Workshop on GNSS Applications

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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

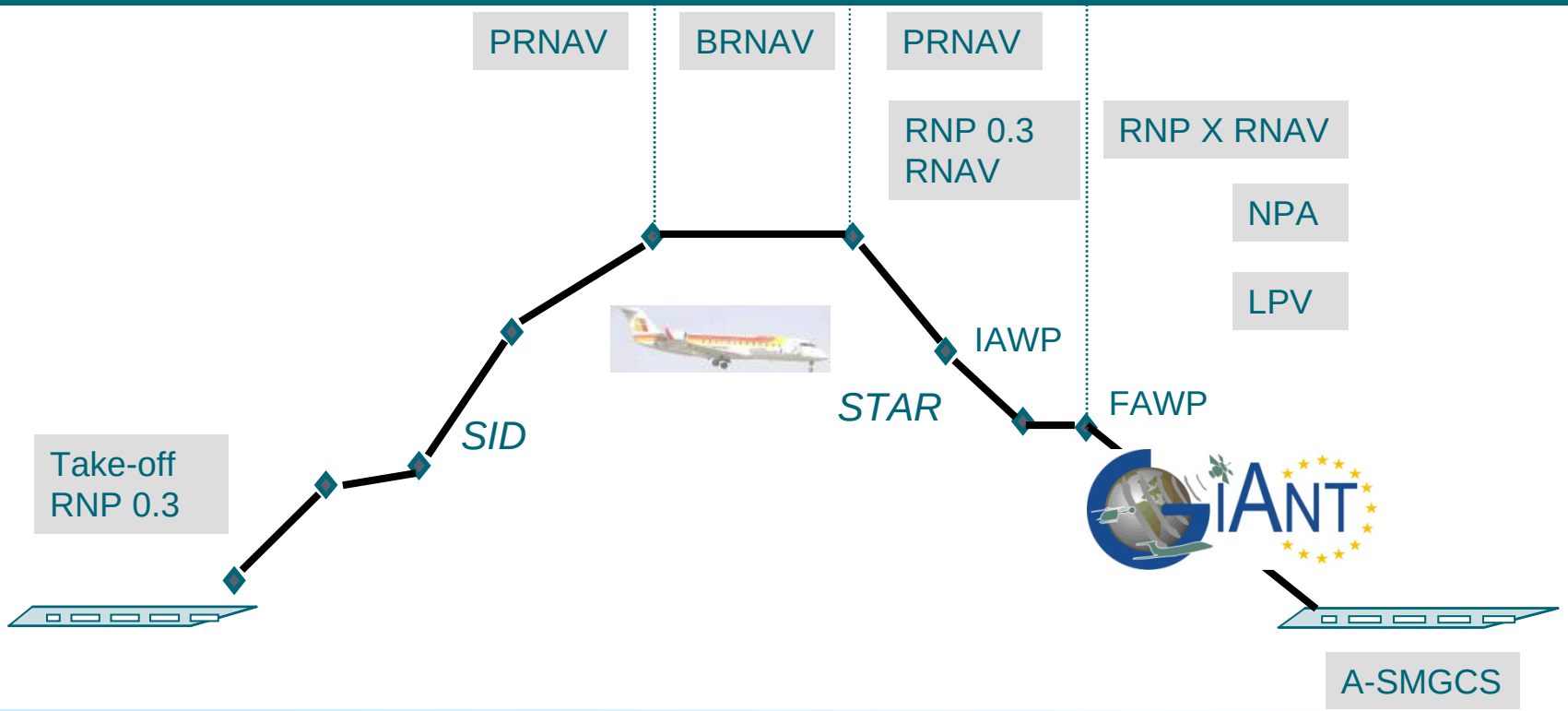
- Aeronautical: airports and air navigation
- Railway
- Road

- 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

GNSS Applications for Civil Aviation



- 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 approaches based on EGNOS (SBAS)

