Septentrio GNSS Solutions

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Contents and Goals of this Presentation

- Septentrio Profile
  - Company profile
  - Product overview
- Technology overview : robust GNSS for harsh environments (interference, multipath, spoofing, vibrations, ionospheric disturbances, etc.) with concrete examples
- PolaRx5 series – GNSS receivers for reference stations and scientific applications
- mosaic series – GNSS modules for large scale hi-accuracy applications
  - Overview
  - Evaluation kits and where to buy ?
  - Eco-systems
- Summary

Company Profile

Septentrio, who we are?

- **Your success is our success**
  - Most accurate and reliable **GNSS position and timing solutions** in the most demanding industrial and scientific environments
- **Our team is your team**
  - Global team of **GNSS HW**, **SW** and navigation experts developing all core elements of high-quality GNSS receivers.
- **Focus on quality**
  - Partner with you to provide **robust high-quality GNSS positioning products** with excellent integration, application engineering and **service**
- **Global Presence**
  - Located in Leuven, Belgium with regional branches in Los Angeles, CA, Shanghai, Korea and Yokohama (near Tokyo), JPN.
  - Worldwide partner networks

Welcome to Leuven, Belgium:

European innovation capital 2021

Center of excellence for education, innovation and semiconductor technology

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LEUVEN MINDGATE

IMEC : Interuniversity Microelectronics Centre

KU Leuven : Katholieke Universiteit Leuven

Septentrio's Roots

imec

esa

In-depth understanding of designing and building advanced ASIC's and systems

In-depth understanding of GNSS and how to maximize its use

Founder & key shareholder of Septentrio.

Spin off from IMEC, Septentrio was founded in 2000.

Direct access to unmatched ecosystem for digital & analog ASIC design, production & testing.

Long term strategic partner since 2002.

All Galileo test receivers designed and built by Septentrio exclusively.

First ever Galileo Receiver made by Septentrio.

Participated in numerous ESA projects in military, avionics & space.

Provided in-depth understanding of GNSS.

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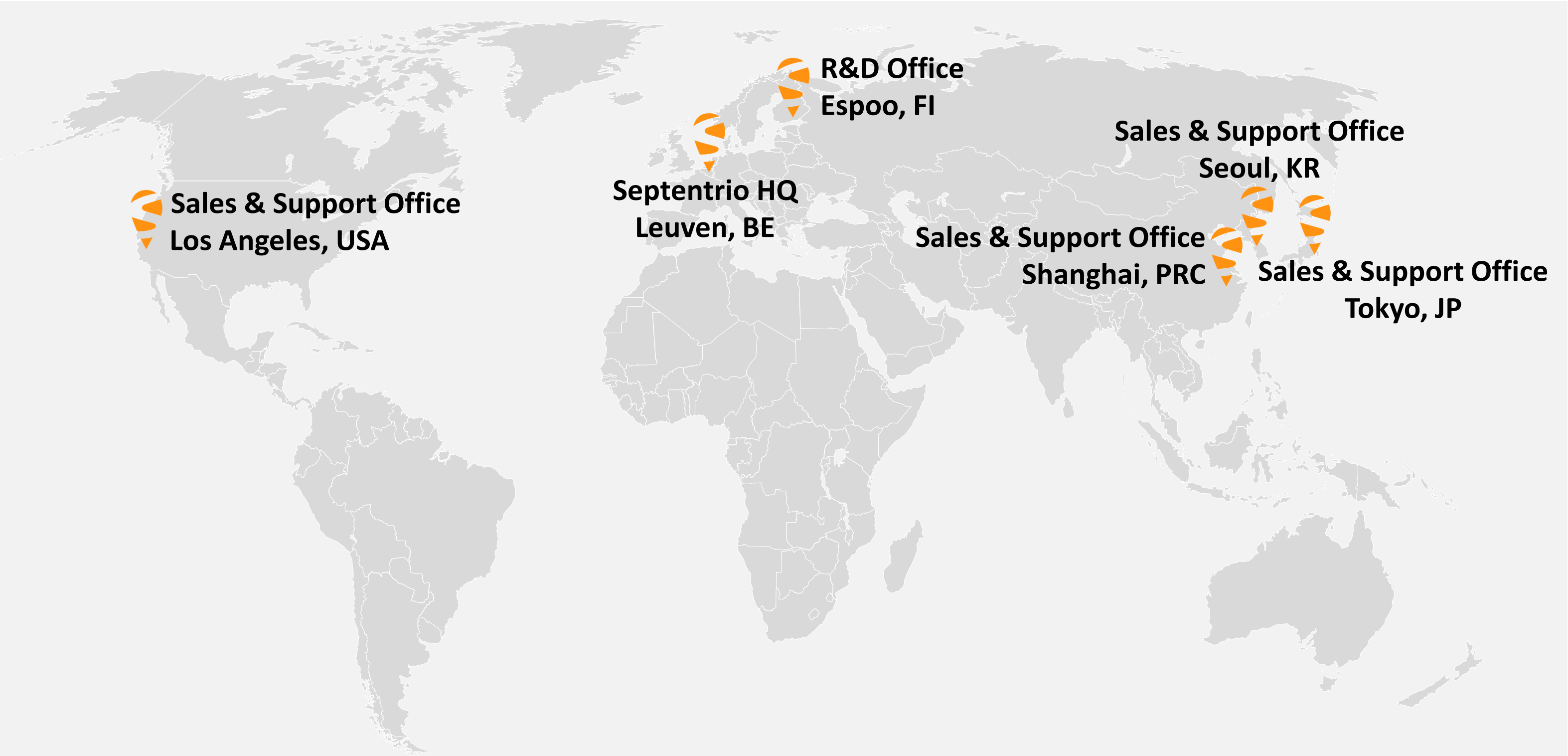
Corporate Overview



