

SESAR 15.3.6 Task 18 Flight Trials Phase 2 – FMG Visit

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Welcome to Frankfurt



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Honeywell Falcon 900EX N966E (SESAR 9.12)



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Overview

- GBAS Ground Station
- SESAR, SESAR 15.3.6
- Frankfurt Airport GBAS sites
- GBAS CAT I (GAST C) Installation
- GBAS CAT III (GAST D) Installation
- GBAS Monitoring Site & Systems (IGM, GIMOS)
- GBAS Ground & Flight Testing, SIS Validation



Early DGPS Ground Station Experience of DFS



D910, Munich
1995



D920, Frankfurt
1998



SLS-3000, Frankfurt
2000

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GBAS Bremen - DFS GBAS CAT I Pilot Project

- 03/2005 Project Kickoff
- 04/2007 Honeywell SLS-3000+ in Bremen
Operational trials TuiFly
- 11/2008 Red label SLS-4000 in Bremen
Operational Trials Air Berlin
- 08/2009 new German regulator (National Supervisory Authority)
- 09/2009 FAA SLS-4000 System Design Approval (SDA)
- 11/2011 German SLS-4000 type approval
- 12/2011 EC Declaration of Verification 'Nav system airport Bremen'
- 01/2012 Final VDB frequency license
- 01/2012 GBAS safety assessment
- 02/2012 maintenance interface (NLS) approved
- 02/2012 DFS Technical Acceptance & Operational Acceptance
- 02/2012 public ICAO GBAS CAT I service without restrictions
Full Operational Use by Air Berlin
- 07/2012 ATC interface in Bremen finalized (IDVS, ATCISS)



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1st GBAS CAT I for Regular Air Service in the World



Feb. 09, 2012: first GLS landing using fully certified GBAS ground system - Air Berlin Boeing 737-800 in Bremen

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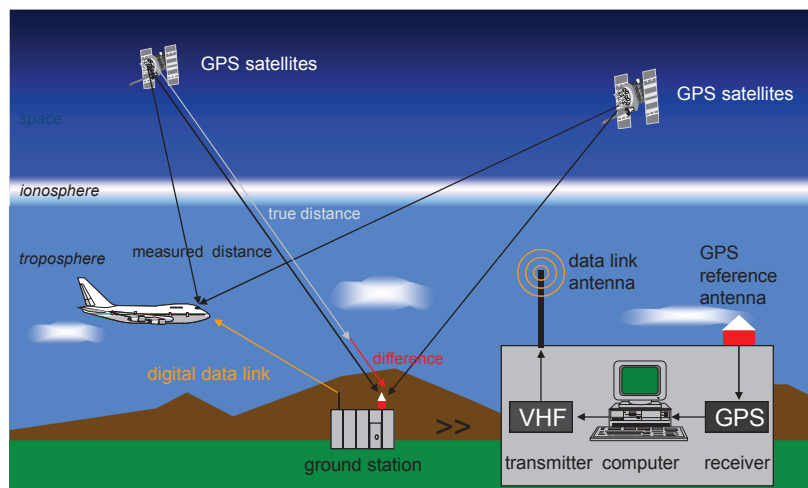


GBAS Principle & Architecture



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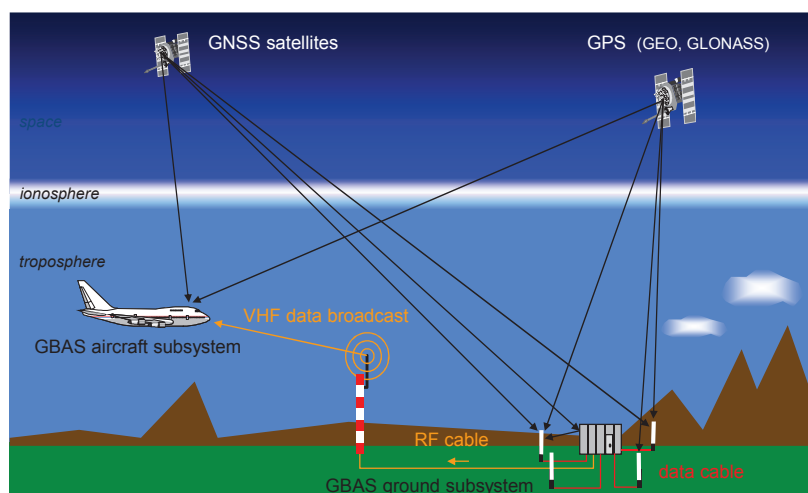
GBAS - Differential GPS Principle



