GNSS/EGNOS services and applications in civil aviation

Euromed GNSS II project/MEDUSA:
Israel national workshop
EGNOS (European Geostationary Navigation Overlay Service)

EGNOS scenario in Europe for civil aviation

EGNOS benefits for civil aviation

EGNOS in Europe: facts and figures

MEDUSA EGNOS Safety of Life service demonstration for civil aviation

MEDUSA planned action for Israel/civil aviation
EGNOS is a Satellite Based Augmentation System (SBAS)

1. GPS Constellation
2. Ranging and Integrity Monitoring Stations (RIMS)
3. Mission Control Centres (MCC)
4. Navigation Land Earth Stations (NLES)
5. 3 geostationary EGNOS Satellites

EGNOS position accuracy
GPS position accuracy

... relay error corrections to users
... uplink error corrections to EGNOS satellites ...
... receive GPS data and send it to MCC ...
... process GPS data to determine errors ...
... determine EGNOS position accuracy
EGNOS main principles (2)

Differential Corrections

Estimate of residual positioning error

Use / Don’t use message + Time to Alert

+ Accuracy

+ Continuity + Availability

+ Integrity + Safety
EGNOS main principles (3)

A SBAS is a navigation system that supplements/augments GNSS providing a more accurate and reliable navigation service than GNSS alone

– A more accurate navigation service than GNSS
– The high level of integrity required for most aviation navigation operations

SBAS enables Localizer Performance with Vertical guidance (LPV) approaches:

– LPVs are operationally equivalent to a CAT-I ILS, but are more economical
– LPVs do not require the installation or maintenance of navigation aids at the airport since the navigation service is provided to the aircraft entirely by satellites

SBAS technology provides the opportunity to cover very large areas of airspace and areas formerly un-served by navigation aids

SBAS also adds increased capability, flexibility, and in many cases, more cost-effective navigation options than legacy ground-based navigation aids

SBAS broadcast the augmentation information in the same frequency and with the same message format as GPS, facilitating avionics design, integration and certification, compared to other augmentations systems
## EGNOS services and coverage

<table>
<thead>
<tr>
<th>Services</th>
<th>Description</th>
<th>EGNOS OS</th>
<th>EGNOS EDAS</th>
<th>EGNOS SoL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>Free to air; mass market; better than GPS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td>High accuracy; professional market</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety of Life</td>
<td>Integrity and authentication of the signal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Euromed GNSS II national workshop, Tel Aviv, 6 May 2013**
EGNOS today’s performances vs coverage

Availability map PRN 126 (29/04/2013 06:59:59) for EGNOS SoL

Euromed GNSS II national workshop, Tel Aviv, 6 May 2013
EGNOS interoperability with other SBASs

In the future operators will be able to travel around the world supported by SBAS

There are plans to extend WAAS coverage over South America, and also some national initiatives

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EGNOS SoL main principles

– Designed:
  Compliant to APV-I
  To support civil aviation operations down to LPV (Localiser Performance with Vertical guidance) minima at any qualifying runway (CAT-I)
  In accordance to the ICAO SARPs criteria
  To be 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
SBAS (EGNOS) interoperable avionics

Each SBAS system has been developed to meet ICAO SARPs Annex 10 standards.

The Interoperability Working Group (IWG) meets regularly to maintain interoperability as systems evolve.

SBAS avionics are intended as interoperable and developed in accordance with ICAO SARPs to enable aircraft seamless transitions between SBAS systems.

<table>
<thead>
<tr>
<th>Operational Class</th>
<th>Phases of Flight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Oceanic and domestic en route, terminal, approach (LNAV), and departure operation</td>
</tr>
<tr>
<td>Class 2</td>
<td>Oceanic and domestic en route, terminal, approach (LNAV, LNAV/VNAV), and departure operation</td>
</tr>
<tr>
<td>Class 3</td>
<td>Oceanic and domestic en route, terminal, approach (LNAV, LNAV/VNAV, LP, LPV), and departure operation</td>
</tr>
<tr>
<td>Class 4</td>
<td>Equipment that supports only the final approach segment operation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ETSO</th>
<th>Hardware Required for SBAS Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETSO-C144</td>
<td>Airborne Global Positioning System Antenna</td>
</tr>
<tr>
<td>ETSO-C145</td>
<td>Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)</td>
</tr>
<tr>
<td>ETSO-C146</td>
<td>Stand-alone airborne navigation equipment using the Global positioning system (GPS) augmented by the wide area augmentation system (WAAS)</td>
</tr>
</tbody>
</table>
ICAO Assembly Resolution A37-11