Headquartered in Leuven, Belgium

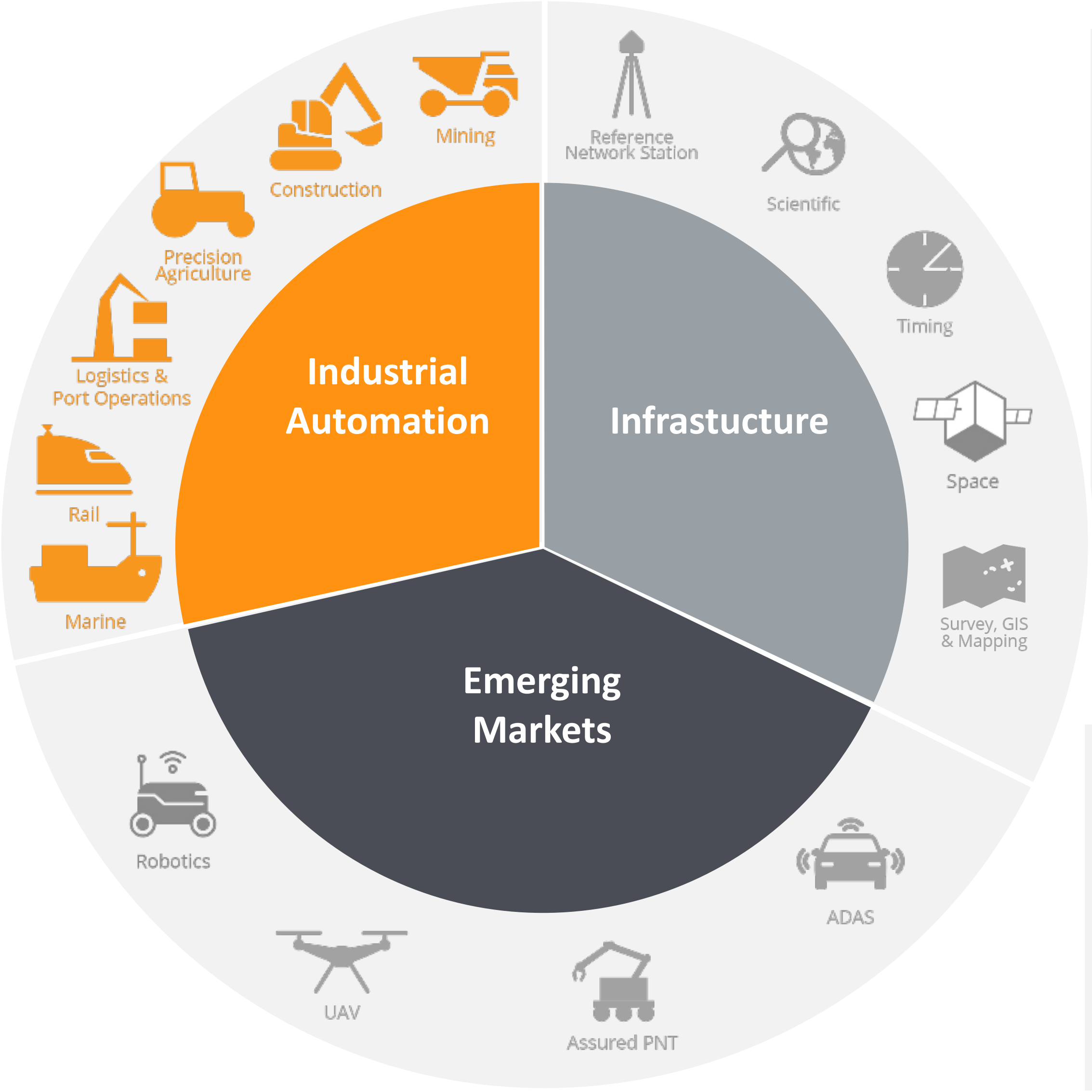
R&D centres in Belgium and Finland.

