EUROMED GNSS II/MEDUSA project

PBN Implementation Workshop / Go Team

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- European GNSS (E-GNSS), EGNOS and Galileo
- Euromed GNSSII/MEDUSA
- MEDUSA technical assistance actions for EGNOS in aviation

Euromed GNSS

EGNOS introduction in Euromed region

Goal: EGNOS introduction in Euromed region (in view of Galileo)

- **Infrastructure implementation for EGNOS service provision (SiS)**

- **Service introduction/exploitation and market preparation**

  2006 - 2009 → Euromed GNSS I/METIS

  2012 - 2014 → Euromed GNSS II/MEDUSA

  in parallel with the infrastructure implementation for EGNOS service extension to cover the area

E-GNSS: EGNOS

MEDUSA

- Regional infrastructures & services (SBAS)
- Augmentation of GPS L1 signal to improve performance, i.e. to increase the accuracy of GPS positioning and provide information on its reliability (integrity)
- 3 services (OS, SoL, EDAS)
- European coverage (ECAC) with built-in capability to be extended to other regions, such as North-Africa, Middle-East and EU neighbouring countries
- Designed for civil aviation (WAAS)
- Enabling multimodal applications
- EGNOS technology readiness and easy usage/adoption
- Operational NOW, free of charge and widely available in consumer/automotive receivers

E-GNSS: Galileo

MEDUSA

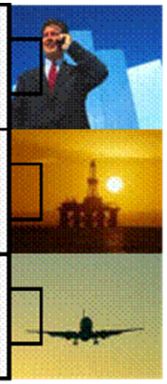
- Global infrastructures & services
- Autonomous system
- Under civilian control and interoperable with GPS, GLONASS, and BeiDou
- 4 services (OS, CS, PRS, SAR)
- Worldwide coverage
- Highly accurate global positioning services worldwide

- Under deployment - Galileo is currently finalising its In-Orbit Validation (IOV) phase using an initial group of 4 satellites launched during 2011-2012 (12th March 2013, the very first determination of a ground location fix with Galileo); early services in 2014/15
- GNSS receiver market is providing new-generation chipsets capable to receive signals from different constellation, e.g. GLONASS and early Galileo satellites in addition to GPS and SBAS/WAAS with no additional costs for the users (about already 30% of receiver models are Galileo ready)
- Open service free of charge and delivering dual frequencies (better performances)

EGNOS services

- **Augmentation of the GPS signal:**
  - **Higher accuracy**
  - **Integrity information**

Services		
	Open	Free to air; mass market; better than GPS
	Commercial	High accuracy; professional market
	Safety of Life	Integrity and authentication of the signal



EGNOS OS	**operational since October 2009**
EGNOS EDAS	**operational since July 2012**
EGNOS SoL	**operational since March 2011/ Certified for civil aviation**

EGNOS users

- **EGNOS OS:**

  Open, not regulated framework

- **EGNOS EDAS:**

  Registered users, professional applications, regulatory/liability needs

- **EGNOS SoL:**

  Navigation service provided under SES

  EGNOS SoL users defined within SoL SDD

  – **Airspace Users (as defined by SES regulation) equipped with EGNOS certified receivers (TSOS/ETSOs C144,C145 or C146)**

  – **Certified Air Navigation Service Providers (ANSPs) having signed an EGNOS Working Agreement (EWA) with the EGNOS Service Provider (ESSP)**

EGNOS SoL - main principles (1)

MEDUSA

- Designed:

  Compliant to APV- I

  To support civil aviation operations down to LPV minima (CAT-I)

  To meet ICAO SARPs

  Compliant to RTCA Minimum Operational Performance Standards (MOPS) for airborne navigation equipment using the GPS augmented by SBAS

- Enabling Performance Based Navigation (PBN)
- Not requiring the installation (and maintenance) of ground-based landing NAVAIDs
- Requiring certified avionics in accordance with ICAO SARPs
- Interoperable with other SBAS to enable aircraft seamless transitions between SBAS systems and interoperable SBAS avionics

EGNOS SoL - main principles (2)