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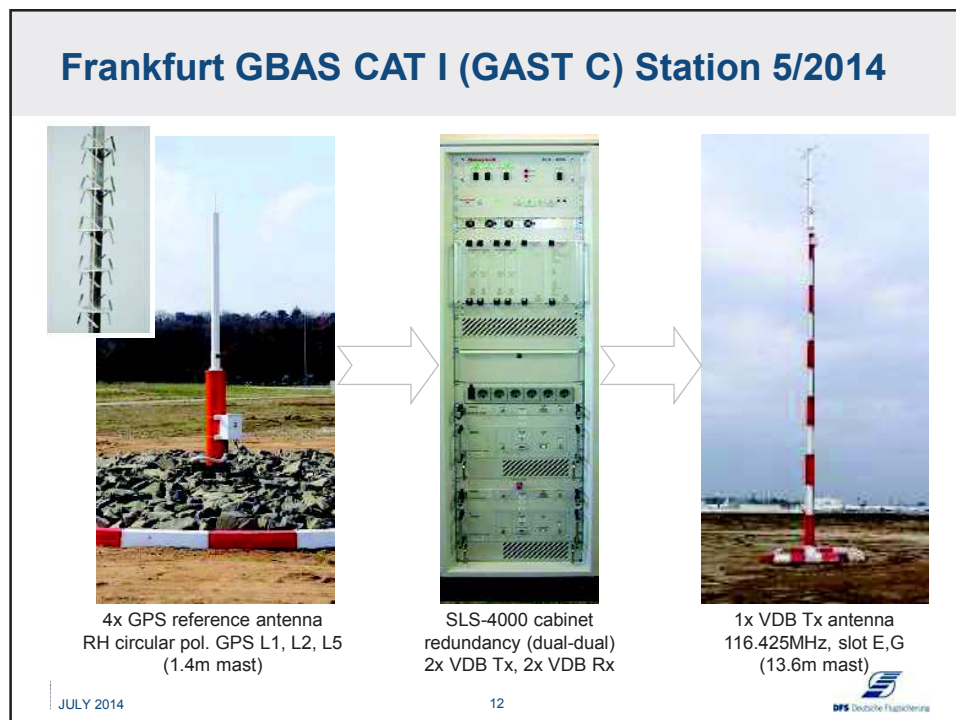
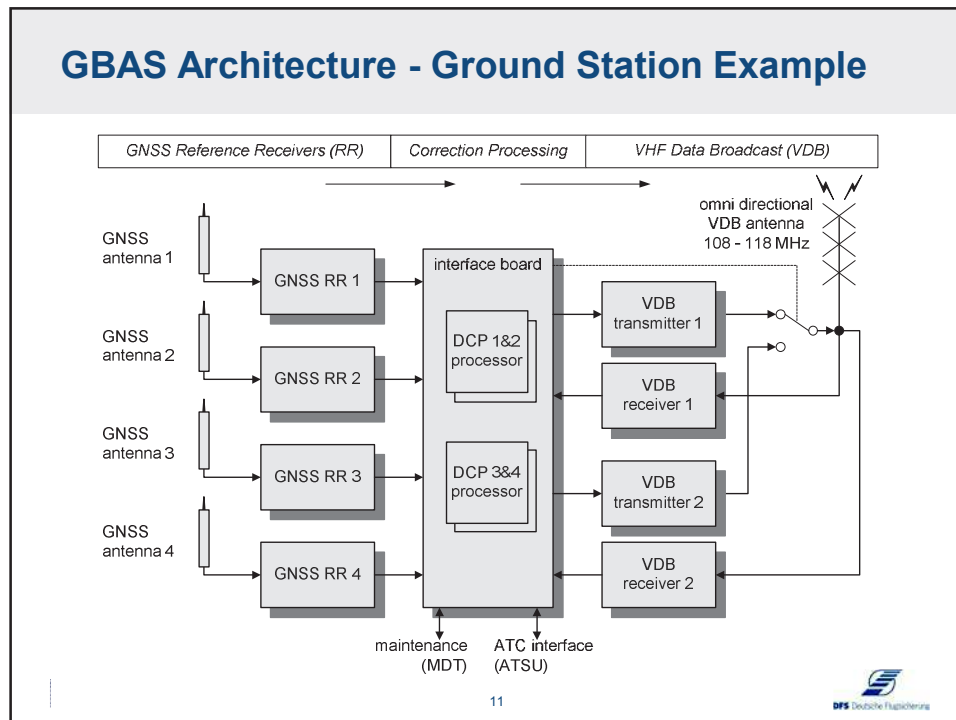
GBAS - System Overview



