Implementation of EGNOS-based LPV approaches in Europe

January 16-20th, 2011; Dubai, UAE
Presentation Outline

• **Introduction**
  - GNSS applications and benefits for Civil Aviation
  - LPV / APV approaches based on EGNOS (SBAS)

• **Previous experience: GIANT project**
  - Objective
  - Aircraft & Helicopter Flight Trials

• **GIANT-2 Project**
  - Project overview
  - GIANT-2 Consortium
  - Flight Trials: Corporate and General aviation
Presentation Outline

• ACCEPTA Project:
  • Project overview
  • Consortium
  • LPV Procedures to be published

• Conclusions

• References
Company presentation

“INECO”

Largest Engineering and Consultancy company in the transport area in Spain

- Aeronautical: airports and air navigation
- Railway
- Road
- Over 3000 employees

Owned by the Ministry of Transport of Spain

- Shareholders:
  - Aena, Spanish Air Navigation Service Provider (ANSP) and Airports manager
  - ADIF, Spanish railway infrastructure manager
  - Renfe, Spanish railway operator
Valid sensor for all phases of flight: take-off, departure, en-route, TMA, arrival and approach (down to LPV)

Provides navigation services to all airspace users: airliners, regional, General & Business aviation, helicopters…
GNSS benefits benefits for aviation

- GNSS Applications for Civil Aviation
- EGNOS (SBAS) Applications for Civil Aviation
  - LPV Approaches
- GNSS Operational benefits
- GNSS Safety benefits
- GNSS Environmental benefits
- GNSS Economic benefits
LPV (APV) approaches: Localizer Performance approaches with Vertical guidance based on GNSS - SBAS (EGNOS in Europe, WAAS in USA, …)

Use the enhanced performances provided by SBAS

- **Accuracy**
- **Integrity**
- **Availability**
- **Continuity**
**LPV Approach: Concept of operations**

**Technical viewpoint**

**ILS**
- Broadcast Path
- Local Ground Based Navaids
- Only one RWY served

**SBAS**
- FAS loaded into DB
- No local Navaids
- Multiple RWYs served
GIANT Project
“GNSS Introduction in the Aviation Sector”

Galileo, 6th Framework Programme
The GIANT Project

Project objective:
Support the introduction of SBAS (EGNOS) & Galileo services in the aviation market

• Managed by the European GSA (GNSS Supervisory Authority) [formerly the GJU (Galileo Joint Undertaking)]

• Supported by EUROCONTROL, as technical manager

GNSS Introduction in the Aviation Sector

Dubai, 16th-20th January 2011
Workshop on GNSS applications
Flight Trials: Aircraft

- LPV approaches
  - Based on EGNOS
  - Runways not equipped with ILS
  - Rich obstacle environment

- Airports
  - Valencia (Spain)
    - 21 October 2006
  - San Sebastian (Spain)
  - Bologna (Italy)

- Airline: **Air Nostrum**
  - Regional airline

- Aircraft
  - Dash 8, stand alone avionics
  - CRJ 200, **integrated avionics**
Flight Trials: Helicopters

- LPV approaches
  - Based on EGNOS
  - Low altitude IFR flights

- Scenarios
  - Hospital helipads: Lausanne (Switzerland)
    - 6-7 June 2007
  - Oil rigs: North Sea (UK, Norway)

- Operators
  - REGA
  - Bond, Scotia, CHC

- Helicopters:
  - Eurocopter EC155
Feedback after Flight Trials

• **Feedback from Pilots**
  - LPV glide path more stable than ILS
  - Would like coupled-VNAV to reduce workload
  - ILS-look-alike concept means minor familiarisation issues for pilots.
  - Continuous and smooth guidance along the entire flight.
  - Great value at non-ILS-equipped runways.

• **Feedback from Air Traffic Controllers**
  - EGNOS allows instrument approaches to airports at low cost.
  - ATC would need training on satellite-based flight operations.
  - Info on the status of the EGNOS service.
GIANT-2 Project
“EGnos AdoptIon in the AviatioN SecTor-2”
http://giant2.ineco.es

Galileo, 7th Framework Programme
Project Objectives

• To continue the work started in the previous GIANT project in order to accelerate adoption of EGNOS in other interested niche markets:
  – Corporate aviation
  – General aviation
  – SAR Helicopters
• To identify testing and operational practices that will lead to a successful EGNOS adoption
• To carry out EGNOS end-to-end LPV applications performing flight trials that make use of GNSS as the primary positioning technology
The GIANT-2 Consortium

- INECO leads the GIANT-2 Consortium composed of 13 partners from 5 different European countries.
The GIANT-2 Consortium