Urges all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the Performance-based Navigation (PBN) Manual (Doc 9613)

PBN benefits:
- Environment-friendly
- Improving safety
- Improving operating returns
- Increasing airspace capacity
- The global rollout

ICAO states that GNSS enables PBN and provides navigation guidance for all phases of flight, from en-route to precision approach
The GNSS is a recognized standard aid to air navigation

GNSS services shall be provided using various combinations of the following elements:

<table>
<thead>
<tr>
<th>Basis Constellations</th>
<th>Global Positioning System - GPS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Global Navigations Satellite System - GLONASS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Augmentation Systems</th>
<th>Aircraft-Based Augmentation System - ABAS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Satellite Based Augmentations System - SBAS</td>
</tr>
<tr>
<td></td>
<td>Ground-Based Augmentation System - GBAS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Airborne GNSS Receiver</th>
<th>Receivers</th>
</tr>
</thead>
</table>
PBN performance indicators

PBN specifications define the: **accuracy, integrity, availability, continuity and functionality** performance indicators for a navigation service

- **Availability** is the probability that the Positioning and Integrity monitoring services are available and provide the required: accuracy, integrity and continuity performances

- **Continuity** is the probability of the system to perform its function without unscheduled interruptions during the intended operation

- **Integrity** is a measure of the trust that can be placed in the correctness of the information supplied by the system

- **Time-to-alert** is the maximum time allowed from the onset of a failure condition to the annunciation in the aircraft

- **Position accuracy** is the difference between a computed and a true position
### ICAO operational requirements

<table>
<thead>
<tr>
<th>Typical Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>En-route (oceanic / continental low density)</td>
</tr>
<tr>
<td>En-route (continental)</td>
</tr>
<tr>
<td>En-route, Terminal</td>
</tr>
<tr>
<td>Initial approach, Intermediate approach, Non-precision approach (NPA), Departure</td>
</tr>
<tr>
<td>Approach operations with vertical guidance (APV-I)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Horizontal Accuracy (95%)</th>
<th>Vertical Accuracy (95%)</th>
<th>Integrity</th>
<th>Time-To-Alert (TTA)</th>
<th>Horizontal Alert Limit (HAL)</th>
<th>Vertical Alert Limit (VAL)</th>
<th>Continuity</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>En-route (oceanic / continental low density)</td>
<td>3.7 km (2.0 NM) (Note 6)</td>
<td>N/A</td>
<td>1 - 1x10⁻⁷/h</td>
<td>5 min</td>
<td>7.4 km (4 NM)</td>
<td>N/A</td>
<td>1 - 1x10⁻⁴/h to 1 - 1x10⁻⁸/h</td>
<td>0.99 to 0.99999</td>
</tr>
<tr>
<td>En-route (continental)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>En-route, Terminal</td>
<td>0.74 km (0.4 NM)</td>
<td>N/A</td>
<td>1 - 1x10⁻⁷/h</td>
<td>15 s</td>
<td>1.65 km (1 NM)</td>
<td>N/A</td>
<td>1 - 1x10⁻⁴/h to 1 - 1x10⁻⁸/h</td>
<td>0.99 to 0.99999</td>
</tr>
<tr>
<td>Initial approach, Intermediate approach, Non-precision approach (NPA), Departure</td>
<td>220 m (720 ft)</td>
<td>N/A</td>
<td>1 - 1x10⁻⁷/h</td>
<td>10 s</td>
<td>556 m (0.3 NM)</td>
<td>N/A</td>
<td>1 - 1x10⁻⁴/h to 1 - 1x10⁻⁸/h</td>
<td>0.99 to 0.99999</td>
</tr>
<tr>
<td>Approach operations with vertical guidance (APV-I)</td>
<td>16.0 m (52 ft)</td>
<td>20 m (66 ft)</td>
<td>1 - 2x10⁻⁷ in any approach</td>
<td>10 s</td>
<td>40 m (130 ft)</td>
<td>50 m (164 ft)</td>
<td>1 - 8x10⁻⁶/15 s</td>
<td>0.99 to 0.99999</td>
</tr>
</tbody>
</table>

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**GPS stand alone is not compliant with ICAO performance requirements**

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**EGNOS allows to fulfil the requirements**

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**SBAS integrity concept (1)**

