



# SBAS/EGNOS Programme



PBN TF/4 Meeting  
ICAO EUR NAT  
Paris, 30 November-1 December 2010



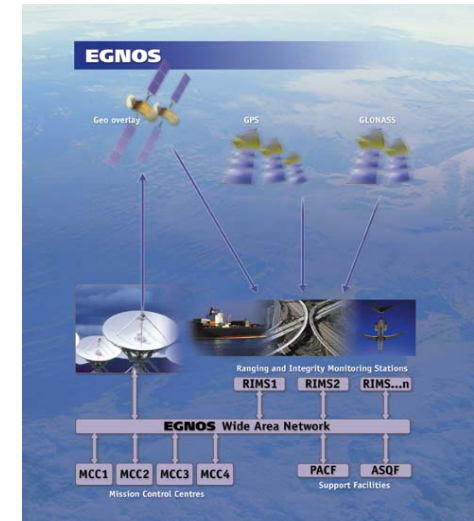
Navigation solutions powered by Europe

# The European GNSS Strategy

## Step 1: EGNOS to provide civil augmentation to GPS and GLONASS

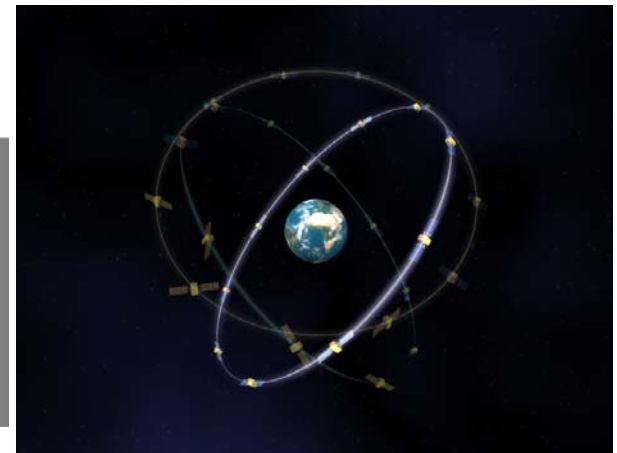
- Interoperable with WAAS-US/ MSAS-Japan
- Operational Validation from 2004
- Open Service declared by EC in Oct 2009
- Certified in July 2010

*EGNOS is a joint initiative of European Commission, Eurocontrol and ESA*



## Step 2: Galileo to achieve:

- European GNSS independence
- Complementarity to GPS
- Global System under civil control



*GALILEO is a joint initiative of European Commission and ESA*

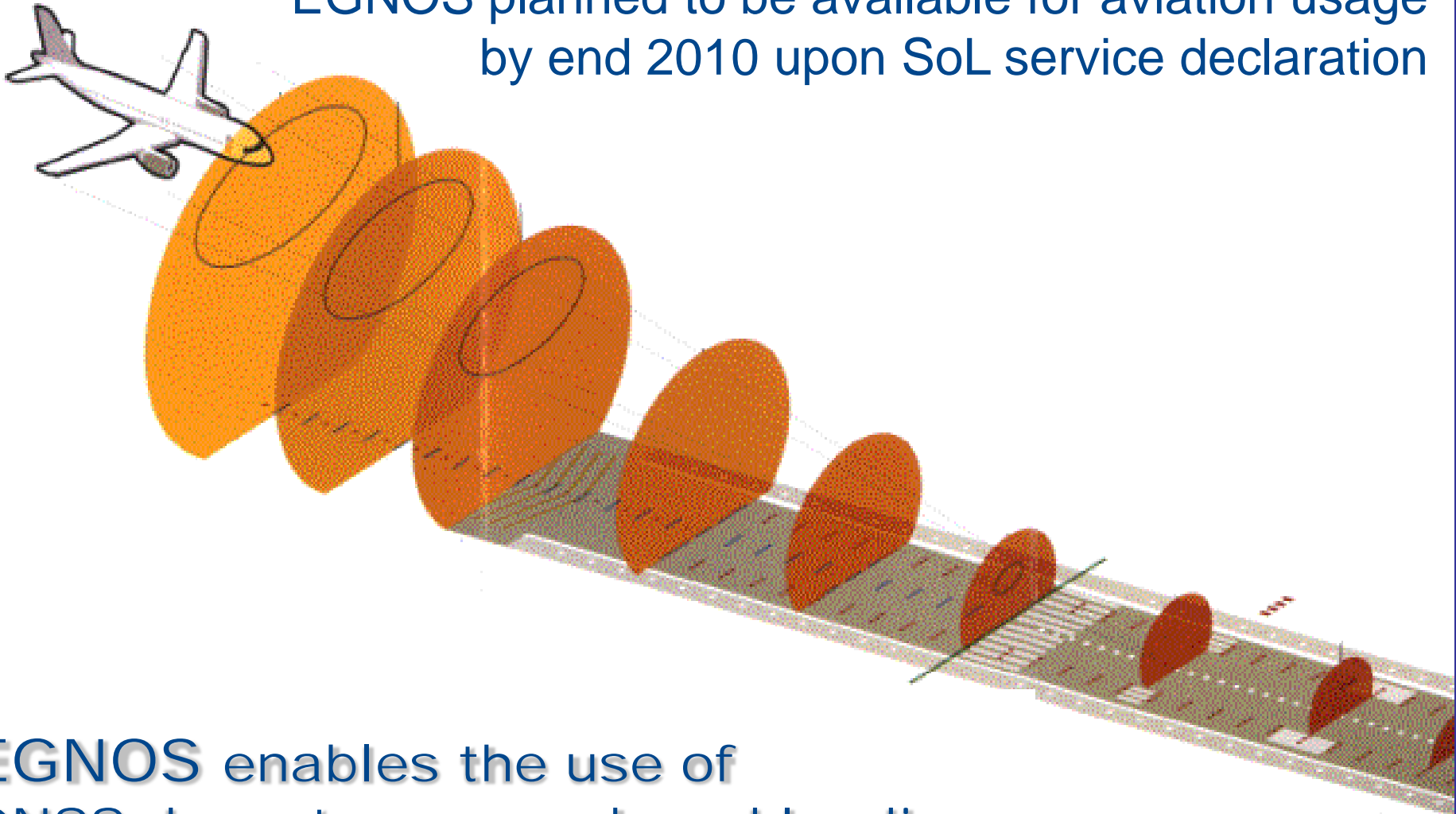


# European GNSS Programme Essentials

- ★ EGNOS is the first pan-European public venture contributing to GNSS, meeting the most challenging safety requirements
- ★ Galileo is one of the largest and most complex systems being realized by European industries
- ★ EGNOS and Galileo, Europe's contribution to the future GNSS, although founded on state-of-the-art technology, are service-oriented navigation systems

