EGNOS

EGNOS, it's there. Use it.

EGNOS in aviation: strategy and implementation status

EGNOS Service Provision Workshop 2017
Athens, 3rd October 2017

Carmen Aguilera, GSA
Jose Maria Lorenzo, ESSP

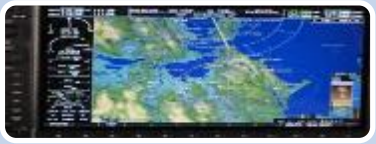
European GNSS Agency

ESSP

Precise navigation, powered by Europe

EGNOS applications in aviation

Performance Based Navigation (fixed wing)



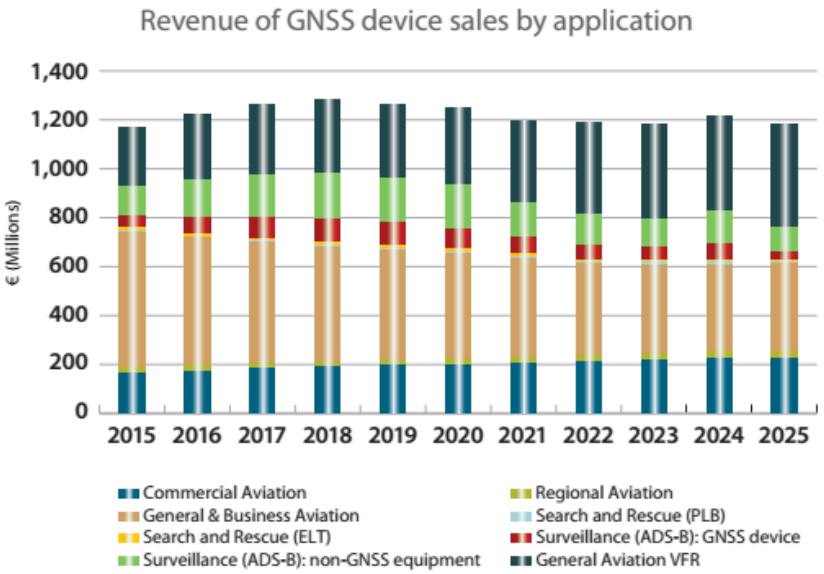
Navigation aid

Performance based navigation for rotorcraft: RNP0.3, Pins LPV, SNI

Automatic Depended Surveillance – Broadcast (ADS-B)

Unmanned Vehicles Systems

Aviation moves towards GNSS for Navigation and Surveillance, increasing SBAS use



Key market trends:

- The aviation market continues to grow worldwide with reliance on GNSS increasing
- Regulators support expansion of PBN, result in increasing sales of GNSS/SBAS
- Rotorcraft operations are rapidly expanding their use of SBAS

RNP APCH deployment on the ground is driving increase of LPV capability on board

Over 45 operators in 18 countries approved and certified to fly LPV

No need for Specific approval anymore!

Increasing the EGNOS target market: LPV to non instrumental runways:

The challenge:

LPV to non-instrument runway (ATS? Runway? MET/COM?)

Regulatory framework:

The UK CAP 1122

PPL/IR EUROPE

"GA need help to increase GNSS approaches implementation and increase safety"

Paul Sherry, PPL/IR Europe.

Pilot cases in UK and Germany

- Egelsbach
- Perth
- Shelburn in Elmut
- Stapleford
- Haverfordwest

Potential market

777 420

475 366

EU28 – 2673 airports with non-instrument RWYs

*Towards an **harmonised implementation framework** together with*

EASA European Aviation Safety Agency

EGNOS supports demanding ADS-B applications while reducing ground infrastructure costs

FAA ADS-B Out Mandate

Demanding operational requirements:
2NM separation for dependent parallel approaches

Mandate to equip all aircraft flying in certain airspace with ADS-B Out by 2020

WAAS recommended
Performance equivalent to radar surveillance

European Mandate

Most demanding ATS surveillance case:
3 NM separation

Mandate to equip Aircraft with MTOM higher than 5700 kg or with maximum true air speed higher than 250 kts (2020)

GPS receiver (ETSO-C129a) compliant is deemed to be sufficient

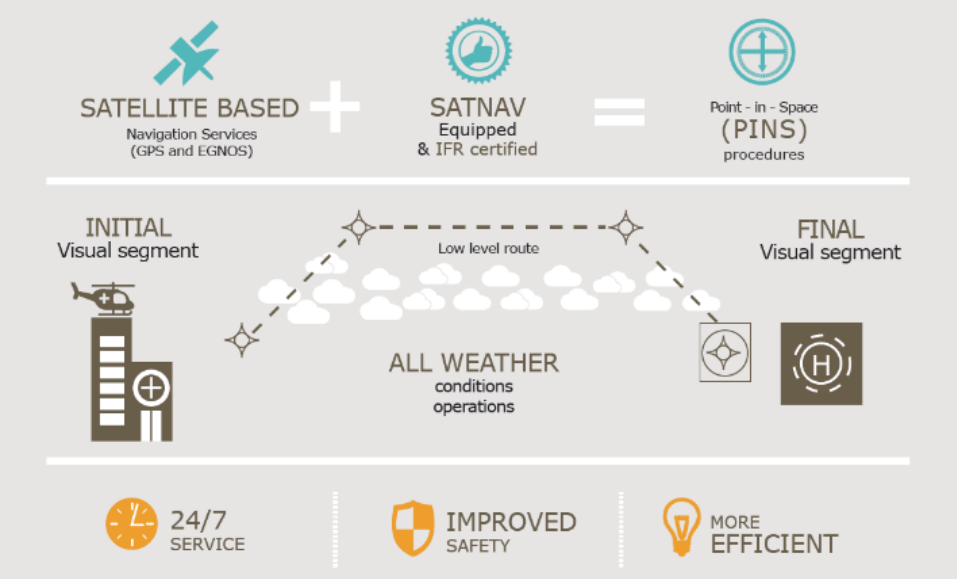
EGNOS supports an overall CNS strategy

Operators are using SBAS for PBN and ADS-B

When other applications are taken into account, upgrade costs are shared

ADS-B based on satellite technology can support ground infrastructure rationalisation

Increase demand for EGNOS based PBN operations for rotorcraft …



Source: PildoLabs

Example of operational PINS in Switzerland (Insel Hospital), used by REGA

Deployment ongoing in:

- Switzerland, Italy, Norway, France

Confirmed plans in 2018 in:

