GBAS CAT II/III concepts for flexible approach procedures

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Content

- Motivation & preparationary work
  - Flexible approach procedures with GBAS
  - Interoperability trials

- GBAS research infrastructure at Research Airport Braunschweig
  - Ground based (GBAS ground station, aviationGATE)
  - Airborne (experimental GBAS equipment)

- Flight Trials
  - On-board system testing
  - Procedure Design

- Conclusion and Outlook
Motivation - Flexible Approach Procedures with GBAS

- GBAS - Ground Based Augmentation System:
  - Based on GPS
  - Ground station transmits arrival path information and GPS correction data
  - Seem less transition from RNAV to approach procedures
  - CAT I (GAST-C) certifiable, CAT II/III (GAST-D) in the definition phase

- GBAS offers flexibility
  - Different approach path geometries are possible
  - Even situation dependent geometries could be used, e.g.
    - due to traffic demand
    - due to wake vortex criteria
Preparatory work: GBAS Interoperability Trials

Scope

- GPS & GLONASS capable GBAS ground station (manufactured and assembled in Moscow)
- Proof of robustness of standards

Contents

- Measurement Campaign in Moscow (April 2009)
  - with mobile equipment
  - discussion with operational involved personal

Founded by EUROCONTROL

- as early contribution to SESAR (Single European Sky ATM Research program)
Preparatory work: GBAS Interoperability Trials

Mobile Test Equipment with
- RockwellCollins Multimode-Receiver GLU925 - 330 (Boeing) and - 430 (Airbus)
- Telerad RE9009 VDB Receiver
- NovAtel DL-4 GPS Receiver
- Laptop with recording software (Condor Engineering BusTools)
- Flexible Connector Interface
Preparatory Work: GBAS Interoperability Trials

• Interoperability and robustness tests
• Baseline data for future multi-constellation research

- Use of extended MT1
- Use of more than 18 SV’s
- Transmission of MT5

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<th>No of Meas.</th>
<th>PRN</th>
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</table>
Ops Feedback – GLONASS/GPS

Note: Remote ops with high availability targeted – different adaptation for high density airspace

- Fleet operations: Some differences unavoidable (installed and test equipment, intervals and procedures)
- Pilots: Minimal differences (procedures / clearances / flight plan); ATC needs aircraft equipment knowledge
- ATC: Clearances depending a/c equipment and GNSS availability.

Note: in Russia ATC responsible for nav aids in clearance

- Procedure design: Differences in operational availability are factor in design
- Aircraft approval: Verification with single/multiple constellations
Research Infrastructure - GBAS Ground Station

Thales GBAS Ground Station
(owned by DLR)
Adaption of aviationGATE infrastructure for GBAS tests in dual-constellation environment

aviationGATE:

Galileo Test Bed around Braunschweig Research Airport
covered area: 5,000 km²
9 pseudolites:
  - 5 inner circle
  - 4 outer circle
2 reference stations
frequencies: E1, E5a, E5b
user defined / variable
  - navigation message
  - time synchronisation
Research Infrastructure - aviationGATE

Adaption of all system components needed
- Further development of aviationGATE
- Extension of experimental GBAS/INS on-board equipment
- GBAS/INS navigation & monitor algorithms

Test environment for dual-constellation
GBAS Research
Research Infrastructure – airborne equipment

Different GLS Approaches

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<td>real approach 3.5°</td>
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<td>real approach 14°</td>
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Example graph showing different GLS approaches with varying ideal and real altitudes.

Research Infrastructure – airborne equipment

Technische Universität Braunschweig

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GBAS Flight Trials Braunschweig - TUBS

GNSS Antennen
GBAS Flight Trials Braunschweig - DLR

- Validation with experimental A320 aircraft and operational used aircraft (B737, Air Berlin)
- Initial procedures based on already implemented RNAV procedures
- Transition from „ILS-Look-Alike“ towards steep and curved approaches
- Validation in simulation and flight trials
GBAS Procedure Design – DLR

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Conclusions and Outlook

- Braunschweig offers a unique research and test environment for GBAS approach procedure design and testing

- Curved and segmented approach procedures have been shown and validated with research and commercial aircraft

- Even with high requirements for GAST-D approaches these flexible approach procedures will be possible

- Continuous work will be done at Research Airport Braunschweig by University and DLR
Thank you for your attention!

Any Questions?

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