EGNOS in aviation: strategy and implementation status

EGNOS Service Provision Workshop 2016
Warsaw, 27th September 2016

Carmen Aguilera, GSA
Jose Maria Lorenzo, ESSP

European Global Navigation Satellite Systems Agency

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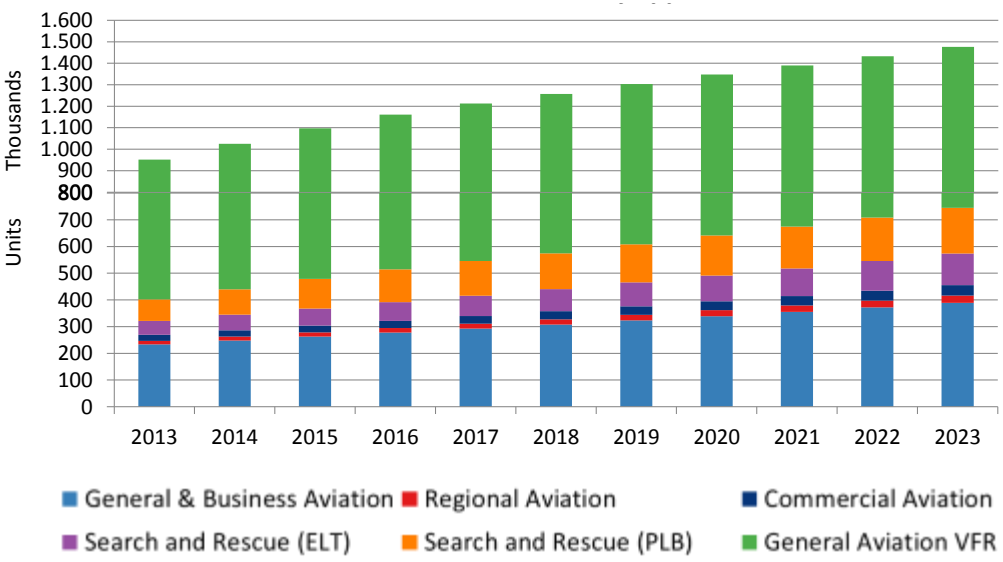
GNSS Market in aviation

Installed base of GNSS devices by applications



- **Performance Based Navigation** driving transition from traditional routing to GNSS navigation
- Growing availability of **SBAS based procedures** in European aerodromes
- GNSS is more used in **surveillance** through technologies like ADS-B, complementing radar
- GNSS enabled **ELTs/PLBs** are gaining importance
- GNSS support recreational pilots using **VFR**

- **RPAS/UAV Market is taking off:** although not quantified in GSA report, other sources estimate it at about €7bln €
- **Multiconstellation/Multifrequency GNSS solutions and ARAIM** enabling:
  - Advanced RNP
  - Aerodrome manoeuvring
  - GBAS CATII/III
  - Space based ADS-B

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GSA and aviation stakeholders join forces to bring EGNOS to users

ESSP

EGNOS Service provider
Technical assistance to foster EGNOS adoption

EUROCONTROL

Cooperation agreement to implement European Union GNSS policies as they apply to the field of aviation.

EUROPEAN AVIATION SAFETY AGENCY

Safety oversight
PBN Implementation, GNSS regulatory advice
Safety, pilot training, airworthiness criteria

EBAA

era european regions airline association

PPL/IR EUROPE

User organisations: business, general aviation, user associations, avionics manufacturers

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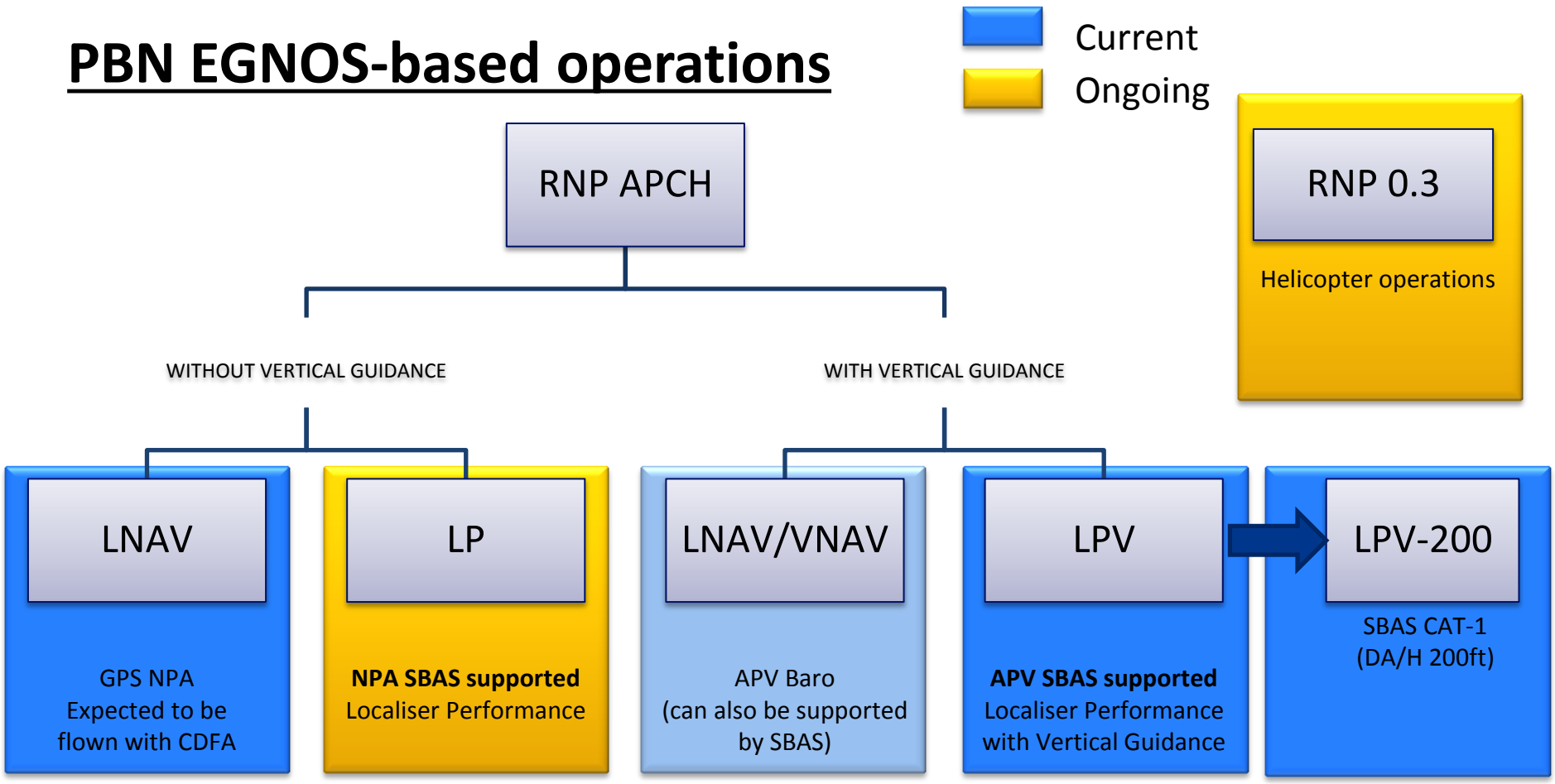
The EGNOS SoL service for aviation: EGNOS is an enabler of PBN

PBN EGNOS-based operations



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Working with Aviation value chain: actions suited to user needs

Device manufacturers	Aircraft/rotorcraft manufacturers	Airspace users	Air Navigation Service Provider	Aerodromes
Main Players:	Main Players:	Main organisations:	Main Organisations:	Main Categories:
				- International airports - Regional airports - Private airports

Co-funding avionics development, equipage and simulators	Co-funding implementation
Cost benefit analysis: which solutions are demanded/available	Cost benefit analysis
Co-marketing / Technical assistance	Feasibility analysis/ preliminary design
Avionics database, guidance on crew training	PBN Training, Guidance material
New operations and pioneers users, e.g. PinS, LP.	