- Germany, United Kingdom, Spain, Czech Republic and Italy

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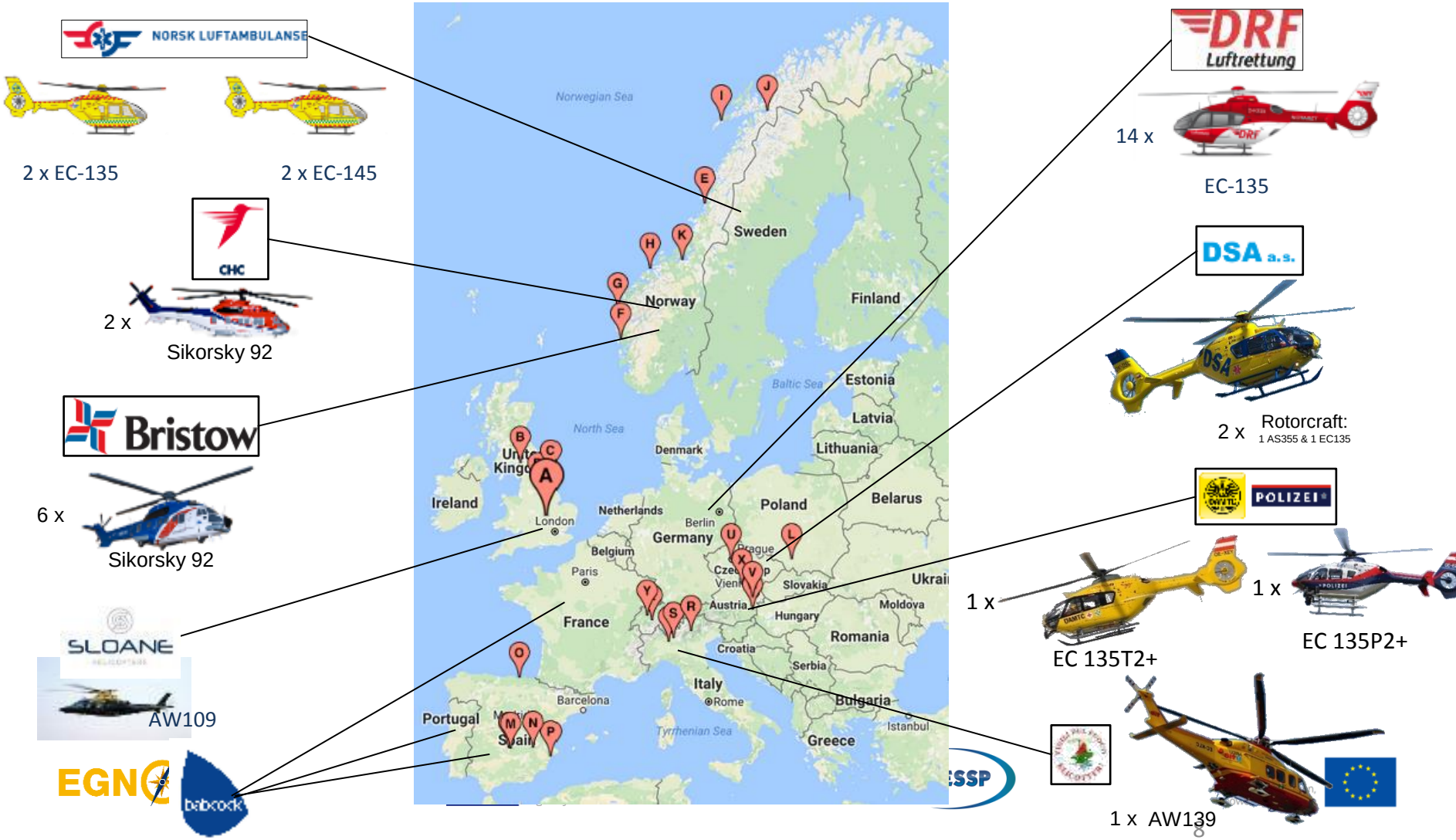
…and operators are getting EGNOS on board



…and operators are getting EGNOS on board

NORSK LUFTAMBULANSE

2 x EC-135

2 x EC-145

CHC

2 x Sikorsky 92

Bristow

6 x Sikorsky 92

SLOANE

AW109

EGNOS babcock

23 PinS

14 RNP 0.3 routes

29 rotorcraft retrofit

DRF Luftrettung

14 x

EC-135

DSA a.s.

2 x Rotorcraft:
1 AS355 & 1 EC135

POLIZEI

1 x

EC 135T2+

1 x

EC 135P2+

1 x AW139

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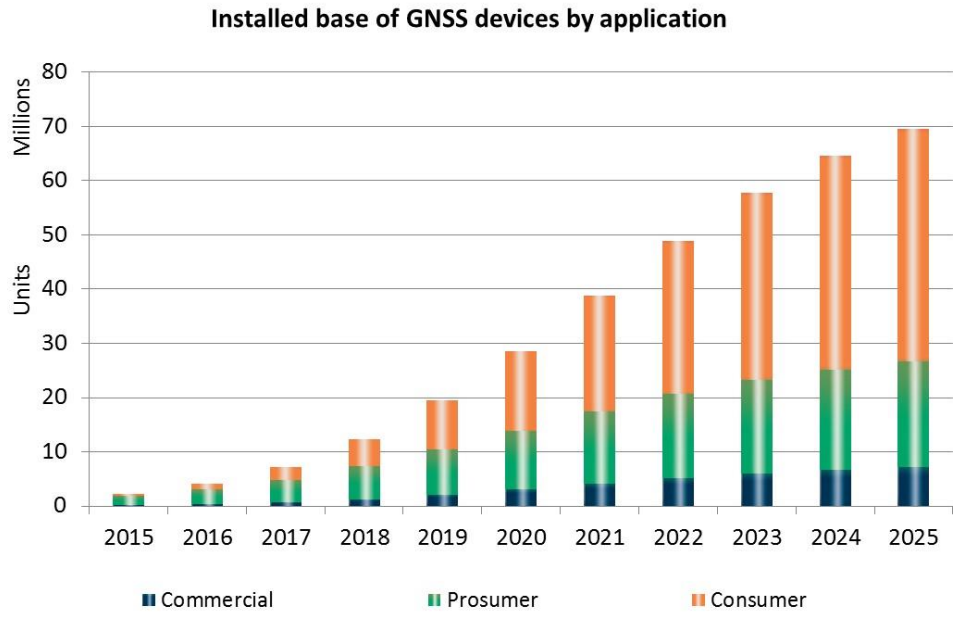
FLAG: Rotorcraft Working group for the harmonisation of PinS and Low Level routes implementation in Europe

Safety Guidance Material
coming soon!

E-GNSS is an enabler for robust RPAS navigation



Key market trends:

- Drones will grow to outstrip any other user base in aviation
- For most ambitious applications in BVLOS, GNSS is the only choice
- Need of highly accurate and reliable performance, specially in professional applications
- Geofencing is required for most drones above 900g

GSA is supporting several geo-fencing test campaigns for proof of concept

1

Precise take-off and landing on power substations

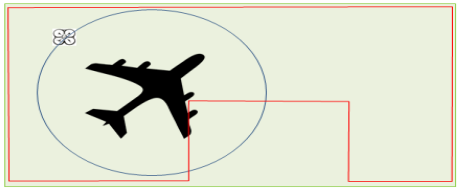
- Range of BVLOS limited to 10km for testing
- Flight along distribution line
- Landing and take-off at same location (Non airport)

Showcase II: Firefighting operations

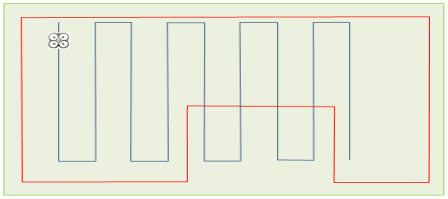
- Testing area in segregated airspace
- Take off and landing from existing airport
- Autonomous landing