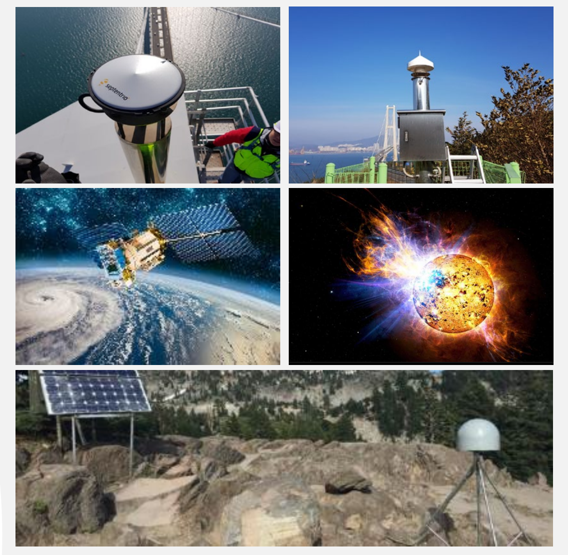
Global customer base, with sales and support offices close to the large industrial clusters

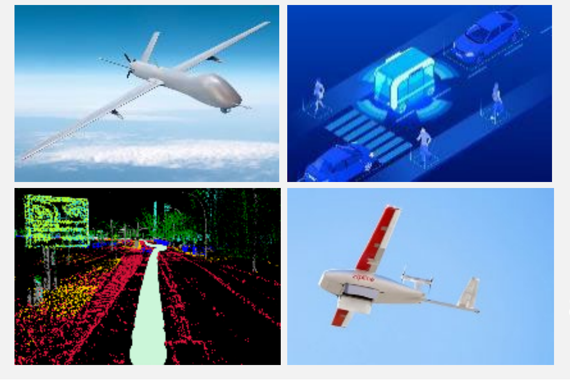
130 employees, 60 of which in R&D

ISO 9001 certified

Key application markets







Product overview

Modules

mosaic-X5
Single-antenna

mosaic-H
Dual-antenna

mosaic-T
Timing variant

mosaic-CLAS
CLAS variant for Japan

Boards

AsteRx-m3
Single- or dual-antenna

AsteRx-i3 D
Non-tethered GNSS-INS

AsteRx-i3 S
Tethered GNSS-INS

Interface Board, Development kits

Housed Receivers

AsteRx-U3, U3 Marine
Dual-antenna, all comms

AsteRx SB3
Single- or dual-antenna

AsteRx SBi3
GNSS-INS

Antennas

AntaRx (Coming soon)
Single- or dual- smart antenna
GNSS or GNSS-INS

Various GNSS Antennae

Scientific Receivers

PolaRx5, PolaRx5e
Reference & scientific

PolaRx5S
Ionospheric monitoring

PolaRx5TR
Time and frequency transfer

Technology overview

Robust GNSS for harsh environments (interference, multipath, spoofing, vibrations, ionospheric disturbances, etc.) with concrete examples

Technology overview of Septentrio GNSS receivers

All Satellites

GPS/GLO/GAL/BDS/

QZSS/IRNS

Low Power

～0.5W (Module)

～1W (Board)

～2W (Boxed-type)

High navigation rate,

Low latency

100Hz (INS 200Hz)
Latency : ～10ms

Multi-Bands

L1,L2

L-band, L5, L6

Easy to use

WebUI (NTRIP Server/

Caster integrated, Spectram Analyzer integrated)

Open Format (SBF)

Free Tool ：conversion, analysis

Rich HW Interface

Ethernet

Serial (3 and 4), USB

On-board Logging, PPS

Anti-interference, Anti-Jamming

Automatic notch-filter

Wide-band and chirp interference

Anti-spoofing

Septentrio's patented GNSS+ technologies (Algorism)