EGNOS — European Global Navigation Satellite Systems Agency — ESSP — Precise navigation, powered by Europe

GSA triggered the first LPV to 18 countries and supports 50% of implementations

GSA supports 50% of implementations

229 LPV/LPV200/PinS
published or under implementation

Country	1st LPV supported by GSA	ICAO code	Publication
Austria	Linz + Graz	LOWL + LOWG	January 2014
Belgium	Antwerp	EBAW	December 2015
Croatia	Dubrovnik	LDDU	December 2015
Czech Republic	Brno + Ostrava	LKTB + LKMT	January 2014
Denmark	Aarhus	EKAH	March 2015
Finland	Joensuu	EFJO	December 2013
France	Toulouse	LFBO	May 2012
Hungary	Budapest	LHBP	September 2015
Italy	Milan Linate	LIML	December 2012
Netherlands	Groningen	EHGG	November 2014
Norway	Rost	ENRS	March 2014
Poland	Katowice	EPKT	April 2014
Portugal	Lisbon	LPPT	May 2015
Slovak Republic	Bratislava + Kosice	LZIB + LZKZ	February 2015
Spain	Santander	LEXJ	October 2013
Sweden	Gothenburg	ESGP	September 2014
Switzerland	Altenrhein	LSZR	November 2011
United Kingdom	Exeter	EGTE	August 2014

Looking forward to the upcoming 1st LPV in new countries!

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Joint work in Poland

- Dedicated training on PBN implementation
- EGNOS mapping into the Polish PBN strategy
- EGNOS based APV down to LPV simulation at the Virtual Flight Laboratory at Silesian University of Technology (SUT), as training support to ANSP and airline operators

First 2 operational LPV in Poland, 13th November 2014

- Helicopter Emergency operations
- Excellent feedback from LPR operator:

"Our priority is safety for the client and the pilot:
to be safe back home when after take-off the weather doesn't allow performing the mission.
Here is when EGNOS comes into the picture.
You can fly safely also at night!". Mieszko Syski , LPR

PinS at Babice
Low Level Route to Lodz airport

Most new popular models include SBAS and availability of retrofit solution increases

- **Business and General aviation lead LPV adoption:**
  - 25% of Business aircraft will be LPV capable by end of 2016
  - 10% of General aviation aircraft are LPV capable
- **Many new popular aircraft models have standard SBAS capabilities:**
  - Commercial aviation: A350
  - Regional aviation: ATR42 & 72 – 600, Bombardier CRJ series,…
  - General aviation: DA42, Cessna all single engine, PC6, SR20,…
  - Business aviation: TBM900, Cessna citation family, G650,…
  - Helicopters: EC135, EC175, AW109, B505,…
- **Many in service aircraft types have retrofit solutions available:**
  - Over 50 STC's and SB's available for more then 20 different A/C types
  - New solutions being developed every day!

AIRBUS

Airbus A350, Beluga

DASSAULT AVIATION

SB Falcon 900LX/5X/ 7X/2000LXS/2000S;

ATR

ATR42-600, 72-600

Bombardier CL60

Dassault 900LX

Dassault 7X

EC 135

Pilatus PC-12

Support actions are tailored to each specific segment's needs

Market segment	Availability of LPV procedures	Availability of SBAS equipment (retrofit)	Equipage of SBAS	Crew training/approval
General aviation	Low	High	Low for LPV	Low
Business aviation	Medium	High	High	High
Regional aviation	Medium	Low	Low	Low
Commercial aviation	Low	Low	Low	High
Helicopters	Low	Low	Low	High
PPL/IR EUROPE	Demand approaches to non instrument runways: - Pilot implementations - Regulatory analysis	Cost efficient avionics solutions development	SBAS avionics database	PBN training material for flight schools

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EBAA	Priority: airports with high BA traffic and limited navaids Feasibility assessment, design	Co-marketing with manufacturers	Analysis of operational benefits	Support to obtain approval

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era (european regions airline association)	Identification of priority airports with high RA/CA traffic	Co-funding STC/SB development	CBA, Co-funding Cost Benefit analysis to airlines flying to LPV destinations	Simulator upgrade

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EHA EUROPEAN HELICOPTER ASSOCIATION	PinS pioneer implementations Support to CAAs	Co-funding STC/SB development	CBA, Co-funding	CAA requirements identification

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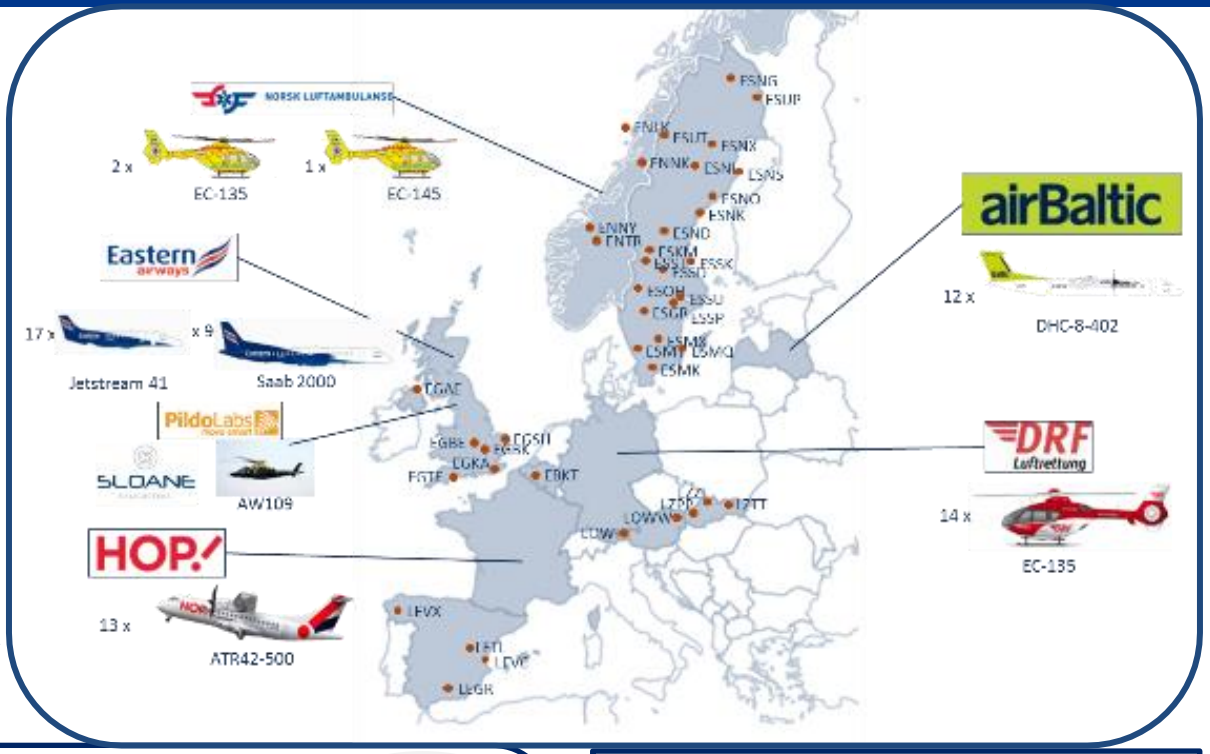
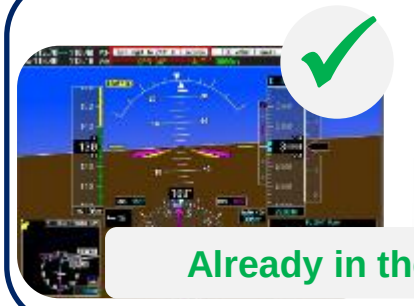
GSA Aviation grants programme - 1st call (6M€)
Expected results from 13 projects

72 EGNOS based procedures in **37** airports

8 PinS at **7** helipads

68 aircraft/rotorcraft retrofit by **5** operators





Already in the market

Upgrade of 3 flight simulators

GSA Aviation grants programme - 1st call (6M€)
Expected results from 14 projects

47 aircraft retrofit by
7 operators
5 flight simulator upgrades
EGNOS for RPAS

CHC
2 x
Sikorsky 92

NEXTJET
10 x
Saab 340

SVENSK PILOTUTBILDNING
2 x
DA40
1 x
DA42

Bristow
2 x
Sikorsky 92

DSA a.s.
FAIR
13 x
General Aviation A/C:
1 Piper PA-28-161, 1 Cessna C172 SP, 1 Tecnam P2010, 1 Tecnam P2006T, 3 Cessna C172 S, 2 Cessna 172, 2 Piper Seneca PA34, 1 Cessna jet 525,1 Beechcraft C90
2 x
Rotorcraft:
1 AS355 & 1 EC135