2

Geofencing test for aircraft inspection

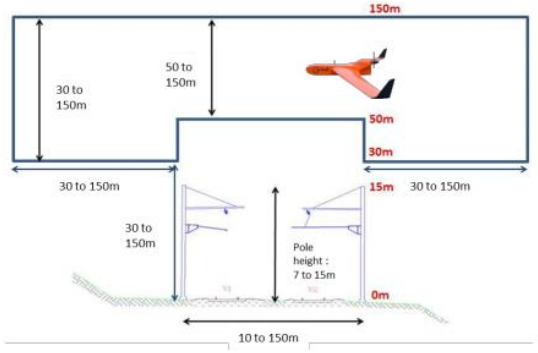


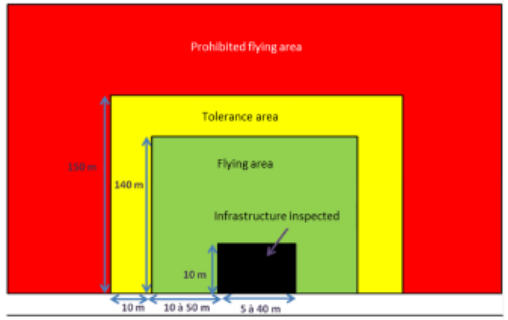
Geofencing in field surveillance



3

Railway inspection





Ongoing Flight test Campaigns: preliminary results highlight EGNOS performance

By: nlr Dedicated to innovation in aerospace

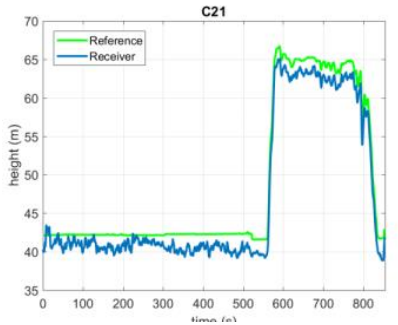
Mikrokopter MKGPS V3 quadcopter:

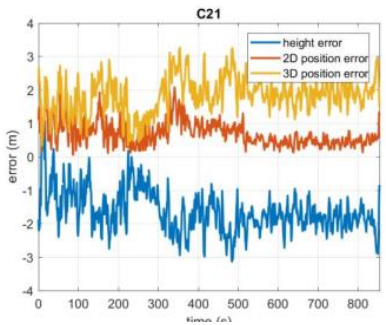
- GPS, EGNOS, Galileo
- uBlox LEA-6S GNSS receiver
- Extra Septentrio AsteRX3 GNSS Rx
- Capable of defining and using geofence zones
- Results of on board GNSS receivers compared to ground reference station providing carrier differential GNSS (<5cm)

Height profile

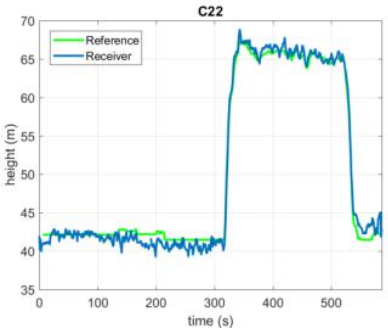
Error profile

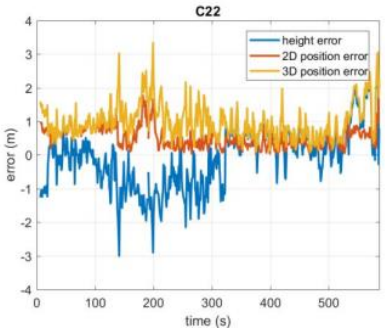
GPS only





GPS + EGNOS





Conclusions:

- Use of EGNOS in position keeping and tracking resulted in more stable flight vs GPS alone
- Position errors with EGNOS < 1m vs > 2 m with GPS alone
- Geofencing capabilities improved by EGNOS: on time detection of no-fly zones

powered by Europe

SBAS ready RPAS receivers in the market

Receivers intended mainly for **Consumer** market

u-blox

EAGLE TREE SYSTEMS

Receivers intended mainly for **Prosumer** market

COMNAV

iNVS

Trimble

Receivers intended mainly for **Professional** market

NovAtel

SBG SYSTEMS

septentrio

VECTORNAV Embedded Navigation Solutions

weControl

* According to GSA Market report definition. Products are not exclusive to each category

GSA tools to boost EGNOS adoption in aviation

Image source: http://www.cornerstonecontent.com/27-marketing-experts-share-their-favorite-content-marketing-tools-and-how-they-use-them/

Four main axis of action

User needs	Partnership with **user communities** to address user needs
Support to regulation	**Aviation Task Force EASA/GSA/GROW/MOVE with agreed workplans on:** ○ Fixed wing navigation, including LPV to non instrument RWY ○ Rotorcraft navigation ○ Drones navigation ○ Surveillance, ADS-B
Towards the value chain	**Practical tools:** ○ Cost/Benefit Analysis for Operators and Airports (navigation and surveillance) ○ Guidelines on how to… ○ Database on avionics
Funding for adoption & R&D	• EGNOS based operations and equipage • **New applications** development • **New receivers** development

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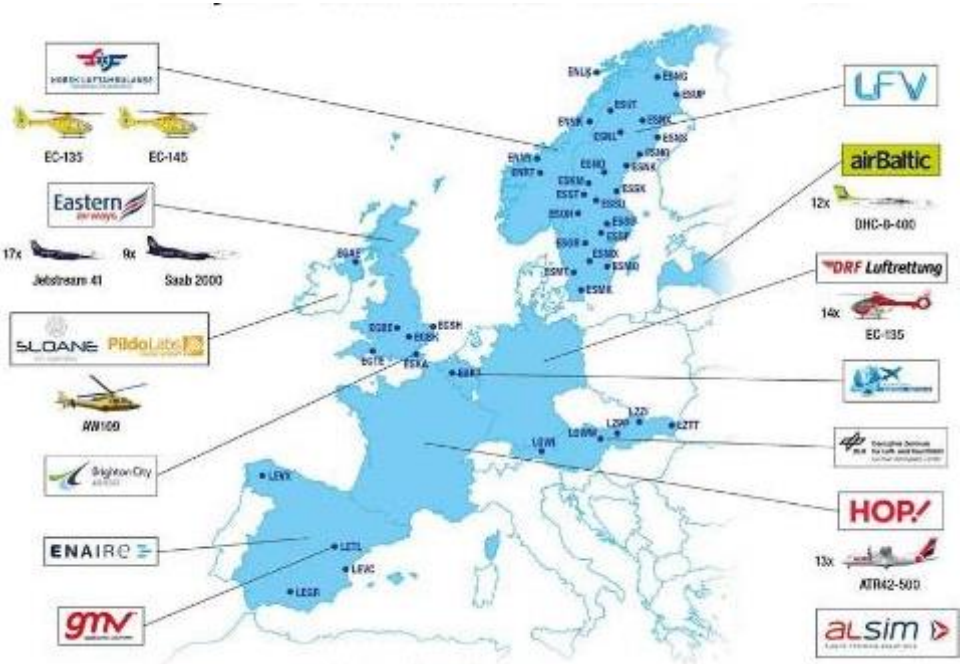
GSA funding for EGNOS operational implementation

