GBAS Operational Implementations

DFS experiences and capabilities

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Agenda

- DFS GBAS Installations
  - Bremen and Frankfurt

- GBAS Tools
  - IGM Independent GBAS Monitor
  - GIMOS GNSS Interference Monitoring System
  - VDB Test Transmitter
  - GPS Site Survey

- Ground Testing
- Flight Inspection
- DFS Services
GBAS Ground Station Installations in Germany

GBAS Bremen

GBAS Frankfurt

Braunschweig DLR
GBAS Installation Bremen
GBAS Installation Bremen

- GPS L1 reference antenna
- GPS reference receiver (4x)
- Honeywell SLS-4000 cabinet
- VDB data link antenna
GBAS Installation Bremen

- RSMU1
- RSMU2
- RSMU3
- RSMU4
- SLS-4000 + VDB
- Runway 23
- Runway 09 / 27
- 200 m
GBAS Implementation Steps

- operational concept
- site survey for GBAS ground station (GNSS, VDB)
- VDB frequency coordination, official approvals, site preparation
- procedure design (final approach segment - FAS data, AIP)
- factory acceptance testing (FAT)
- GBAS ground station installation, configuration
- ATC & maintenance interfaces (implementation, testing, training)
- ground testing (IGM, GIMOS)
- flight inspection (certified GBAS flight inspection aircraft)
- site acceptance testing (SAT)
- maintenance concept (spare parts, maintenance contract, …)
- operational safety assessment
- ATCO training (briefing)
- technical & operational approval (facility approval, service approval)

→ EC Declaration of Verification
GBAS Frankfurt

GBAS Site
GBAS Frankfurt
Frankfurt Installation
Monitoring Systems – IGM

**Independent GBAS Monitor**

- 2 different GNSS receivers (SF GPS & DF SBAS)
- VDB ground station data link receiver
- Online GBAS CAT I receiver simulation
- Certified GBAS CAT I MMR

in mobile (laptop) or stationary configuration (server) to support

- GNSS data recording (ICAO SARPs Att. D.11)
- GNSS performance assessment (ICAO SARPs Att. D.12)
- GBAS ground testing (ICAO Doc 8071 Vol. II, 4.2)

2005 IGM development started
2010 update of server & laptop HW & operating system
2011 GAST D update phase 1 (HETEREX)
  - handling of new GAST D message types
  - add online GAST D receiver simulation (algorithms TU BS)
2012 GAST D update phase 2 (SESAR 15.3.6)
  - additional online tools to support GAST D validation
Monitoring Systems – GIMOS

**GNSS Interference Monitoring System**
- programmable real time spectrum analyzer
- TSO C-129 certified GPS receiver
- embedded PC

to support mobile and stationary measurements of
- GNSS interference (GPS NPA, SBAS, GBAS)
- VDB interference (GBAS)
- VDB field strength (GBAS)

1998 GIMOS I development started (GNSS interference)
2000 GIMOS II second generation introduced
2006 GIMOS II GBAS VDB capabilities added
2011 GIMOS III development started
  - improve performance for GAST D VDB measurements (more than one VDB Transmitter)
  - new hardware (PC, spectrum analyzer)
  - update software capabilities
2014 GIMOS IV interference monitoring implemented
GPS L1 interference mode

VDB field strength mode
VDB Measurements – VDB Transmitter Setup

VDB transmitter setup to support

- **Lab measurements**
  - improve setup for unwanted emission & adjacent channel measurements (ground testing, type approval)
  - develop frequency coordination criteria (SESAR 15.3.6)

- **Site measurements**
  - **Munich** 2010 – VDB site survey for GBAS CAT I (ground & flight measurements)
  - **Frankfurt** 2011 – VDB ground coverage for GBAS CAT II/III (GAST D, SESAR 15.3.6)
  - **Zurich** 2011 – support Skyguide in VDB site survey for GBAS CAT I (ground measurements)
  - **Frankfurt** 2014 - VDB site survey for GBAS CAT I (ground & flight measurements)
Equipment for GPS siting
GBAS Ground Testing (Doc 8071)

- GBAS ground testing divided into blocks
  - GNSS interference (GIMOS)
  - Survey of antenna phase center position (geodetic equipment)
  - RF measurements (GIMOS)
  - VDB runway coverage & interference (IGM, GIMOS)
  - FAS data check on runway thresholds (IGM)
  - Performance evaluation & data content (IGM)

- Matrix in DFS maintenance directive to allow more flexible response to certain maintenance activities
GBAS Flight Testing – Flight Inspection Aircraft

GBAS CAT I flight inspection performed by FCS (Flight Calibration Services, Braunschweig)

- Certified flight inspection aircraft King Air 350
- Certified flight inspection system (FIS)
  - modified GBAS MMR integrated
  - MMR guidance signal can be switched to primary avionics incl. autopilot
  - FIS software is now GBAS capable
- Licensed crew (pilots, FI engineer)

- 02/08/2011 First GBAS flight inspection in Europe with certified aircraft, equipment and crew performed in Bremen
- GBAS Flight Inspection performed at Bremen, Frankfurt, Braunschweig, Zürich, Malaga

source: FCS
DFS Experience & Services

DFS has 16 years of experience in GBAS standardisation, testing & implementation

- ICAO Navigation Systems Panel (NSP)
- EUROCAE WG28 (ED-114 GBAS ground station MOPS)
- IGWG - International GBAS Working Group (EUROCONTROL, FAA)
- EUROCONTROL LATO - Landing & Guided Take-Off Task Force
- world’s first ICAO GBAS CAT I implementation in Bremen 2012
- ICAO GBAS CAT I implementation in Frankfurt 2014

Your partner for

- GBAS project planning
- GBAS ground station siting, installation
- operational concept, GLS procedure planning
- GBAS ground & flight testing/inspection
- GBAS monitoring & GNSS interference monitoring, etc.

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Thank You!