**Integrity risk:** the probability that the position error is larger than the alert limit for the intended operation and the user is not warned within the time to alert (TTA)

**Alert Limit:** the error tolerance not to be exceeded without issuing an alert. There is a Horizontal and Vertical Alert Limits, HAL and VAL for each operation

**Time To Alert:** The maximum allowable time elapsed from the onset of the system being out of tolerance until the user is alerted

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The Horizontal Protection Level (HPL) is the radius of a circle in the horizontal plane, centered at the true position, which describes the region which is assured to contain the indicated horizontal position

The Vertical Protection Level (VPL) is the half length of a segment on the vertical axis with its center being at the true position, which describes the region which is assured to contain the indicated vertical position

**SYSTEM SITUATIONS**

HPE: Horizontal Position Error

VPE: Vertical Position Error
SBAS integrity concept (2)

H Alarm Limit

H Protection Level (HPL)

Computed position

True position

VPL

VAL

flight phase ok

flight phase not ok

desired path

horizontal protection level HPL

horizontal alert limit HAL

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SBAS in ICAO’s approaches

General Evolution of Approaches

- NPA: Non Precision Approaches
  - Conventional
  - RNP APCH
    - LNAV
  - CDFA

- APV: Approaches with Vertical Guidance
  - Baro/VNAV
  - SBAS LPV

- PA: Precision Approaches
  - Conventional
  - GBAS Approach

Sensors
- VOR/DME/NDB Localizer
- GPS
- GPS + Baro
- GPS + SBAS
- ILS
- GPS + GBAS
SBAS in ICAO’s RNP approaches

**Chart title: RNAV (GNSS)**

- RNP APCH
  - Without Vertical guidance
    - LNAV
      - GPS NPA
        - Approach expected to be flown with CDFA
    - LP
      - SBAS supported Localiser Performance
  - With Vertical guidance
    - LNAV/VNAV
    - APV Baro
    - LPV
      - APV SBAS
        - SBAS supported Localiser Performance with vertical guidance

**Chart title: RNAV (RNP)**

- RNP AR APCH
  - With Vertical guidance
    - LNAV/VNAV
APCH NAVAIDs trade off

Non Precision Approaches (NPA)
Use Conventional Navigation: VOR, DME to the MDH for VFR landing

Precision Approaches (PA)
Use Instrument Landing system: ILS, GBAS. Provide Lateral and Vertical guidance on stabilised continuous descent path

Approach with Vertical Guidance (APV)
Use GNSS navigation and can use SBAS (LPV) or baro-VNAV for the vertical guidance
APCH GNSS NAVAIDs trade off

EGNOS competitive space

- **GPS**: 400 – 600 ft DH
- **GPS Inertial/SBAS**: 350 – 400 ft DH
- **SBAS**: 250 – 300 ft DH
- **SBAS/GBAS**: 200 ft DH
- **GBAS**: 0 – 200 ft DH
- **LNAV/VNAV**: NPA
- **LPV**: GLS
- **CAT I-III**: 3/4 nm
- **1/2 nm**: 1 nm
- **3º**: 2 nm

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EGNOS APV/CAT-I APCH benchmarking

**Alert Limits**

<table>
<thead>
<tr>
<th>Operation</th>
<th>Horizontal Alert Limit</th>
<th>Vertical Alert Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>APV-I</td>
<td>40m (130ft)</td>
<td>50m (164ft)</td>
</tr>
<tr>
<td>APV-II</td>
<td>40m (130ft)</td>
<td>20m (66ft)</td>
</tr>
<tr>
<td>CAT I</td>
<td>40m (130ft)</td>
<td>15m to 10m (50ft to 33ft)</td>
</tr>
</tbody>
</table>

**Accuracy**

<table>
<thead>
<tr>
<th>Type of Operation</th>
<th>Horizontal Accuracy</th>
<th>Vertical Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>APV-I</td>
<td>16.0m (52ft)</td>
<td>20m (66ft)</td>
</tr>
<tr>
<td>APV-II</td>
<td>16.0m (52ft)</td>
<td>8.0m (26ft)</td>
</tr>
<tr>
<td>Cat-I</td>
<td>16.0m (52ft)</td>
<td>6.0m to 4.0m (20ft to 13ft)</td>
</tr>
</tbody>
</table>