- ✓ **12 Million €, 29 projects** in 2 calls
- ✓ more than **100 EGNOS based approach procedures**
- ✓ more than **15 operators equipped and certified for EGNOS based operations**
- ✓ STC for **5 aircraft types** with a potential retrofit solution for more than **260 aircraft in EU**
- ✓ **6** EGNOS enabled **simulators types**
- ✓ More than **20 PinS and RNP0.3 routes** for rotorcraft
- ✓ **3 EGNOS based RPAS operations**



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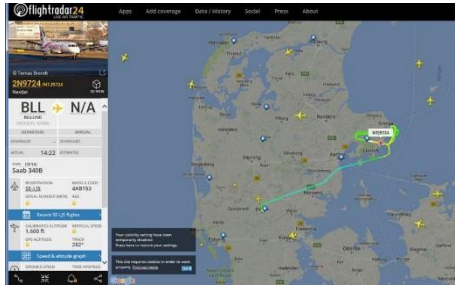
The investment is paying off!

NEXTJET

Objective:
- Develop STC for upgrade of Saab 340
- Upgrade 10 Saab 340 aircraft with EGNOS capabilities

Status:
- Preliminary STC design completed
- Prototype aircraft upgraded
- Prototype aircraft successfully passed ground testing
- Prototype aircraft successfully passed in-flight testing, during a 3h23 minutes flight, with multiple LPV tests at Aarhus airport



Tracking of in-flight testing

HOP!

Objective:
- Develop STC for upgrade of ATR42-500
- Upgrade 13 ATR42-500 aircraft of the HOP! (Air France) fleet towards EGNOS capabilities

Status:
- STC approved during summer 2017
- 7 aircraft already prewired, scheduled to activate upgrade before end of 2017

Prototype aircraft for first upgrade

Bristow

Objective:
- Upgrade of 6 Sikorsky S92 helicopters

Status:
- All aircraft have received their upgrade
- Training program for training pilots accepted by CAA and finalized


Cockpit and cabin dismantled for upgrade

Avionics developed within the grants programme deliver solutions for over 260 aircraft of 30 different operators

Aircraft type	GSA grant project	STC developer	Avionics	Estimated fleet size in Europe
DHC8-402	AirBaltic	CanardAerospace	UNS1-Ew	140
JetStream41	Eastern Airways	Cranfield Aerospace	UNS	20
Saab2000	Eastern Airways	Cranfield Aerospace	UNS	32
Saab340	NextJet	Scandinavian Avionics	UNS1-Ew	54
ATR42-500	HOP!	AeroConseil	CMC	25

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Staying close to users to provide first hand answers to your needs

GSA-European Business Aviation Association LPV WG

- ✓ LPV implementation to priority aerodromes
- ✓ Guidance on operation approval
- ✓ Retrofit solutions availability for the EBAA fleet

Last meeting:
Brussels, 22 Sep

European Regional Airlines Association-Operations Group

- ✓ Enable LPV operations to priority airports
- ✓ Foster development of avionics solutions for E-GNSS operations
- ✓ Increase awareness of EGNOS RNP APCH benefits to regional airpo

ERA General Assembly, Operations group:
Athens 17-19 Oct

FLAG-Rotorcraft Working group

- ✓ Harmonise implementation of EGNOS based Rotorcraft operations
- ✓ Address operational and regulatory aspects
- ✓ Identify service provision needs
- ✓ Compliance criteria
- ✓ Validation of new concepts

FLAG workshop
Barcelona, 30 Nov-1 Dec

THANK YOU FOR YOUR ATTENTION

Carmen Aguilera

Aviation and R&D Market Development Officer, GSA

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www.gsa.europa.eu

All major avionics manufacturers have EGNOS ready products available

Avionics certified to ETSO C145 or C146 (SBAS)

GARMIN

GNS 430W / 530W

GTN 6XX / 7XX TS

G1000, G2000, G3000, G5000

AVIDYNE

EASA cert. pending

IFD540 & IFD440 TS

BendixKing by Honeywell

EASA cert. pending

KSN 765/770 TS

Rockwell Collins

Building trust every day

GPS-4000S

UNIVERSAL AVIONICS SYSTEMS CORPORATION

UNS-1Ew, -1Lw, -1Fw

Honeywell

KGS 200

(Primus Apex /Easy II)

Esterline

CMA 5024 GLSSU

THALES

AVIONICS

Topstar 200 LPV

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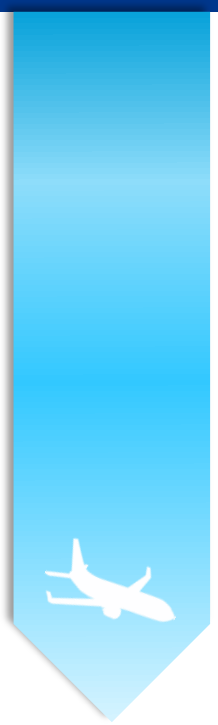
EWA



LPV Implementation Status

EWA for non-EU Countries

EGNOS at Non-instrument RWY

IFR/SBAS benefits

IFR

- Increases airport accessibility
- ↑ SAFETY due to INSTRUMENTAL aid
- Reduces environmental impact

SBAS

- Higher performances → Lower minima
- Not Temperature/Pressure dependent
- LPV Procedure is ILS look alike
- No RAIM check
- No ground infrastructure at the airport

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LPV: WHO DOES WHAT?

ESSP

EGNOS Service Provider

Certified as SES ANSP (Navigation)

EGNOS SoL Service Safe introduction

EGNOS DoV produced

E
W
A

ANSP

ATS Service Provider

Certified as SES ANSP

Standard Approach Procedure Approval Process:

- ✓ Operational Safety Assessment
- ✓ IFP Design (PANS-OPS)
- ✓ Flight Validation, etc.
- ✓ Specific National Requirements

Final users

Airlines / Operators

Airworthiness/ops app. (AMC-20-27/28, TGL 2/10)

Authorised Equipment (ETSOs C144,C145 or C146)

Crew Trained/Qualified, etc.