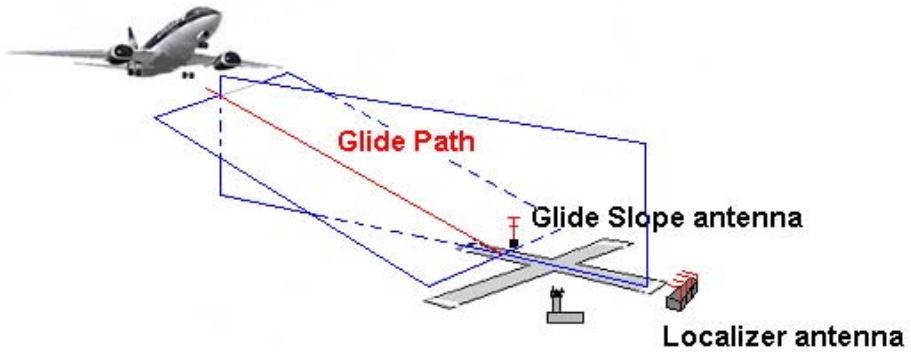
LPV (APV) approaches: Localizer Performance approaches with Vertical guidance based on GNSS - SBAS (EGNOS in Europe, WAAS in USA, …)

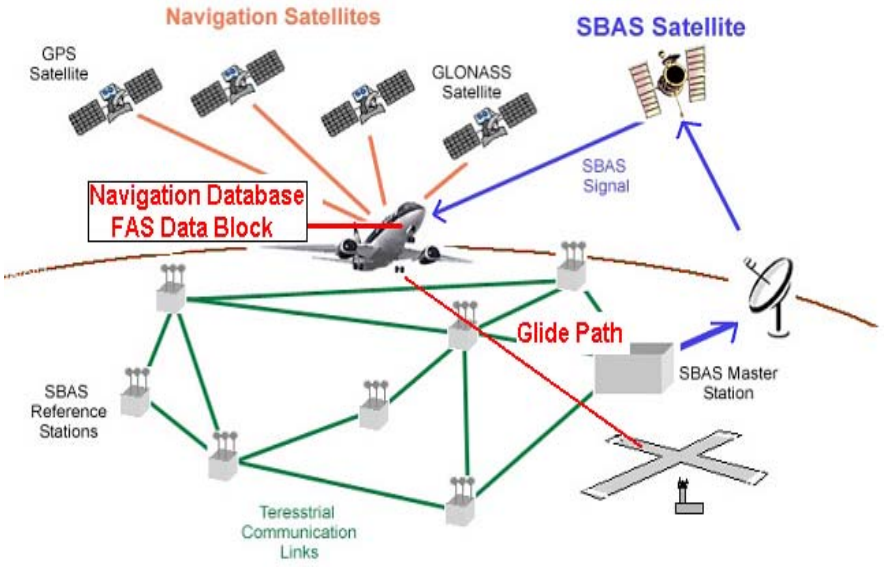
Use the enhanced performances provided by SBAS

- ***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

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Assisted by:

EUROCONTROL

GIANT Project

"GNSS Introduction in the AviatioN SecTor"

Galileo, 6th Framework Programme

GIANT

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

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.

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GIANT-2 Project

"EGnos AdoptIon in the AviatioN SecTor-2"

http://giant2.ineco.es

Galileo, 7th Framework Programme

GIANT 2

Project Objectives

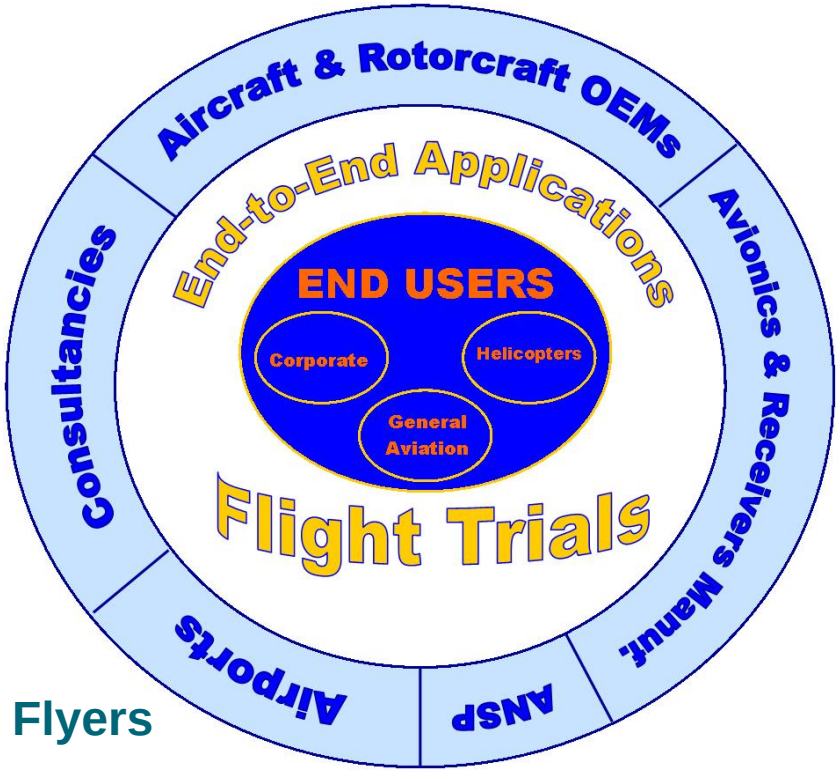
- To continue the work started in the previous GIANT project in order to accelerate adoption of EGNOS in other interested niche markets:
  - **Corporate aviation**
  - **General aviation**
  - **SAR Helicopters**
- To identify testing and operational practices that will lead to a successful EGNOS adoption
- 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