ENAC
12 x
Raytheon Beech 58

POLIZEI
1 x
AW139
1 x
EC 135T2+
1 x
EC 135P2+

ENBN
ENKB
ENFL
ENBR
EIDL
EISG
EICM
EINN
EIKY
EICK
EIWF
EIDW
EIME
EGPG
EGPK
EGNC
EGFE
EGBJ
EGSG
EGMC
LKMH
LKPR
Allentsteig
LODO
LOAV
Trento
'UAV'

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40 LPV procedures at **18** airports
2 LPV200 at 1 airport
15 PiNS LPV approach
2 RNP0.3 routes

Ongoing training to new EGNOS aviation users

CaBilAvi

- **Pilot's education & training**
- **EGNSS capacity building in Joint Service Provision Area:**

Albania
Republic of Bosnia and Herzegovina Kosovo
Montenegro
Serbia
Hungary

BLUEGNSS

EGNOS in the PBN plan
Procedure designers training
15 LPV implementation
Greece
Cyprus
Malta

BEYOND H2020

Republic of Moldova
Montenegro
Hungary
Former Yugoslav Republic of Macedonia
Kosovo
Turkey
Morocco
Egypt
Palestine
Israel

UKRAINE

PBN plan
Preliminary LPV design
Performance assessment

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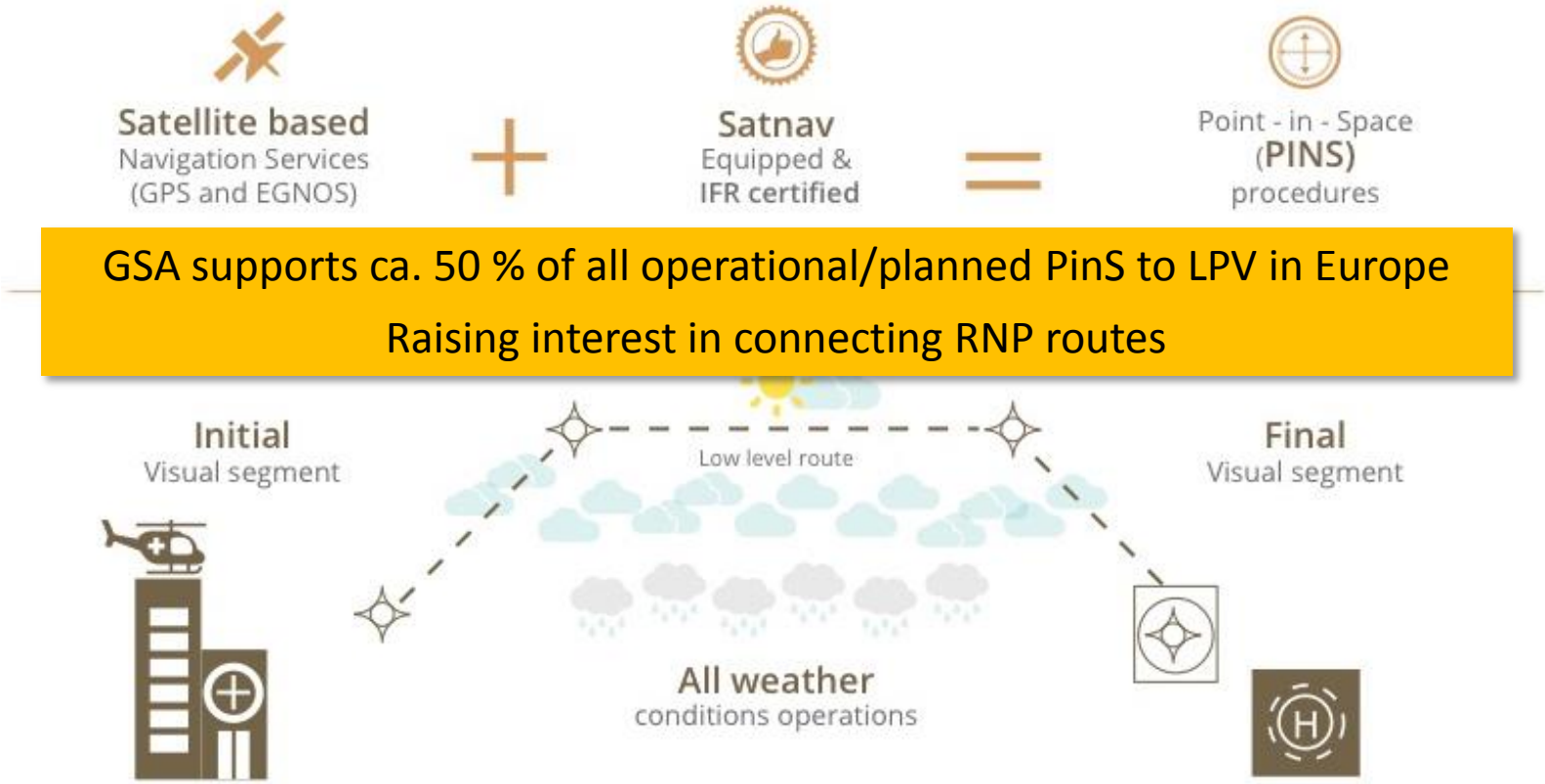
EGNOS for rotorcraft operations: a technology enabler in SESAR



Enabling pioneer implementation of PinS to LPV

PIONEERS PIONEERS²

Fostering the implementation of PinS procedures based on EGNOS in Rotorcraft industry

PildoLabs move smart · austro CONTROL · ÖAMTC · SLOANE · POLIZEI · CHC · SYWELL AERODROME

5lives

Research initiative in enhanced navigation concepts for Rotorcraft emergency missions in 5 different scenarios

PildoLabs · PildoLabs wessex · rega · inaer fly the future

Aeroporto G.Caproni · Vigili del Fuoco Elicotteri

Increasing safety and continuity of HEMS by building network the low-level routes and 17 PinS in Trente region together with retrofit of 2 AW139.

FLAG

Working group for the harmonisation of PinS regulation in national authorities through Europe

PildoLabs · AIRBUS HELICOPTERS · DRF Luftrettung · JEPPESEN · babcock · EUROCONTROL

Main EGNOS benefits for RPAS

Satellite Navigation (PinS) is an opportunity for RPAS operators

Better navigation performance through higher accuracy, specially vertical

Improved safety through position integrity in ADS-B source

Robust geofencing thanks to positioning integrity and reliability

Low-level routes, lower protection volumes, more opportunities under challenging environments

Easier integration into manned airspace through the use of compatible concept of operations

24/7 service

improved safety

more efficient

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REAL:
RPAS EGNOS Assisted Landings

Real

EGNOS based navigation and surveillance sensor, coupled with autopilot and ground station

Contribute to the approval of innovative RPAS operations, supported by a Safety Case

Scenario 1

Urgent Medicine Transport

RPAS is load with requested urgent medicines

RPAS fly along a low level route below 500ft

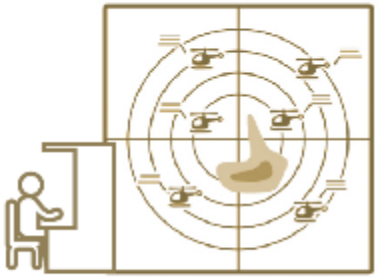
RPAS delivers medicines to inaccessible areas