SUPERVISORY BODY

Competent NSA

EASA

EGNOS Working Agreement

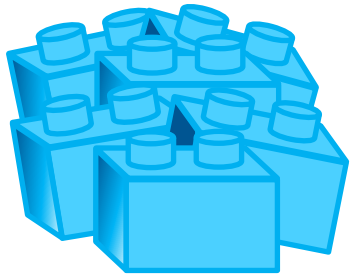
EWA

- Complies with Applicable Regulation
- Provides support to ANSPs
- Working Interfaces
- EGNOS SoL Service Definition Document (SDD)
- Service Arrangements
- NOTAM Proposal Origination
- GNSS Data Recording (incident/accident investigation)
- Collaborative Decision Making (CDM)
- Contingency Management
- Airport Data Tool (to register new EGNOS based procs)

Competent NSA

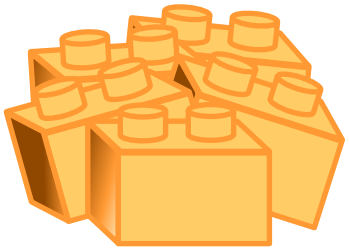
EASA

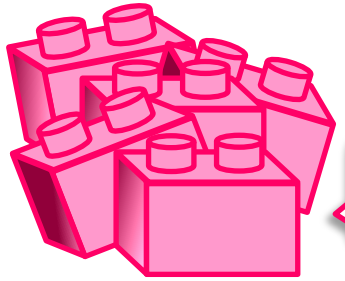
LPV Implementation Status - EWAs



ANSPs

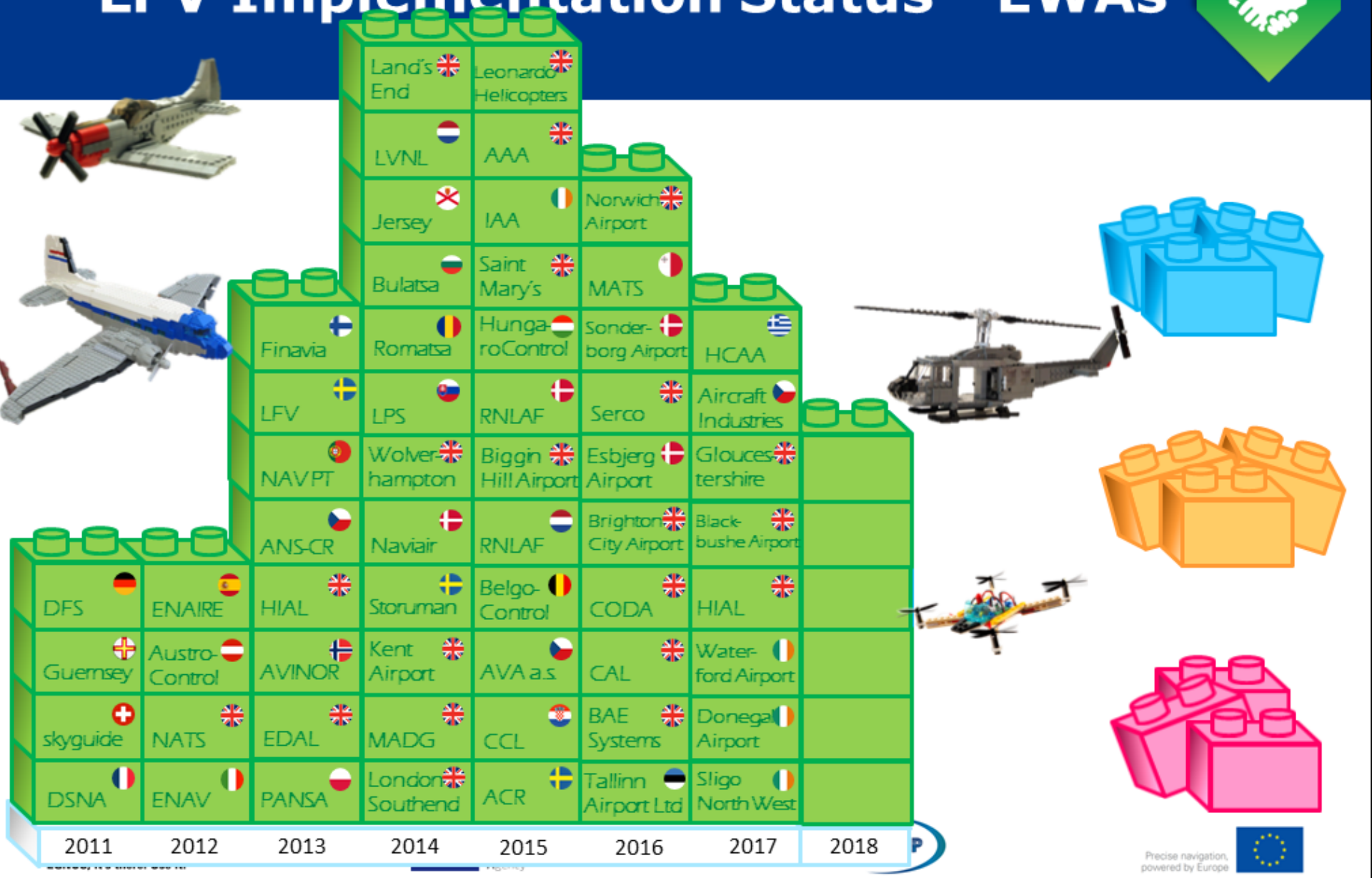
Aerodrome Operator





Non-EU

LPV Implementation Status - EWAs



LPV Implementation Status - EWAs

56 EWAs in place

- EU Members

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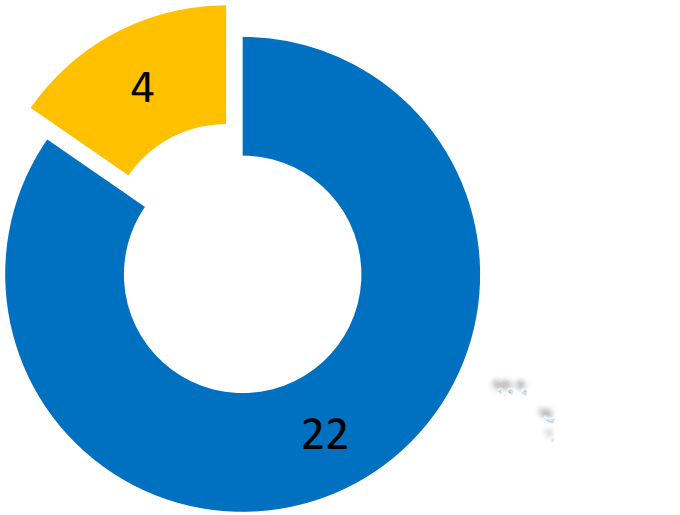
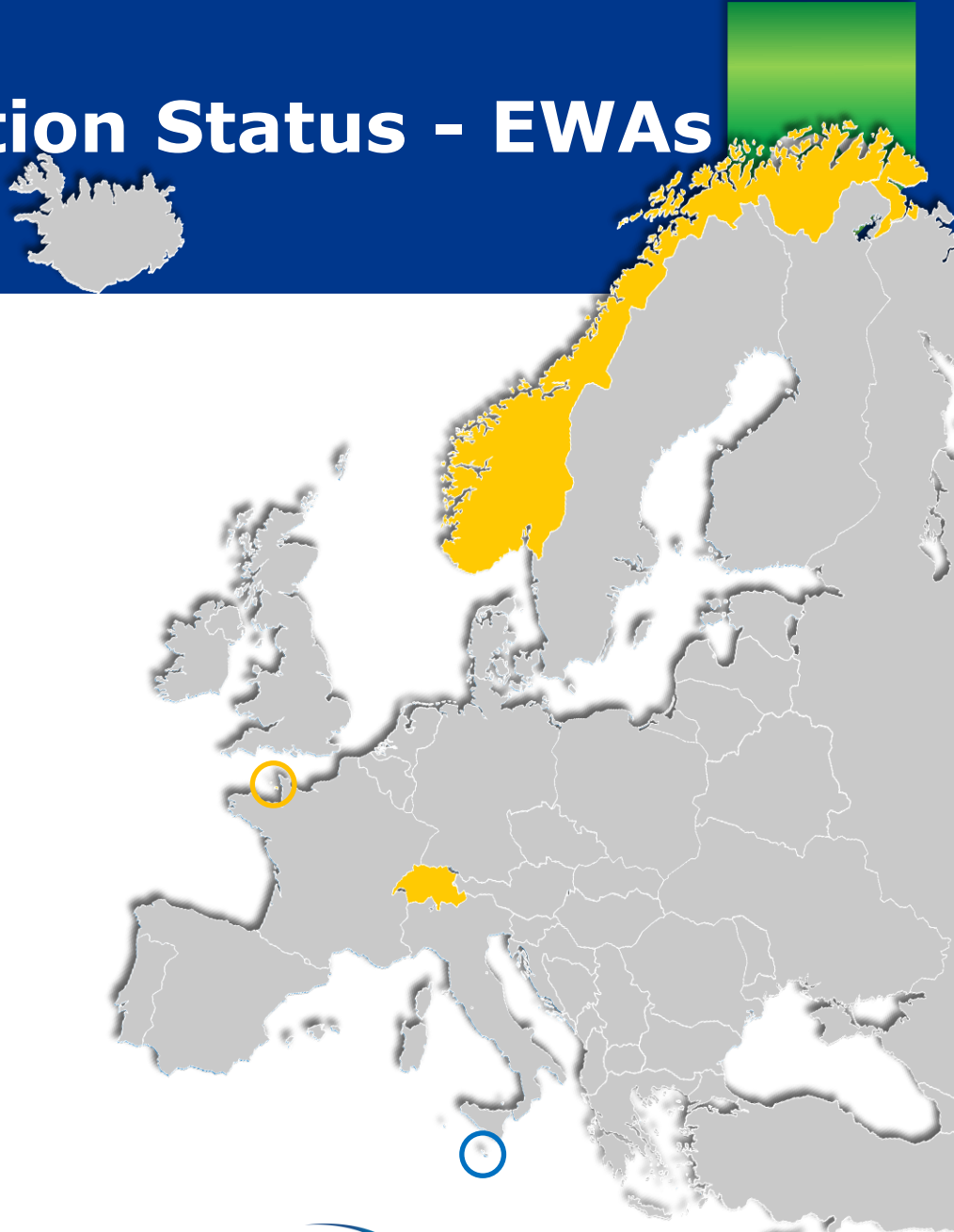
LPV Implementation Status - EWAs

