EGNOS status and plans

Joint ACAC/ICAO MID Workshop on GNSS

Rabat, 5 April 2016

Ugo Celestino
European Commission
EU GNSS Programmes
European satellite navigation consists of two systems

- **EGNOS**
  - SBAS
  - Improves GPS performance (and Galileo)
  - 3 services (operational since 2009)
  - Continental coverage

- **Galileo**
  - Autonomous infrastructure
  - Performances similar to GPS
  - 5 services (under development, start 2016)
  - Worldwide coverage
EGNOS System Architecture and Service Area

**2 Support Facilities**

**4 Mission Control Centres**

**6 Navigation Land Earth Stations**

**39 Ranging & Integrity Monitoring Stations (RIMS)**

**GPS signals**

**EGNOS Service Area**

**GEO Satellites**

**Geostationary satellites**
- INMARSAT AOR-E 3F2 (15.5 W)
- SES 5 – (5 E)
- INMARSAT IOR-W 4F2 (64 E)
- ASTRA 5B – commissioning phase (31.5 E)
EGNOS services will be delivered on a long-term basis

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<tr>
<th>Service</th>
<th>Accuracy</th>
<th>Availability</th>
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<tr>
<td>Open Service (OS)</td>
<td>Accuracy ~1m, free</td>
<td>Available since October 2009</td>
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<tr>
<td>Safety of Life Service (SoL)</td>
<td>Accuracy ~1m, compliant to aviation standards</td>
<td>Available since March 2011</td>
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<td>EGNOS Data Access Service (EDAS)</td>
<td>Accuracy &lt;1m, corrections provided by terrestrial networks</td>
<td>Available since July 2012</td>
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EGNOS SoL is fully operational for aviation

- **Safety of Life** service has been declared operational in March 2011
- EU committed to keep it free of charge (letter to ICAO), for at least 20 years and with 6-years notice
- Service provider certified based on the Single European Sky Regulatory package
- EGNOS landing procedures being developed around EU for their benefits:
  - Very precise vertical guidance
  - Safer landings at airports not equipped with ground-based navigation aids (e.g. ILS)
  - Increased airports capacity
EGNOS SoL APV-I performance

APV-I  November 2015

LPV-200  November 2015
LPV Airport Implementation status and forecast

As of today
249 LPV procedures
70 ‘EGNOS enabled’ APV Baro
→ Serving 176 airports

Plans by 2018
> 450 LPV procedures

Source: ESSP, GSA
Most common SBAS-ready aircraft/rotorcraft in Commercial, Business and General Aviation...

### Commercial/Regional
- **ATR42-600, 72-600**
- **Airbus A350, Beluga**
- **Bombardier CRJ 700/900/1000, CS100/300, Dash 8 Q400**
- **AW109SP, AW119Kx, AW139, AW169, AW189**
- **Bell 429, 505,650**
- **H135, H145, H175, H225, EC135, EC145**

### Business
- **Challenger 300/350, Learjet 70/75/60XR**
- **Citation Mustang, M2, CJ2+, CJ3+, CJ4, XLS+, Latitude, Sovereign+, X+ and Longitude**
- **SB Falcon 900LX/5X/7X/2000LXS/2000S;**
- **G650 and G280, SB G150/G550/G450/G350**
- **King Air, Baron, Bonanza, Hawker 400XPR/800XPR**

### General
- **Citation, Caravan and Single Engine**
- **Pilatus PC6, PC24 and PC12/47E (SB)**
- **DA20, 40XLT, 40CS, D-Jet,42 and 50**
- **SR20, SR22, SR22T, and Vision SF50**
- **Meridian, Seminole, Mirage, Matrix, Archer, Seneca V and Arrow**
... and other have retrofit solutions available

- Bombardier CL60
- Bombardier GL5T
- Bombardier 850
- BAE H25B (800 series)
- GulfStream GV-SP
- Dassault 900LX
- Dassault 7X
- Dassault 2000LXS
- Dassault 2000S
- Pilatus PC-12
- Piaggio Avanti I
- Avanti II & evo
- Beech kingAir200
- Beech 1900
- Beech 300
- Bell 412
- EC 135
- Cessna Citation II
- Cessna 525
- Cessna 500