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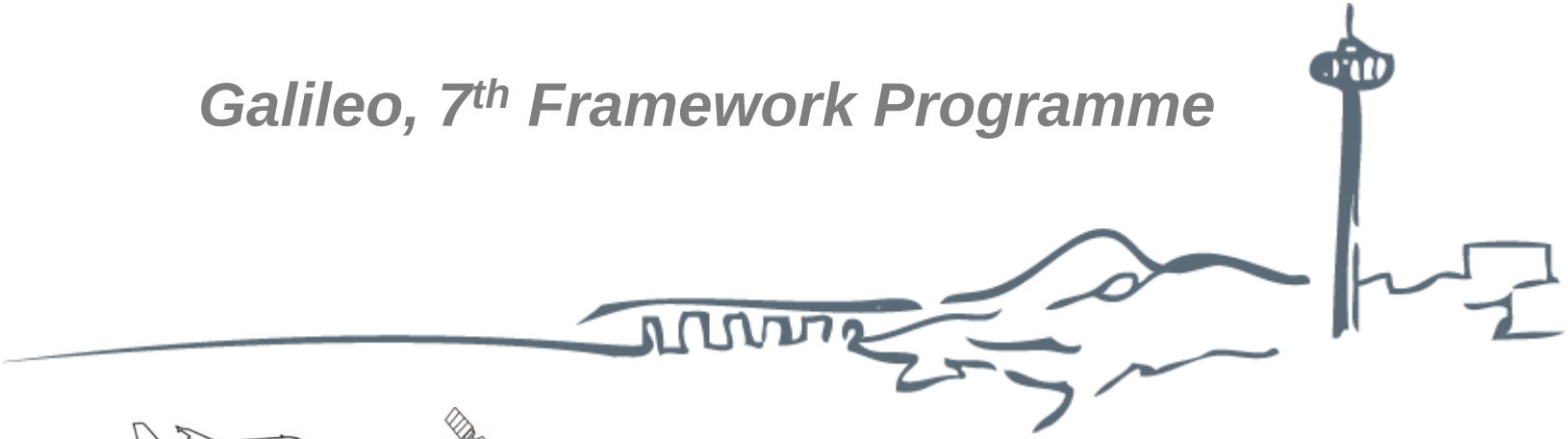
ACCEPTA Project

"ACCelerating EGNOS AdoPTion 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