56 EWAs in place





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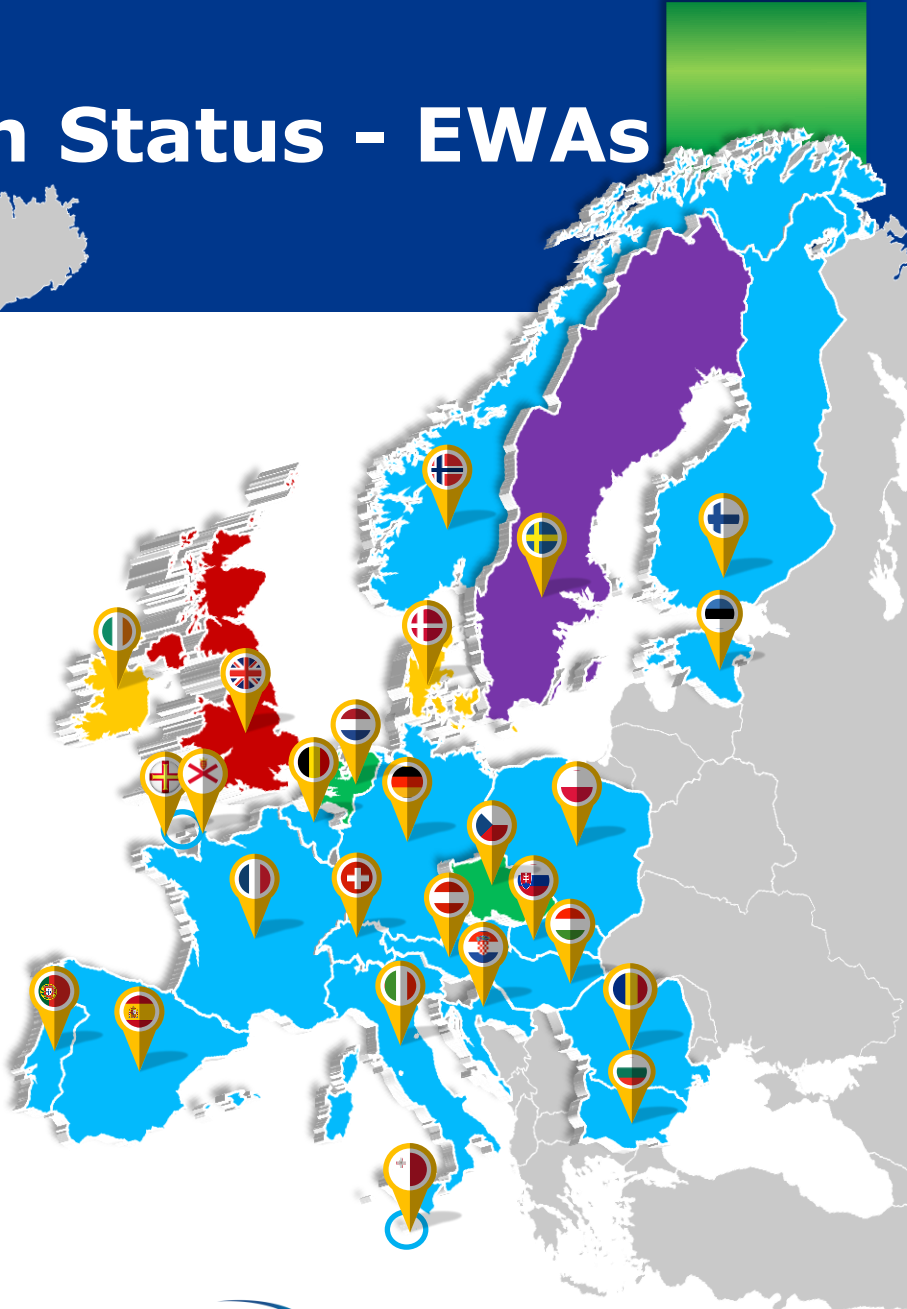
LPV Implementation Status - EWAs