Scenario 2

Fire Extinction Operations

RPAS is transported to the emergency location by ground

RPAS takes off and stay above fire extinction traffic



On ground, RPA is controlled and extinction traffic is coordinated

EGNOS

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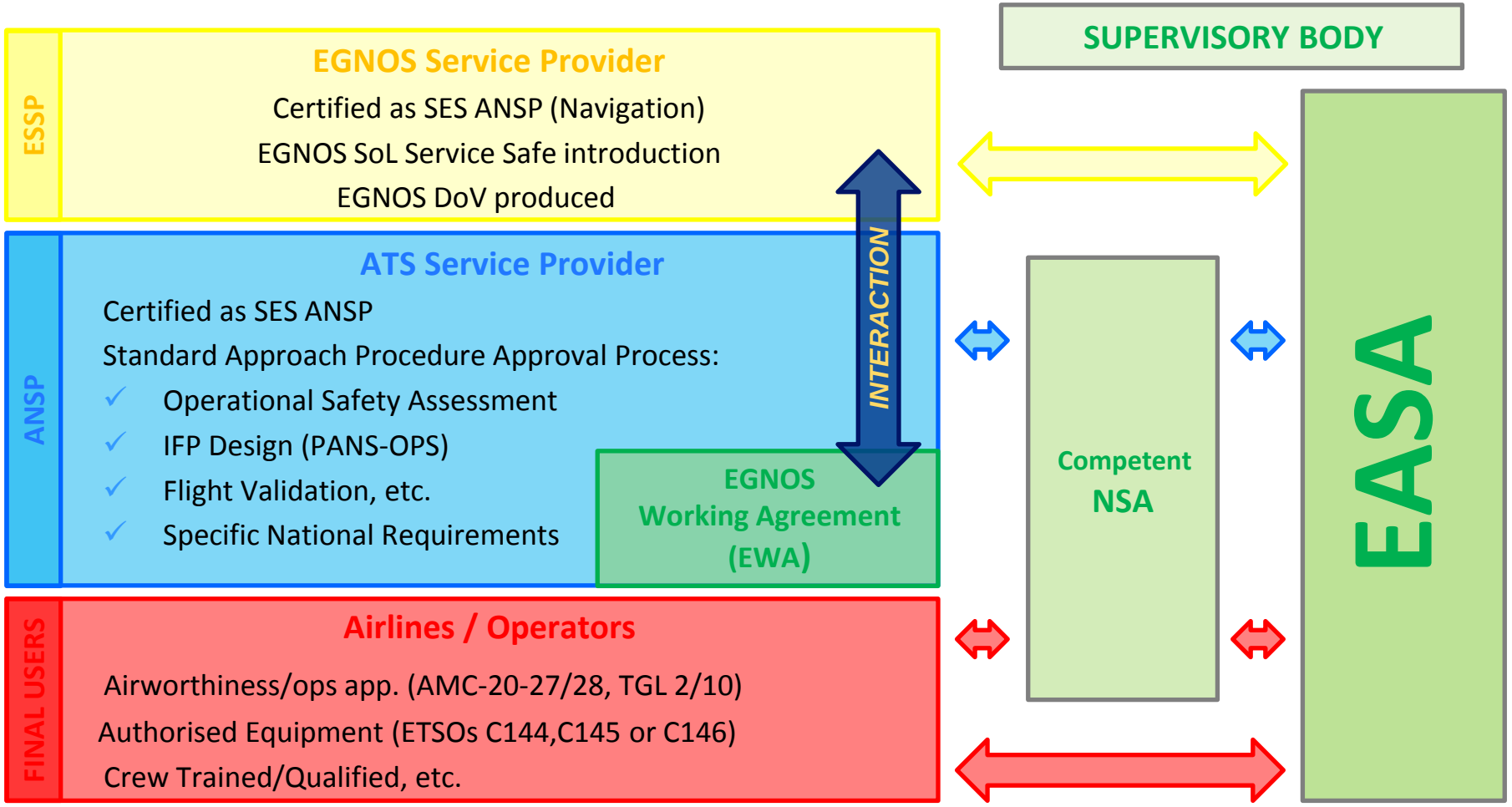
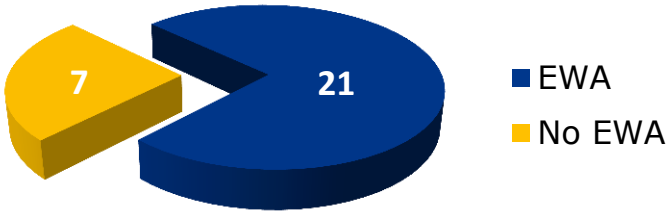
LPV: WHO DOES WHAT?

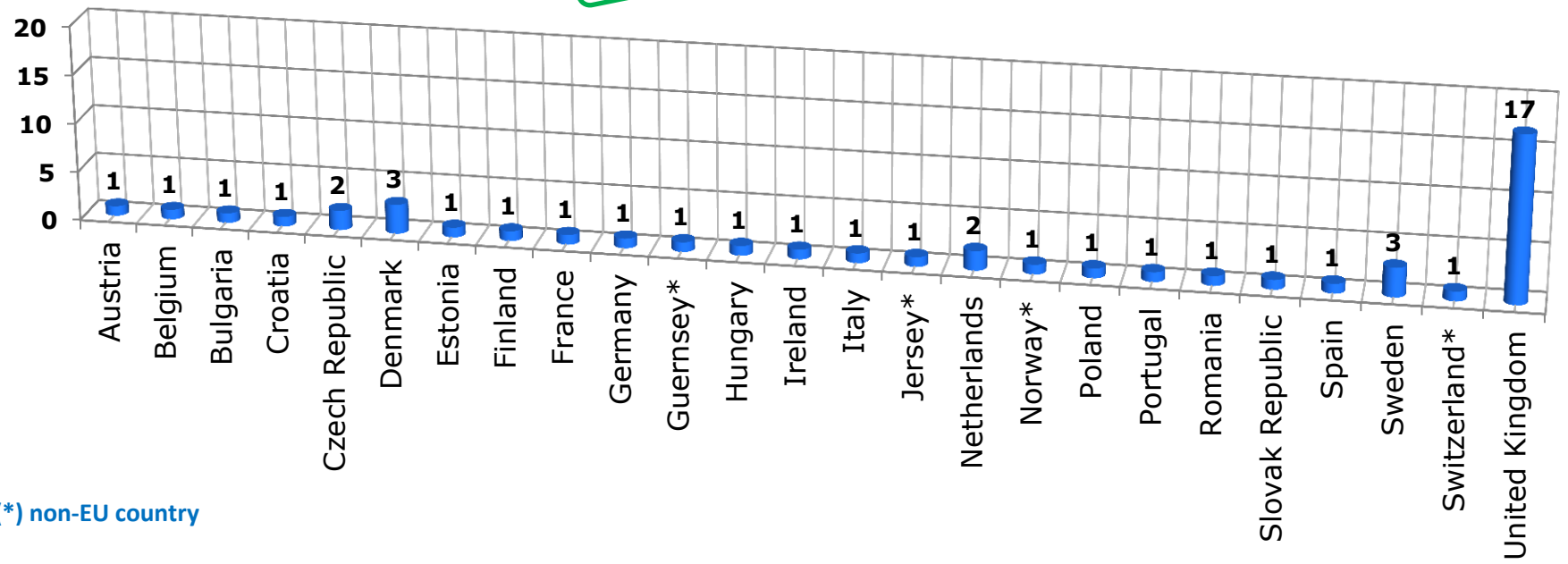


LPV Implementation Status - EWAs

47 EWAS IN PLACE

15th September 2016





(*) non-EU country

LPV Implementation Status - EWAs

Latest (2016)

- Tallinn Airport Ltd (Estonia)
- BAE Systems Marine Ltd (UK)
- Coventry Airport Ltd (UK)
- City of Derry Airport Operations Ltd (UK)
- Brighton City Airport Ltd (UK)
- Esbjerg Airport (Denmark)
- Serco Ltd (UK)

In progress

- Sonderborg (Denmark)
- Norwich Airport Ltd (UK)
- MATS (Malta)

Initiated

- EANS (Estonia)
- Latvijas Gaisa Satiksme (Latvia)
- Kortrijk Airport (Belgium)
- FerroNATS (Spain)

LPV Implementation Status

COUNTRY	Airports	LPV Procedures		APV baro Procedures
		APV-I	LPV-200	
Austria	2	2	0	0
Belgium	3	4	0	0
Croatia	1	1	0	0
Czech Republic	4	8	0	4
Denmark	3	6	0	0
Finland	1	2	0	0
France	90	148	7	5
Germany	22	36	0	63
Guernsey	1	2	0	0
Hungary	1	0	4	0
Italy	7	17	0	0
Netherlands	2	3	0	0
Norway	11	23	0	16
Poland	4	7	0	0
Portugal	1	2	0	0
Slovak Republic	2	4	0	0
Spain	1	2	0	0
Sweden	2	3	0	0
Switzerland	8	10	1	0
United Kingdom	2	4	0	0
TOTAL	168	284	12	88

