Maritime Galileo Application

SEA GATE test environment, Rostock Port, Germany using EuroPak-15ab receivers

Figure 1: Galileo Satellite Launch
Photo Credit: European Space Agency (ESA) - P. Müller

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.

SEA GATE Overview

SEA GATE is a test environment in the port of Rostock, Germany for developing and testing maritime Galileo applications. Six terrestrial Galileo transmitters, that broadcast a Galileo-like signal, are located around the port of Rostock. A mobile user operating in the broadcast area is able to calculate their position by using these signals. SEA GATE is set up under a contract from the German Aerospace Agency (DLR).

In the port of Rostock there are three critical areas: the sea channel between the harbor and the Baltic Sea, the turn-around area for ships, and the docking stations for ferries. The accuracy for docking maneuvers should be better than 0.2 m for any future automatic solution. GPS alone offers an accuracy of ~4 m. SEA GATE, using NovAtel EuroPak-15ab receivers and 704-X wideband antennas, achieves an accuracy of 0.5 m. The performance of SEA GATE has been proven on-board the Scandlines ferry Mecklenburg-Vorpommern, see *Figure 3*.

Test Setup

SEA GATE provides pseudolite signals which resemble the final Galileo signals as far as possible to allow for a realistic scenario.

Figure 3: Scandlines Ferry, SEA GATE Maritime Galileo Testbed in the Port of Rostock, Germany
Photo Credit: M. v. Voithenberg, Astrium GmbH, Munich, Germany, 2007

SEA GATE did several simulations to verify the required performance and has been fully operational since May 2008. An iterative process optimized the locations and quality of service. The expected horizontal accuracy in the operations area is better than 0.5 m based on the geometry of the transmit stations and signal quality.

There are six SEA GATE transmit stations equipped with a GNSS signal generator and an antenna to broadcast the Galileo signal, see *Figure 4* below. The transmitters are located around the operations area. Stations are linked via a wireless LAN (WLAN) system to the Monitor and Control station, which controls them.

Figure 4: Transmit: Station Positions (left) and Antenna Example (right)
Photo Credit: S. Martin, Astrium GmbH

The reference station is responsible for monitoring SEA GATE and GPS signals, see *Figure 5* on *Page 2*. The GPS signals achieve a common time base and link SEA GATE to GPS time. The reference station is geographically located in the centre of the operations area with line-of-sight to all transmit stations. It includes a NovAtel GNSS receiver, communication and housekeeping units.

The GNSS receiver forwards raw measurements to the monitor station via a WLAN link.

Figure 5: SEA GATE Reference Station Photo Credit: S. Martin, Astrium GmbH, Munich, Germany, 2007

The user segment, on the ship, consists of two NovAtel EuroPak-15ab receivers with NovAtel 704-X antennas, see *Figures 6* below and *Figure 7*, a SEA GATE PC and a graphical display to visualize a maritime chart and performance parameters, see *Figure 8.*

Figure 6: External NovAtel Antenna Onboard Ship
Photo Credit: S. Martin, Astrium GmbH, Munich, Germany, 2007

The user segment links to the master station over a WLAN link that operates even when the ship is moving inside the operations area.

SEA GATE Application

The first SEA GATE application was installed on the Scandinavian ferry Mecklenburg-Vorpommern to support precise maneuvering and docking. The ferry travels between Rostock and Trelleborg, Sweden carrying cars, trucks and train wagons. The tight schedule allows only 45 minutes for unloading and reloading in each harbor. The ferry enters the harbor with its bow in front and has to turn 180° as it docks backwards. Under severe weather conditions this maneuver has to be done extra carefully leading to schedule delays.

Figure 7 shows the locations of the antennas on portside and starboard of the ship. Each antenna is connected to a NovAtel EuroPak-15ab receiver. The baseline of ~30m between both antennas allows for precise heading and heel determination based on GPS and Galileo signals. Incoming raw measurements from both receivers feed into a position and attitude calculation algorithm running on an on-board PC. Additionally, reference station measurements are broadcast and taken into account for a high precision position calculation.

The reference application of SEA GATE assists the maneuver by providing precise position, heading and attitude information based on Galileo signals. EuroPak-15ab units on-board receive the SEA GATE Galileo signals and compute position, heading and attitude of the ship. A monitor on the bridge displays information to assist the captain, see *Figure 8.*

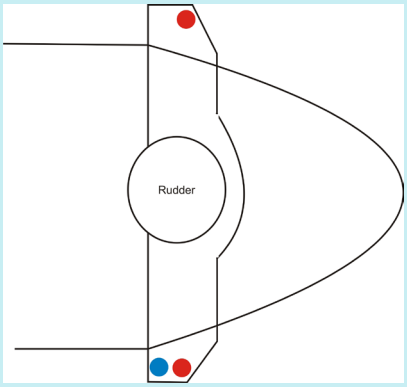

Figure 7: Antenna Locations Onboard the Mecklenburg-Vorpommern Ferry (Red: GNSS; Blue: Communications)

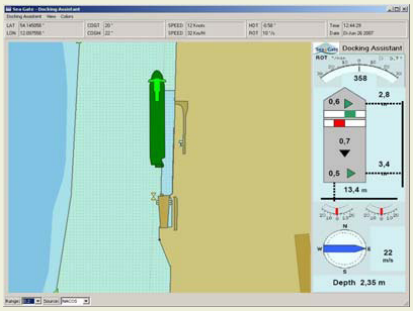

Figure 8: Graphical User Interface (GUI) Display on Bridge Monitor Onboard the Mecklenburg- Vorpommern Ferry

The ferry travels between Trelleberg, Sweden and Rostock and has to turn 180° as it docks backwards

Summary

This case study presents a maritime application using NovAtel's EuroPak-15ab receivers and 704-X wideband antennas in Germany.

The SEA GATE port project met its accuracy requirements using the EuroPak-15ab. As a result, the SEA GATE project is fully operational and open to interested users who intend to develop their own applications in the maritime Galileo test environment.

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