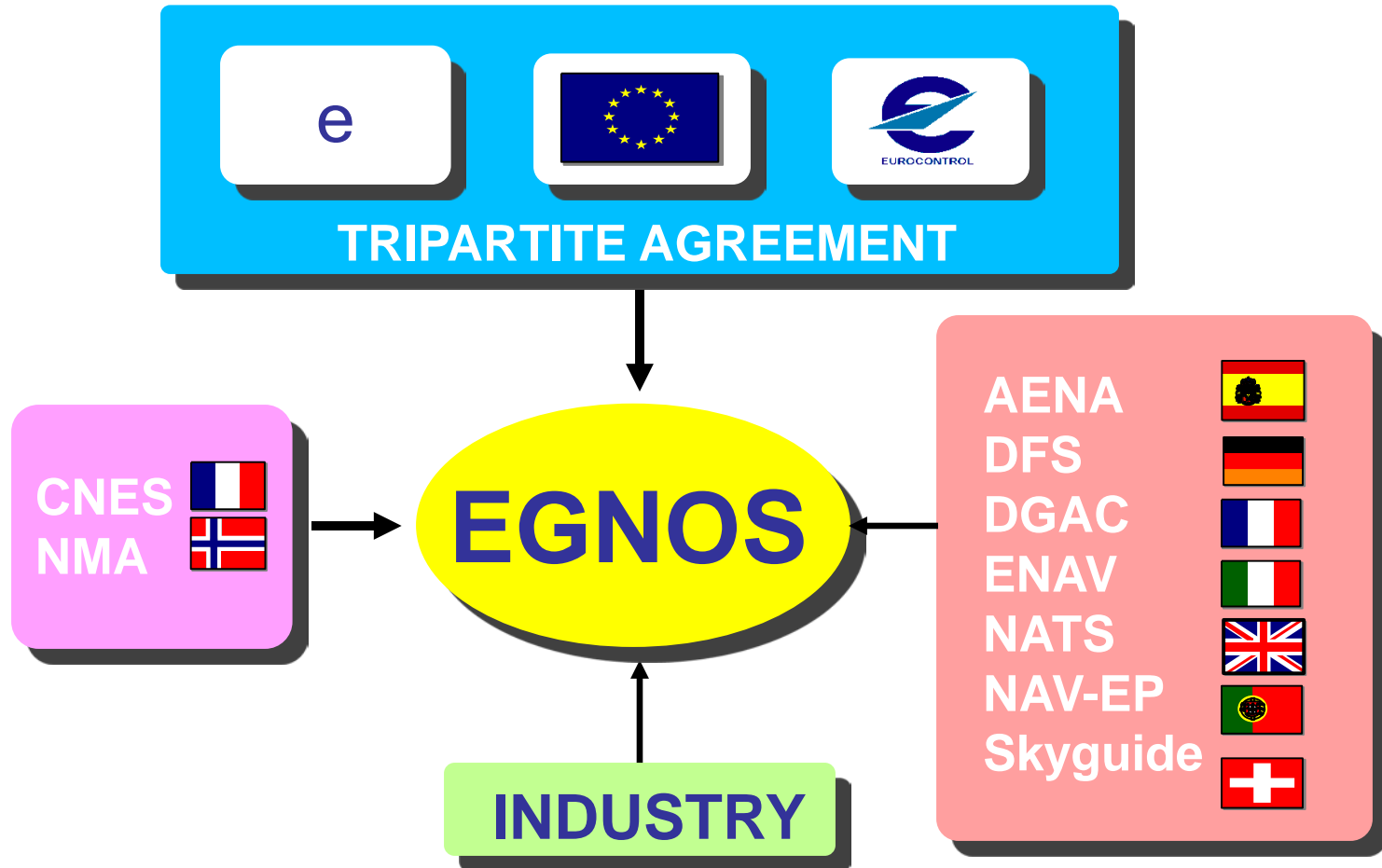
# EGNOS for Aviation

EGNOS planned to be available for aviation usage by end 2010 upon SoL service declaration



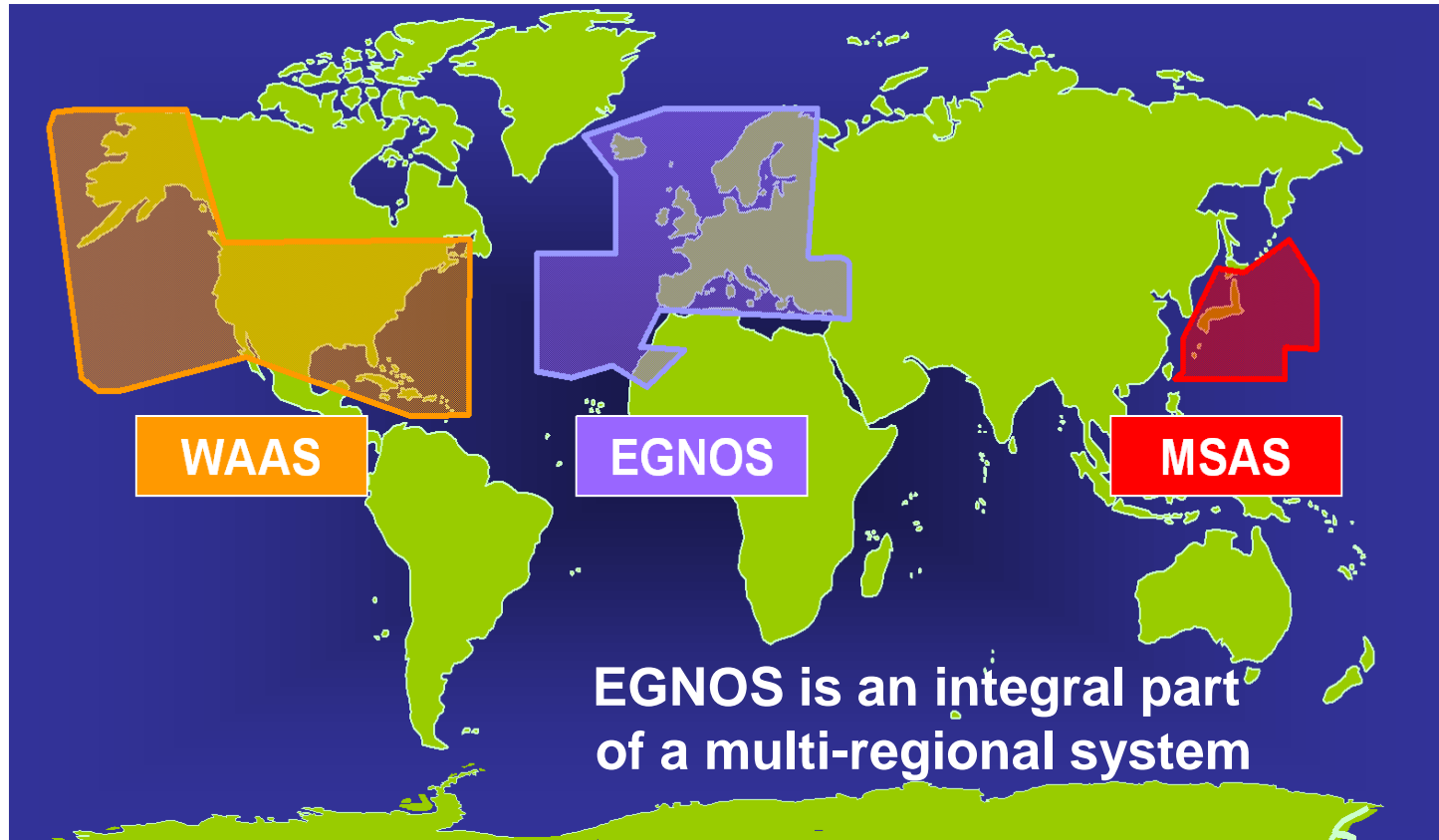
EGNOS enables the use of GNSS down to approach and landing