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AIR NOSTRUM

NETJETS

Aena

dgac DSNA

BRITAIR

skyguide

Rockwell Collins

NATS

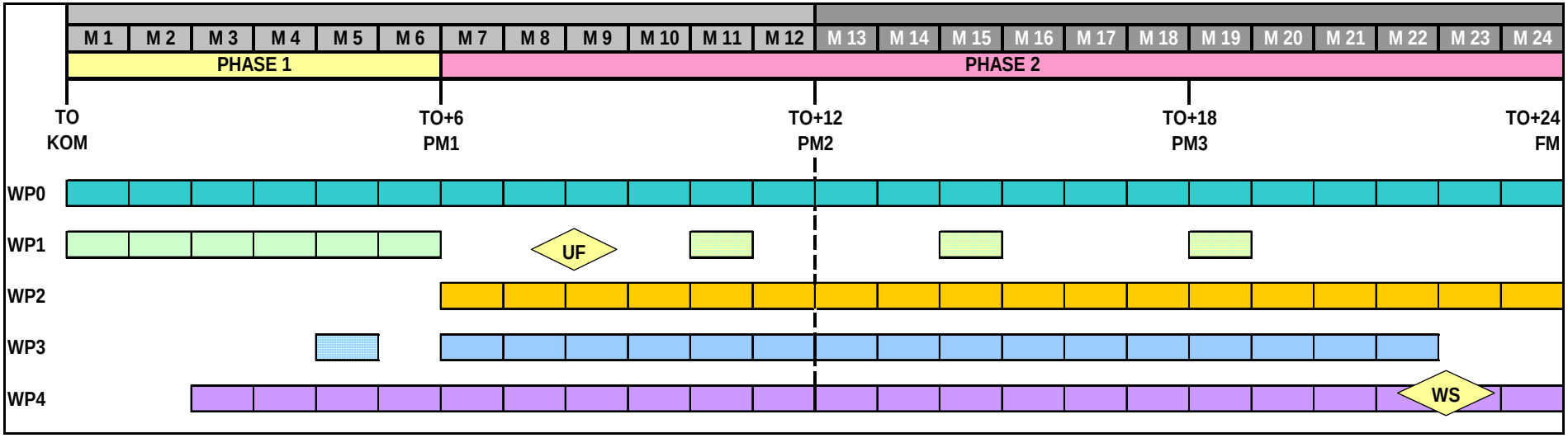
HELIOS

EBAA European Business Aviation Association

era european regions airline association

Plus …
new partners

User Forum / Info Day



- "ACCEPTA Info Day / User Forum" foreseen 2Q 2011
  - In Spain, location TBC

- "ACCEPTA Workshop" foreseen by the end of the project

Planning LPV Procedures

ACCEPTA		
DSNA	AENA	Skyguide
-Pau (RWY 31) -Le Bourget (RWY 27) -Clermont Ferrand (RWY 26)	-San Sebastián (RWY 04) -Córdoba (RWY 21) -Santander (RWY 11)	-Les Eplatures (RWY 24) -Altenrhein (RWY 10)

- NATS will produce 3 LPV procedures:
  - Alderney
  - Southampton
  - Gamston

Planning LPV Procedures

Future LPV procedures

DSNA	AENA	ENAV
-Limoges (RWY 22) -Clermond F (RWY 26) -Merville (RWY 04) -Vannes (RWY 22) -Le Bourget (RWY 27,07) -Orly (RWY 02, , 04, 06, 24, 26) -CDG (RWY 08, 09, 20, 26, 27) -Marseille (RWY 13, 31) -Albert Bray (RWY 09) -Angouleme (RWY 28) -Bordeaux (RWY 05, 23) -Valence (RWY 01) -Caen (RWY 31) -Calais (RWY 35) -Colmar(RWY 19) -Cannes (RWY 17, 35) -La Rochelle (RWY 28) -Le mans (RWY 02) -Melun (RWY28) -Pau (RWY 31) -Saint Nazaire (RWY 08) -Saint Yan (RWY 33) -Tarbes (RWY 20)	-Valencia (RWY 12) -San Sebastián (RWY 04) -Cuatro Vientos (RWY 10) -Santander (RWY 11, 29) -Córdoba (RWY 03, 21) -Granada (RWY 27) -Almería (RWY 08, 26) -Salamanca (RWy 21) -Málaga (RWY 13, 31) -La Palma (RWY 01)	-Bologna -Fitrenze -Napoli -Perugia

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:

[1] EGNOS Service Provision Yearly Report (Apr09-Mar10)
[2] ICAO 36th Assembly
[3] GIANT Website: www.gnss-giant.com
[4] GIANT-2 Website: http://giant2.ineco.es/
[5] ACCEPTA Website: http://accepta.ineco.es/
[6] EUROCONTROL Website: www.ecacnav.com
[7] GSA Website: http://www.gsa.europa.eu/
[8] ESA-EGNOS Website: http://www.esa.int/esaNA/egnos.html
[9] ESSP SAS corporate website: www.essp-sas.eu

Dubai, GNSS 2011

Thank you very much for your attention!

Questions?

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Head of GNSS Division

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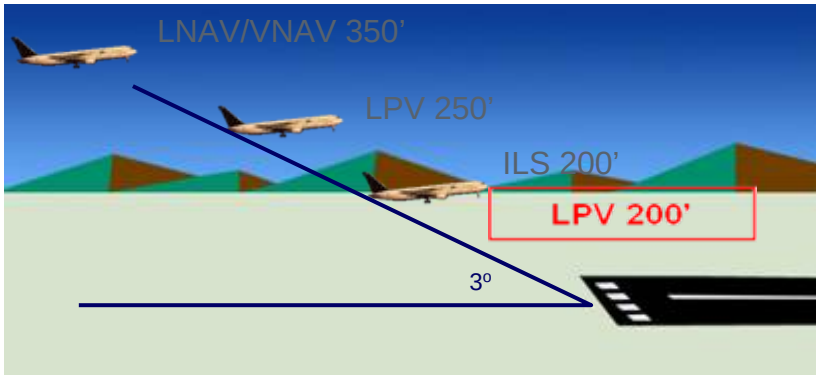
Dubai, GNSS 2011