OSNMA

Septentrio's patented GNSS+ technologies (Algorithms)

AIM+, IONO+, RAIM+, APME+, LOCK+, INS+

Performance mode

Stand-alone SBAS Differential

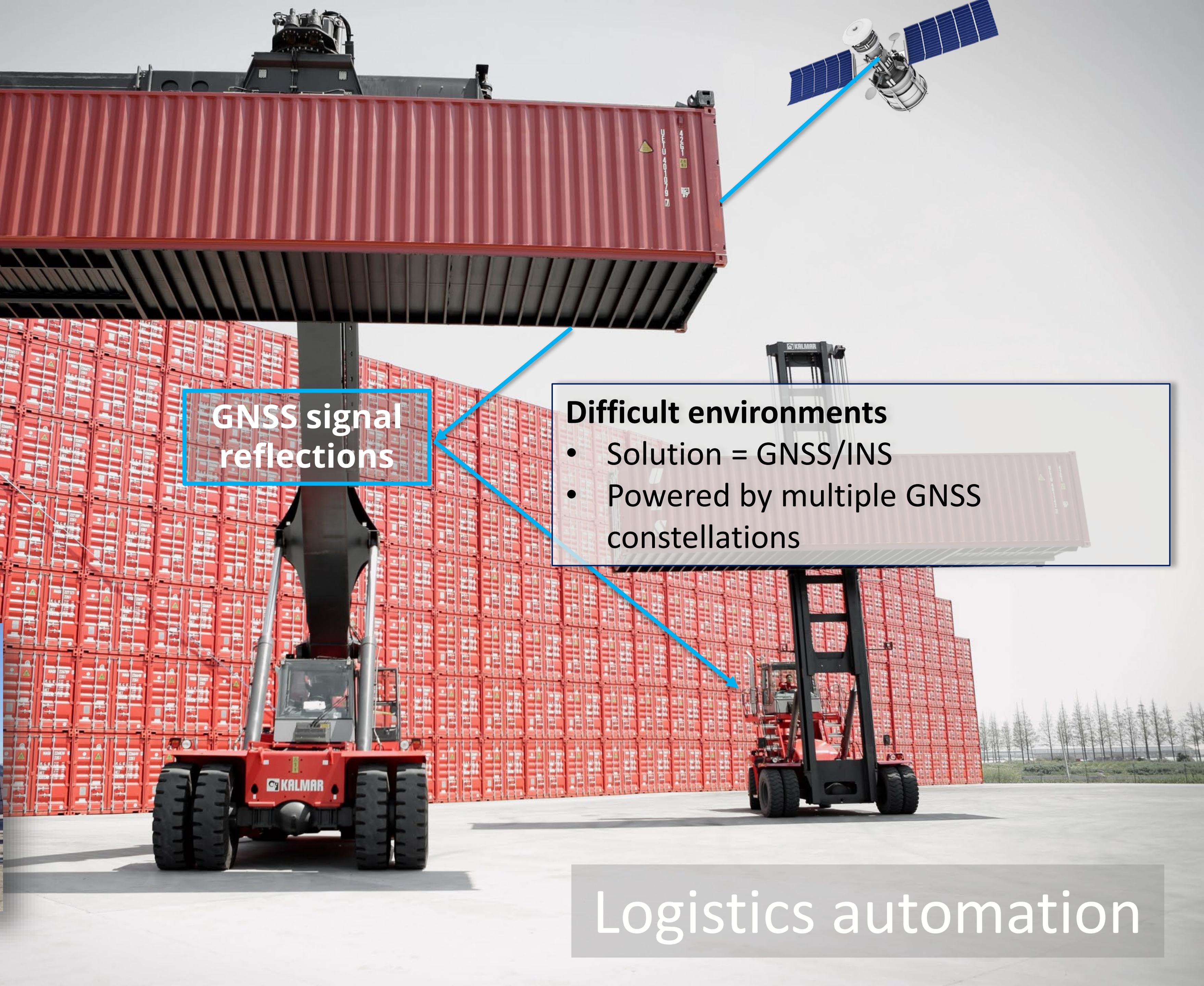
RTK RTK-VRS PPP(L-band)

Base INS

Makin (Norway)

Jan De Nul (Belgium)

Kalmar (Norway)



