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 Transitter
  - GPS Site Survey
- Ground Testing
- Flight Inspection
- DFS Services

GBAS Ground Station Installations in Germany

GBAS Bremen

GBAS Frankfurt

- DFS Headquarters
- Tower
- Center
- DFS Academy
- AIS
- GBAS ground station

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GBAS Installation Bremen

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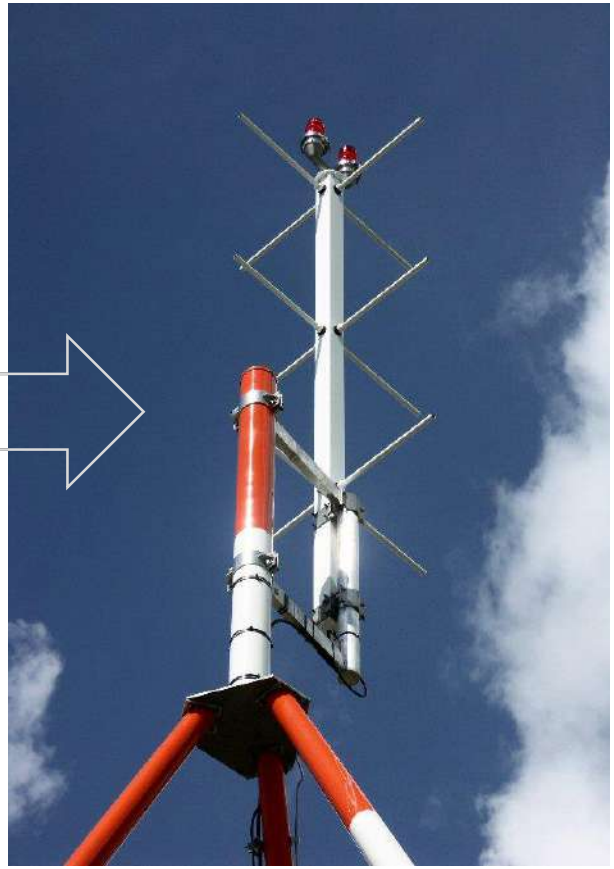
GBAS Installation Bremen

GPS L1 reference antenna
GPS reference receiver (4x)

Honeywell SLS-4000 cabinet



VDB data link antenna

GBAS Installation Bremen

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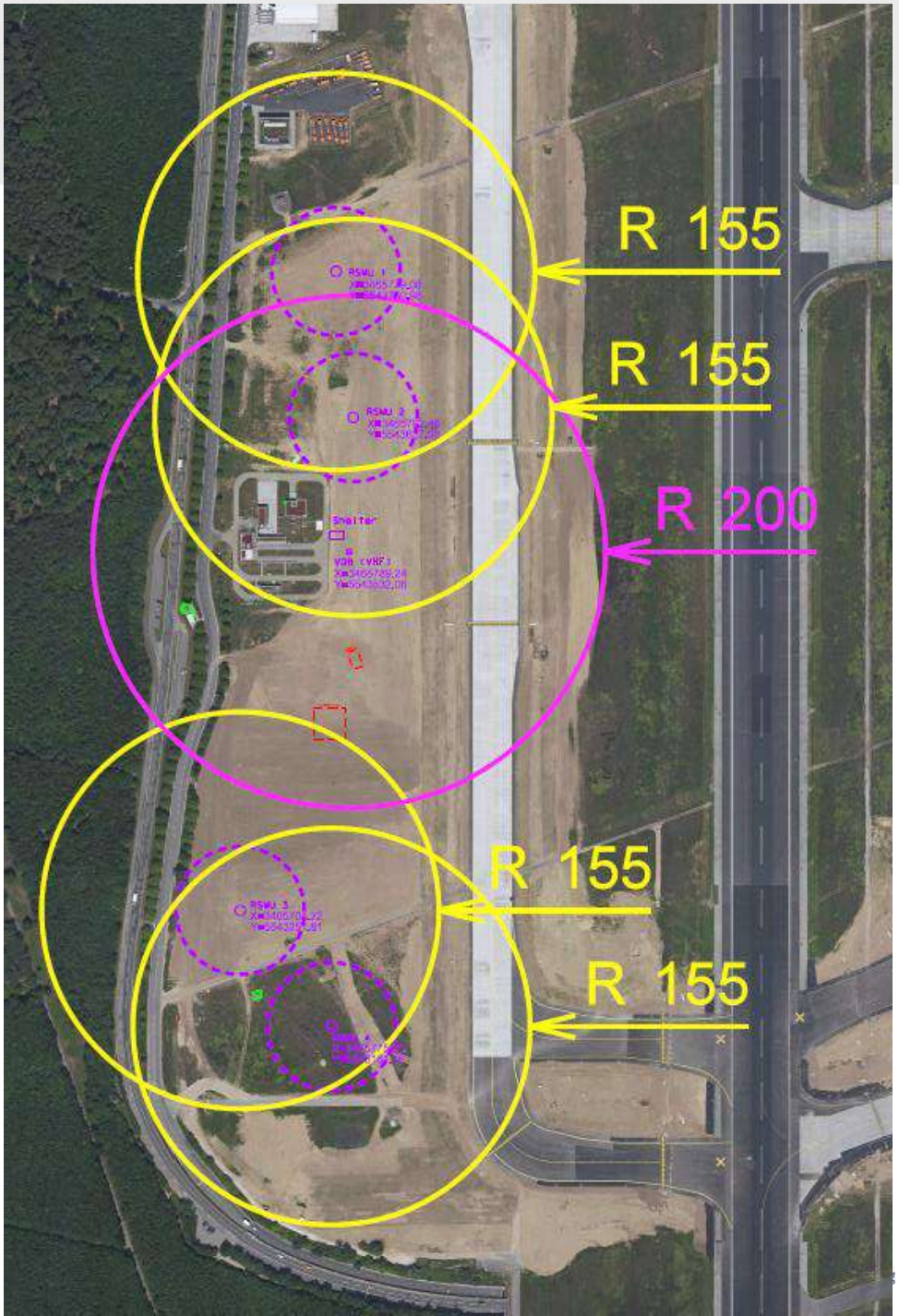
GBAS Implementation Steps