GBAS ground subsystem has 2 - 4 precisely surveyed GNSS reference antennas

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SESAR GBAS Activities in Frankfurt



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SESAR

Single European Sky ATM Research - Program by EC, ECTL

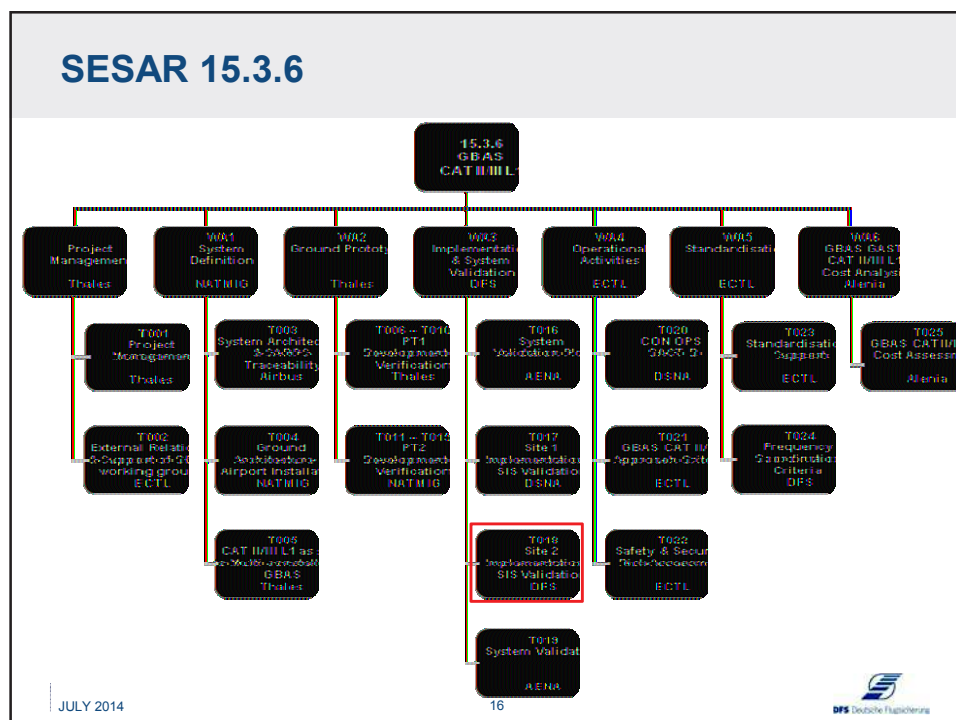
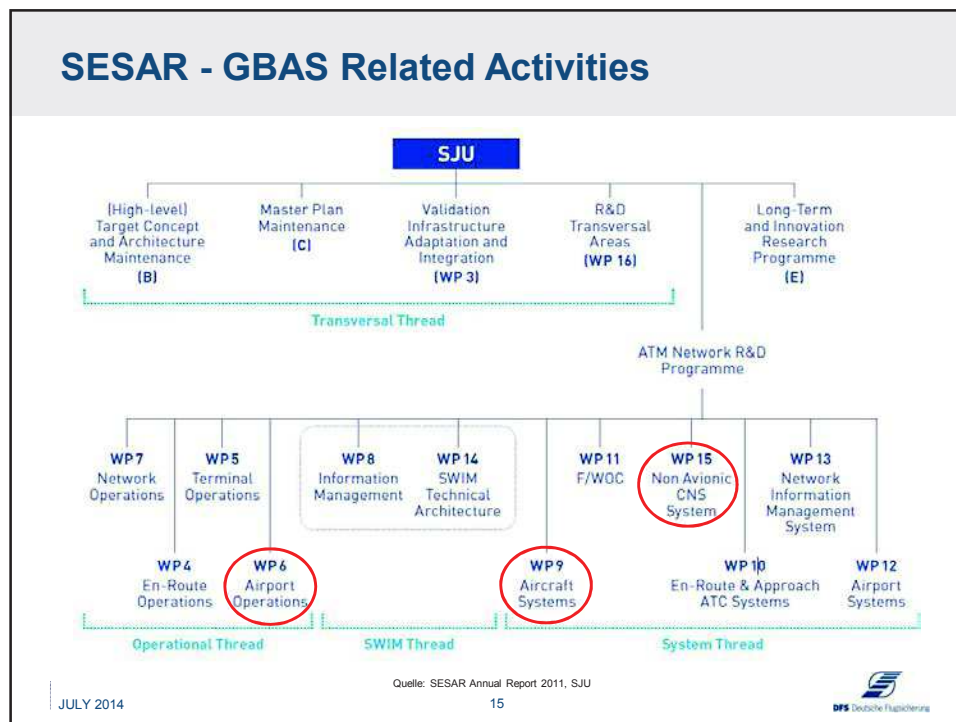
- Goal
 - Modernization of the European ATM system by coordinating and concentrating all relevant research and development efforts with a view to harmonizing implementation.