15th September 2016

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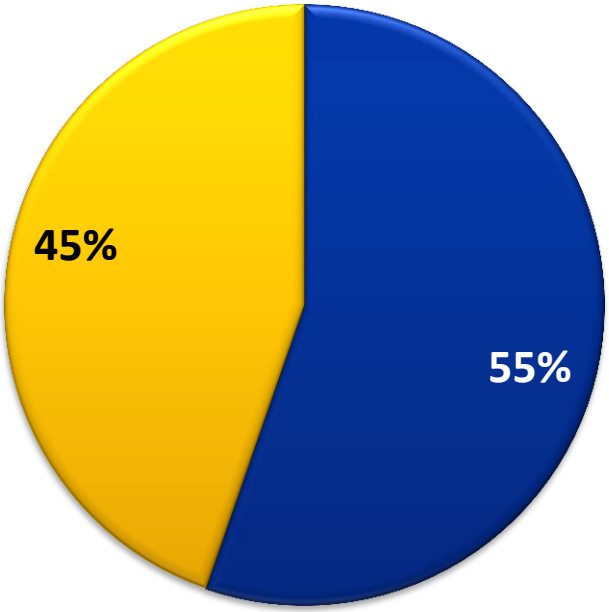
LPV Implementation Status

EWA AS A DRIVER TO SUPPORT LPV IMPLEMENTATION

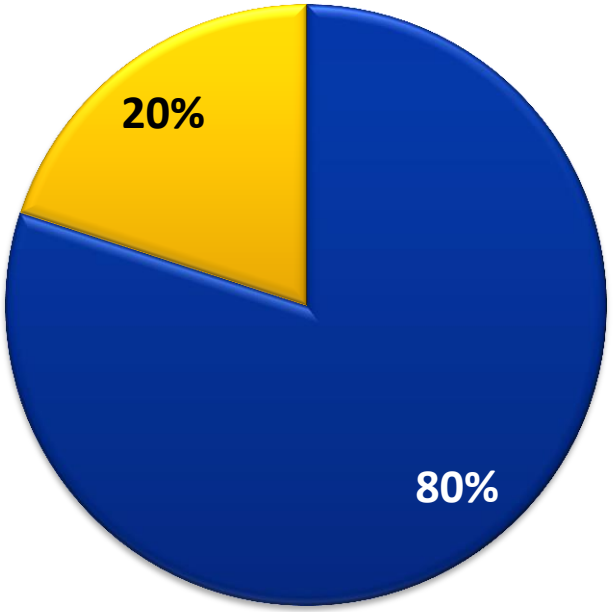
Publications by EWA



With NO LPV published

Publications by Country

21 EU + 4 non-EU



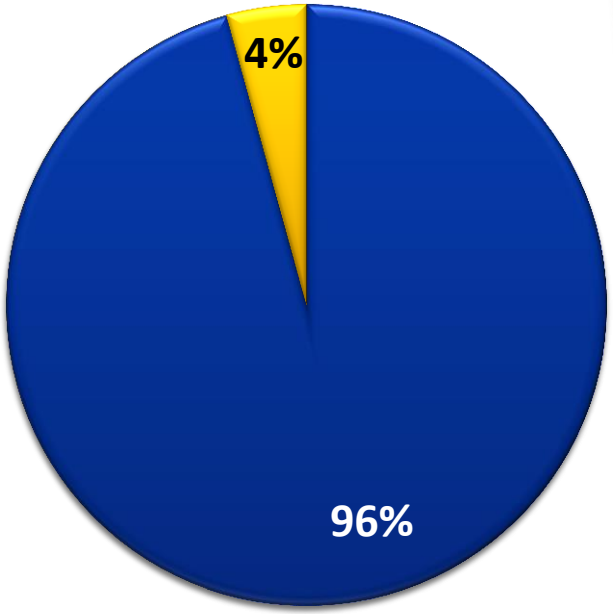
With at least one LPV published

LPV Implementation Status

EWA AS A DRIVER TO SUPPORT LPV IMPLEMENTATION

Signed EWAs
Short Term
Forecast

Publications by EWA



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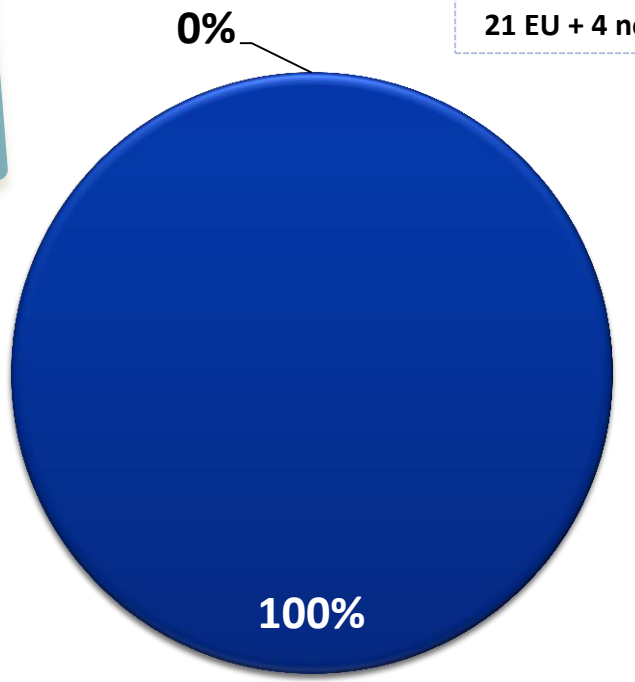
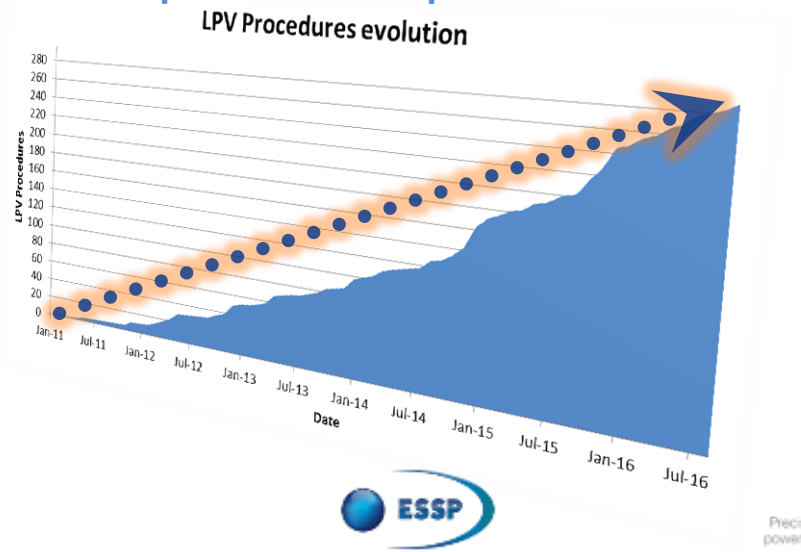


With NO LPV published

With at least one LPV published

LPV Implementation Status - Plans

- **As of 15th of September 2016: 296 LPVs** (APV-I and LPV-200 Service Levels) serving **168 airports**.
- **Numerous LPV publications** expected in **Denmark, France, Germany, Italy, Norway, Poland, Spain, Sweden, Switzerland and UK.**
- **Significant increase of new plans** also in **Belgium, Bulgaria, Hungary, Ireland, and Romania.**
- **>440 LPV publications expected for 2018.**



ESSP's LPV supported by ESSP (Sweden: Norrköping)