MEDUSA

Typical Operation	Horizontal Accuracy (95%)	Vertical Accuracy (95%)	Integrity	Time-To-Alert (TTA)	Horizontal Alert Limit (HAL)	Vertical Alert Limit (VAL)	Continuity	Availability
En-route (oceanic / continental low density)	3.7 km (2.0 NM) (Note 6)	N/A	1 - $1x10^{-7}$/h	5 min	7.4 km (4 NM)	N/A	1 - $1x10^{-4}$/h to 1 - $1x10^{-8}$/h	0.99 to 0.99999
En-route (continental)					3.7 km (2 NM)	N/A		
En-route, Terminal	0.74 km (0.4 NM)	N/A	1 - $1x10^{-7}$/h	15 s	1.85 km (1 NM)	N/A	1 - $1x10^{-4}$/h to 1 - $1x10^{-8}$/h	0.99 to 0.99999
Initial approach, Intermediate approach, Non-precision approach (NPA), Departure	220 m (720 ft)	N/A	1 - $1x10^{-7}$/h	10 s	556 m (0.3 NM)	N/A	1 - $1x10^{-4}$/h to 1 - $1x10^{-8}$/h	0.99 to 0.99999
Approach operations with vertical guidance (APV-I)	16.0 m (52 ft)	20 m (66 ft)	1 - $2x10^{-7}$ in any approach	10 s	40 m (130 ft)	50 m (164 ft)	1 - $8x10^{-6}$/15 s	0.99 to 0.99999

