

Executive Summary

- Septentrio Satellite Navigation is a young and dynamic yet experienced company founded in January 2000 to develop and sell satellite navigation receiver and technology for professional markets. Septentrio is based in Leuven, Belgium, and has a business development office in Los Angeles, USA
- Septentrio specializes in the development of OEM GNSS receiver modules that provide high accuracy position information for demanding applications in challenging environments. Its modules are used by a variety of users in wide ranging applications demanding accuracy, integrity and reliability.
- The team of Septentrio consists of apx 70 highly educated and experiences GNSS professionals. The development and engineering experience spans the full range of GNSS receiver related technologies, including RF design, digital (ASIC) design, electronic board design and manufacturing, algorithm design, embedded software and GUI design. Septentrio closely collaborates with experienced electronics manufacturing companies in Western Europe to guarantee optimal quality at attractive costs.
- Septentrio believes in developing state-of-the-art technology in close co-operation with its customers, to include innovation in its products that directly serves the needs of our customers in their final applications. Its application engineers work closely together with our customers to optimally configure and integrate the products in their products, and to learn directly which innovations are required to drive the efficiency and effectiveness of Septentrio customers' customers. As an OEM supplier, Septentrio is active in a wide variety of applications, thus allowing diverse markets and applications to benefit from experience in other areas. The teams have always strongly supported multi-GNSS solutions, pioneering new signals and making them available in time for their customers to benefit as soon as technically and economically reasonable.



Galileo and Septentrio

Galileo is the European contribution to the world of GNSS, adding significantly to the capabilities of Satellite Navigation signals. From its beginning, Septentrio has staunchly supported and actively contributed to the Galileo program.

The first ever GNSS unit to receive live Galileo signals was designed and built by Septentrio. Septentrio continues to play a key role in the realization of Galileo. Septentrio will also continue to provide its customers with the earliest possible access to Galileo receiver technology.

Septentrio contributes to the GSTBv2 (Galileo System Test Bed Version 2) with its GSTBv2 test receivers. The purpose of the GSTBv2 receiver is to verify the acquisition, tracking and noise characteristics of all Galileo signals in the frame of the Galileo demonstration and frequency filing activities. With these receivers, Septentrio was the first to actually receive the first signals coming from the Giove A Satellite.

Since 2003 Septentrio is also leading the Galileo Phase C0 & CDE1 Test User Segment (TUS) project under contract by ESA. The Test User Receivers will be used by ESA during the Galileo In-Orbit Validation (IOV) Phase to assess the performances of all services under various static and dynamic conditions.

Innovation at the service of customers

Central in Septentrio's product development is innovation at the service of customers' applications. Activities such as the Galileo research mentioned above, are based Septentrio's belief that multi-constellation GNSS is central to broaden the applicability and practical use of GNSS.

Septentrio is in the front-line with these developments as a supplier to the European Space Agency, but more important even is to transfer the technology resulting from such activities into its commercial products. The first-line experience with these signals in practice place Septentrio in a unique position to provide the benefits to Septentrio customers and Septentrio customers' customers at an early stage.

Following technology building blocks are integrated in AsteRx2, the core receiver integrated in Altus APS-3™.

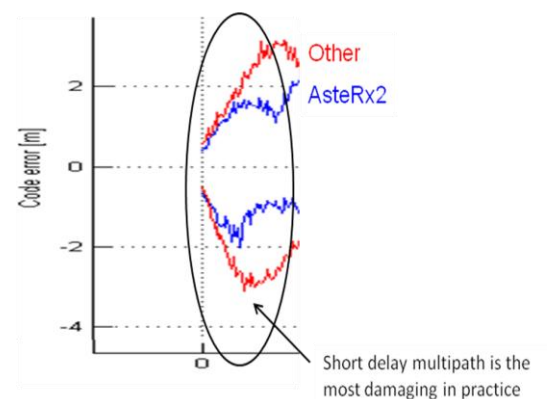
- GRCo3™ (GNSS (GPS/GLONASS/Galileo/Compass) digital receiver core) : As a spin-off of IMEC, Europe's largest independent research center in micro- and nano-electronics with over 1,600 employees coming from all over the world, Septentrio has strong ASIC design capabilities both in-house and nearby. This has resulted in the 3rd generation of Septentrio's advanced multi-constellation correlation technology, which couples a large number of correlation channels with high configurability, low power consumption and a number of acquisition and tracking innovations (see further : FAU™, low noise tracking technology and APME™) to enable optimal use of all available GNSS signals.