ILS-CAT I minima ~ 200 ft
APV-I (LPV) minima ~250 ft

**Procedure Minima**

APV-I is ILS look-alike
LPV is ILS look-alike

Crew reports Flying LPV is similar and even more stable than ILS

LPV Approach Real Flight Trial
EGNOS scenario in Europe for civil aviation
EGNOS institutional and service provision frame

- **Design Authority**: ESA
- **Contract**: European Commission (customer)
- **Service**: EGNOS Service Provider [AENA, DGAC, ENAV, NATS, NAV, Skyguide, DFS]
- **Certification**: EASA
- **ANSPs**: ANSPs
- **Procedures**: Aeronautical users
- **EWA**

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EGNOS operational frame

In Europe, EGNOS is subject to regulation/approval by “EASA system” (including NSAs)
WHO
   Between the ANSP and the EGNOS Service Provider

WHY
   To define roles and responsibilities for the actors involved
   To formalize the working procedures and interface

WHAT (contents)
   Contractual document (including liability)
   Contingency coordination
   NOTAM proposal
   Data recording
   Collaborative decision making
   Service commitment with reference to EGNOS SoL SDD Doc
   Identification of the main focal points
   Service arrangements

WHEN
   As soon the procedures implementation process is defined and decided
EGNOS retrofitting for aircraft in service (1)

- SBAS receiver
- Integration
- Installation
- Documentation
- Certification
- Other cost

- Number of aircraft
- Crew training

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EGNOS retrofitting for aircraft in service (2)

EU certification process

1. Aircraft in Service Process
2. Service Bulletin available
   - no
   - yes
   - Minor change
     - yes
     - Contact a DOA approved by EASA Part 21
     - Technical report for the installation
     - DOA acceptance
     - EASA acceptance
     - Installation and Certification approval
     - Installation of the receiver
     - Certificate to Release to Service (CRS)
   - no
   - STC available
     - no
     - yes
     - STC release
       - Technical report for the installation
       - EASA application Form 33 (*)
       - EASA acceptance
   - Minor change?
     - yes
     - no

(*) The application should be done by a DOA approved by EASA Part 21
EGNOS benefits for civil aviation
EGNOS added value for civil aviation

- **Back-up** for conventional NAVAIDs
- **Instrument approach capability** for those airdromes or runways where ILS cost is not justified, with a huge increase in safety
- **Instrument navigation** in those regions not covered by conventional ground NAVAIDs
- Enabler of **procedures with curved segments** in air space scenarios with particularly difficult constraints, facilitating solutions needed in the case of:
  - Difficult orographic conditions in the terminal area
  - Environmental impact/protected zones (e.g. noise footprint impact minimisation over urban areas, natural areas/parks protection)
  - Military or security air space restricted areas
  - Border areas between countries
- Enabler of **optimised procedures** for special applications, e.g. general and business aviation, helicopters serving oil rigs
EGNOS costs vs benefits for the civil aviation community

**Benefits**

- Increased **efficiency** through the reduction in the number of **Delays, Diversions and Cancellations (DDCs)**
- Increased **safety** through the reduction of **Controlled Flight Into Terrain (CFIT)**
- Phasing out of conventional NAVAIDs

**Costs**

- Avionics
- Flight procedures
EGNOS social benefits

**Safety improvement:** EGNOS enables APV approaches, providing significant safety improvements at airports where approaches with vertical guidance are currently not available (Non Precision Approaches NPA)

**CFIT** reduction of 75% (source: Eurocontrol)

**Environmental impact reduction:**
- Noise reduction in urban areas
- CO2 emissions reductions due to optimised routes and CDA (continuous descent approach)
EGNOS economical benefits

- **DDCs reduction**: lower minima makes landing possible with lower visibility levels at airports not equipped with ILS (48% reduction ANSP/airlines estimate)
- **Time and fuel savings**: more flexible curved/segmented and continuous descent approach procedures result in time/fuel savings
- **Increased runway capacity**: EGNOS has no critical/sensitive areas, reducing the time between consecutive approach/departure aircraft operations. Approach terrain constraints are also easier to overcome. ILS backup in case of failure
- **Ground infrastructure cost savings**: decommissioning of ground based NAVAIDs, with expensive maintenance costs. Regional coverage enables operations in areas with insufficient conventional NAVAIDs infrastructure
- **Enhanced efficiency in air space use**: supporting en-route and terminal area PBN procedures, allows more aircraft to follow preferred trajectories
- **Reduced costs for procedure compared to ILS**: (on other conventional NAVAIDs), since periodic flight verifications are not required
- **Reduced aircrew training costs** when all approaches can be flown using vertical guidance
LPV vs. NPA approaches