Source: GSA
# Operators adopting EGNOS

## REGIONAL

- **Aurigny**
  - 2x BN2B Trislander
- **Air Nostrum**
  - 5x ATR 72-600
- **Skybus**
  - 15x CRJ 1000
- **Chalair**
  - 2 x Beechcraft1900
- **Twin-Otter**
  - 2x BN2B Islander
- **Wideroe**
  - DHC 8-100
- **Hebridean Air**
  - 2x Twin Otter
- **CityJet (VLM)**
  - 8x Fokker 50
- **Loganair**
  - 2x Twin Otter

## BUSINESS

- **Inaer**
  - Bell 412
- **NetJets**
  - Hawker 750
- **Specsavers**
  - 2x Beech 350
- **REGA**
  - Eurocopter EC135
- **Royal Star-Aero**
  - Piper PA-34 Seneca II
- **Cirrus SR20**
- **Dutch & MartinAir Flight Academies**
  - 4x Diamond DA42

## GENERAL

- **NLR**
  - Fairchild Metro II
- **Air Charters Europe**
  - Cessna Citation II
- **Aviation South West**
  - King Air 300
- **Beechcraft 76**
- **Ljungbyheds Flygklubb Lund University School of Aviation**
  - King Air 1900D
- **Piper P28A**
- **Royal Star-Aero**
- **Cessna Citation II**
- **Dutch & MartinAir Flight Academies**
- **Cirrus SR20**
- **DA40-180**
### Other applications beyond LPV

#### Rotorcraft operations

EGNOS as enabler of:
- Point in Space (Pins)
- Low Level RNAV Routes
- Simultaneous Non Interference
- Curved procedures/RNP-AR

EGNOS benefits:
- Increased accessibility in all weather
- Increased capacity

#### Surveillance-ADS-B

EGNSS Role:
- Current ADS-B Out European mandates requires GNSS:
  - June 2016 for new aircraft, June 7th 2020 for retrofit
  - GNSS required, not SBAS

EGNSS benefits:
- SBAS ensures 99% availability (= radar)
- Ground Infrastructure rationalisation
- Increased safety

#### RPAS/Drones

EGNSS Role:
- Component of Guidance, Navigation and control
- Component of detect and avoid functions
- Support to integration in non segregated airspace

EGNOS benefits:
- Reliable PVT: precise positioning/ orientation
- Robust safe navigation

#### Search and Rescue

EGNSS Role:
- ELT required for every aircraft with >19 passengers
- More and more pilots carry handheld PLB’s
- Many ELTs/PLBs use GNSS to report their position when triggered.

EGNSS benefits:
- EGNOS improves accuracy
- Galileo SAR in Second Generation Beacons
All SBAS systems are designed by the same standard (ICAO SARPs) - current coverage: GPS + monofrequency

Availability as a function of user location

WAAS, EGNOS, SDCM, GAGAN, MSAS

Availability with VAL = 35, HAL = 40, Coverage(99%) = 7.54%

VAL: Vertical Alert Limit       HAL: Horizontal Alert Limit
SBAS Future Coverage: Dual Constellation (GPS + Galileo + dual frequency EGNOS V3) + extended networks
Who provides EGNOS services?

Political Oversight

Programme Oversight and Programme management

Execution

European Council and Parliament

European Commission

European Space Agency (ESA)

delegation

delegation assistance

European GNSS Agency (GSA)

Industry

Industry

System management and service provision

Public sector

Private sector

ANSP country 1, ..., ANSP country 28
Certified provider of **Safety of Life service** in aviation in EU in March 2011.

Each EU-28 Air Navigation Service Provider **has to sign an EGNOS Working Agreement (EWA) with ESSP** to be able to activate use of EGNOS SoL in its country.

Other uses (non-SoL) take place without any formal step.

[https://www.essp-sas.eu/](https://www.essp-sas.eu/)
Navigation solutions powered by Europe

Extension beyond EU-28
EGNOS extensions – the drivers (EU)

- Promote use of SBAS, especially for air transport.

- Pursuing other EU policies (i.e. cooperation, external relations, neighbouring, transport harmonisation).