- Phases
 - definition phase (2005 - 2008)
 - development phase (2008 - 2013)
 - deployment phase (2014 - 2020)
- Performance targets for 2020
 - enable a threefold increase in capacity
 - improve safety by a factor of 10
 - reduce by 10% the environmental impact per flight
 - cut ATM costs by -50%

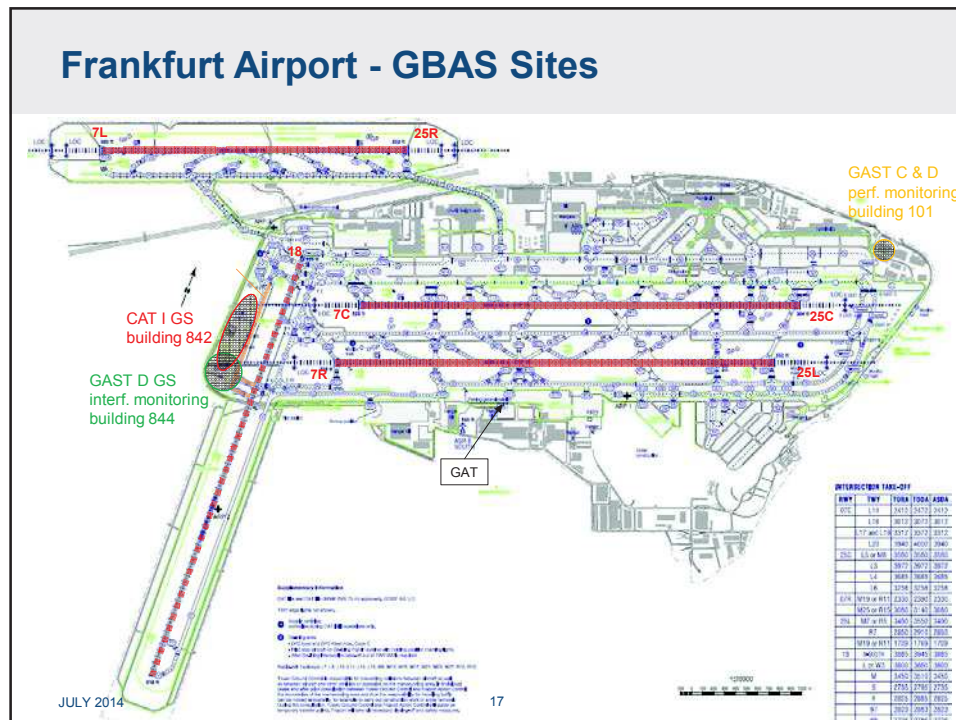
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Quelle: SESAR Modernisierung des Flugverkehrsmanagements in Europa