Average decision height
- NPA: 450 ft
- LPV: 250 ft

Benefits of LPV
- Reduction in DDC of 48%\(^1\)
- Reduction of CFIT of 75%\(^2\)
- Reduction in Ground infrastructure cost

Cost of implementing EGNOS LPV
- Cost of a procedure = 1 year ILS maintenance
- Cost of the receiver (if needed)

1. Eurocontrol estimate; 2. ANSP/ Airlines estimate

Approach segments ignored in case of ATC radar vectoring

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EGNOS in Europe: facts and figures
### Status of the EGNOS implementation in aviation

EGNOS LPV procedures already published in Europe

<table>
<thead>
<tr>
<th>Country</th>
<th>Airports</th>
<th>LPV Procedures</th>
<th>APV Baro Procedures¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>29</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>Switzerland</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Italy</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Guernsey</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Germany</td>
<td>39</td>
<td>11</td>
<td>71</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>75</strong></td>
<td><strong>58</strong></td>
<td><strong>71</strong></td>
</tr>
</tbody>
</table>

¹ Enabled to be flown with EGNOS vertical guidance

**Source:** ESSP (May 2013)
Status of EGNOS introduction in Europe (2)

Status of EWAs between ESSP and national ANSPs

Source: ESSP (May 2013)
Examples of operational scenarios of EGNOS use

- Scenario at Perugia (Italy)
- Scenario at Valencia (Spain)
- Scenario at Saarbrücken (Germany)
- Scenario at Pamplona (Spain)
- Scenario at Egelsbach (Germany)
- EGNOS pioneer operators
- EGNOS pioneer airports
Operational scenario at Perugia (Italy)

Aircraft: CESSNA CITATION VI
Scenario characteristics: airspace constraints; mountainous terrain
Date: November 2009
Demonstration objectives
- Procedural surveillance
- IFR RWY 19 desirable (in case of south wind)
Operational scenario at Valencia (Spain)

Aircraft model/operator: CRJ-1000NG/Air Nostrum
Scenario characteristics: noise restrictions
Expected date: Q4 2013
Demonstration objectives:
– Curved departure for RWY 12
– Curved approach (RF leg) prior to FAP
– and final transition to LPV RWY30
Operational scenario at Saarbrücken (Germany)

**Aircraft model/operator:** Boeing 737/Air Berlin  
**Scenario characteristics:** noise restrictions, terrain and airspace limitations (border)  
**Expected date:** Q4 2013  
**Demonstration objectives:**  
– Assessment and introduction of RF legs prior to FAF with transition to LPV  
– Assessment and comparison with RNP AR with minima equivalent to LPV
Operational scenario at Pamplona (Spain)

Aircraft model/operator: CRJ-1000NG/Air Nostrum

Scenario characteristics: difficult terrain environment

Expected date: Q4 2013

Demonstration objectives:
– Reduction of approach minima (LPV to non ILS RWY 33)
– More stabilised final segment approach
– Reduction of departure climb gradient at RWY15
Operational scenario at Egelsbach (Germany)

**Aircraft model/operator:** Hawker 750/NetJets

**Scenario characteristics:** airspace restrictions

**Expected date:** Q4 2013

**Demonstration objectives:**
- IFR procedures with lower minima
- Advanced RNP with transition to LPV (RWY 27)
- RF prior to FAF transition to RNP APCH
- Decongest Frankfurt area
**EGNOS pioneer operators**

<table>
<thead>
<tr>
<th>Commercial</th>
<th>Commercial &amp; Medical</th>
<th>Training</th>
<th>Business &amp; Instrumentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>+5x ATR 72-600</td>
<td>+2x Twin Otter</td>
<td>Beechcraft 76</td>
<td>Hawker 750</td>
</tr>
<tr>
<td>+8x Fokker-50</td>
<td>+2x BN2B Islander</td>
<td>Piper P28A</td>
<td>King Air 1900D</td>
</tr>
<tr>
<td>+15x CRJ-1000</td>
<td>+2x Bell 412</td>
<td>+2x Diamond DA42</td>
<td>Fairchild Metro II</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>+28</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>+42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4 main avionics manufacturers:
- Thales
- Rockwell Collins
- Universal
- Garmin
EGNOS pioneer airports