NORRKÖPING AIRPORT

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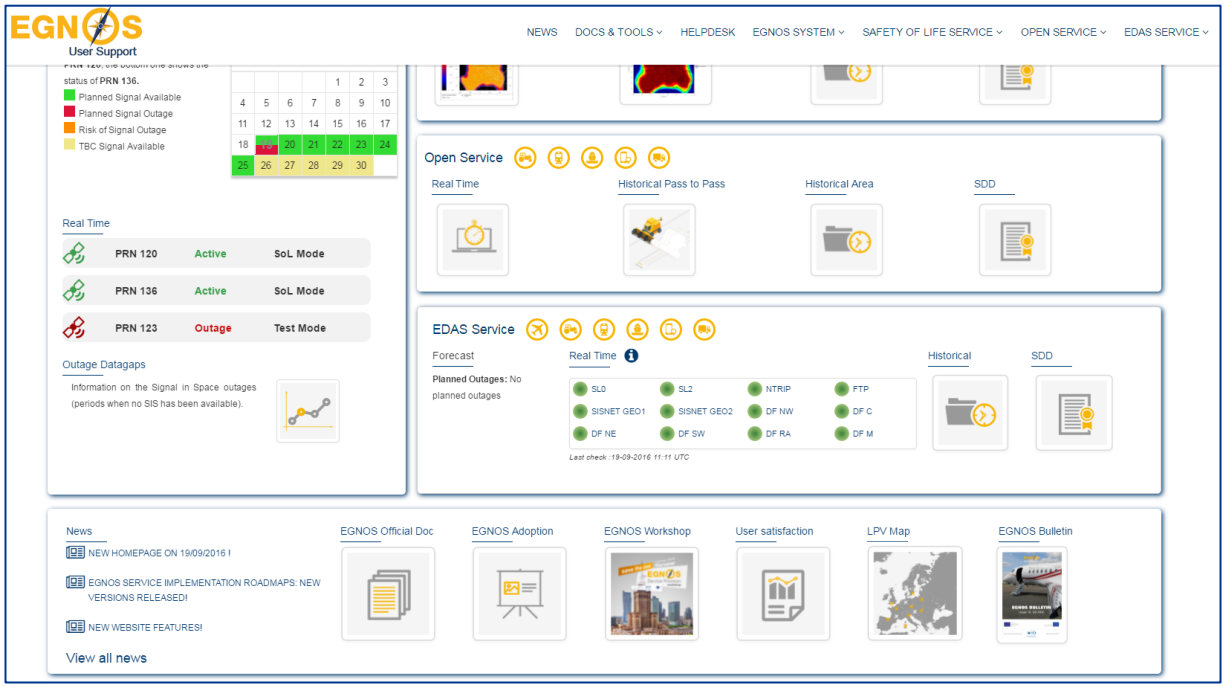
LPV Implementation Status and Plans

- EGNOS-based procedures implementation map and detailed list included in the ESSP User Support Website: http://egnos-user-support.essp-sas.eu/



- All information coordinated with Eurocontrol's PBN Approach Map Tool available at: https://ext.eurocontrol.int/pbn/

EGNOS Working Agreements for non-EU countries

- **Existing EWAs with non-EU countries (compliant with SES Regulation):**
  - Bailiwick of GUERNSEY (Channel Islands – 2011).
  - Switzerland (2011).
  - Norway (2013).
  - Bailiwick of JERSEY (Channel Islands – 2014).

- **Explicit interest expressed by several neighbouring regions/countries:**
  - An International Agreement (between EC and the non-EU State), defining the overall framework for the use of the EGNOS SoL Service.
    - An agreement/coordination scheme: if deemed necessary between EASA and the Civil Aviation Authority of the non-EU country.
      - EWA (EGNOS Working Agreement with ESSP): Established on the basis of the previous agreement/s.

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- **Albania**
- **Bosnia&Herzegovina**
- **Macedonia**
- **Montenegro**
- **Serbia**
- **Kosovo**

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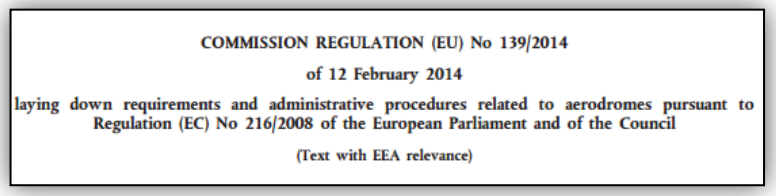
ICAO new RWY classification
EASA Opinion No 03/2016


COMMISSION REGULATION (EU) No 139/2014

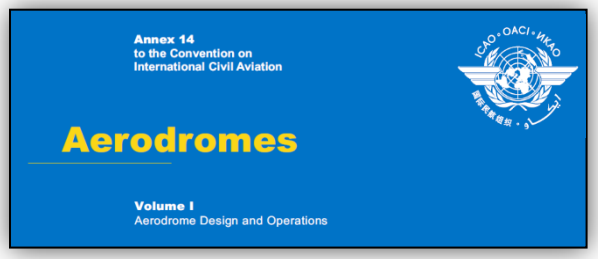
of 12 February 2014

laying down requirements and administrative procedures related to aerodromes pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council

(Text with EEA relevance)

Reg.139/2014 (Feb 2014) - Aerodromes:

~~***"non-instrument runway"*** *- a runway intended for the operation of aircraft using visual approach procedures*~~.



ICAO Annex 14 Amendment 11-B (Nov 2014):

"non-instrument runway" *- a runway intended for the operation of aircraft using visual approach procedures or an* ***instrument approach procedure*** *to a point beyond which the approach may continue in visual meteorological conditions.*


European Aviation Safety Agency

Opinion No 03/2016

Maintaining the aerodromes rules —
ICAO new approach classification

RELATED NPA/CRD: N/A — RMT.0591 — 8.3.2016

Opinion 03-2016 (Amending Reg.139/2014)

Executive summary:

It facilitates ***performance-based navigation approach operations*** *with vertical guidance to be applied* ***at non-precision approach runways****, and instrument approach operations to be associated with non-instrument runways without the need in both cases to upgrade runway infrastructure"*

Non-instrument RWYs
EASA Basic Regulation - Scope

Basic Reg. 216/2008

Local CAA

Reg 216/2008, *Article 4 (3a) - Basic Principles and applicability*

- ✓ *Aerodromes open to public use, and*
- ✓ *Serve Commercial Air Transport, and*
- ✓ ***Using instrument approach*** *or departure procedures, and*
- ✓ *[Paved RWY ≥ 800m] or [Exclusively serve helicopters]*

Non-instrument RWYs
EASA Basic Regulation - Scope

Basic Reg. 216/2008

EASA Opinion 03-2016
(Reg.139/14 scope amended)

Local CAA

CAP1122

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- ✓ *Serve Commercial Air Transport, and*
- ✓ ***Using instrument approach*** *or departure procedures, and*
- ✓ *[Paved RWY ≥ 800m] or [Exclusively serve helicopters]*

EU28 – 2673 aerodromes with non-instrument RWYs

777 420

475 366

ICAO new RWY classification
EGNOS SoL Service Levels

New Approach Classification						
Domain	**Document**	**Aspect**				
Approach Operations	Annex 6	Classification	Type A (>= 250')		Type B CAT I (>= 200')	Type B CAT II (>= 100') / CAT III (<100')
		Method	2D	3D		
		Minima	MDA/H	DA/H*		
Approach Runways	Annex 14	M(DA/H) >= VMC	Non Instrument RWY			
		M(DA/H) >= 250' Visibility=1 000m	Non Precision Approach RWY			
		DA/H >= 200' Visibility>=800m or RVR >= 550m	Precision Approach RWY, Category I			
		DA/H >= 100' RVR >= 300m	Precision Approach RWY, Category II			
		DA/H >= 0' RVR >= 0m	Precision Approach RWY, Category III (A, B & C)			
System Performance Procedures	Annex 10 PANS-OPS Vol. II	NPA	NDB, Lctr, LOC, VOR, Azimuth, GNSS			
		APV		GNSS/Baro/SBAS		
		PA		ILS, MLS, SBAS, GBAS		

New Approach Classification as described in ICAO State Letter AN 11/1.1-12/40 June 2012

ICAO new RWY classification
EGNOS SoL Service Levels

New Approach Classification

Domain	Document	Aspect					
Approach Operations	Annex 6	Classification	NPA	Type A (>= 250')	Type B CAT I (>= 200')	Type B CAT II (>= 100')	Type B CAT III (<100')
		Method	2D	3D			
		Minima	MDA/H	DA/H*			
Approach Runways	Annex 14	M(DA/H) >= VMC	Non Instrument RWY				
		M(DA/H) >= 250' Visibility=1 000m	Non Precision Approach RWY				
		DA/H >= 200' Visibility>=800m or RVR >= 550m	Precision Approach RWY, Category I				
		DA/H >= 100' RVR >= 300m	Precision Approach RWY, Category II				
		DA/H >= 0' RVR >= 0m	Precision Approach RWY, Category III (A, B & C)				
System Performance Procedures	Annex 10 PANS-OPS Vol. II	NPA	NDB, Lctr, LOC, VOR, Azimuth, GNSS				
		APV		GNSS/Baro/SBAS			
		PA		ILS, MLS, SBAS, GBAS			