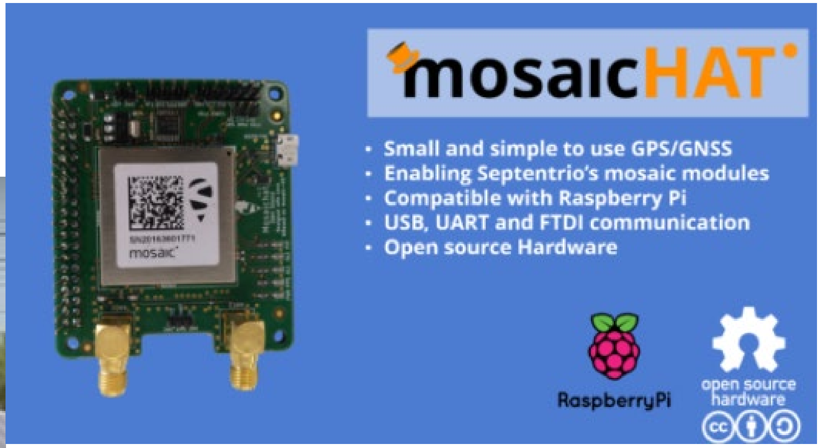
Avoid accidents

Naio Technologies (France)

Why Septentrio

- Altus NR3
- Reliability
- Ease of integration
- Support for SSR (L-band + NTRIP)

Renu Robotics (US)



Why Mosaic

- Multipath near solar panels
- Price
- Integrity info for IMU sensor.

ISRC (Japan)

Why Mosaic
- Multipath near dam
- Fix in limited sky visibility
- PixHawk plug-compatible

At Shikoku Dam

APME+ Advanced Multipath Mitigation

Measurement Engine

Available

Proven Performance

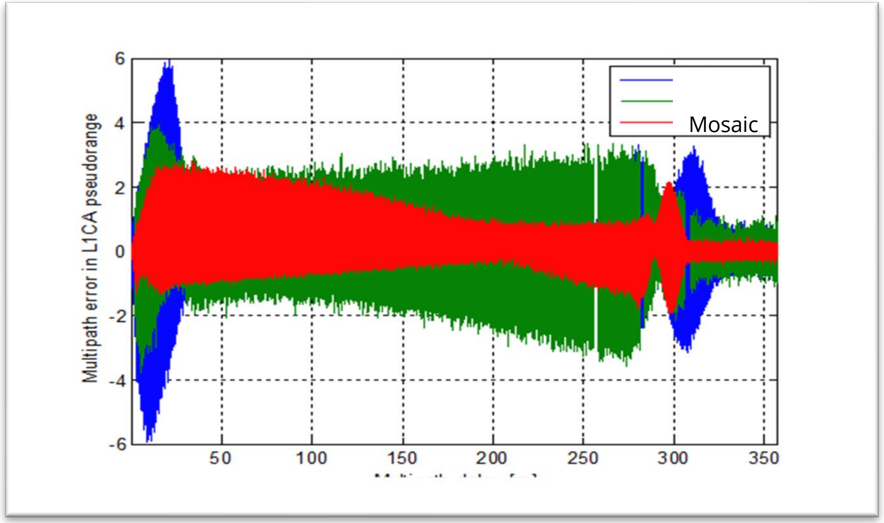
Multipath is the dominant error source in GNSS applications. It causes meter-level error on the measured satellite distances on both pseudoranges and carrier phases. It significantly degrades the position and time accuracy.

APME+ uses extra correlators in each tracking channel to estimate the multipath error on pseudorange and carrier phase measurements. Well, unlike most other techniques which only do code multipath estimation, APME+ support both code and phase multipath estimation. The measurements are then corrected by subtracting the estimated error. While most other multipath mitigation techniques involve modifying the correlators in the tracking channels, APME+ leaves the tracking channels unchanged. The multipath errors are estimated independently from the tracking of the signal.

On the other hand, APME+ is by design free of any bias. APME+ estimates the multipath error in real-time without modifying the underlying tracking loop.