56 EWAs in place

EWAs per country

- 1 EWA
- 2 EWAs
- 3 EWAs
- 4 EWAs
- 21 EWAs



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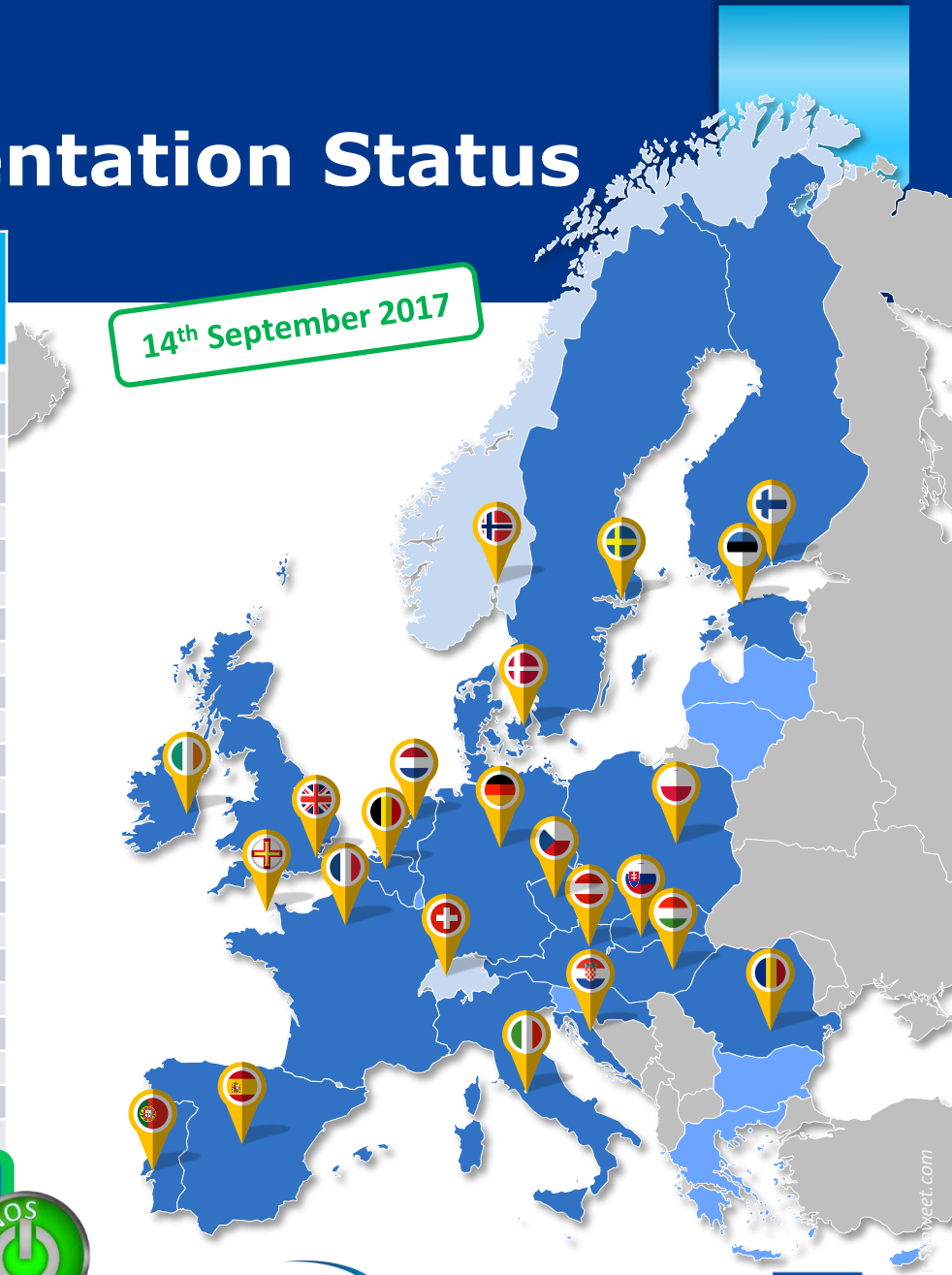
LPV Implementation Status

COUNTRY	Airports		LPV Procedures		RNP 0.3 Procs
	APV-I	LPV-200	APV-I	LPV-200	
Austria	2	2	2	4	0
Belgium	4	0	10	0	0
Croatia	1	0	1	0	0
Czech Republic	4	0	8	0	0
Denmark	4	1	8	2	0
Estonia	1	0	2	0	0
Finland	1	0	2	0	0
France	89	10	141	18	0
Germany	21	4	34	7	0
Guernsey	1	0	2	0	0
Hungary	0	1	0	4	0
Ireland	1	0	1	0	0
Italy	10	0	20	0	0
Netherlands	2	0	3	0	0
Norway	16	7	24	13	0
Poland	5	0	9	0	0
Portugal	1	0	2	0	0
Romania	1	0	2	0	0
Slovak Republic	2	2	4	2	0
Spain	2	0	4	0	0
Sweden	1	0	1	0	0
Switzerland	7	2	9	2	5
United Kingdom	14	0	31	0	0
TOTAL	**190**	**29**	**320**	**52**	**5**



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LPV Implementation Status - Plans

2011

The journey begins...

Juno is launched

LPV Implementation Status - Plans

2013

The journey begins...

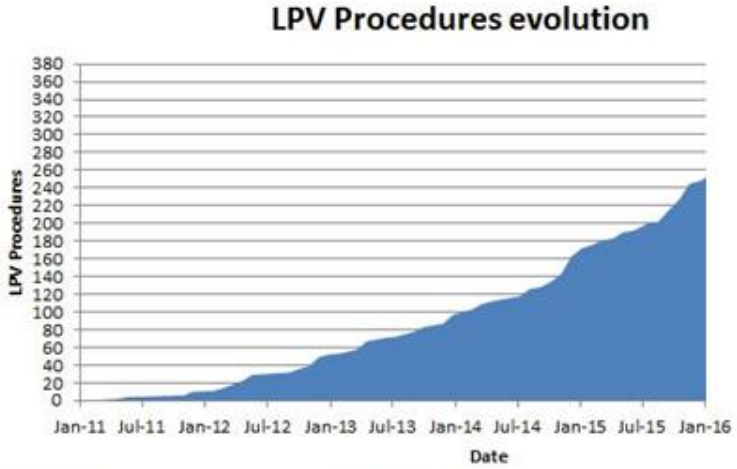
... it continues...

Juno is launched

Juno is half-way to Jupiter

LPV Implementation Status - Plans

2015



The journey begins...

... it continues...

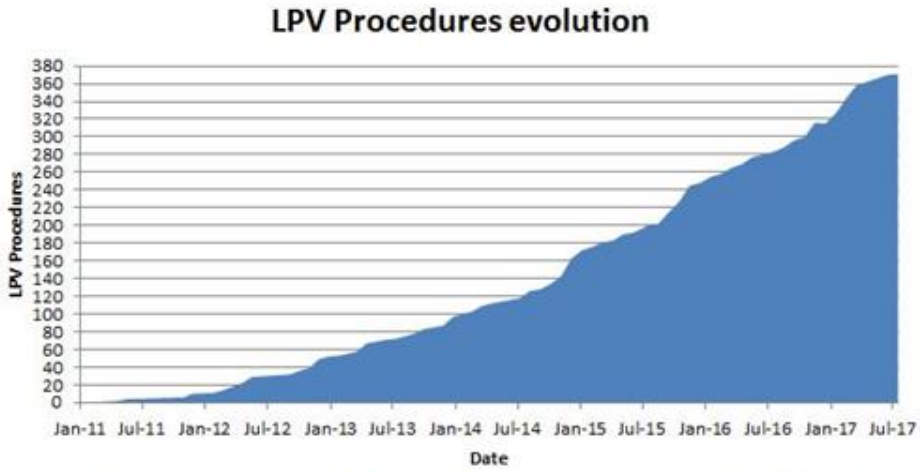
Juno is launched

Juno is half-way to Jupiter

NASA is preparing the arrival to Jupiter

LPV Implementation Status - Plans

2017



The journey begins...