# Development Phase Organisation

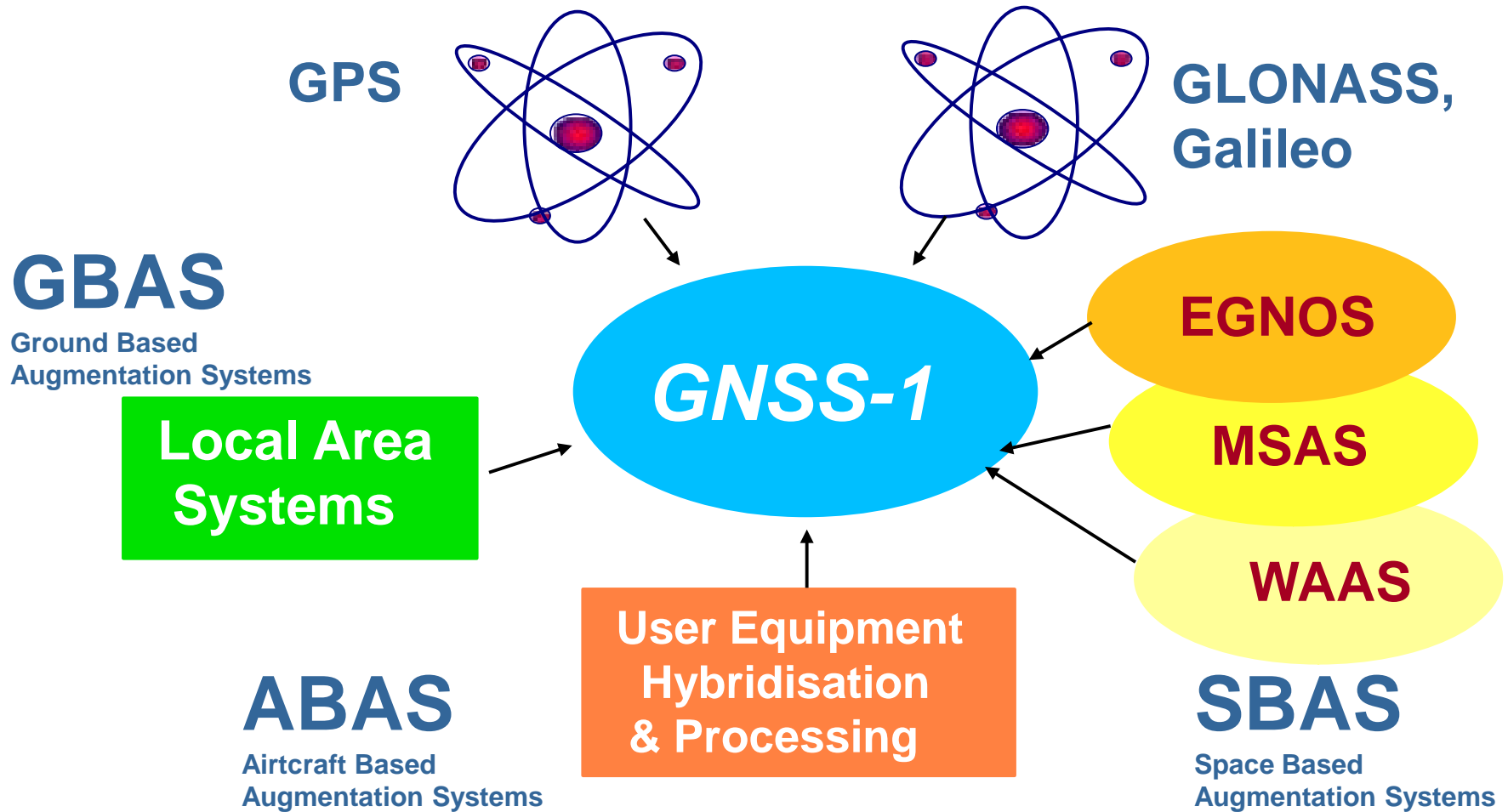


# Interoperability Standards

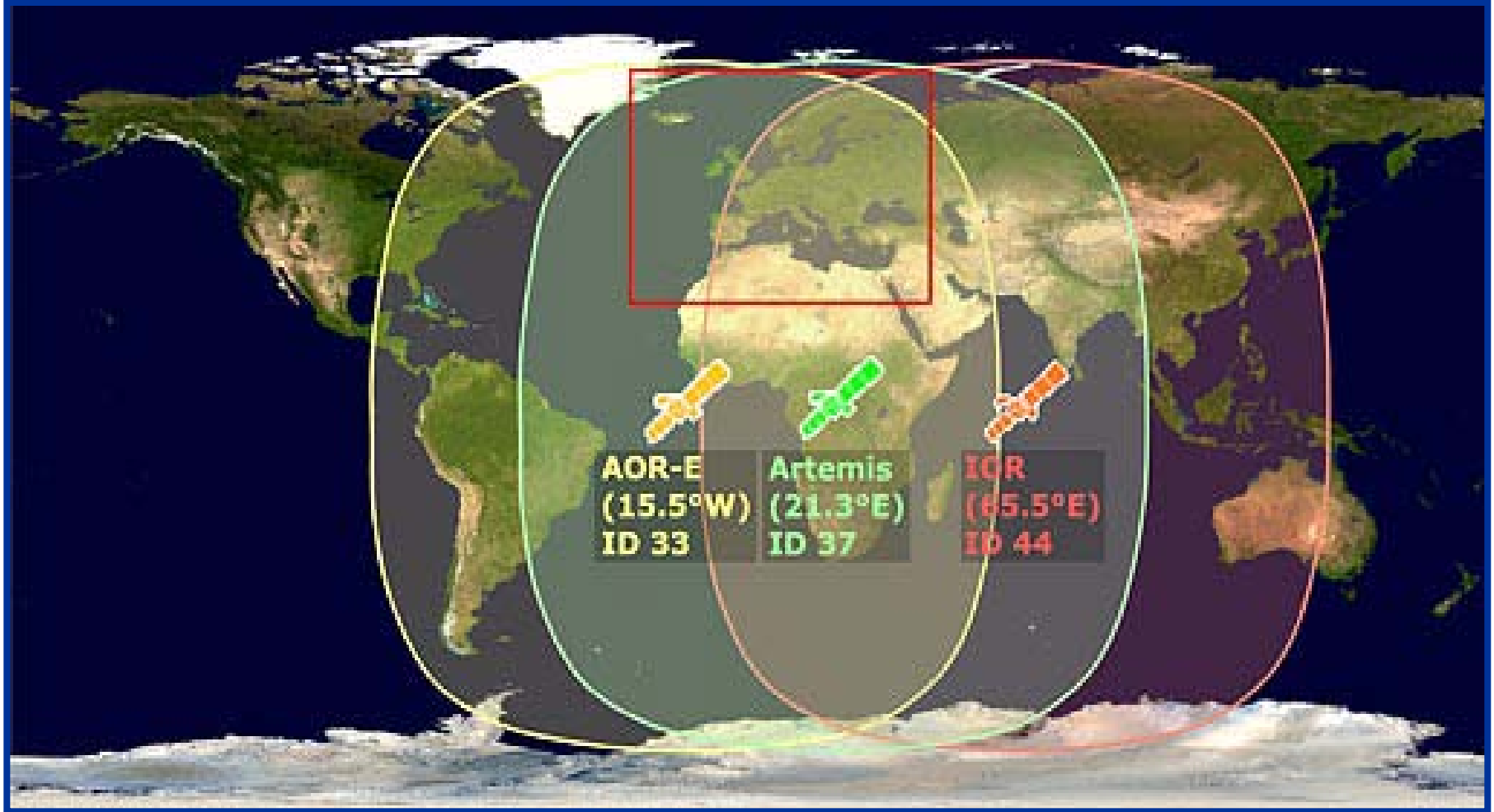
(ICAO SARP's and Interoperability Working Group)