Publication year:
- 2011
- 2012
- 2013

Total of 74 RWYs
Incl. 5 heliports

Existing procedures:
- ILS (Belfast Int.)
- APV Baro (Brno)
- LNAV (Exeter)
- VOR/DME/LOC
- VFR (Barra)

Existing services:
- Full ATC (Lisbon)
- AFIS (Islay, Tiree)
- NO ATC (La Perdiz)
MEDUSA
EGNOS Safety of Life service demonstration for civil aviation
**Demonstration overview (1)**

- **Objective:** demonstration of EGNOS SoL service for LPV
- **Outcomes:** flight validation of experimental procedures and list of “to-dos” for the relevant publication

<table>
<thead>
<tr>
<th>Market/Application</th>
<th>Civil Aviation/ LPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGNOS Service</td>
<td>EGNOS SoL</td>
</tr>
<tr>
<td>Euromed team partners</td>
<td>MEDUSA team: INECO, ENAV, OACA, HELIOS</td>
</tr>
<tr>
<td>MEDA country</td>
<td>Tunisia</td>
</tr>
</tbody>
</table>

**Tasks**
- Procedure design
- Safety assessment
- Flight demos
- Business case development
- Analyses of certification and standardization
- Exploitation towards operational use
- Promotion material, training and training material

**Outcomes**
- LPV procedures, Safety assessment and business case, Training, Contribution to promotional material, Information package on EGNOS/contents of training material and contents for workshops, Definition of necessary steps and enablers allowing Tunisia to publish procedures in the AIP according to the AIRAC cycle.
Demonstration overview (2)

- Monastir (Tunisia) airport
- RWY 07 and RWY 25
- Piaggio P180 Avanti

- Team:

[Logos of MONASTIR, OFFICE DEL AVIATION CIVILE ET DES AEROPORTS, ENAV, INECO, HELIOS, Telespazio]

Euromed GNSS II national workshop, Tel Aviv, 6 May 2013
Main activities

– LPV design for RWY 07 (currently ILS)

– LPV design for RWY 25 (currently NPA)

– FAS data blocks codification

– Airborne data bases generation

– 2 validation flight trials for RWY 07

– 2 validation flight trials for RWY 25

– Business Case development

– Safety Assessment

– Exploitation towards operational use, including the analysis of certification and standardisation (AIS & AIP requirements)
Main outcomes

Real demonstration of EGNOS SoL service in civil aviation:
- Technical feasibility
- Operational feasibility
- Added value verification
- Benefits validation

Technology transfer:
- “to-do-list” + a sequence of steps for future LPV procedures operational adoption
- Training and training material
- Promotional material + Information package
Present status

**RWY 25 LPV preliminary design**

<table>
<thead>
<tr>
<th>Category of Aircraft</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPV – 2.5%</td>
<td>275</td>
<td>287</td>
<td>295</td>
<td>305</td>
</tr>
<tr>
<td></td>
<td>(267)</td>
<td>(279)</td>
<td>(287)</td>
<td>(297)</td>
</tr>
</tbody>
</table>

Currently 460 ft

OCA/H proposal for LPV to RWY 25 (ft)

**RWY 07 LPV preliminary design**

<table>
<thead>
<tr>
<th>Category of Aircraft</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPV – 2.5%</td>
<td>240</td>
<td>252</td>
<td>260</td>
<td>270</td>
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<tr>
<td></td>
<td>(232)</td>
<td>(244)</td>
<td>(252)</td>
<td>(262)</td>
</tr>
</tbody>
</table>

Currently 320 ft

OCA/H proposal for LPV to RWY 07 (ft)
MEDUSA planned action for Israel/civil aviation

- Technical meeting on EGNOS-based operations (mainly LPV) for the Middle-East sub-region of the Euromed area, to follow-up the request received during MEDUSA visit last February 2013

Dedicated meeting in Brussels (c/o Telespazio, tentatively in May-June 2014) on:

- Performance requirements
- Operational use and benefits
- Technology vs performances/costs trade-off
- Deep technical discussion of the outcomes of the MEDUSA’s EGNOS SoL service demonstration for civil aviation
- Enablers and EGNOS service coverage extension, in particular with reference to sub-regional issues
- Information available regarding the EGNOS SoL service roadmap (2013-2015)

Any information associated with the potential deployment of additional RIMSSs or the potential coverage extension out of this EGNOS SoL service roadmap (in later stages) not included today in the current EGNOS releases planned should be discussed with the EC
Thank you!
Questions?