Juno is launched

... it continues...

Juno is half-way to Jupiter

NASA is preparing the arrival to Jupiter

... starts leaving a mark

Juno sent pictures of Jupiter's red spot

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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 neighboring 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.

EGNOS Working Agreements for non-EU countries

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

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EASA Roadmap for GA

General Aviation

6 Objectives we are committed

IFR Flying
Easier access of GA pilots to IFR rating, as a concrete measure that will improve safety.

Training
By end of 2018 the 3rd option for licensing will be fully developed providing a simple system for pilot training outside ATO.

Part-M 'Light'
Work towards a simpler and more proportionate framework for aircraft maintenance and license: a Part-M 'Light'.

Technology
Continue development of CS-STAN and other similar tools to enable the introduction of new technologies which contribute to safety.

Simpler Certification
Towards a simpler framework for certifying LSA aircraft in the short term by increasing the support to applicants e.g. workshops , document templates etc. in the long term by amending applicable regulations in order to bring a radical simplification.

Industry standards
Build on the improvements of CS-23/Part-23 on other CS or regulations in order for EASA to focus on its safety objectives and to delegate the preparation of associated standards to industry groups (ASTM, ASD etc.)

EASA Roadmap for GA

EASA Strategic Objectives for General Aviation (GA)

Introduction of IFR procedures

New ICAO RWY Classification

Safety Level Increase for non-commercial operations with IFP at non-instrument RWYs

EGNOS, it's there. Use it.

European Global Navigation Satellite Systems Agency

ESSP

Precise navigation, powered by Europe

RNP APCH - Non instrument RWY – non towered AD Current VFR scenario

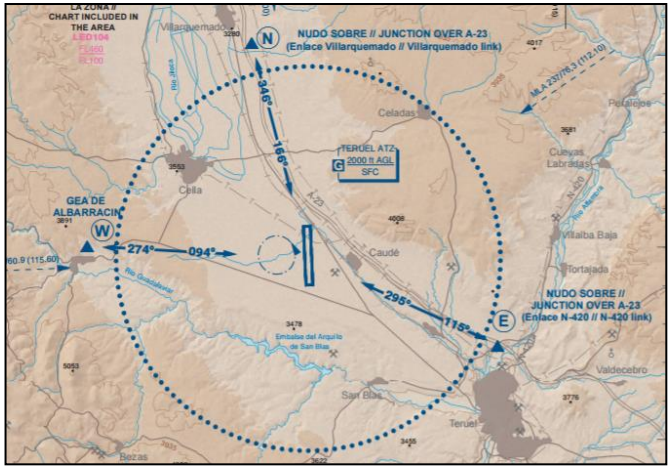
VFR
Visual approach Chart

ARRIVALS
VFR traffic bound for Teruel AD shall remain in the A/A frequency. Entry into ATZ shall be via the established routes to join the aerodrome traffic circuit, communicating its position at the points N (Junction over A-23, Villarquemado link), W (Gea de Albarracín) and E (Junction over A-23, N-420 link).
Entry into air traffic circuit, on downwind and final segments shall be no ified.

Aircraft joining the circuit shall overfly the aerodrome maintaining 2000 ft AGL. They must then descend to circuit height on the inactive (dead) side of the RWY in use and join the circuit by crossing the upwind end of he RWY in use.
Aircraft joining directly on the crosswind leg must arrange their flight to track over the upwind end of the RWY in use, in the same position as if approaching it from the 'deadside'. This must be at circuit height.

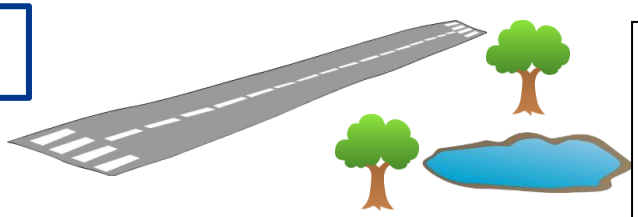
VFR-*No instrumental guidance*

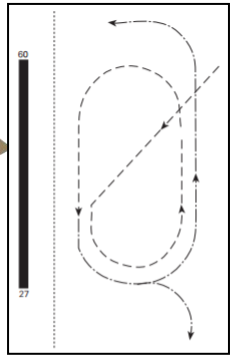
VAC TERUEL AD (FR)



Class G

AD Traffic circuit





AERODROME WITHOUT CONTROL SERVICE
The frequency is only available for AIR/AIR communications.

AD SIN // WITHOUT ATS
FREQ A/A 122.675

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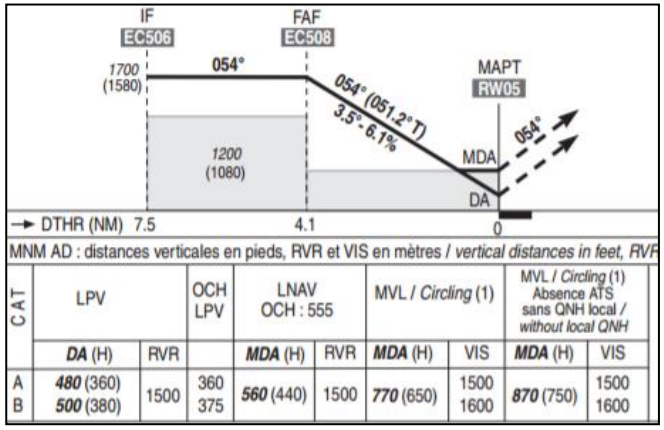
RNP APCH - Non instrument RWY – non towered AD New scenario – Actors involved

IFR – RNP APCH
down to LPV minima



MNM AD : distances verticales en pieds, RVR et VIS en mètres / *vertical distances in feet, RVR*

CAT	LPV		OCH LPV	LNAV OCH : 555		MVL / *Circling* (1)		MVL / *Circling* (1) Absence ATS sans QNH local / *without local QNH*	
	DA (H)	RVR		***MDA*** (H)	RVR	***MDA*** (H)	VIS	***MDA*** (H)	VIS
A	***480*** (360)	1500	360	***560*** (440)	1500	***770*** (650)	1500	***870*** (750)	1500
B	***500*** (380)		375				1600		1600

RNAV (GNSS) RWY05 OUESSANT AD (FR)

SBAS capable A/C

3D, IFR
'similar to PinS'

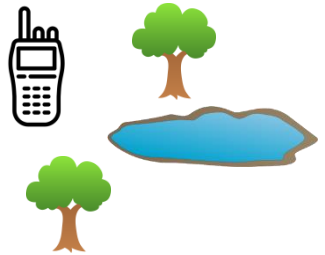
Class E
1000 ft
Class G

DA/H

missed approach

EGNOS
Navigation service provider

UNICOM
A/A, A/G frequency



CAA

AIS
NOTAM Info

MET
QNH, VMC/IMC conditions

AD operator
Non instrument RWY

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EGNOS

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Thanks for your attention!

Now it's your turn!

EGNOS

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Corporate Video

THANK YOU!