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Frankfurt Airport - Sites

GBAS CAT I (GAST C) Site, Honeywell SLS-4000

- new ground station shelter (building 842)
- 4 GPS reference antenna sites (>100m)
- 1 VDB transmit antenna site (10m)

GBAS GAST D Site, Indra Navia Normarc 8100

- ground station shelter (ILS Marker 07R, building 844)
- 4 GPS reference antenna sites (50...200m)
- 1 remote VDB shelter & VDB transmit antenna site (250m)
- 1 GNSS Interference Monitoring System

Monitoring Site in 6.1 km distance from ground station

- building 101 is highest building in this part of the airport
- direct line of sight to old runway system
- green roof (grass, limited multipath)
- 6 GNSS antennas, 2 VDB antennas
- 2 IGM - Independent GBAS Monitor Systems
- Novatel base station from Honeywell (reference path)

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DFS Deutsche Flugsicherung

SESAR 15.3.6 Prototype Phase 2 Installation 2014



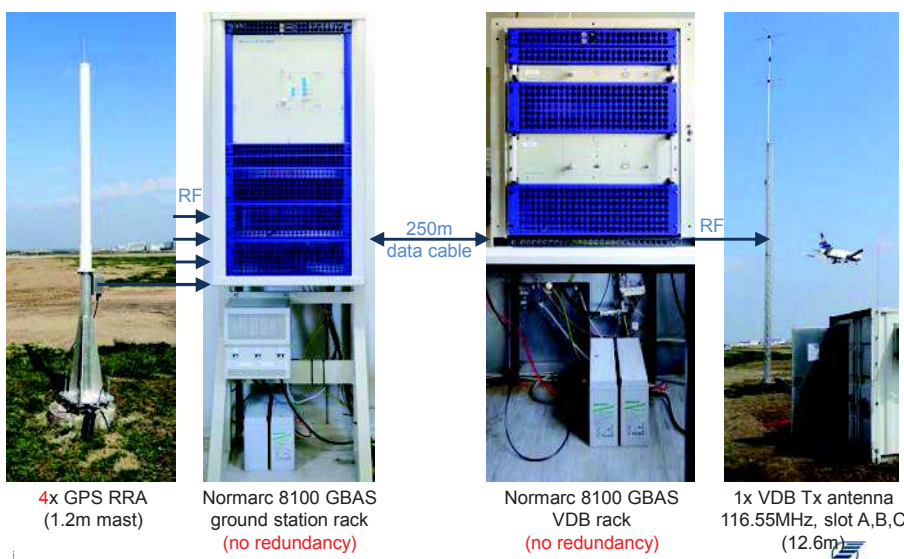
Indra RRA#4

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SESAR 15.3.6 Frankfurt GAST D Station 5/2013

