Airborne GPS Test Plane

aviationGATE test environment in Germany using NovAtel's EuroPak-15ab receivers

Figure 1: Experimental aircraft D-IBUF of the Technical University of Braunschweig, Germany
Photo Credit: Gerko Wende, Technische Universität Braunschweig, Institut fuer Flugfuehrung

Galileo Status

The first GIOVE-A test satellite has been in orbit since December 2005 and the second GIOVE test satellite (GIOVE-B) was launched in April 2008. Galileo is expected to be fully operational in 2013 with up to 30 satellites orbiting the earth. It is designed for both civilian and government purposes with civil management.

NovAtel has devised an approach which allows independent tracking of the 'PRN' codes associated with Galileo E5a and E5b signals. The PRN code is a unique satellite identification reference that enables receivers to find the very low level satellite signal within background thermal noise.

EuroPak-15ab Overview

The EuroPak-15ab is a high-performance GPS, Galileo and GEO receiver capable of receiving and tracking 32 GPS L1, GPS L5, Galileo L1, Galileo E5a and Galileo E5b signals. Alternatively, four of the signals can be Satellite Based Augmentation System (SBAS) GEO L1 and SBAS GEO L5 signals. The EuroPak-15ab also frames the navigation signals.

Figure 2: EuroPak-15ab, NovAtel Inc.

Flight Institute Overview

The Institute of Flight Guidance and Control (IFF) is located at the Technical University of Braunschweig. The Institute provides technical consultation to the German Ministry of Transport, the International Civil Aviation Organisation (ICAO) and the European Space Agency (ESA) in the field of satellite navigation.

The role of the institute is to:

- Analyse final approaches for civil aviation under bad weather conditions
- Develop and apply an experimental, high precision, flight control system
- Automate landings with the experimental flight controller at civil airports

- Investigate an aircraft's reaction to wind and turbulence, optimize a cockpit man-machine interface or identify parameters for the design of flight control algorithms
- Develop a satellite-based, fully automatic taxi guidance system
- Conduct meteorological experiments including in-flight pollution

This paper focuses on a new activity, *aviationGATE*, which uses NovAtel's EuroPak-15ab receivers.

aviationGATE

aviationGATE in Braunschweig is a new test environment currently in development. It will be operational for test purposes by the end of 2008 and fully operational in 2009. It will broadcast the main Galileo carrier frequencies E1, E5a and E5b via pseudolites. In addition to laboratory tests on Galileo signals, *aviationGATE* opens up a direct test environment for airborne and ground-based positioning devices allow:

- Experimentation with received signals
- Development and testing of receivers
- Development, testing and certification of Galileo-based applications

The program focus is on positioning and navigation during approach and landing phases, surface movements on the apron, and special applications in nearby limited areas. *aviationGATE* is closing the gap between laboratory tests and actual Galileo usage in aviation.

Test Equipment

The IFF operates a research aircraft, see *Figure 1* on *Page 1*. The Dornier 128-6 is a high wing aircraft with two propeller-turbine-engines and fixed landing gear. It is equipped with scientific instrumentation specialized for meteorological measurements in the lower atmosphere. The standard instrumentation consists of a nose boom containing the main meteorological sensors such as temperature, pressure, humidity and wind speed. Additional wind measurement sensors are installed at each wingtip and at the vertical stabilizer. A GNSS EuroPak-15ab receiver from NovAtel Inc. and an inertial laser navigation platform (INS) output the position and attitude of the aircraft. Specific scientific instrumentation can be installed inside the cabin. For example, air chemical sensors, meteorological drop sensors or an airborne gravimeter.

Technology

aviationGATE is based on pseudolite principles. Satellites are rebuilt as ground based stations to send out real satellite signals equivalent to Galileo signals. Using this signal reception, the user can determine their distance to each of the pseudolites and from this, derive their position. As in Galileo, the pseudolites broadcast E1, E5a and E5b, to enable precise positioning.

The geometric formation of the pseudolites, used to generate Galileo signals, ensures good reception during approach, landing or moving on the apron at the Braunschweig airport. There are outer and inner rings of pseudolites for the airport. There are 9 pseudolites placed on masts around and at the airport covering an area of more than 5000 km². See also *Figure 3* below.

NovAtel plans to develop a white paper in 2009 to include data and results from the *aviationGATE* test environment.

a Galileo test environment for airborne and ground-based positioning

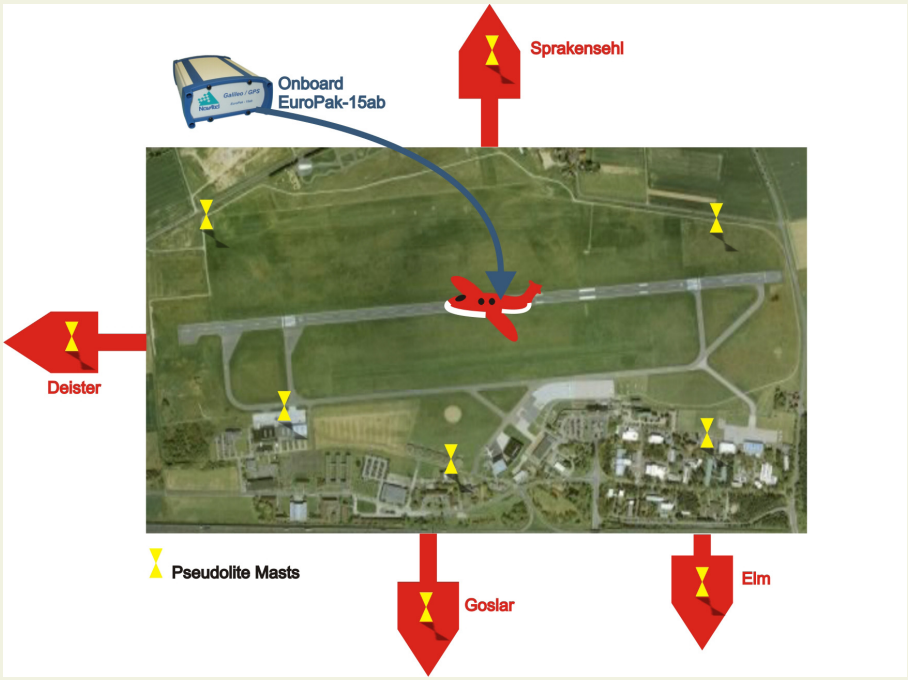

Figure 3: Braunschweig Airstrip and *aviationGATE* Pseudolite Mast Locations

Summary

This case study presents an aviation application using NovAtel's EuroPak-15ab receivers at the Technical University of Braunschweig in Germany. At the university's Institute of Flight Guidance and Control, the EuroPak-15ab is proving itself onboard a Dornier 128-6 aircraft. Performance and test data will be available from the *aviationGATE* test environment in 2009.

This case study shows that people, organisations and companies can trust NovAtel's receiver performance for testing and implementation of important commercial applications.