ICAO operational requirements

EGNOS requirements

SARPS

Applicable Document

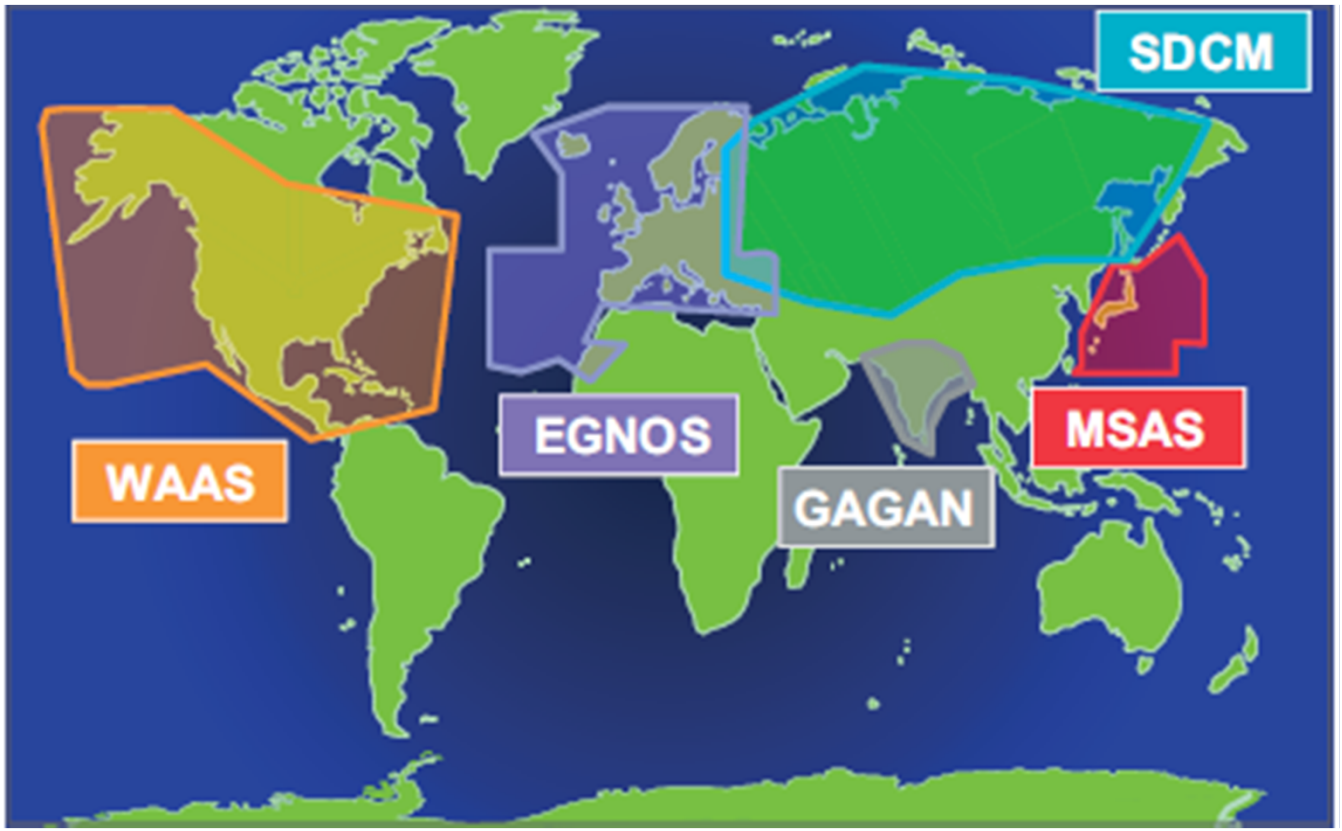
MRD (Mission Require Docume

	Open Service	Safety-of-Life Service		
		En Route to NPA	APV-1	Cat I PA (LPV-200)
Horizontal accuracy 95%	3 m	220 m	16 m	16 m
Vertical accuracy 95%	4 m	N.A.	20 m	4 m
Vertical NSE – fault-free conditions	N/A	N/A	N/A	10 m with 10^{-7} probability
Vertical NSE – system failure conditions	N/A	N/A	N/A	15 m with 10^{-5} probability
Integrity	N/A	10^{-7} / hour	2.10^{-7} / 150s	2.10^{-7} / 150s
Time To Alarm	N/A	10 s	10 s	6 s
HAL	N/A	0,3 NM	40 m	40 m
VAL	N/A	N.A.	50 m	35 m
Continuity	N/A	10-5 / hour	8.10-6 per 15s	8.10-6 per 15s
Global availability	99%	99.9%	N/A	N/A
Local Availability	N/A	N/A	99%	99%
Area Covered	Landmasses of: EU-27 (plus Norway / Switzerland) Mediterranean countries	FIRs of: ECAC countries Mediterranean countries	Landmasses of: ECAC countries Mediterranean countries	Landmasses of: ECAC countries Mediterranean countries