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 lunched and supported by EC and Eurocontrol in order to implement LPV approaches



***ICAO**: International Civil Aviation Organization*

European GNSS Supervisory Authority

GIANT

"GNSS Introduction in the AviatioN secTor"

Galileo, 6th Framework Program

GNSS Benefits in Aviation

SEVENTH FRAMEWORK PROGRAMME

GIANT-2

"EGnos AdoptIon in the AviatioN SecTor-2"

Galileo, 7th Framework Programme

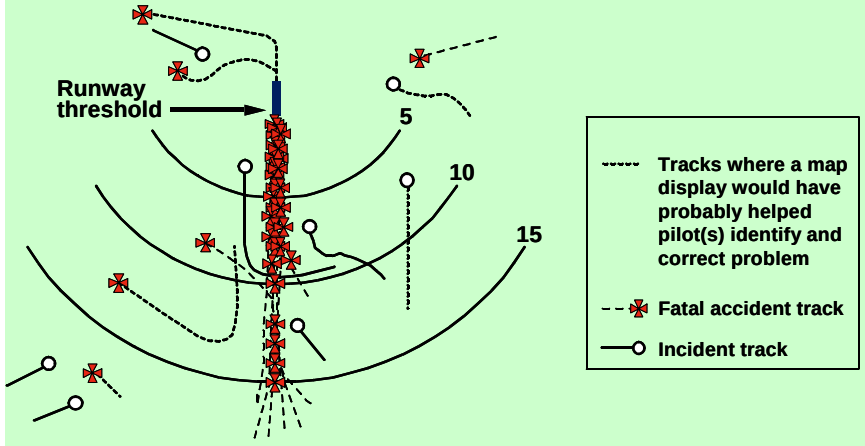
GNSS Operational benefits

- **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

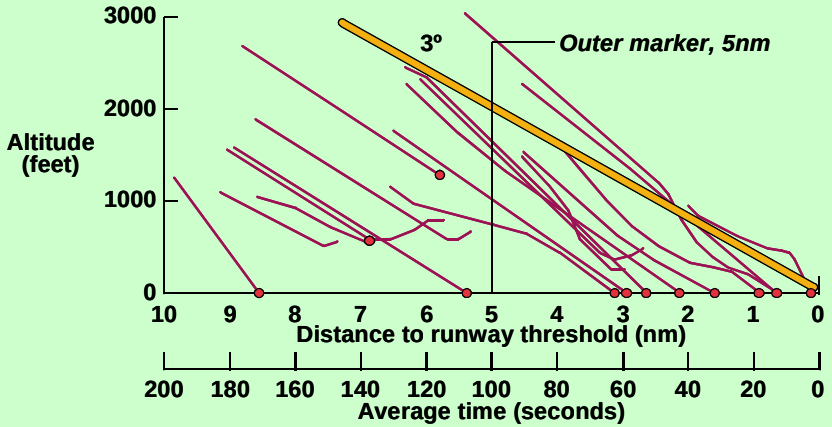
GNSS Operational benefits

- **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

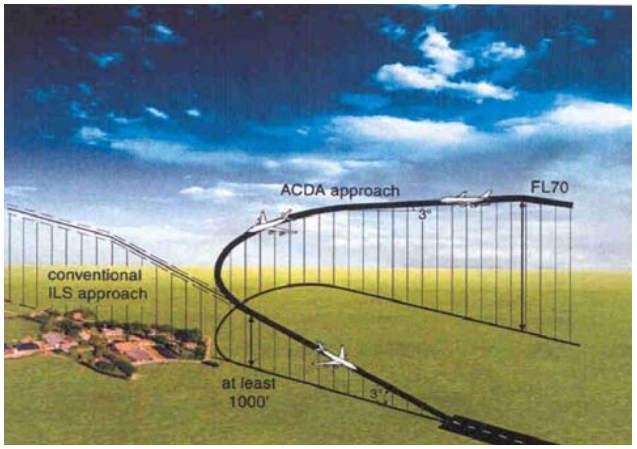
Not possible with NPA

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

GNSS → Allows Advanced Arrival & Departure procedures



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.

SESAR WP 5.6.3 “APV” (2)

- 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 (>4.5º) 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 ➔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

END