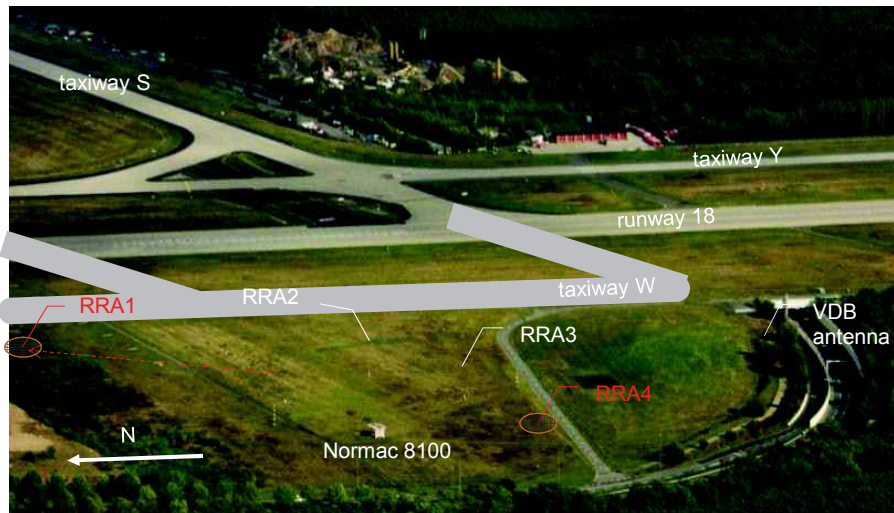


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SESAR 15.3.6 Prototype Phase 2 Installation 2014



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DFS Monitoring System - IGM

Independent GBAS Monitor

- 2 different GNSS receivers (SF GPS & DF SBAS)
- VDB ground station data link receiver
- Online GBAS CAT I + CAT III 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 IGM testing Bremen (CAT I), Braunschweig (GAST D)

2013 IGM verifying Frankfurt SESAR 15.3.6 phase 1 GAST D GS

2014 GAST D GS update phase 2 (SESAR 15.3.6)



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DFS Monitoring System - 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 VDB capabilities added

2011 GIMOS III development for VDB measurements started

- new hardware (PC, spectrum analyzer)
- update software capabilities

2012 GIMOS III testing Bremen (CAT I), Braunschweig (GAST D)

2013 GIMOS III validating Frankfurt SESAR 15.3.6 GAST D GS

2014 GIMOS IV add GNSS interference capabilities



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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)
- Testing of the DFS measurement systems (IGM, GIMOS)
- 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 2013 – VDB site survey for GBAS CAT I and Prototype GBAS CAT III (GAST D)



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GBAS Ground Testing

- GBAS ground testing divided into blocks
 - GNSS interference (GIMOS)
 - Survey of antenna phase center position (geodetic equipment)
 - RF measurements (Tektronix RSA 6114A)
 - 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



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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
 - participation of BAF representative
- 30/09/2011 final flight inspection report

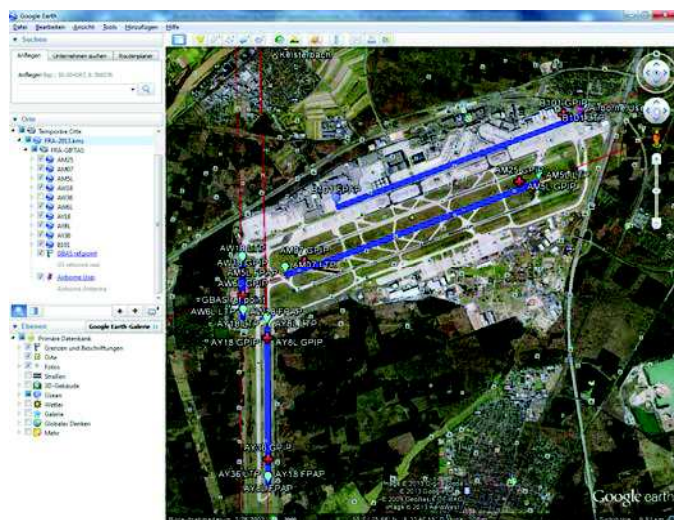


source: FCS

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SESAR 15.3.6 - Site Survey Taxiway Coordinates