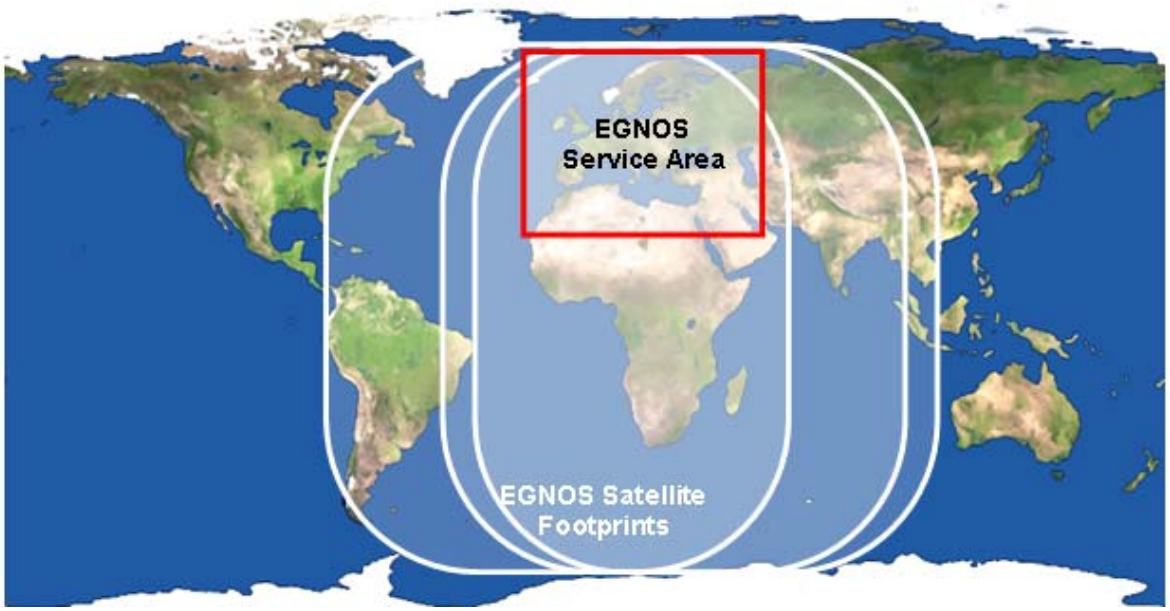
EGNOS: one SBAS among others

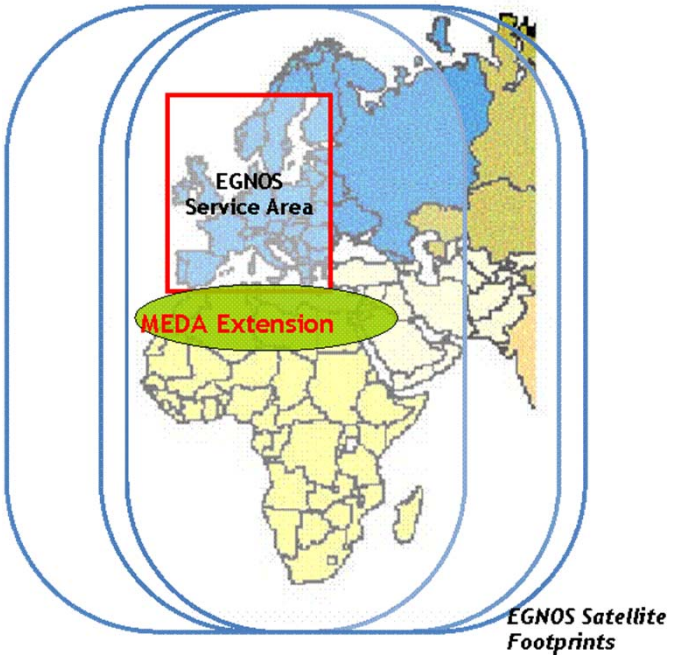
EGNOS is part of a multi-modal inter-regional SBAS service, able to support a wide spectrum of applications in many different user communities.

All SBAS systems are designed according to the same standard (i.e. ICAO SARPs)



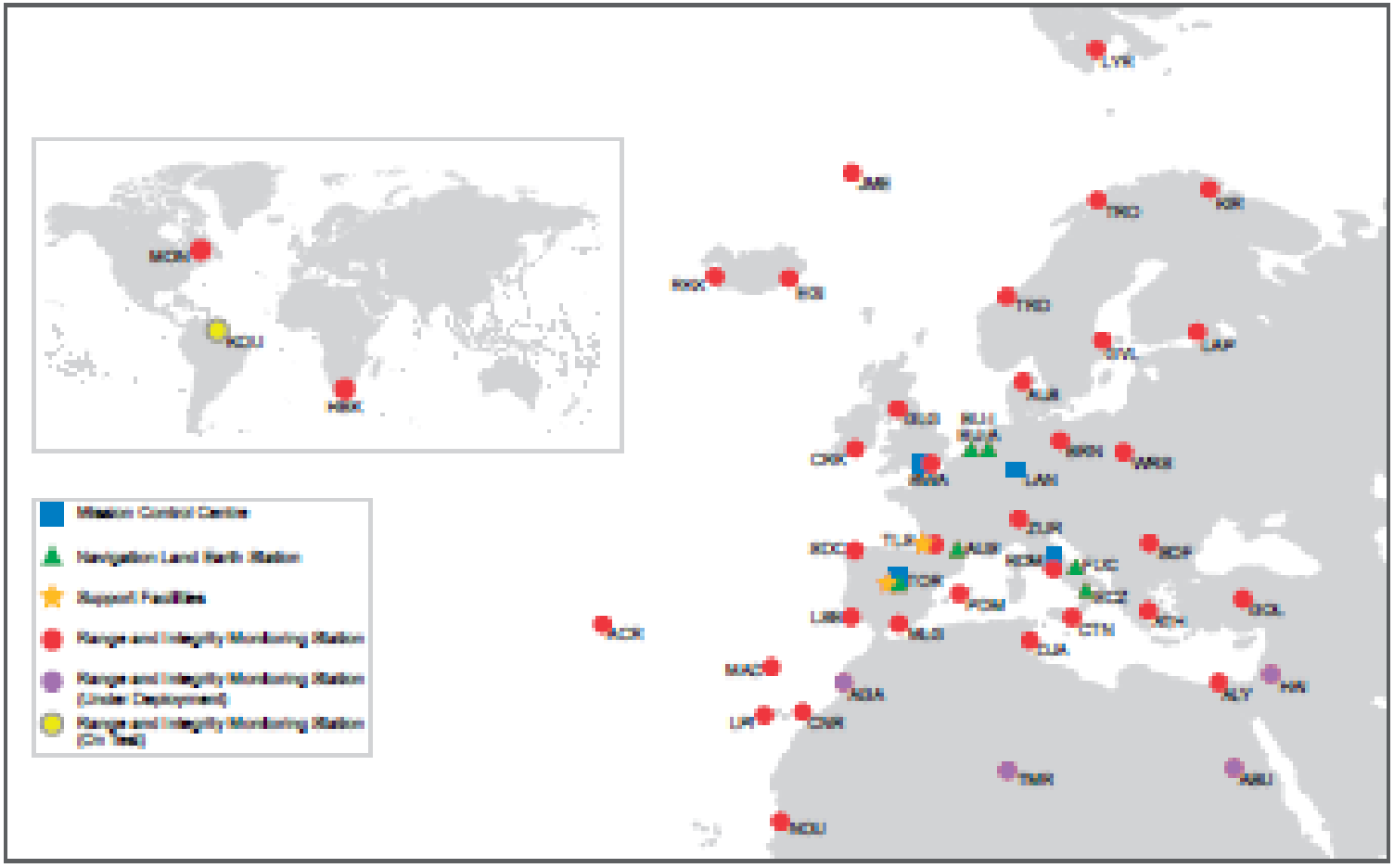
EGNOS space infrastructure and service area





