  
la Navigation aérienne

DSNA

### RNAV approaches with vertical guidance strategy

- Any new published RNAV(GNSS) approach shall also support SBAS vertical guidance (APV SBAS - LPV).
  - ESARR4 APV SBAS safety studies completed by DSNA
  - DSNA is now awaiting EGNOS certification for LPV publication
- APV Baro-VNAV will also be implemented on RNAV approach charts when operational needs are identified with airspace users.
  - ESARR 4 generic safety studies expected from Eurocontrol (end 2009)
- Increase the RNAV procedures production capacity to follow the resolutions of the ICAO 36th Assembly (2007):
  - All IFR runway ends support an APV (SBAS and/or BaroVNAV) in 2016
  - DSNA is now hiring new procedure designer staff and aims to publish 25 to 30 new procedures per year until 2016.

# National PBN Strategies

## France (2)



direction générale de l'Aviation civile

direction des services de la Navigation aérienne

DSNA

### LNAV & LPV approaches deployment status 2009

#### ANNEX 1

Initial planning for RNAV approaches development (LNAV + LPV)