# EGNOS: the European SBAS

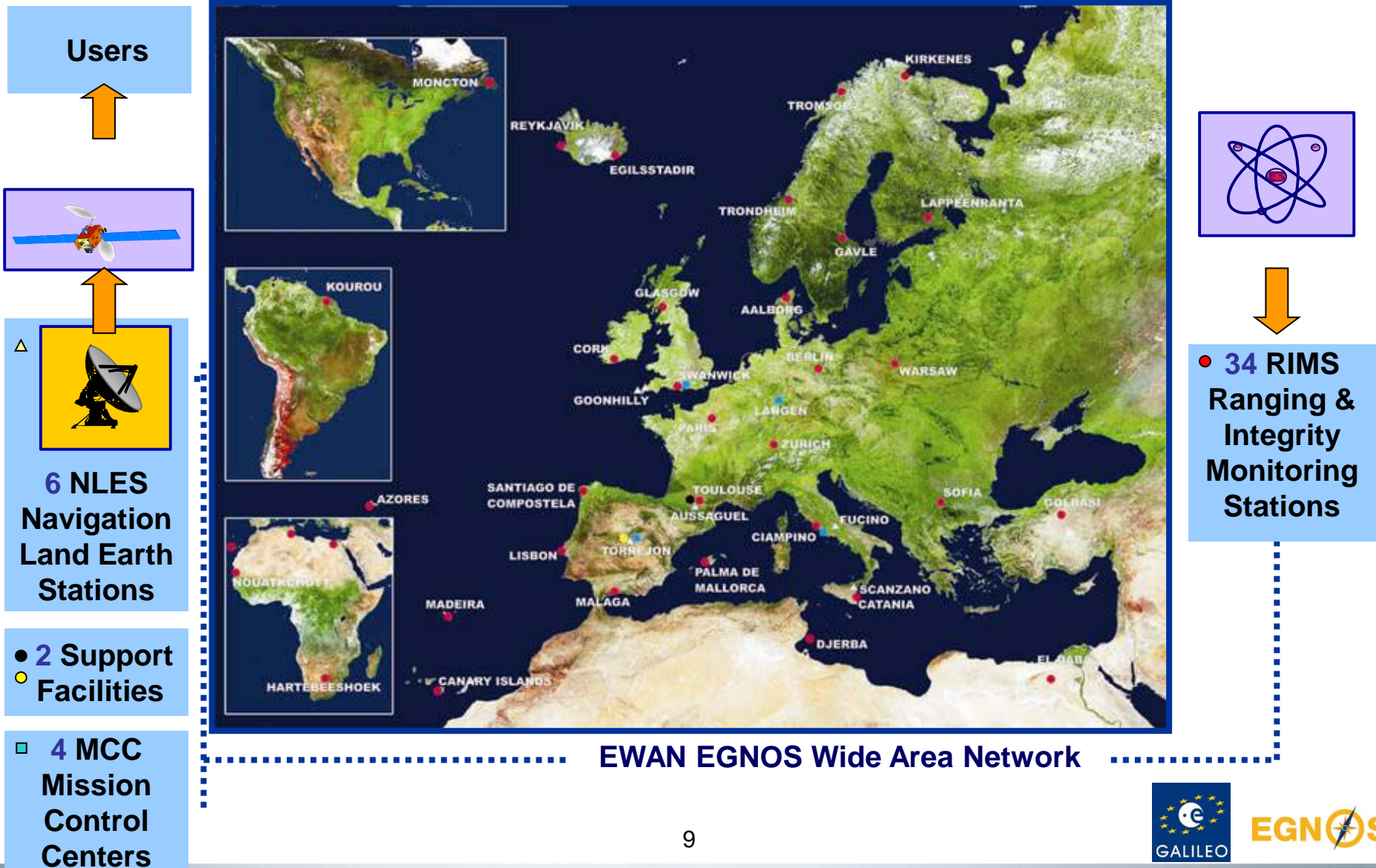


# EGNOS : Space Segment

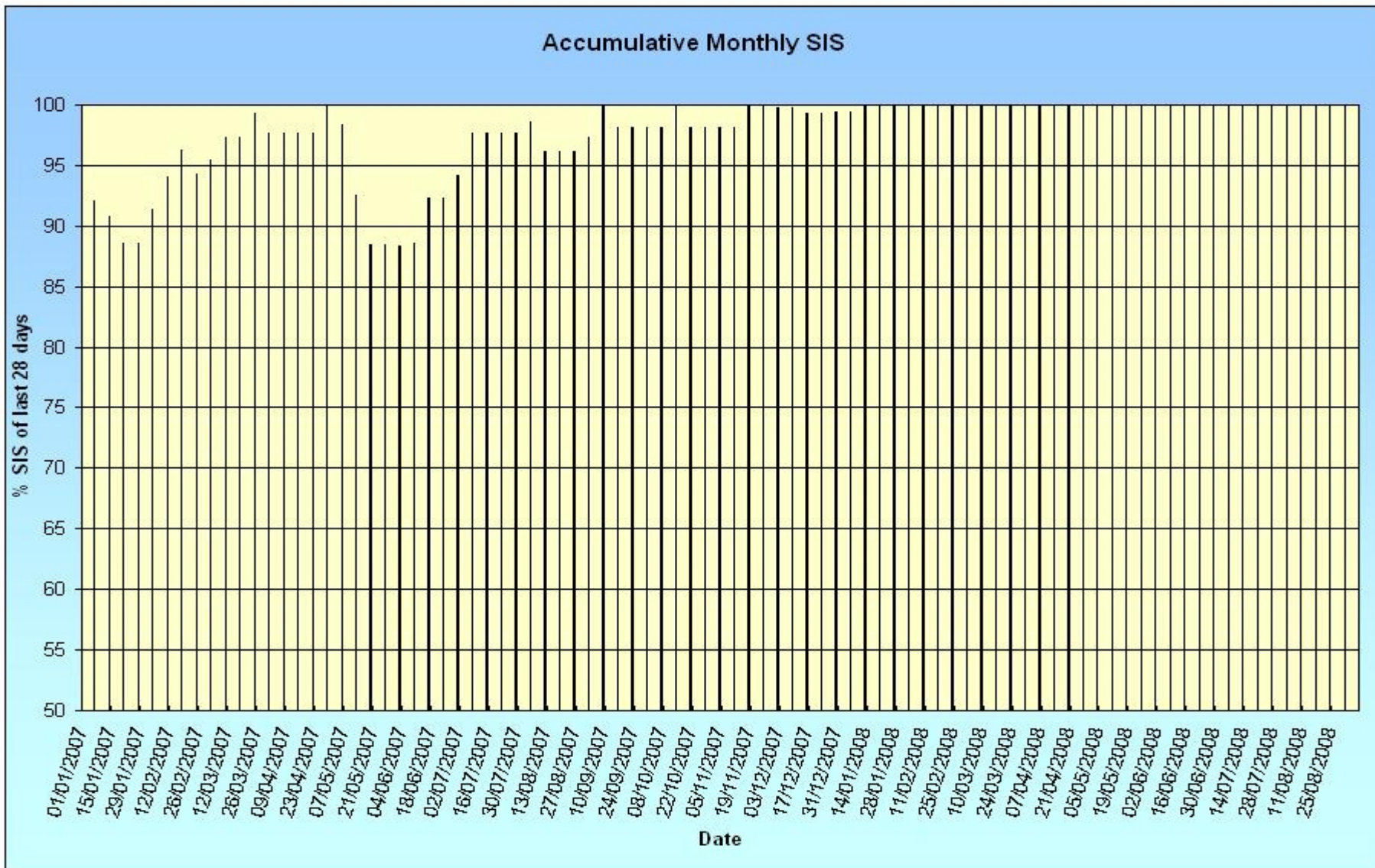




# EGNOS : Ground Segment

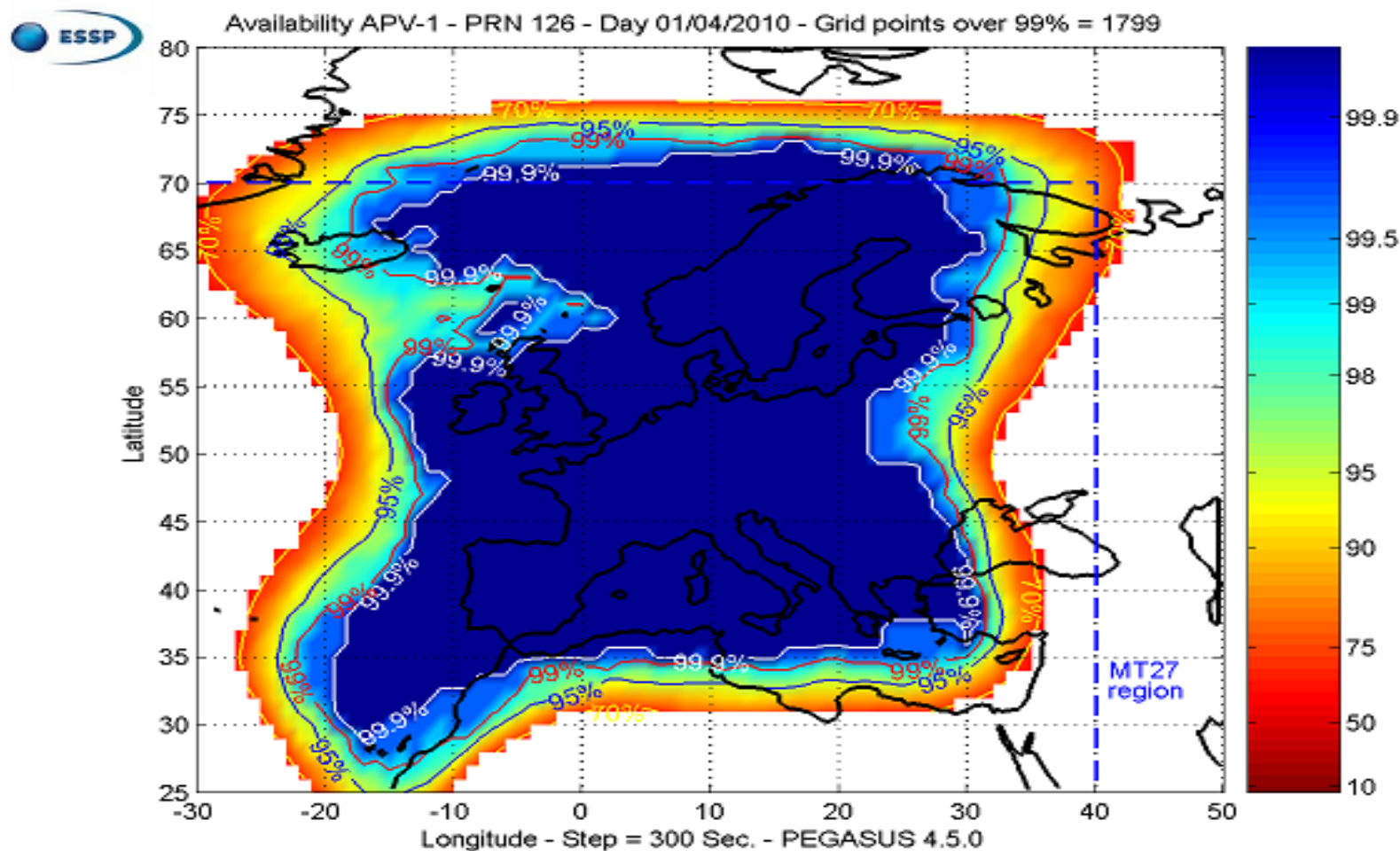


# EGNOS Performance 01/2007-08/2008



# EGNOS Coverage Status

Release V2.3.1 (Qualified in June 2010)



## 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 No 1315/2007)

# GNSS Technologies vs Aviation Needs

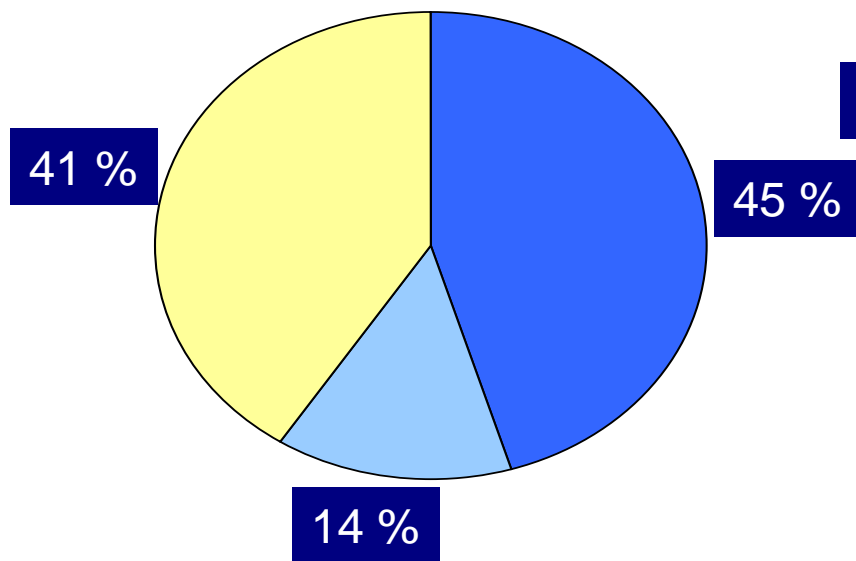
	RNP (≥99.0% Availability)		Positioning Technology	
	Accuracy (95%)	Alert limit (10 <sup>-7</sup> )	GNSS system Augmentation	
En Route	10 nm	20 nm	ABAS: GPS+ RAIM	GNSS system Augmentation
	4 nm	8 nm		
	2 nm	4 nm		
Terminal	1 nm	2 nm	ABAS: GPS + RAIM+ Baro +INS	GNSS system Augmentation
LNAV	0.3 nm	0.6 nm		
RNP	0.1 nm	0.2 nm	SBAS(EGNOS)	GNSS system Augmentation
APV LNAV/VNAV	0.3nm/20m	0.6nm/50m		
APV I (LPV)	16m/20m	40m/50m	GBAS	GNSS system Augmentation
LPV-200	16m/4m	40m/35m		
GLS Cat-I	16m/4m	40m/10m	GBAS	GNSS system Augmentation
GLS Cat-III	16m/2m	40m/10m		

# EGNOS : 2010 programme status

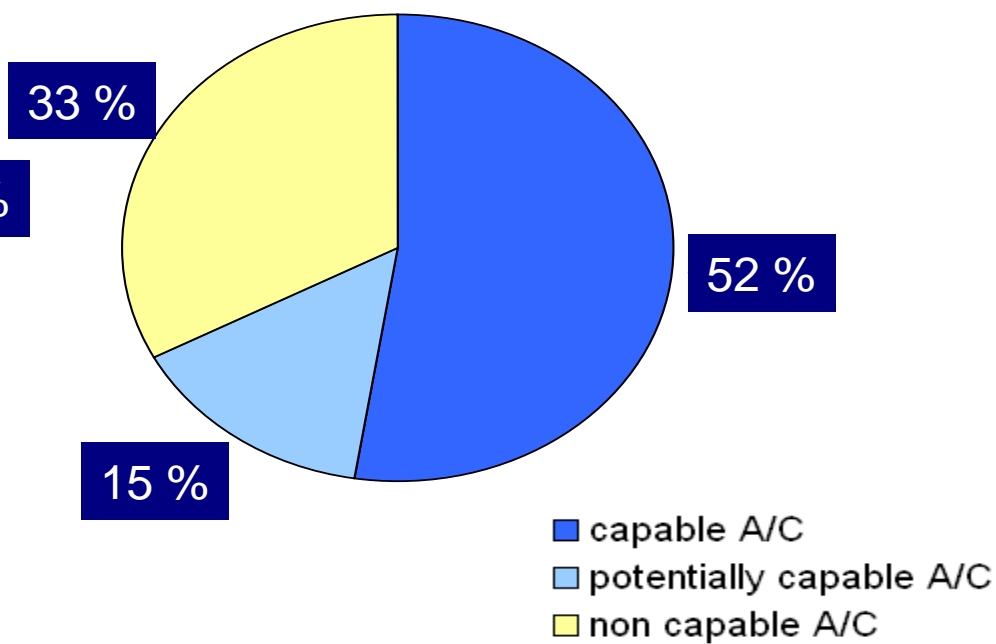
- ★ EGNOS system development and initial operational phase successfully accomplished by ESA in March 2009
- ★ EC has been managing the EGNOS Operational Phase since April 2009
- ★ EGNOS OS service declared available in October 2009
  
- ★ EGNOS certification for first pan-European GNSS services achieved in July 2010, according to SES Regulation
- ★ Performance issues detected in August 2010 are debugged and fixed
- ★ EGNOS SoL service declaration planned by beginning 2010, after a further performance assessment period
  
- ★ ESSP is the certified EGNOS service provider
- ★ ESA in charge of further system design enhancements and procurement
- ★ European National Air Traffic Service Providers are developing actions to enable EGNOS-based services for aviation

# APV-BARO capability in Europe

Estimated no. of  
capable aircraft  
(total=16975)



Estimated no. of  
capable flights  
(total=9196310)



# SBAS for APV

- The objective: enabling APV operations for the very many aircraft that do not have barometric vertical navigation (Baro-VNAV) capabilities