Geostationary satellites broadcasting EGNOS messages to provide the SIS that is today used by the EGNOS aviation users

EGNOS ground infrastructure



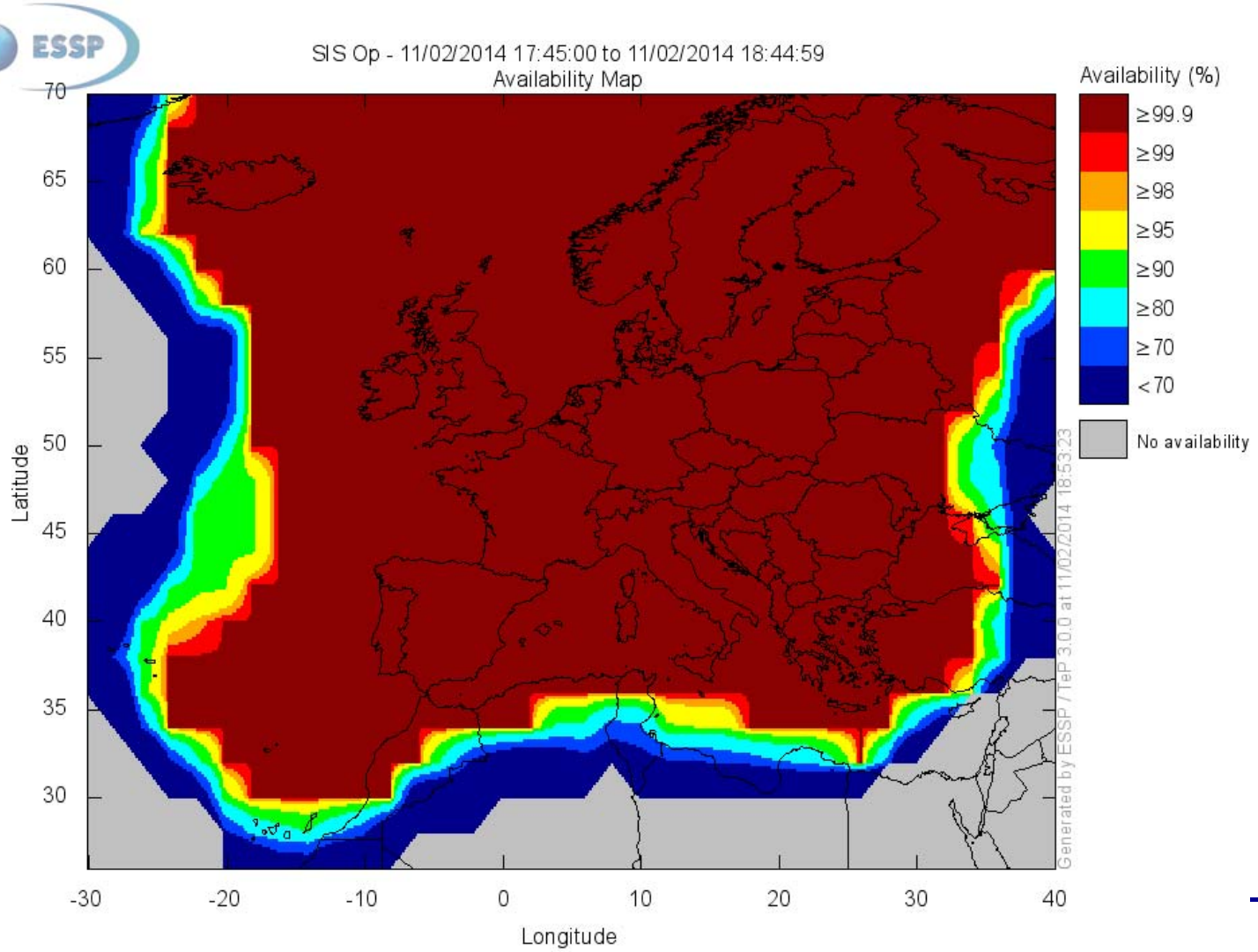
EGNOS RIMS (source: EGNOS SoL SDD, June 2013)