- ✓ 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 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

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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

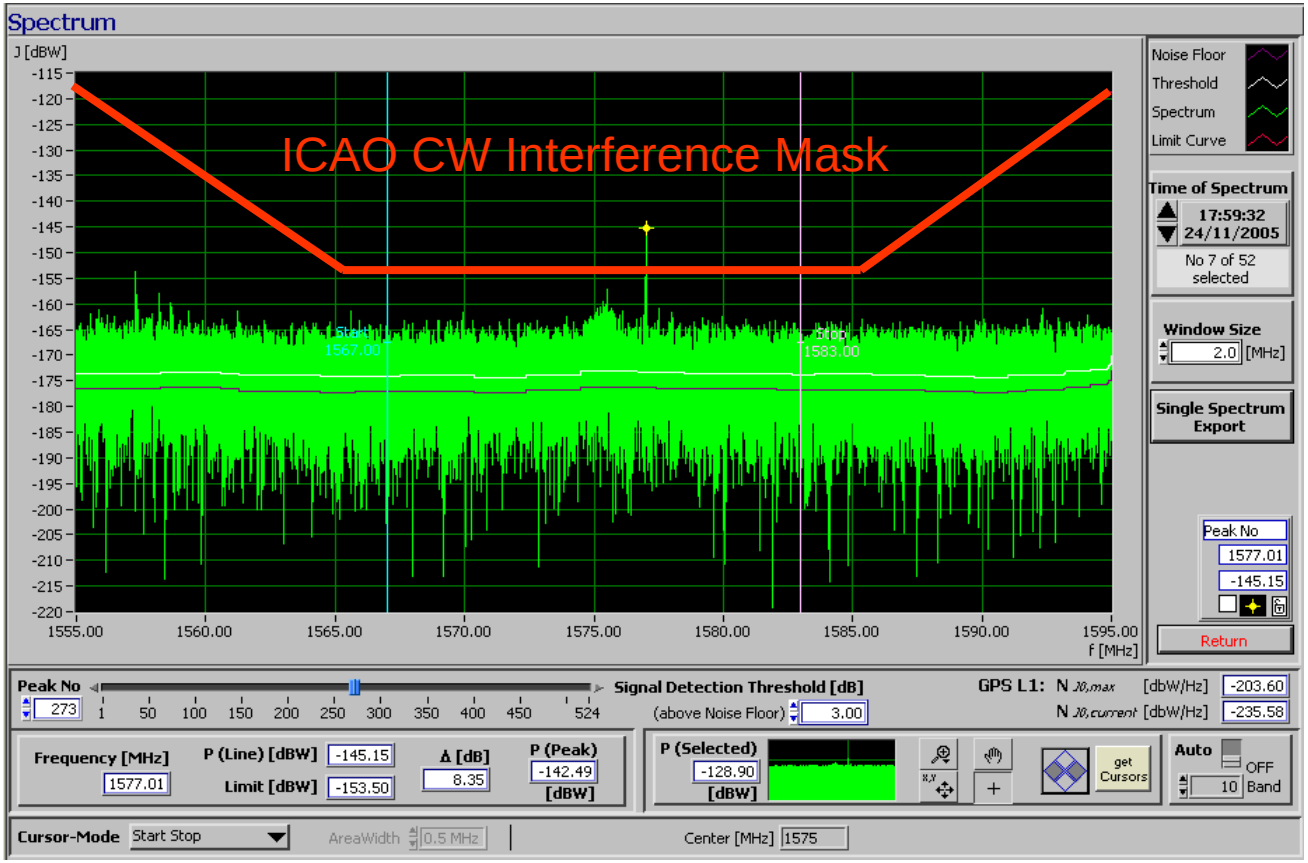
2006 GIMOS II GBAS VDB capabilities added