Dr. Winfried Dunkel, SIS/ND
28.07.2014

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SESAR Phase 2 Ground Compatibility Testing



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SESAR 15.3.6 - GBAS Ground & Flight Testing

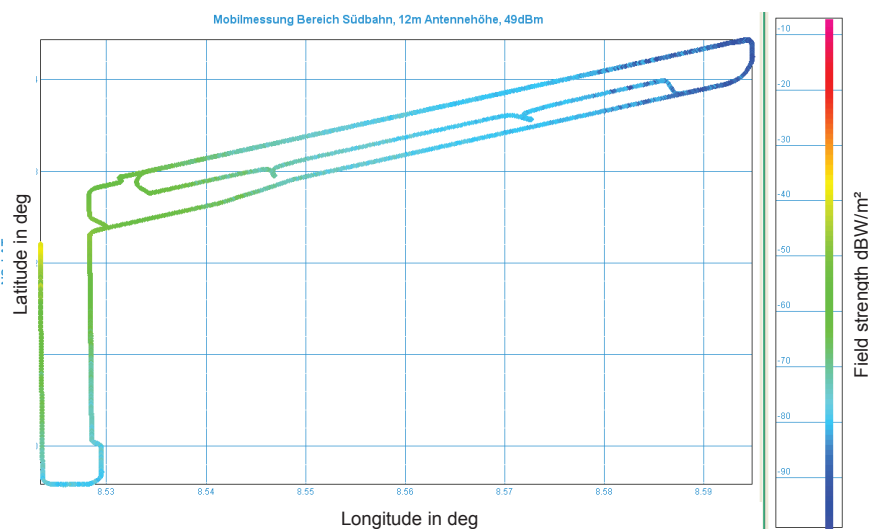


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VDB Ground Coverage Runway 25L/07R (GAST D)

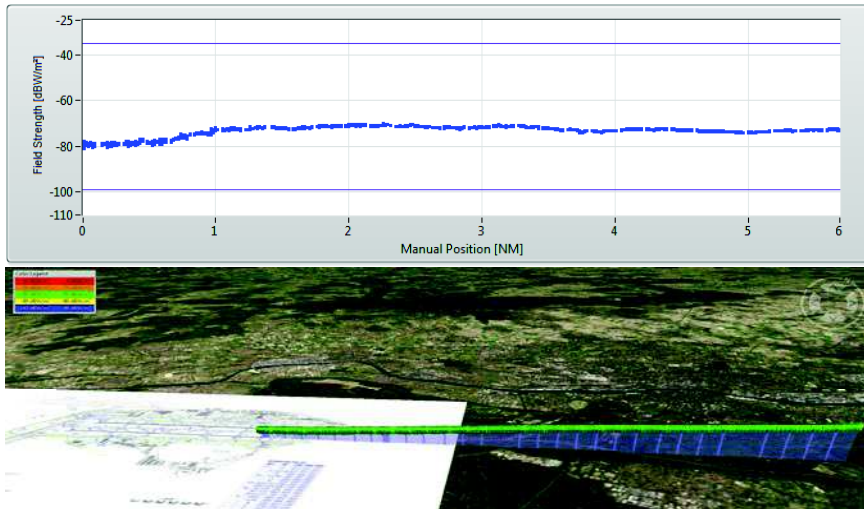


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VDB Flight Test - Approach 25L, Indra VDB 11.5m