2 new RIMS in Abu Simbel and Agadir entered in operation in November 2013

2 further RIMS, one to be completed/qualified, one to be moved to another site

EGNOS service coverage

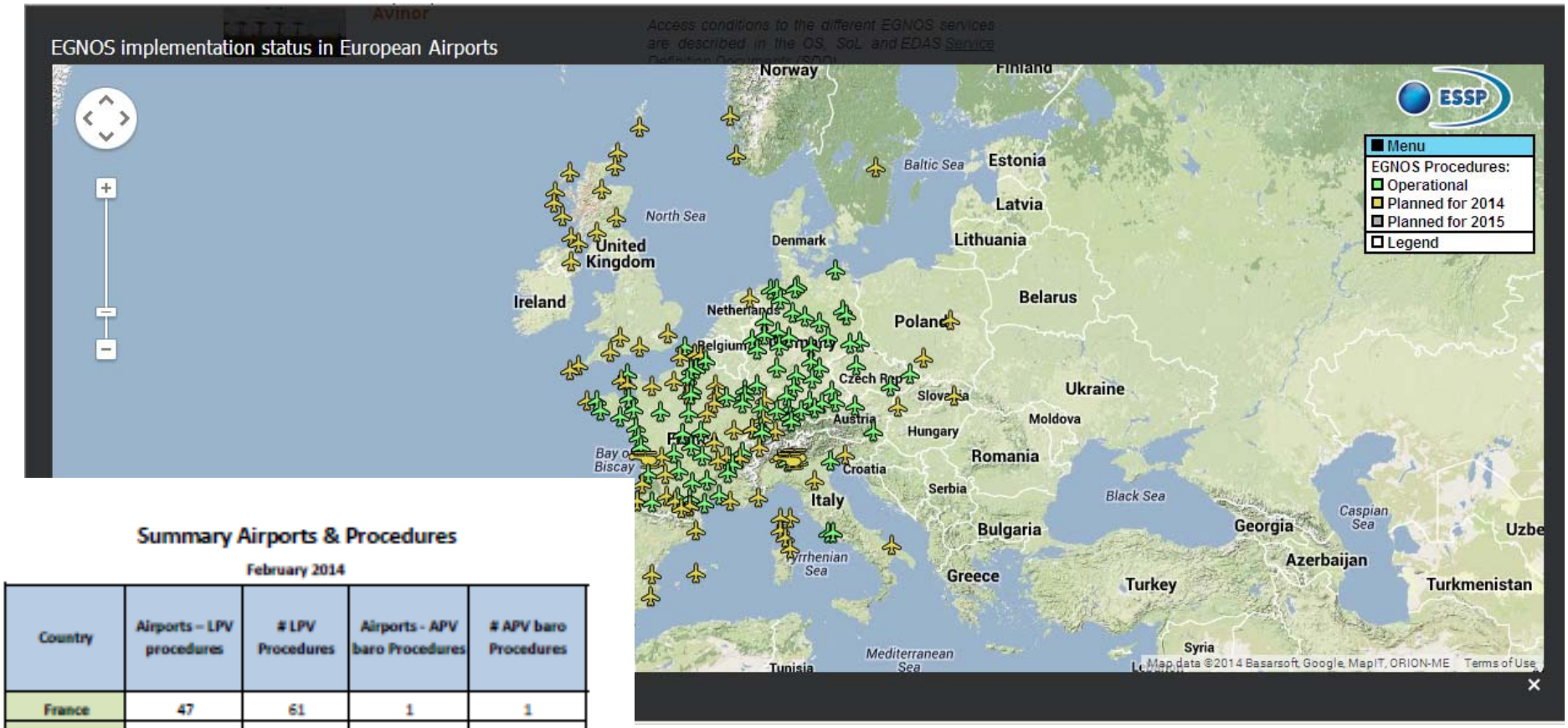
EGNOS SoL (APV-I) availability on 11 February 2014