- The consortium constitutes a complete value chain from the manufacturer to the actual end user:
  - Air Navigation Service Provider (ANSP) and Airports Manager: Aena
  - Corporate aircraft manufacturer:
    - Dassault Aviation
  - Helicopter manufacturer:
    - AgustaWestland
  - Avionics manufacturer:
    - Rockwell Collins
  - Regional airline: Air Nostrum
  - Receiver manufacturer: Garmin
  - Corporate aviation company: Gestair
  - School & Training aviation: American Flyers
Flight Trials: Corporate Aviation

• **Santander airport** (North Spain)
  - Difficult terrain, environment
  - LPV RWY 11 / 29
  - Procedures already designed
  - Database generated by Rockwell Collins

• **Pre-demo flight:**
  - Cuatro Vientos AD (Madrid)
  - LPV RWY 10

• **Aircraft:**
  - **Dassault Falcon 2000**, operated by Gestair
  - Integrated RC avionics

• **Expected date:** Q2- 2011
Flight Trials: General Aviation

- **Cordoba airport** (South Spain)
  - Limited approach capabilities: just visual approaches
  - LPV RWY 03 / 21
  - Procedures already designed
  - Database generated by Garmin.

- **Pre-demo flight:**
  - Cuatro Vientos AD (Madrid)
  - LPV RWY 10

- **Aircraft:**
  - **Cessna 172**, operated by American Flyers
  - Integrated Garmin 1000 avionics

- **Expected date:** Q1-2011
Flight Trials: SAR Helicopters

• EGNOS as a high precision positioning sensor for Helicopter Search and Rescue (SAR) Operations

• Objective: Perform Helicopter flight trials including typical SAR operation based on EGNOS

• Selected Scenario:
  • Italian sea coast: Genova

• Helicopter:
  • AgustaWestland AW139

• Expected Date: Q2-2011
ACCEPTA Project
“ACCELERATING EGNOS ADOPITION IN AVIATION”

http://accepta.ineco.es

Galileo, 7th Framework Programme
Objectives

• The purpose of ACCEPTA is:
  • To accelerate development, certification and marketing of EGNOS enabled avionics
  • To promote the development and publication of EGNOS LPV approach procedures

• Promote adoption of EGNOS LPV approaches and avionics by commercial airlines, general aviation and end users
  • Marketing activities, technical assistance, training, cost-benefit analyses, etc.
Initial Consortium

**ineco**

Plus … new partners
• “ACCEPTA Info Day / User Forum” foreseen 2Q 2011
  • In Spain, location TBC

• “ACCEPTA Workshop” foreseen by the end of the project
• NATS will produce 3 LPV procedures:
  - Alderney
  - Southampton
  - Gamston
## Future LPV procedures

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<th>DSNA</th>
<th>AENA</th>
<th>ENAV</th>
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<td>-Limoges (RWY 22)</td>
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<td>-Saint Yan (RWY 33)</td>
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<td>-Tarbes (RWY 20)</td>
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### Main goal 2011:
More than 50 LPV procedures are prepared to be published in the national AIP this year.
Conclusions

• EGNOS-based LPV approach demonstrations and related technical support studies and analyses **already being performed** in different projects:
  • Key interested markets
  • Benefits demonstrated
• Ready to start a **European wide-scale real-life adoption of EGNOS** and GNSS in aviation
  • No more single-aircraft, single-airport tests
• EC/GSA, Eurocontrol and Member States to **facilitate, foster and provide support** to:
  • Airlines and end users
  • ANSPs and airports
References

- For further information:
  [2] ICAO 36th Assembly
  [3] GIANT Website: www.gnss-giant.com
  [5] ACCEPTA Website: http://accepta.ineco.es/
  [6] EUROCONTROL Website: www.ecacnav.com
  [8] ESA-EGNOS Website: http://www.esa.int/esaNA/egnos.html
Thank you very much for your attention!

Questions?

Luis Chocano
Head of GNSS Division
BACK-UP SLIDES
ICAO and European strategy on instrument approaches

- Resolution made at the ICAO 36th Assembly, 2007
- European States plan for the implementation of APV/SBAS (LPV) procedures, based on EGNOS to instrument runway-ends in European airports
- Projects launched and supported by EC and Eurocontrol in order to implement LPV approaches

ICAO: International Civil Aviation Organization
GNSS Benefits in Aviation

GIANT-2
“EGnos Adoption in the Aviation Sector-2”
Galileo, 7th Framework Programme

Dubai, 16th-20th January 2011
GNSS Operational benefits

- **New procedures** in runways not equipped with ILS
  - And **back-up for ILS** approaches
- **Reduction of missed approaches**
- **Operation in areas with limited or none ground navigation infrastructure**
  - Remote areas, developing countries
- **Supports area navigation**
  - B-RNAV, P-RNAV, RNP-RNAV
  - Allows advanced procedures (e.g. curved approaches)
- **Dedicated system for Helicopters**
  - Allows to navigate helicopters in IMC
  - Special LPV approaches and low level IFR altitude routes
GNSS Operational benefits

• Controlled Flight Into Terrain (CFIT)
  - A high percentage of CFIT accidents occur during approach and landing (ALA)

• LPV contributes to reduce CFIT events

Location and vertical profile of CFIT accidents / incidents:

In most of the CFIT (ALA) accidents, the airplane was lined up with the runway.