2011 GIMOS III development started

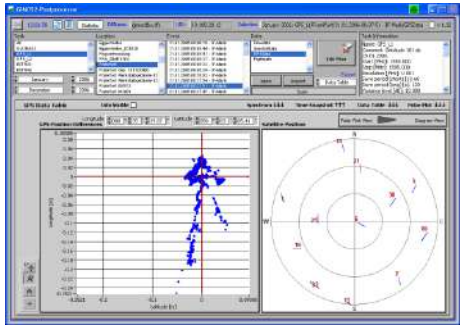
- improve performance for GAST D VDB measurements (more than one VDB Transmitter)
- new hardware (PC, spectrum analyzer)
- update software capabilities

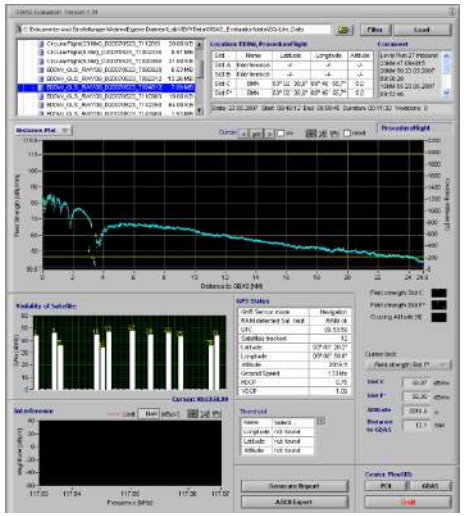
2014 GIMOS IV interference monitoring implemented

Monitoring System GIMOS (2)



GPS L1 interference mode





VDB field strength mode

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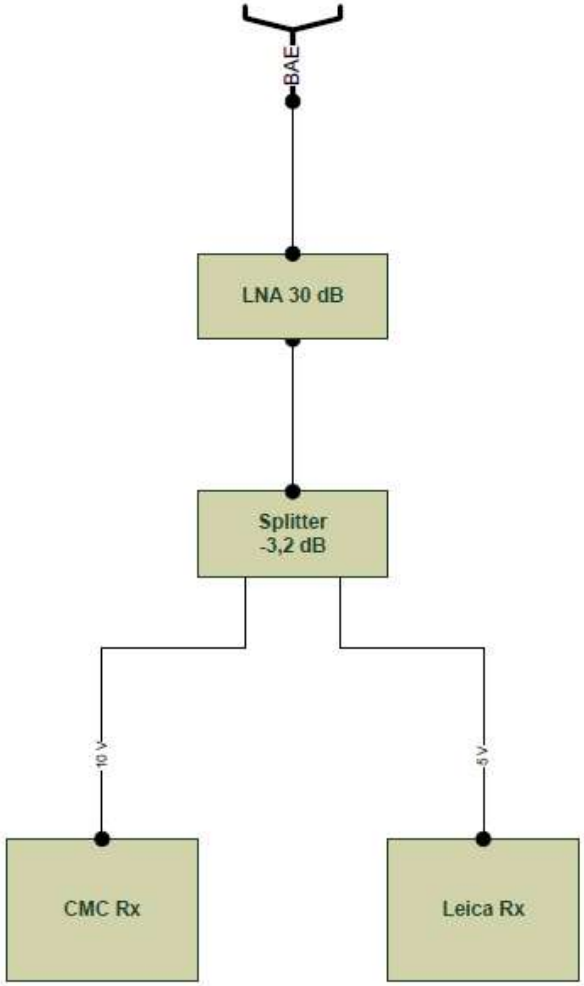
VDB Measurements – VDB Transmitter Setup

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



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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

- test implementations in Munich 1995, Frankfurt 1998, 2000, 2013, Bremen 2007, 2008
- 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 !