- Enhance the opportunities for the European GNSS technologies and application industries (upstream and downstream).
EGNOS extensions – the drivers (non-EU)

- Aviation: use EGNOS to comply with ICAO requirements on PBN
  - Save on ILS investment
  - Increase safety
  - Open new routes
  - Improve operations efficiency

- Use the EU SBAS technology in other transports & non-transport domains.

- Cooperate with EU on space matters.
EGNOS extensions possible within satellite footprints…
...with expansion of EGNOS ground segment
EGNOS beyond EU – activity to date

Four areas covered:
1) Users needs, real life tests and demo (e.g. SoL)
2) GNSS skills
3) System infrastructure
4) Governance, regulatory roadmap to adoption
EU and African partners are working to provide SBAS services based on EGNOS over Africa

- **Objective**
  - Identify appropriate technical and financing solution for covering Africa with SBAS services, based on the EGNOS current and future technology.

- **Implementation**
  - GNSS cooperation reaffirmed with the adoption of the Roadmap (2014-17) at the Africa-EU Summit in April 2014, and funds allocated (2016-) as part of the pan-African Cooperation and Development Instrument (DCI).
  - Commission received a mandate from Member States to negotiate with ASECNA conditions for cooperation towards provision of SBAS services based on EGNOS.
  - Technical solutions, financing, governance and service provision aspects are the subjects of the ongoing technical work and discussions.
Objectives
- To extend the EGNOS SoL coverage to the Ukrainian territory.
- To enable six Western Balkans countries to use EGNOS SoL.

Implementation
- EU-Ukraine GNSS Agreement (entered into force in 2013) foresees the possibility to extend EGNOS to Ukraine. Joint Statement (2013) expressed intention to extend.
- EU-Ukraine Association Agreement (June 2014) promotes transport cooperation, use of space systems and GNSS.
- Financing Agreement (August 2014) between the Commission and Ukraine, reserving 5M€ from the European Neighbourhood funds to extend EGNOS.
- To implement the extension a new international agreement is needed. The Commission is preparing the negotiating guidelines for this agreement.
- No need of funds and International Agreement for W. Balkans (to be confirmed)
EU and ENP South partners have been working since 2006 to extend the EGNOS SoL coverage over N. Africa/M. East

- **Objective**
  - Leveraging the EGNOS core service area infrastructure to extend coverage to 10 Mediterranean countries.

- **Implementation**
  - Commission’s Communication (8/3/11) on cooperation with Southern Mediterranean countries, reinforced by the Ministerial Transport Conference of the Union for the Mediterranean (14/11/13), the area of Satellite Navigation is being pursued as field of technical cooperation, for its impact on transport efficiency, safety (e.g. civil aviation) and regional cooperation (RTAP 2014-20).
  - Euromed GNSS I & II (METIS, MEDUSA, ESA, 2007-15): CBA per country, initial infrastructure, technical demonstrations, service demo in aviation and logistics, definition of institutional framework.
  - **Funding under definition** to provide EGNOS SoL coverage.
  - **Bilateral International Agreements needed.**
EGNOS beyond EU: ENP South priorities

Priority Area 1 (green airports)
Priority Area 2 (yellow airports)
Priority Area 3 (red airports)

Source: MEDUSA Analysis with ENP Countries, Jan 2014
EGNOS and ACAC

**ENP South extension of EGNOS core system**

We need:
1) Infrastructure for signal (RIMS stations)
2) International agreements with each State (therefore a letter before Aug. 2016)

**Arabic Peninsula, Middle East (no ENP South)**

Another potential extension. Feasibility study, Cost-Benefit Analysis can be performed, following official request from ACAC and the concerned countries (co-signed letter ad director level to Commission)

**West Africa**

Technical solution (i.e. infrastructure) being developed via development funds, in parallel with international agreement negotiations with ASECNA

**East Africa**

Infrastructure for signal coverage potentially covered by development funds.
EGNOS extensions in GNSS Regulation (1285/2013)

"...Subject to technical and financial constraints and on the basis of international agreements, the geographical coverage of the services provided by the EGNOS system could be extended to other regions of the world, in particular to the territories of candidate countries, of third countries associated with the Single European Sky and of countries in the European Neighbourhood Policy..."

(12)

"... In view of the global nature of the systems, it is essential that the Union enter into agreements with third countries and international organisations in the context of the Galileo and EGNOS programmes under Article 218 TFEU, in particular to ensure their smooth implementation, deal with certain questions relating to security and charging, optimise the services provided to citizens of the Union and meet the needs of third countries and international organisations..."