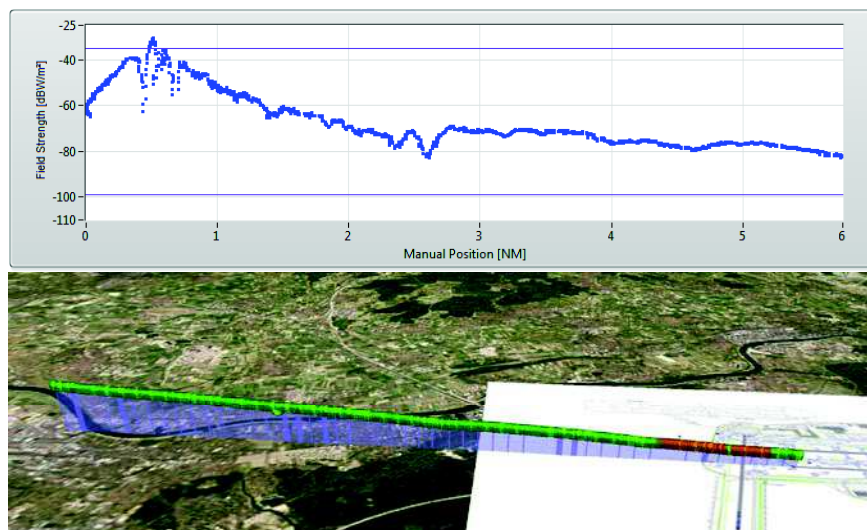


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VDB Flight Test - Approach 07R, Indra VDB 11.5m



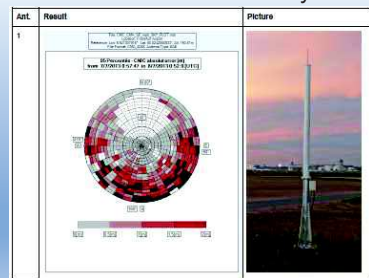
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T18 - SIS Verification Phase 1 & Phase 2

- Input: Verification exercises prepared in T16 "System Validation Plan"
- Output: Documented verification of the GS - "15.3.6 D18 Implementation and SIS Verification Report Site 2 - V1.1 - 30.09.2013 (Phase 1).pdf"
- Summary of the verification exercises performed in 2013 (1)

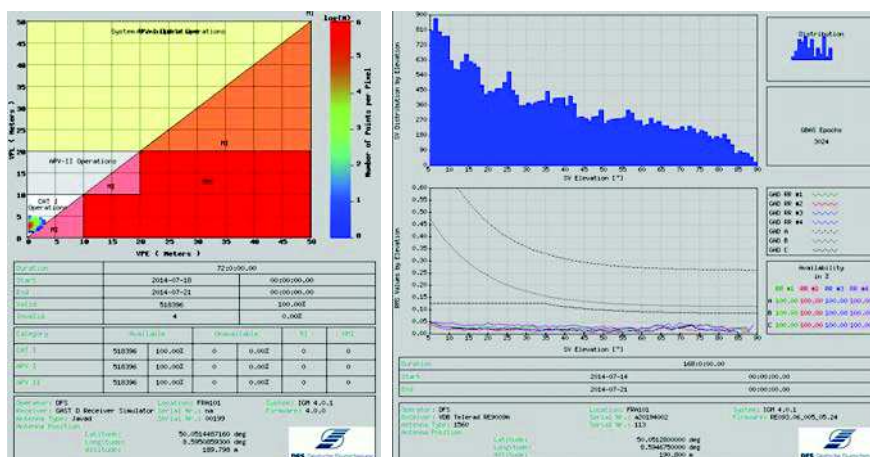
Exercises	Short Description	Example Result
EXE-15.03.06- VALP-SITE.0001	Siting measurements – reference antenna phase center position distance of the GBAS reference point to approach threshold points ≤ 5 km – reference antenna multipath analysis	Antenna 1 – CMC Analysis 
EXE-15.03.06- VALP-SITE.0002		
EXE-15.03.06- VALP-SITE.0003		

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GAST D Ground Station Performance



Stanford Plot, 72h
100% availability, no MI, HMI

Ground Accuracy Designator Plot, 1 week
GAD C4 in 100% of the time

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