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ICAO new RWY classification
EGNOS SoL Service Levels

New Approach Classification

Domain	Document	Aspect					
Approach Operations	Annex 6	Classification	NPA	Type A (>= 250')	Type B CAT I (>= 200')	Type B CAT II (>= 100')	Type B CAT III (<100')
		Method	2D	APV-I	3D		
		Minima	MDA/H		DA/H*		
Approach Runways	Annex 14	M(DA/H) >= VMC	Non Instrument RWY				
		M(DA/H) >= 250' Visibility=1 000m	Non Precision Approach RWY				
		DA/H >= 200' Visibility>=800m or RVR >= 550m	Precision Approach RWY, Category I				
		DA/H >= 100' RVR >= 300m	Precision Approach RWY, Category II				
		DA/H >= 0' RVR >= 0m	Precision Approach RWY, Category III (A, B & C)				
System Performance Procedures	Annex 10 PANS-OPS Vol. II	NPA	NDB, Lctr, LOC, VOR, Azimuth, GNSS				
		APV		GNSS/Baro/SBAS			
		PA		ILS, MLS, SBAS, GBAS			

APV-I Service Level:

- Operation :

Type A (DH≥250ft), 3D

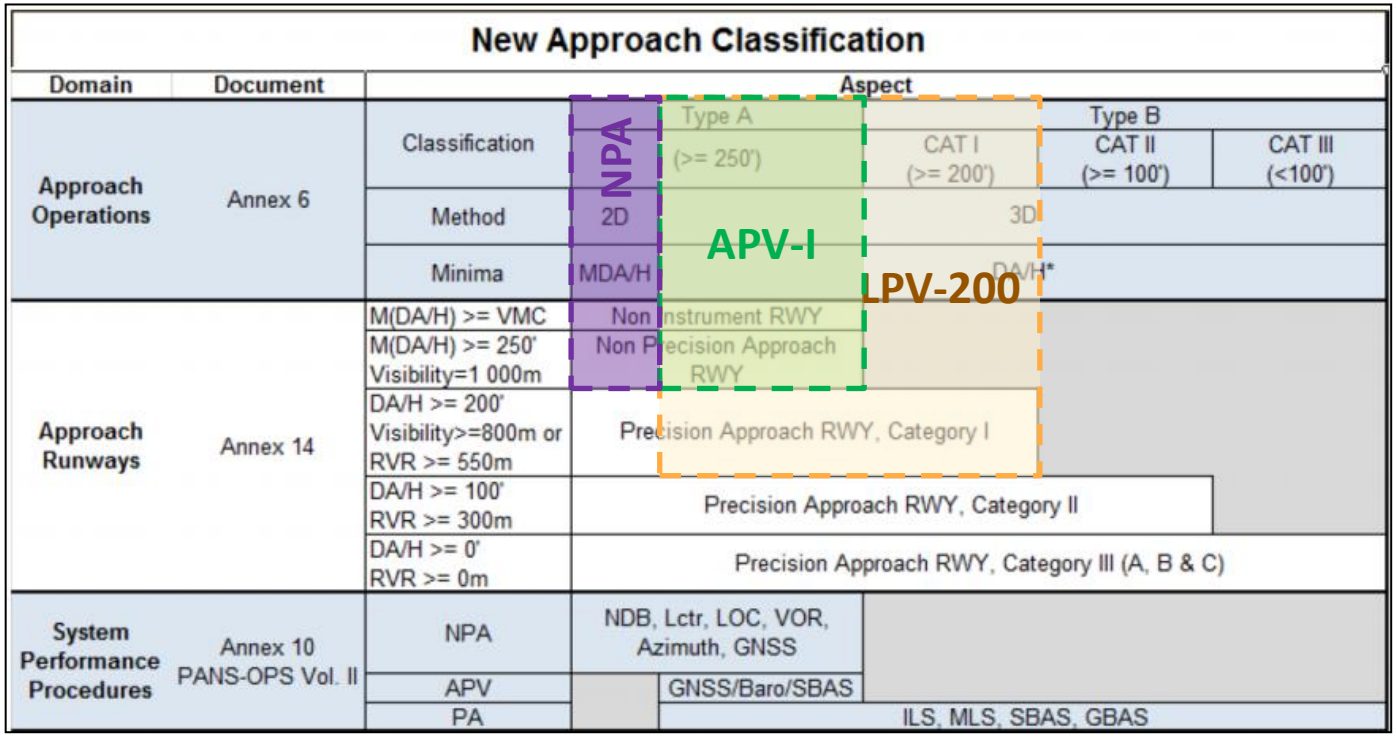
- RWY:

Non-instrument

Non-precision approach

New Approach Classification as described in ICAO State Letter AN 11/1.1-12/40 June 2012

ICAO new RWY classification
EGNOS SoL Service Levels



APV-I Service Level:

- Operation :

Type A (DH≥250ft), 3D

- RWY:

Non-instrument

Non-precision approach

LPV-200 Service Level:

- Operation:

Type A (DH≥250ft), 3D

Type B Cat I (DH ≥200ft), 3D

- RWY:

Non-instrument

Non-precision approach

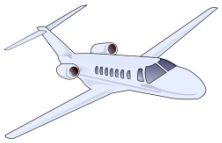
Precision approach Cat I

New Approach Classification as described in ICAO State Letter AN 11/1.1-12/40 June 2012