(42)

"... The geographical coverage of the EGNOS system may be extended to other regions of the world, in particular to the territories of candidate countries, of third countries associated with the Single European Sky and of countries in the European Neighbourhood Policy, subject to technical feasibility and on the basis of international agreements. The cost of such extension, including the related exploitation costs, shall not be covered by the resources referred to in Article 9. Such extension shall not delay the extension of the geographical coverage of the EGNOS system throughout the Member States' territories geographically located in Europe..."
**What is needed for EGNOS SoL service in non-EU?**

<table>
<thead>
<tr>
<th>SoL signal coverage</th>
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</table>
| • System Mission & Architecture  
  • ....  
  • ....  |
| • Security  
  • ....  
  • ....  |
| • Funding  
  • Capex  
  • Opex  |
| • Governance  
  • ....  
  • ....  |
| A bilateral International Agreement between EC and the non-EU State |

<table>
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<tr>
<th>Service provision</th>
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</table>
| • Regulatory Framework  
  • ....  
  • ....  |
| • Operations  
  • ....  
  • ....  |
| A Working level Agreement (non-EU EGNOS WA) between ESSP and the non-EU country’s ANSP |

ANSP Country 1, ..... N
What is needed for EGNOS SoL service in non-EU:

<table>
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<tr>
<th>System Mission &amp; Architecture</th>
<th>Funding</th>
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- SoL signal coverage
- A bilateral International Agreement between EC and the non-EU State

- Security
  - • ..... 
  - • ..... 

- Liability
  - • ..... 

- Certification
  - • ..... 

Negotiation can take as long as SoL coverage extension, so the two processes should run in parallel.
Agreements will be based on "Minimum Regulatory Baseline" (20 ICAO provisions)

Bilateral International Agreement

Non-EU EWA
EGNOS International Agreement – how?

- EU Commission envisages an 'Common Template' Agreement to define all key issues for a specified set of countries (ENP South, Ukraine) – 2017-2018. With bilateral negotiations.

- Ad hoc agreement with ASECNA, international organization representing a specified set of countries (Sub-saharian Africa) – 2018.

- Special cases: Western Balkans – 2016 onwards
  - Signatory to the European Common Aviation Area (ECAA) agreement
  - Compliant with SES (80-100%)
  - EU candidate / associate countries
  - No need of additional infrastructure. SoL signal already available
ENP South countries

- Governments need to express formally their interests in entering discussions for the international agreement on EGNOS (i.e. a formal request has to reach Commission by August 2016)
- Four countries already took this step

EU

- Mobilise funds for SoL signal coverage extension
- Ask Council for mandate to negotiate international agreements
## EGNOS extensions – where we were (2014)

<table>
<thead>
<tr>
<th>Needed steps</th>
<th>UA</th>
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*Note: OK indicates completion, - indicates pending or not applicable.*
## EGNOS extensions – where we are (2016)

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Notes:
- Green indicates completion of the process.
- Red indicates pending completion of the process.
Announcement: workshop on EGNOS International Agreement for interested Countries

A bilateral International Agreement between EC and the non-EU State

- System Mission & Architecture
  - ....
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  - ....
  - ....
- Certification
  - ....

Representatives from Foreign Affairs, Transport and Aviation will be invited.

September 2016 (precise date tbc)
Conclusions

- **EGNOS is operational**: OS since October 2009, SoL service since March 2011

- **Galileo is taking off**
  - Deployment is being accelerated (12 Satellites / 30)
  - Early OS/SAR/PRS services from 2016, full services by 2020

- **International**
  - Balkans: legal/institutional framework is to be finalised
  - Ukraine: ongoing extension of EGNOS SoL, international agreement to be negotiated (start June 2016)
  - ASECNA: provision of SBAS services based on EGNOS
    - International agreement under negotiation (Mar 2015 – 2016)
  - Africa:
    - Study to be launched in 2016 to define budget, timeline and development plan of EGNOS V3 extension to the whole Africa


  - Other ACAC members: cooperation possible on specific needs & geography
Thanks for your attention

Ugo Celestino
European Commission
Directorate General GROWTH - unit J3

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