EGNOS SoL - Service Definition Document (SDD)

- EGNOS SoL SDD describes the characteristics and conditions of access to the service. Published on June 2013 (http://www.essp-sas.eu/service_definition_documents)
- EGNOS Service Notices generated whenever there is any complementary information to be provided to users that could affect the SoL SDD contents (http://www.essp-sas.eu/service_notices)

EGNOS use in Europe for aviation



Summary Airports & Procedures

February 2014

Country	Airports – LPV procedures	# LPV Procedures	Airports - APV baro Procedures	# APV baro Procedures
France	47	61	1	1
Switzerland	4	4	0	0
Guernsey	1	2	0	0
Germany	9	14	31	71
Italy	4	7	0	0
Spain	1	2	0	0
Finland	1	2	0	0
Austria	2	2	0	0
Czech Republic	2	4	1	4
Total	71	98	33	76

Source: ESSP

Euromed GNSS II/MEDUSA

MEDiterranean follow-Up for EGNOS Adoption

May 2012 for 3 years

- **Pool of EU experts**
- **Euromed partner countries**

Goal:

- **Best practices sharing**
- **Aid to countries to prepare/set up the basis for the feasibility assessment/decision making process**
- **Aid to countries towards the exploitation of EGNOS services and operational adoption**
- **Technological transfer and capacity building**
- **A programme of technical assistance actions tailored on specific needs/local, sub-regional, regional**

EGNOS SoL regional coverage needs (1)

- 2nd UfM (Union for the Mediterranean) Ministerial Conference on Transport held last 14 November in Brussels

- "Priority guidelines for a new Regional Transport Action Plan for 2014-2020 in Euromed region" endorsed
- GNSS is included among the themes

- Support EC to:
  - Gather regional needs
  - Identify priorities
  - Outline recommendations for the deployment of the infrastructures necessary to extend the EGNOS service coverage across the Euromed area

EGNOS SoL regional coverage needs (2)

Operational implementation for LPV (1)

