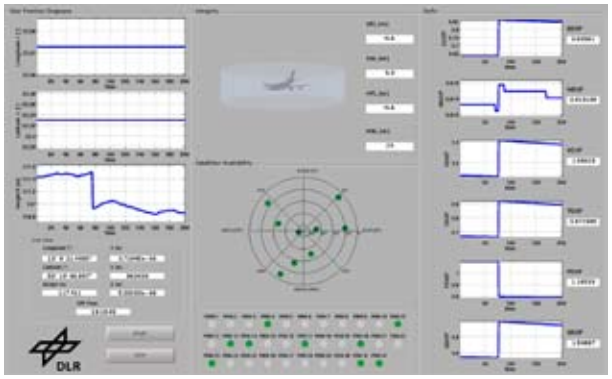
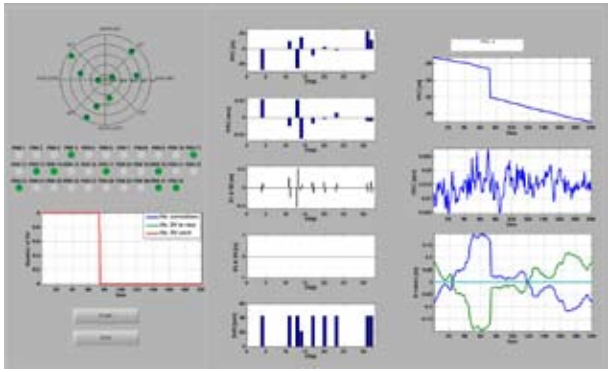
# GBAS Performance Demonstration

Currently, a graphical user interface is running on an eightcore computer with a Linux operating system on four screens.
The GUI provides real time information from ground and airborne subsystems.
Among other outputs, the following parameters are displayed:

- PVT solution
- Protection levels
- DOP factors
- Range and range rate corrections
- B-Values
- P-Values indicating ephemeris decorrelation
- CCD monitor

All parameters are stored on the harddisk for software or hardware validation in post-processing. For the software validation, a possible connection to the EUROCONTROL's PEGASUS validation tool is investigated at present. Moreover, an interface to the DLR's signal generator MASTER for postprocessing hardware validation is currently under development.





## DLR at a glance

DLR is Germany´s national research center for aeronautics and space. Its extensive research and development work in Aeronautics, Space, Transportation and Energy is integrated into national and international cooperative ventures. As Germany´s space agency, DLR has been given responsibility for the forward planning and the implementation of the German space program by the German federal government as well as for the international representation of German interests. Furthermore, Germany's largest project-management agency is also part of DLR.

Approximately 5,700 people are employed at thirteen locations in Germany: Koeln (headquarters), Berlin, Bonn, Braunschweig, Bremen, Goettingen, Hamburg, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Stuttgart, Trauen and Weilheim. DLR also operates offices in Brussels, Paris, and Washington D.C.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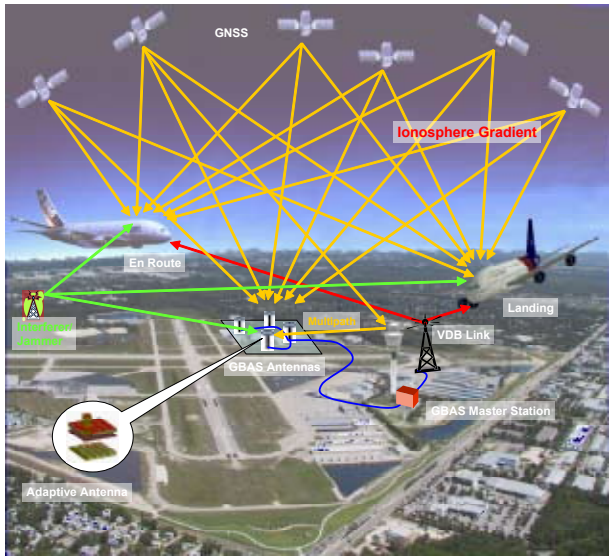
Information

# GBAS Demonstrator

For Future Precision Approach and Automatic Landing of Aircrafts

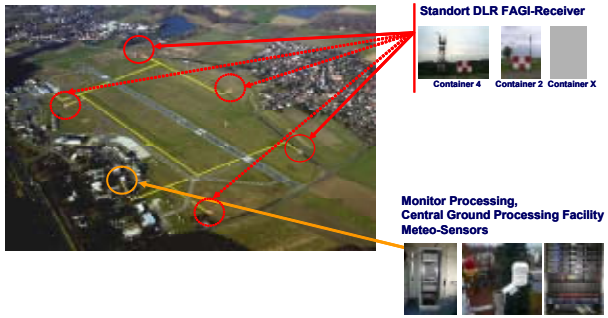
# GBAS for Precision Approach

Initial research and development efforts have shown that navigation sub-systems relying on Ground Based Augmentation Systems for GNSS (GBAS) can be considered as a promising solution for approach and landing in all weather conditions up to CAT II/III.
In this context, DLR's Institute of Communications and Navigation created a Hardware/Software GBAS demonstrator with full CAT-I approach functionality. This demonstrator is part of DLR's progressive research in CAT-III capable GPS landing systems.




Local Element Network & VDB Communication
GNSS Navigation
GBAS Antenna
VDB Links to ACFT
GBAS Master Station (Signal Processing & Integrity Monitoring)
Interferer / Jammer

# GBAS Ground Architecture




The ground subsystem located at the DLR's research airport in Braunschweig is composed of 3 dual frequency (L1/L2) receivers providing real time observations to a GBAS central processing facility. Here, corrections are computed and integrity monitoring algorithms evaluate the quality of the data. Corrections and integrity information are included in the standard message types (ICAO SARPS and EUROCAE ED-114) and broadcast to the aircraft in approach phase.
DLR's GBAS platform offers the possibility to integrate a software based receiver as well as to implement and test improved signal quality monitoring, multipath and interference mitigation/monitoring algorithms.

## GBAS Ground Monitors

In addition to the core processors constituting the GBAS ground subsystem, it is necessary to implement different types of monitors in order to augment the robustness of the GBAS solution for Safety of Life applications. The most important of them are:
- Ephemeris monitors
- Ionosphere monitors
- Sigma-pr-ground monitors
- Signal quality monitors

# GBAS Airborne Architecture

## GBAS Airborne Core Architecture

The Multi-Mode Receiver applies pseudorange corrections and range-rate corrections received from the ground subsystem and computes a position, velocity and time (PVT) solution. Parallel to the PVT processing, integrity information is processed onboard using the error bounds information provided by the ground processing facility. The output of the airborne processing as well as airborne raw data is broadcast via TCP/IP to the GBAS demonstration GUI.

## GBAS Airborne Monitors

To reach the most stringent requirements (CAT IIIc) of an aircraft navigation system, additional airborne based monitors need to be implemented. For GAST-D (Single frequency GPS CAT III) requirements, in addition to the 100 sec smoothing filter, a 30 second smoothing filter needs to be implemented in order to monitor ionosphere temporal gradients.
Novel airborne integrity monitoring algorithms currently undergoing research are planned to be implemented in an airborne receiver.

## Future GBAS Navigation Concepts

The above defined GBAS demonstrator will be used as development platform for future concepts. Important upgrades have been already identified:
- Multi constellation, multi frequency GBAS to enable full CAT III capabilities
- Carrier phase based solutions including carrier phase based integrity monitoring to enable autotaxiing and full gate-to-gate navigation
- Inertial hybridization techniques to improve robustness
- Coupling of Autopilot and GBAS system to explore a total performance concept.