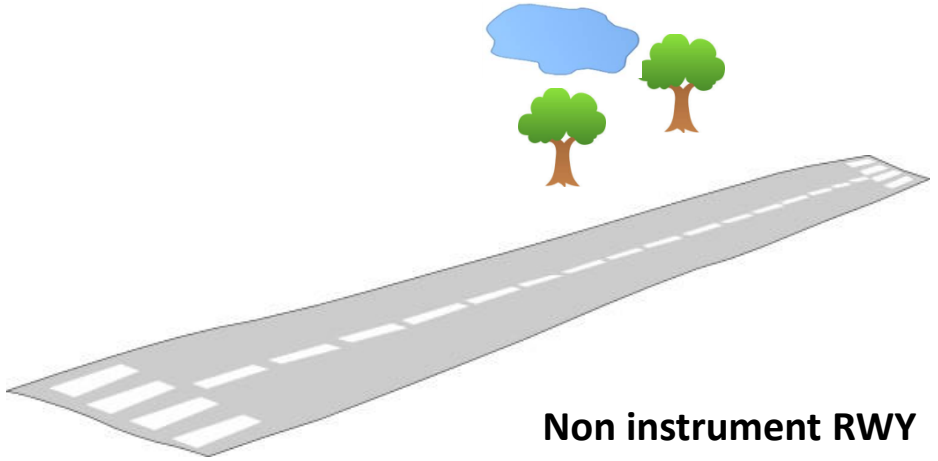
EGNOS based operations
New scenario

UP TO NOW

VFR



VMC

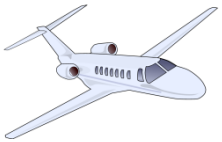


Non instrument RWY

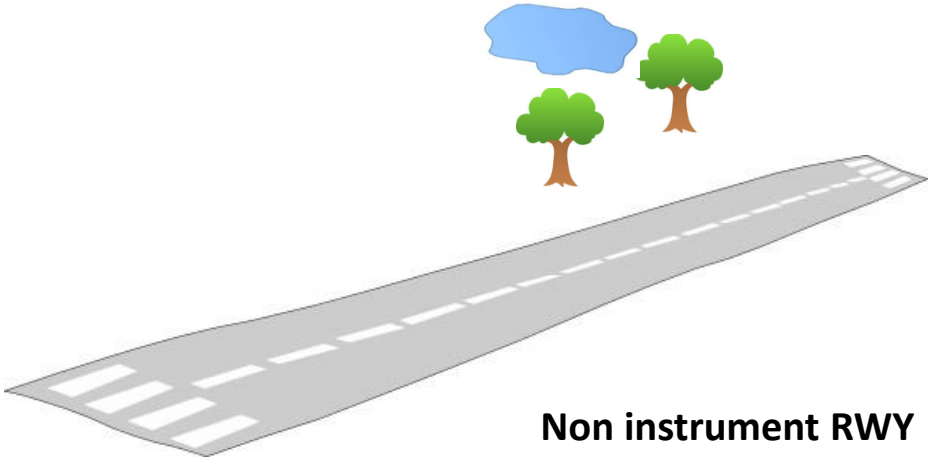
EGNOS based operations
New scenario

AFTER EASA OPINION 03/16

VFR → IFR



VMC



Non instrument RWY

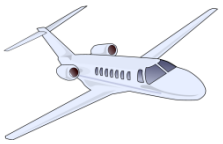
EGNOS based operations
New scenario

AFTER EASA OPINION 03/16

VFR → IFR

EGNOS

SBAS capable

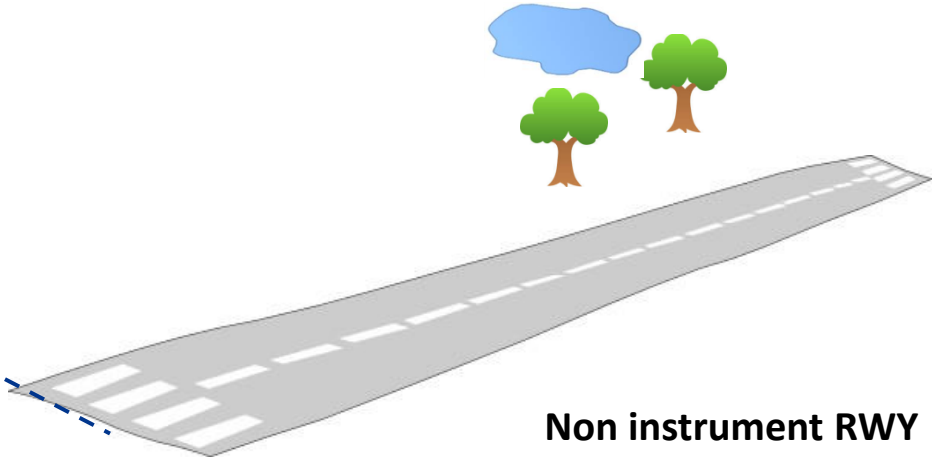


DA/H

VMC

3D, Vertical guidance

'similar to PinS'



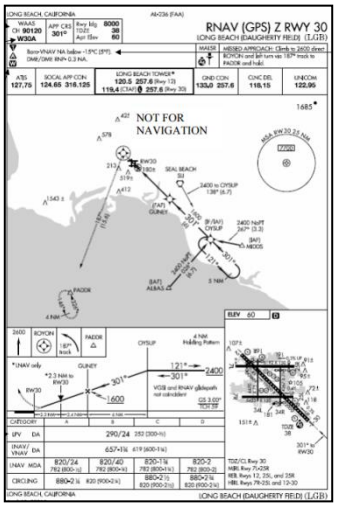
Non instrument RWY

EGNOS based operations
New scenario

AFTER EASA OPINION 03/16

VFR → IFR

AIS



SBAS capable

ATS

DA/H

VMC

MET

COM

3D, Vertical guidance

'similar to PinS'

Non instrument RWY

OPTION 1: UPGRADE

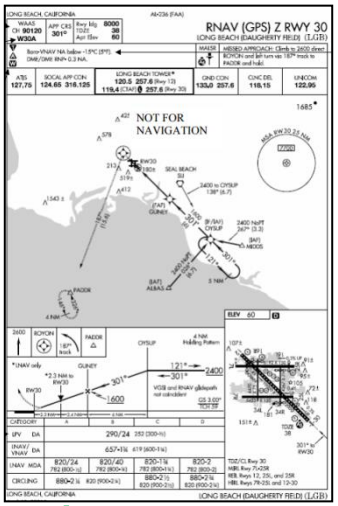
EGNOS based operations
New scenario

AFTER EASA OPINION 03/16

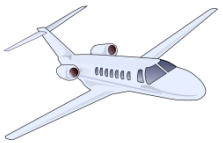
VFR → IFR

AIS

THE CHALLENGE!



SBAS capable

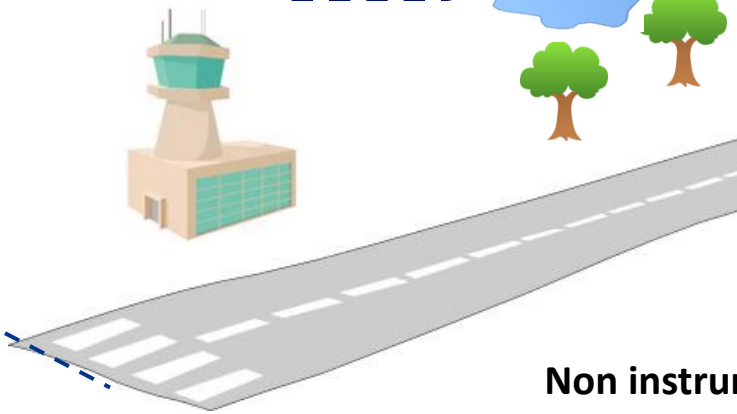


DA/H

VMC

ATZ – Class G

ATS



MET

COM

3D, Vertical guidance

'similar to PinS'

Non instrument RWY

OPTION 2: NO UPGRADE

EGNOS based operations
New scenario

Two projects funded by GSA fitting this new scenario:

- **Cumbernauld Airport (EGPG):**
  LPVs on both (non-instrument) runway ends.

- **GAGA Project (GNSS Approaches for General Aviation):**
  Stapleford Airport (EGSG), no ATS, 1 or 2 LPVs.

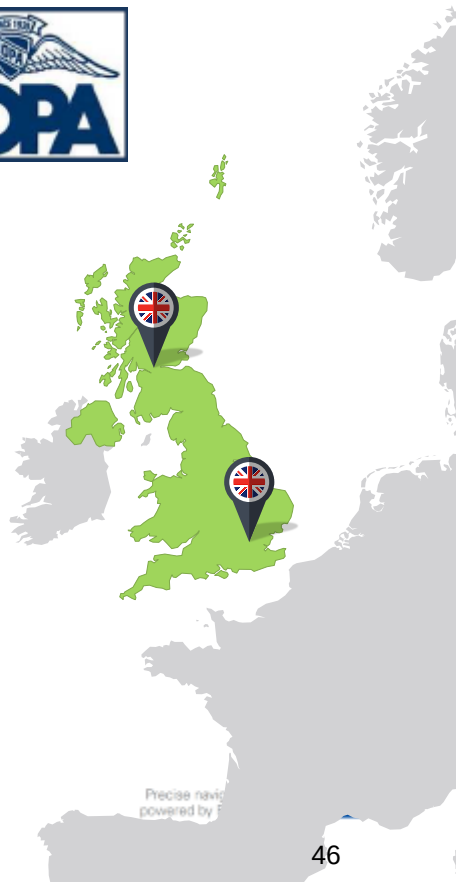
UK CAA

Assessing the case under CAP1122 framework

ESSP is ready to support this kind of approaches providing:

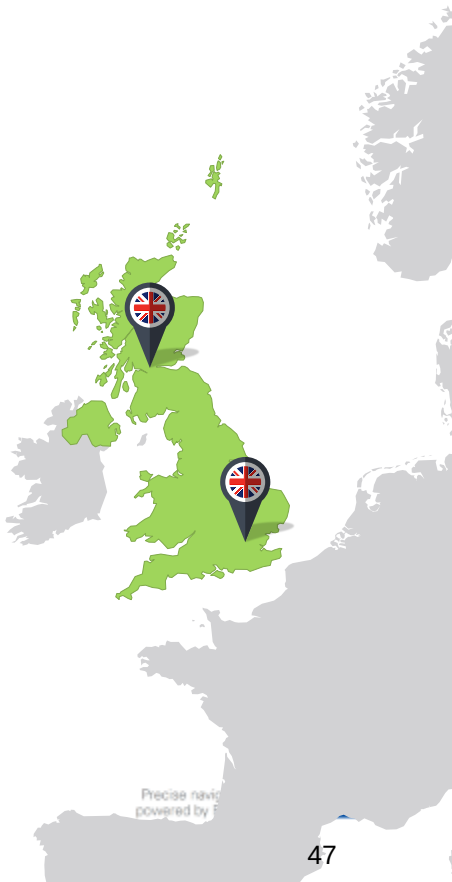
NOTAM Proposals
Collaborative Decision Making
GNSS Data Recording

We certify you're there.



EGNOS based operations
New scenario

WHO'S NEXT?



EGNOS

QUESTIONS?