- APME™ (A Posteriori Multipath Estimator) is a patented multipath mitigation technique, unique in its ability to tackle especially short-delay multipath, which is the most prevalent and damaging form of multipath in real-life circumstances.

Moreover, Septentrio can provide the values of multipath corrections in its binary output, thus allowing customer applications to use this information for error reporting or user feedback.

APME™ was originally developed for GPS signals, but has been extended for modernized GNSS signals as well.

- FAU™ (Fast Acquisition Unit). Modern signals (GPS and especially Galileo) are designed for improved multipath resistance and low noise. The increased complexity (code length and modulation techniques) unfortunately have as a result significantly more complicated



acquisition, which could increase acquisition times with a factor of up to 25 or more. Septentrio has developed special Fast Acquisition technology to address this, with the result of improved (re)acquisition times even with respect to legacy GPS performance. FAU™ implemented in GReCo3™ can deliver over 16 Million time-frequency hypothesis testing per second.

- Septentrio has developed proprietary high-sensitivity low-noise tracking algorithms for legacy GPS signals and extended these for the new signals, including a patented technique for the especially performant Galileo AltBOC signal. The superior quality of Septentrio tracking technology has been independently confirmed by various sources, a/o by O. Montenbruck from DLR¹. High sensitivity allows tracking of satellites with high quality phase down to lower elevations, thus extending the working times and improving DOP values by using more satellites in the measurement process.
- Septentrio has developed its RTK algorithms with special attention to fast fixing of RTK ambiguities over a wide range of circumstances. As integrator, Altus has optimized settings in the RTK algorithms together with Septentrio for optimal results. Moreover, the technology used in AsteRx2 has already shown its ability to realize RTK fix solutions with real-life Galileo signals, as described in an article by Technical University of Delft², who carried out independent tests including ambiguity fixing of signals received from the experimental Galileo satellites with Septentrio AsteRx receivers.

Septentrio Products

Versatile OEM GNSS Receivers ...

Septentrio designs and sells high-performance OEM Satellite Navigation Receivers for all GNSS systems: GPS, Galileo, GLONASS and SBAS.

- PolaRx® family

The PolaRx2 family of receivers is a complete platform of high-end single and multi-frequency/ single and multi-antenna receivers including special models for attitude calculation and time transfer.

- AsteRx® family

The AsteRx platform is a platform of compact rover receivers featuring low power consumption, high update rates and easy integration in various static



¹ *Performance comparison of semicodeless GPS receivers for LEO satellites*, Oliver Montenbruck et al., GPS Solutions (2006) 10: 249–261

² *Galileo Down to the Millimeter*, Christian Tiberius et al., InsideGNSS September/October 2008, pg 40-43

or kinematic products.

All variants can be delivered as an OEM board or in a rugged enclosure. Septentrio also delivers antennas, cables and other accessory products.

All receivers are provided with intuitive graphical user interface software and various software tools to facilitate instant use and ease integration in various applications.



... for Demanding Applications

Septentrio offers a broad range of reliable and competitive OEM products for use in existing and emerging markets.

- Land & Marine Survey and Mapping
- Dynamic positioning
- Continuously Operating Reference Stations and Networks
- Aerial survey
- Machine Control for Agriculture, Construction, Mining and other scientific applications
- Precise Time and Frequency Transfer
- High Integrity Navigation for land, sea and air
- SBAS applications

and many others.

Worldwide Customer base

Septentrio is represented by distributors in more than 25 countries and supplies its products to a wide variety of customers in many different segments. Over 100 different customers, spread over more than 20 countries were served in 2008 alone, ranging from public customers such as the European Space Agency and the European Commission, Trinity Lighthouse Service, DSTL (Defence Science and Technology Laboratory, part of UK MOD), Belgian Government, Norwegian Mapping Agency, EuroControl, the Indian Space Agency, the Chinese Metrology Laboratories, to name a few; to private international customers such as Dredging International in field of Survey and Machine Control or SubSea7 in Marine contracting and Engineering, and other well known customers such as EADS Astrium, SSTL, QinetiQ and Inmarsat.