## Baro-VNAV Capable Operations

MITRE Estimates

The US case



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%

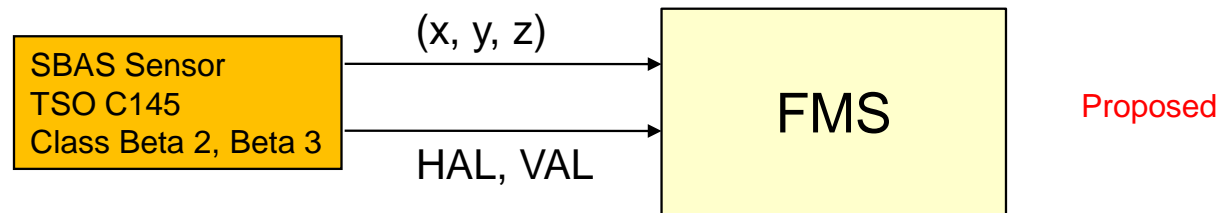
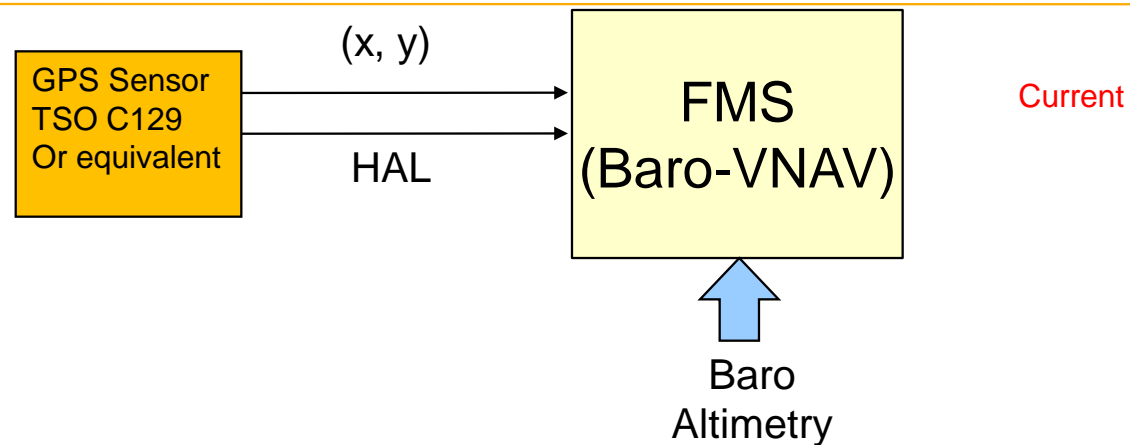
The solution:  
using vertical  
guidance from  
SBAS

\* 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.





# Nominal AR Architectures



FMS: Flight Management System

HAL: Horizontal Alert Limit

VAL: Vertical Alert Limit

# SBAS on-board capability status

- ★ SBAS-capable on-board avionics is steadily wide-spreading and becoming the de-facto GNSS standard, also in large aircraft (e.g. Airbus A350)

## 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



## 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, ...)

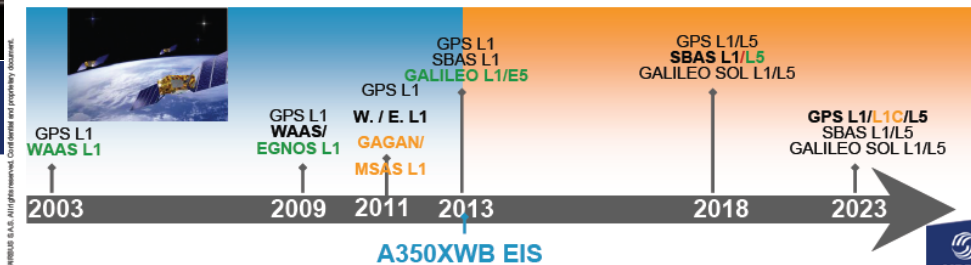
### Future steps:

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

IWG 18 Meeting  
June 17, 2009



Federal Aviation  
Administration



# 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 - 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.



# 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



# 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 Poland

- **Partners :**

- Pildo
- PANSA
- Royal Star-Aero
- ANS Czech
- Helios
- ADV Systems

- **Aircraft:**

- Piper PA-34 Seneca II

- **Airport/Procedures:**

- Mielec
- Katowice

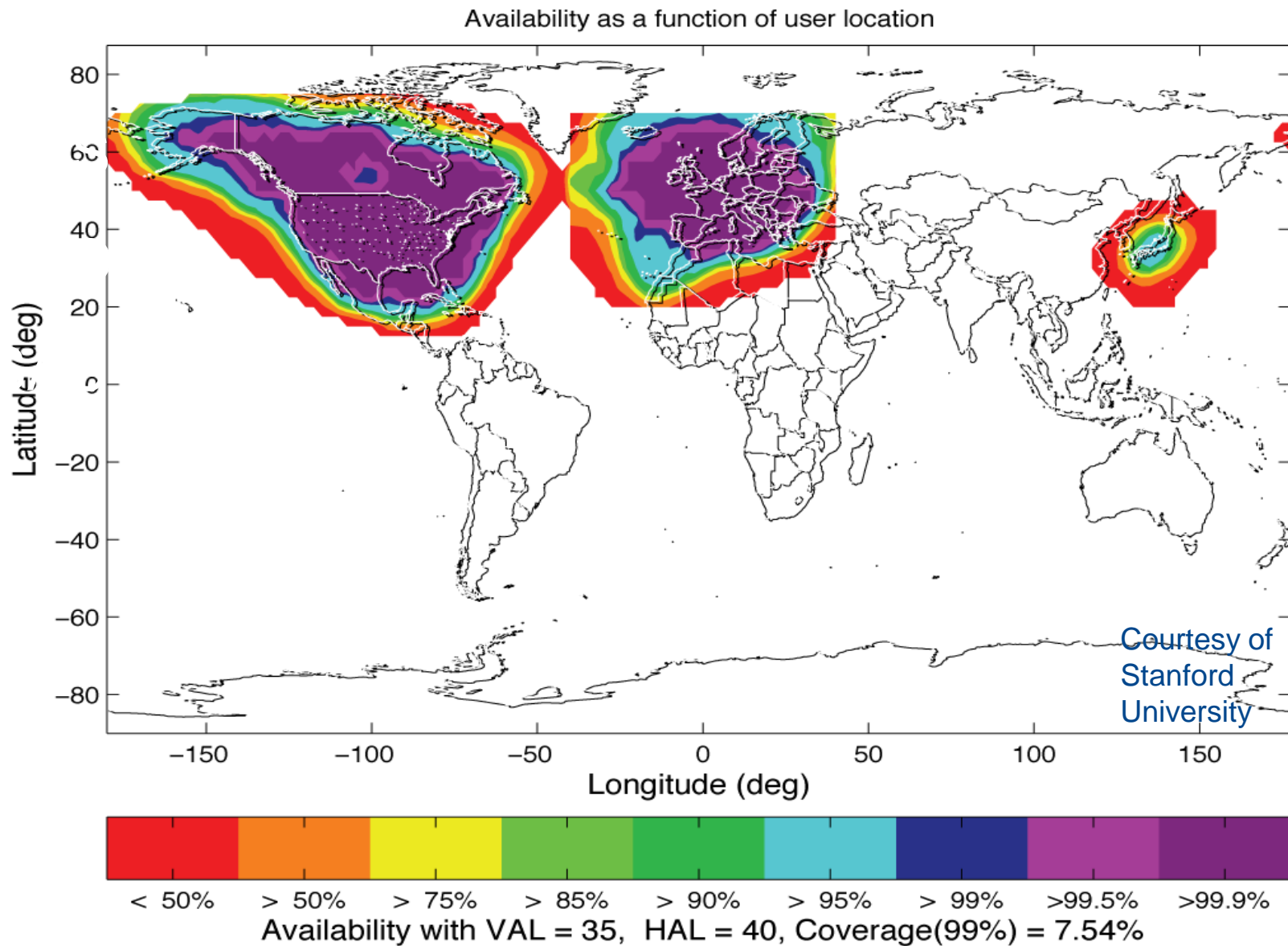
- **Receiver:** Garmin 430



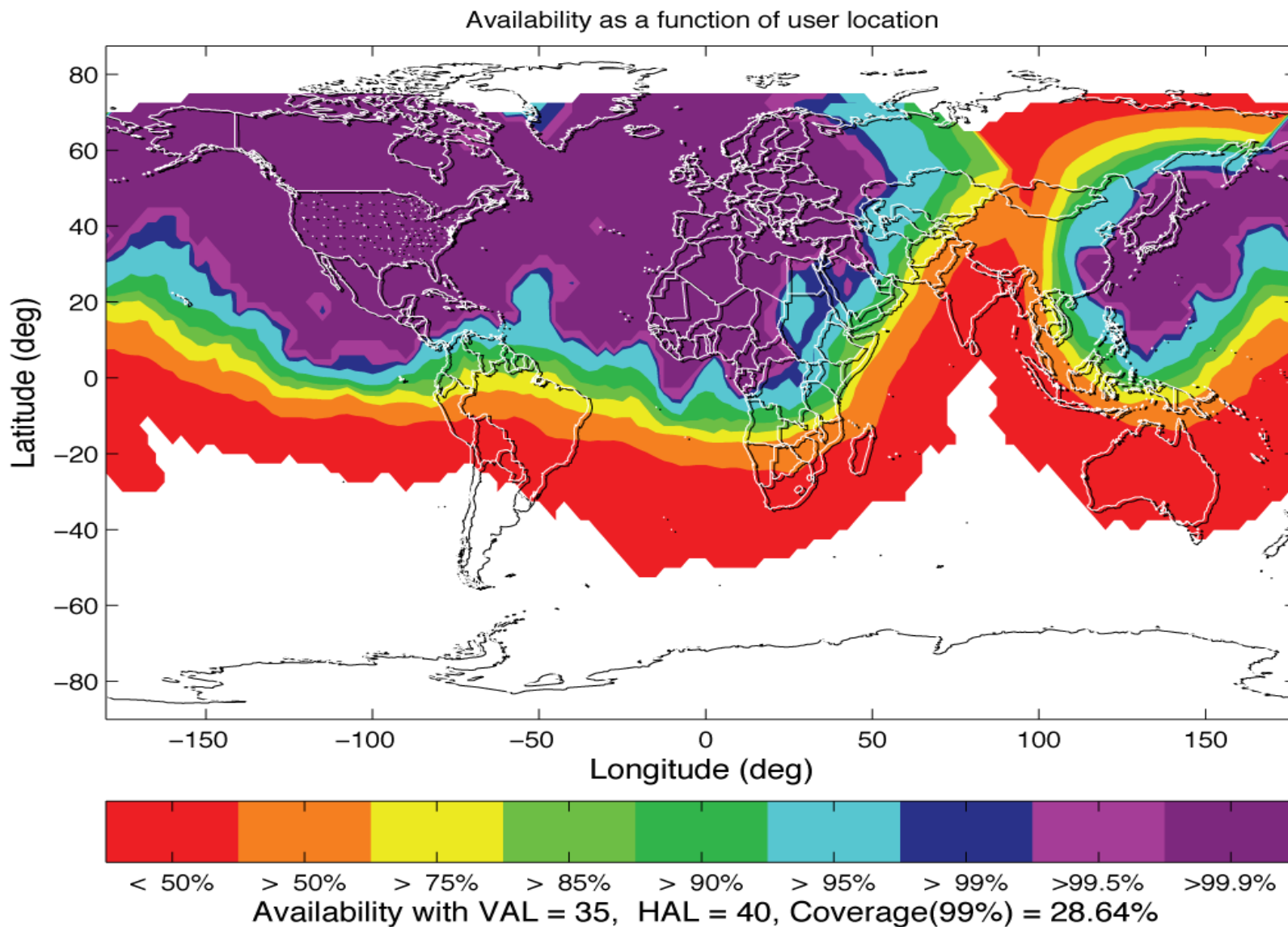
# Future SBAS evolutions

- ★ Single frequency coverage is good within the countries fielding SBAS
- ★ Dual frequency extends coverage outside reference networks & allows LPV-200 operations in equatorial areas
- ★ Expanding networks into southern hemisphere could allow global coverage of land masses
- ★ Additional constellations allow even greater coverage with fewer stations