There was a lack of vertical situation awareness.
GNSS Safety benefits

GNSS (EGNOS) provides vertical guidance in the approach to any runway

Not possible with NPA

INCREASED SAFETY

- Enhanced operational safety due to the vertical guidance provided
- Reduction of CFIT events
- Increase situational awareness to the pilot
- Better precision in low altitude routes (helicopters, obstacles)
GNSS Environmental benefits

ENVIRONMENTAL ASPECTS

- Mitigate impact on noise / environment sensitive areas
- More flexibility for highly populated areas
- More efficient routes and time / fuel saving
GNSS Economic benefits

**COST SAVINGS**

- Reduced dependence on terrestrial navaids
  - Cost reduction in maintenance of ground infrastructure and conventional navaids
  - Allows for rationalisation of ground navigation infrastructure
- Low cost avionics with high performance, thus better access to a large number of users
  - Specially suited for regional, general aviation and helicopters

Outcome from **GIANT** Project

**Air Nostrum**: 6.3M€ Net benefit over 10 years
TEN-T Projects

• Projects managed by Eurocontrol (European Organisation for the Safety of Air Navigation) and supported by TEN-T funds:

• AURIGNY (NATS-UK)
  – Aircraft: *Britten Norman Trislander*
  – Airport/Procedures: *Southampton and Alderney*
  – Receiver: *Garmin GNS430W*

• AIRBUS ATI (DSNA-France)
  – Aircraft: *Beluga – Airbus A300-600ST*
  – Airport/Procedures: *(Clermont-Ferrand), Pau*
  – Receiver: *CMC electronics, both FMS and sensor*

• MIELEC (PANSA-Poland)
  – Aircraft: *Piper PA-34 Seneca II*
  – Airport/Procedures: *Mielec and Katowice*
  – Receiver: *Garmin GNS430W*
SESAR WP 5.6.3 “APV”

• **WP 5.6.3 ‘Approach Procedures with Vertical guidance (APV)’**
  – Led by Aena (Spanish ANSP).
  – Duration 3 years
  – Divided in 2 phases.

• **Phase 1**
  – Focused on preparing the APV/SBAS (LPV) implementation.
  – 1 Procedure per country: Spain, Italy, UK and Norway

• **Phase 2**
  – Devoted to the research and development of advanced concepts and procedures based on GNSS.
  – Development of a total of 2 advanced procedures.
• The advanced procedures to be assessed in the project refer to anything beyond the ‘ILS-look-alike’ concept of APV:

  – Transition from PRNAV / RNP APCH / RNP AR APCH to LPV.
  – Transition from Continuous Descent Approach (CDA) to LPV.
  – Steep approach (>4.5°) based on GNSS.
  – Double slope steep approach based on GNSS.
  – LPV200 capability (to reach at least same minima than ILS CAT I).
  – Advanced Missed Approach enabled by GNSS.
  – RNP to support simultaneous approaches to closely spaced parallel runways.
  – Wake Vortex Free Approaches on Hub Runway.
Technical & Economic studies conclusions

- **Business jets**: reduce total travel time
  - Interest of EGNOS:
    - Need for relatively high precision approaches requiring no ground-based navaids \( \Rightarrow \) SBAS based approaches (LPV)

- **General aviation**: to increase safety and reduce limitations due to bad weather
  - Interest of EGNOS:
    - Better navigation accuracy and integrity
    - Enables instrument approaches requiring no ground equipment (LPV)
    - Low cost

- **Rotorcraft for SAR**: reduce time and locate precisely the people in distress
  - Interest of EGNOS:
    - Better navigation accuracy, availability and integrity
    - Approaches with low decision height
Project Objectives

• **Airlines and end-users** using EGNOS for their daily operations
  - Installation, certification and operational approval of EGNOS enabled **avionics** to perform LPV approaches in selected aircraft
  - **Airlines, aircraft operators and Users to propose which runways at European airports are of their interest**

• **ANSPs and airports** with LPV approach procedures
  - Design, development, checking, verification and publication of EGNOS LPV **approach procedures** at selected European airports

• To develop customized **business cases** for the partner airlines and end users analyzing real-life **cost and benefits** of EGNOS use.

• Promote the adoption of EGNOS in **Aviation** by the **dissemination and awareness** of the results and benefits.