- Frames:
  - Regulatory
  - Institutional
  - Service provision

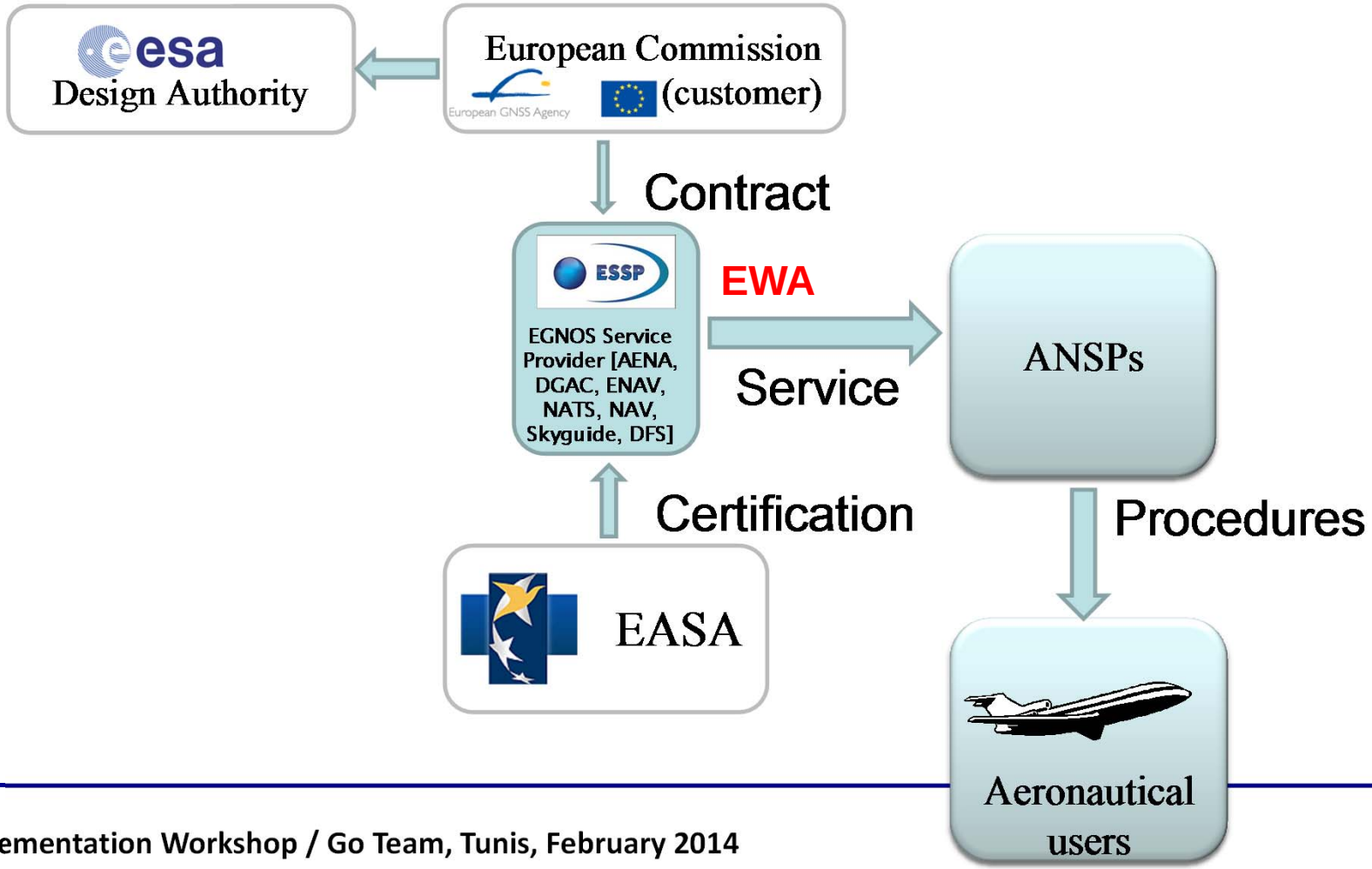
- Working group common for non-EU countries

- Technical workshop for Algeria, Morocco and Tunisia
- Working meeting with EC

- *International-institutional agreement*
- *Mutual recognition among ASNPs*

Operational implementation for LPV (2)

EGNOS institutional and service provision frame
In Europe, EGNOS is subject to regulation/approval by "EASA system" (including NSAs)



GNSS APCH and EGNOS based APCH in Tunisia (1)

- Goal: technical assistance action to support the operational implementation of GNSS approach (RNP APCH) and EGNOS based approach operations
- Airport: Monastir (Tunisia)
- RWY 07 and RWY 25
- Aircraft: Piaggio P180 Avanti

Market/application	Civil Aviation/LPV
EGNOS Service	EGNOS SoL
Team	ديوان الطيران المدني والمطارات OFFICE DE L'AVIATION CIVILE ET DES AEROPORTS; ENAV; ineco; HELIOS; Telespazio A Finmeccanica/Thales Company
MEDA country	Tunisia
Tasks	Procedures design
	Safety assessment
	Business case development
	Flight campaign for procedures validation
	Analysis of the steps for the operational exploitation/elaboration of list of "to-dos" for the publication of the procedures in the National AIP
	Training
	Promotional workshop
Outcomes	- Validated procedures - Safety assessment and business case - Training material - Promotional material - Path towards the implementation of operations

GNSS APCH and EGNOS based APCH in Tunisia (2)

- Design of procedures in a "3 minima lines combined chart"

- FAS data blocks codification & airborne data bases generation
- Training
- Validation flights campaign
- Safety Case
- Business Assessment

- Installation and operation of a GPS/EGNOS receiver for GNSS performance monitoring

- Technical assistance for the procedures publication and for the operational introduction (list of "to-dos")

- Workshop 4th June in Tunis

Analysis of GNSS data recording and monitoring

MEDUSA

Contributing to the elaboration of a methodology for GNSS data recording and monitoring/GNSS status information:

- **Implementation**
- **practical aspects**
- **Tools (e.g. PEGASUS)**
- **Independent real-time ground based stations (national/IGS GPS stations, EDAS)**
- **Focusing on Euromed countries**

GNSS approach procedures

- Development of GNSS approach procedures (including LPV)
- Safety case
- Business assessment

- Beirut APT (on-going)
- Bejaia APT (suspended)

Thank you!
Questions?