GNSS in Aviation

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EUROCONTROL
Presentation Overview

- EUROCONTROL and its role on GNSS
- Use of GPS in aviation today
- Transition to GNSS
- GNSS policy
- Navigation Strategy
- GBAS
- EGNOS
- Galileo
The European organization for the Safety of Air navigation

- A civil and military organisation

- Primary objective is to **ensure safety** in the development of a seamless, pan-European Air Traffic Management (ATM) system to cope with capacity needs and environmental aspects.

- Partnership with European and international stakeholders (e.g. EC, ICAO, FAA,...)

- More information: [http://www.eurocontrol.int/](http://www.eurocontrol.int/)
38 Member States:

Albania, Armenia, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, the former Yugoslav Republic of Macedonia, Malta, Moldova, Monaco, Montenegro, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom.
EUROCONTROL role on GNSS

- Long term involvement in GNSS matters

- EUROCONTROL contributes to the development of GNSS applications addressing different aspects:
  - Safety
  - Technical
  - Operational
  - Economic
  - Institutional
  - Legal
  - Security

- Focal point for the definition of the needs of aviation regarding GNSS
- Playing a major role in the operational validation of GNSS performance according to aviation requirements.
Use of GNSS in aviation applications

Civil domain

- Navigation
- Surveillance (ADS-B)
- Airport operations
- Timing

Military domain (based on GPS PPS & Galileo PRS)
The use of GPS has been authorized in Europe since 1998.
- Around 70% of European flights are made by aircraft equipped with GPS/RAIM.

GPS offers a very efficient and free service...but current GPS has some weaknesses:
- single frequency
- low power signals
- number of satellites
- single system/operator
- lack of sufficient guarantees

Safety Case relies upon reversion to conventional navigation means.
Transition to GNSS in European aviation

Operational needs
- Increase capacity to cope with increasing traffic demands
- Improve safety
- Reduce environmental impact
- Lower costs

Operational implementation
- More flexible routes (e.g. RNAV)
- Mode demanding performance (e.g. Integrity, Accuracy,...)
- Enhanced Safety (e.g. Vertical guidance in approaches)
- Better surveillance capabilities (ADS-B) to reduce separations
- Improved low visibility operations
- Common and accurate time reference

Driven by operational needs pull rather than by the technological push

In line with:
- ICAO global strategy
- SESAR Master Plan
GNSS in Approach

- **Precision Approaches are Best**
  - ILS now, MLS or GLS coming
  - Expensive and cannot be implemented everywhere

- **Non Precision Approaches are less safe**
  - Particularly for large passenger jets
  - Often complex and error prone
  - No vertical guidance

- **RNAV Approaches using GNSS aim to improve safety**
  - Vertical guidance
  - Using better capabilities on the aircraft
  - Provide better situational awareness
Why? - Safety

Traditional NPA accounts for 60% of all CFIT accidents
Loss of Vertical Situational Awareness is a primary contributor

- Vertical Guidance to each Runway End
- Stabilized Approach

There was a lack of vertical situation awareness.
## Instrument Approach Procedures

### Worldwide Summary

<table>
<thead>
<tr>
<th>Region</th>
<th>IFR airports</th>
<th>ILS</th>
<th>Non-Precision</th>
<th>Total Approaches</th>
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<tr>
<td>Africa</td>
<td>293</td>
<td>114</td>
<td>267</td>
<td>381</td>
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<td>Canada/Alaska</td>
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<tr>
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<td>9,330</td>
<td>11,659</td>
</tr>
</tbody>
</table>

**RNAV / xLS**
May 2008: Agreement among aviation stakeholders in Europe:

- Gradually increasing reliance on GNSS for all phases of flight as it becomes progressively more robust.

- A multi-constellation and multi-frequency GNSS environment in 2020+. Galileo signals will be used in combination with GPS and other GNSS components to have:
  - Better performance (accuracy, availability, continuity and integrity).
  - More robustness against vulnerabilities.

User receivers will process signals from different GNSS constellations in diverse frequency bands in combination with augmentations, depending on individual business cases and the phase of flight.

Final goal is GNSS as sole service to the extent that this can be shown to be the most cost beneficial solution and if supported by successful safety and security analyses.

A rationalised terrestrial infrastructure must be retained for the foreseeable future.
ECAC Navigation Strategy

1. EN ROUTE
   - P-RNAV
   - A-RNP1

2. TERMINAL
   - P-RNAV
   - A-RNP1

3. APPROACH, & LANDING
   - RNP APCH
   - RNP APCH (GBAS/GPS)
   - Cat III (Multiconstellation)
   - LPV (SBAS)
   - LPV 200
   - Cat III (GBAS/GPS)
   - Cat III (GBAS/GPS)
   - Cat III (GBAS/GPS)

4. EVOLUTION OF NAVAIRED INFRASTRUCT.
   - Rationalisation: Ground-based Navaids
   - Increasing use: Space-based Navaids

INCREASED USE: Space-based Navaids
RATIONALISATION: Ground-based Navaids
ILS (Instrumental Landing Systems) provide a very efficient service in many European airports, but are facing some problems (e.g. multipath effects, frequency spectrum).

Airports may overcome these problems by implementing GBAS for low visibility operations.

Multi-constellation GBAS for CAT II/III.

EUROCONTROL policy on GBAS is to support a progressive and cost effective transition from ILS towards GBAS by supporting the development of:

- Advanced concept of operations
- Safety assessments
- Technical and standardisation aspects
- Airborne aspects
- Operational implementation

The implementation of GBAS can be economically viable for an increasing number of airports and airspace users.
EGNOS can provide operational benefits and be a cost-effective option for “small” aircraft (e.g. General Aviation, Business jets, Regional Airlines) and to retrofit some old “big” aircraft.

First level commercial aircraft manufacturers and most of the airlines do not currently plan to invest in EGNOS.

EGNOS LPV procedures to be published by 2010.

Uncertainties about EGNOS in terms of date of its operational introduction, life-time period, institutional issues and charging policy have been impeding some ANSPs and airspace users to take their business decisions.

Individual business cases will determine the suitability of EGNOS for each aviation stakeholder.
Operational concept: Galileo signals will not be used alone but in combination with GPS and other GNSS components.

Galileo Open Service: Yes! We need it on time to increase overall performance and robustness of the multi-constellation and multi-frequency GNSS.

Galileo Safety of Life (SoL): Aviation questions its current definition:

- The Galileo global integrity concept is not aligned with the aviation operational concept and is not interoperable with the SBAS integrity concept.
- Aviation doesn’t want to see the Galileo SoL delaying the Galileo Open Service.

Proposed way forward:

- To define a more cost-effective distribution of integrity responsibility between the GNSS space, ground, and user segment considering advanced RAIM capabilities.
- Pursue interoperability between GPS III and Galileo at integrity level.
Gradual reliance on GNSS to support more demanding navigation, surveillance and timing applications... as we get better performance and more robustness in a multi-constellation and multi-frequency environment.

GNSS baseline configuration for aviation and future GNSS receiver architecture to be agreed by stakeholders to allow a cost effective transition (one main driver is high on-board related costs).

Final goal (very long term) is sole service concept to the extent that this can be shown to be cost beneficial and if supported by successful safety and security analyses.
QUESTIONS ?