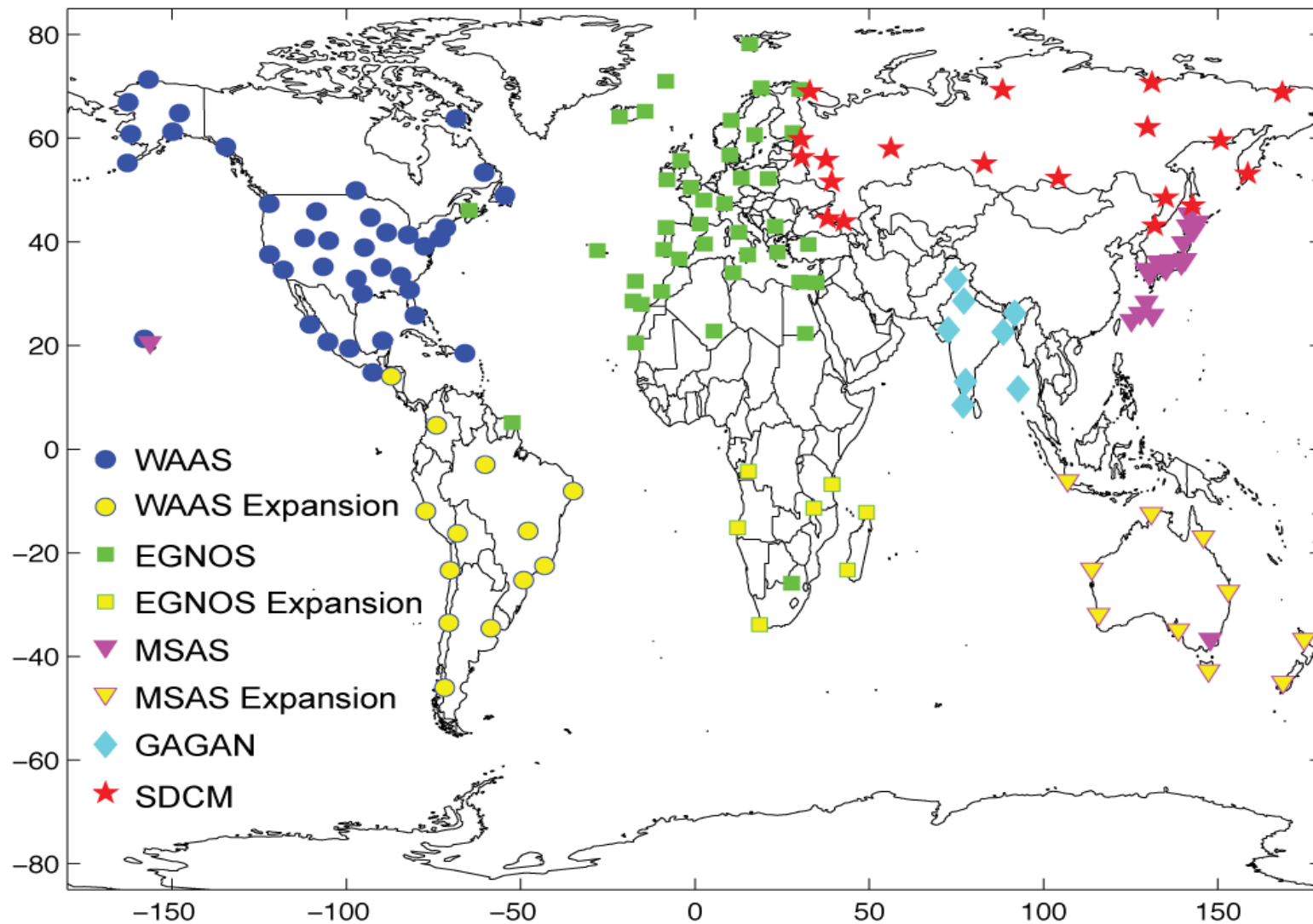
# Current WAAS, EGNOS, MSAS Coverage



# Dual Frequency Coverage (WAAS, EGNOS, MSAS)

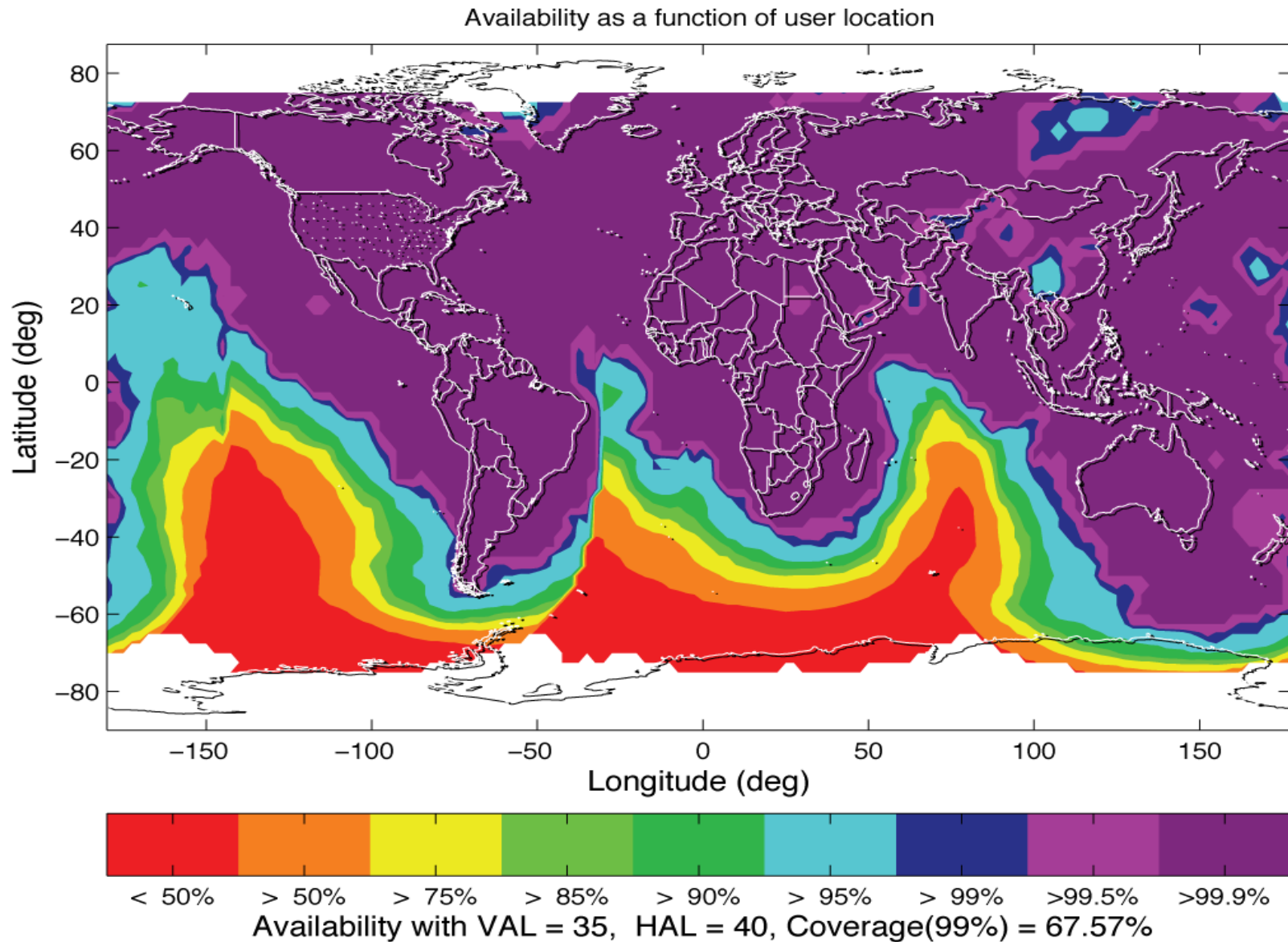


# Expanded Networks

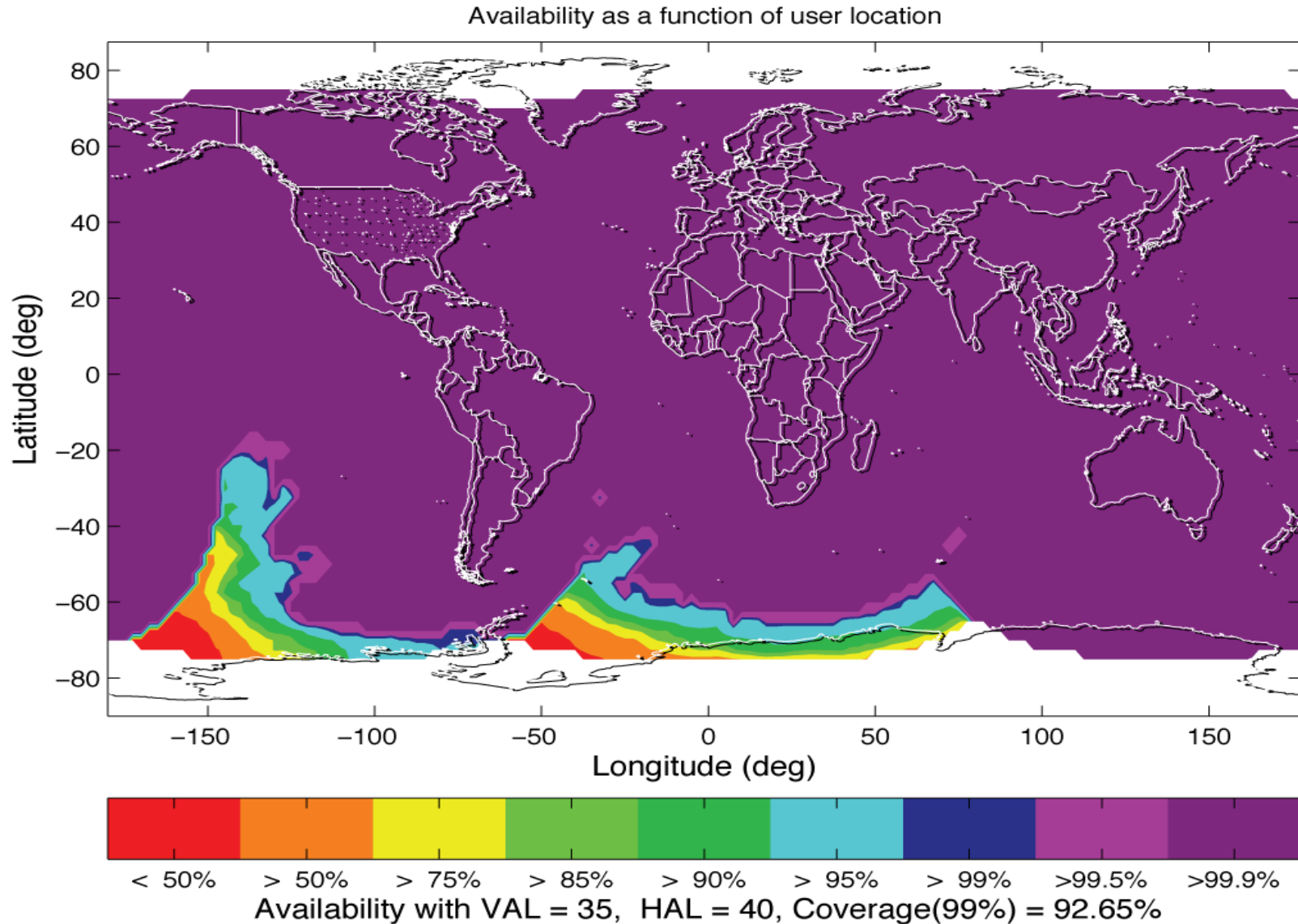




# Dual Frequency, Expanded Networks



# Dual Frequency, Dual GNSS, Expanded Networks



# Multi-regional SBAS: Cooperation issues

- ★ Coordination at infrastructure implementation level already on-going among SBAS providers (US, Canada, EU, Japan, India)
- ★ The implementation of a worldwide multi-regional SBAS will require a high degree of coordination among provider and non-provider States/Regions
- ★ Major issues at stake:
  - ★ Multi-regional service provision organisation
  - ★ Governance and funding
  - ★ Liability
- ★ ICAO role will be key to facilitate/harmonise resolution of these major cooperation issues

# Conclusions

- ★ The European SBAS service (EGNOS) will be declared available for aviation usage at the end of 2010
- ★ The EGNOS service provider (ESSP) is already certified according to SES regulations
- ★ APV-I performance is already available over European land masses
- ★ Opportunity of exploiting available SBAS/EGNOS capabilities when designing APV procedures