Key Features

- Better against short delay multipath
- Estimates multipath without changing tracking loops
- Estimates multipath per satellite
- Indicates amount of multipath error
- Allows phase multipath



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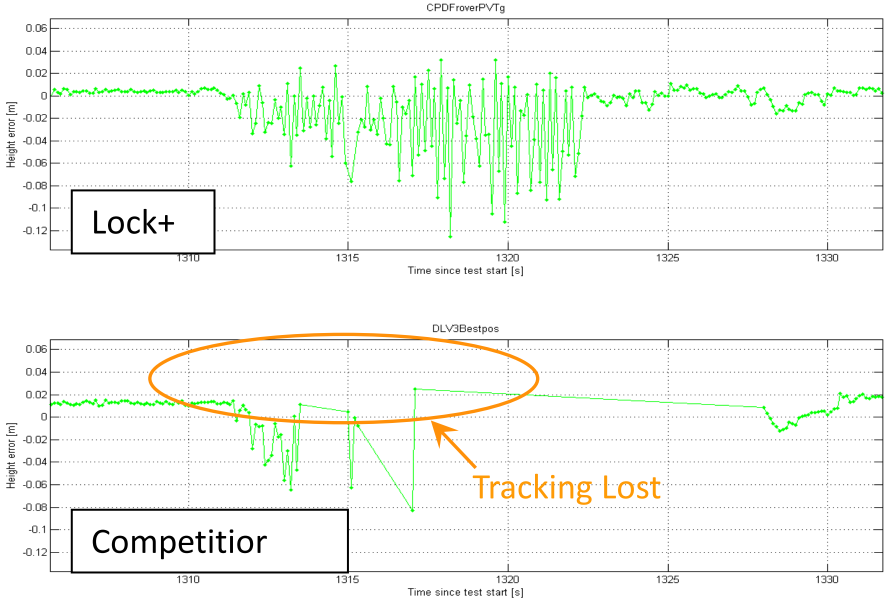
LOCK+
Superior Tracking Robustness

Machine vibration severely impacts tracking continuity which is harmful for RTK, PPP and heading positioning e.g. grade control

Special algorithms are implemented to maintain tracking under heavy vibrations.



AIM+ Advanced Interference Monitoring & Mitigation

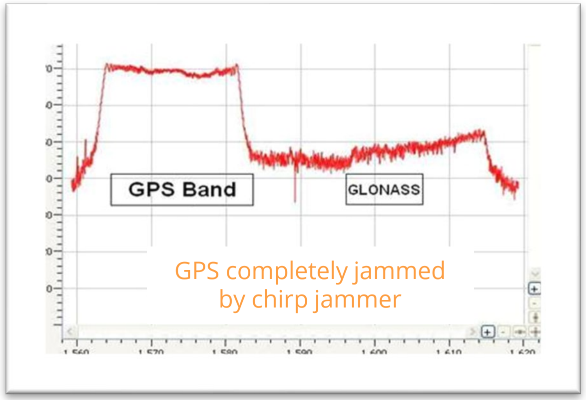
Monitoring

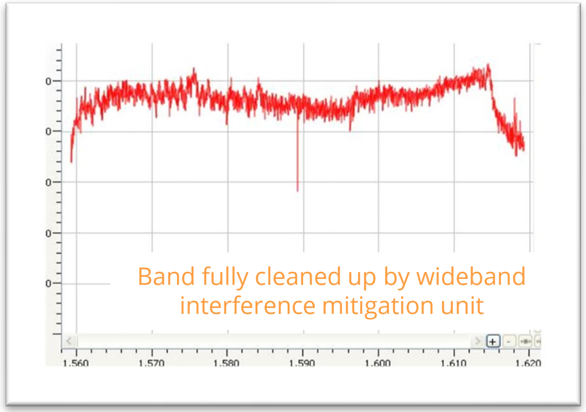
AIM+ Interference Mitigation

Proven Performance

Septentrio's **AIM+** technology, the most advanced on-board interference mitigation technology on the market. It can **detect** and **suppress** the widest variety of interferers, from simple continuous **narrowband** signals to the most complex **wideband** and **chirp** jammers. The radiofrequency (RF) spectrum can be viewed in real-time in both time and frequency domains .

- **Monitor the RF spectrum**
  You can monitor the RF spectrum in the Spectrum window of the GNSS menu.
- **Narrow-band interference**
  Narrow-band interference can be caused by electronic devices and effects only a small portion of the GNSS frequency spectrum. To mitigate the effects of narrow-band interference, 3 notch filters can be configured either in auto or manual mode. These notch filters effectively remove a narrow part of the RF spectrum around the interfering signal.
- **Wide-band and chirp interference**
  The L2 band, being open for use by radio amateurs, is particularly vulnerable to this type of interference. The effects of wideband interference, both intentional and unintentional, can be mitigated by enabling the WBIM mitigation system. The WBI system also reduces, more effectively than traditionally used pulse-blanking methods, the effects of pulsed interferers.
- **Inmarsat and Iridium satellite interference**
  The mosaic can suppress the interference from high-powered Inmarsat and Iridium satellite communications signals.





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Technology for Robustness – Spoofing

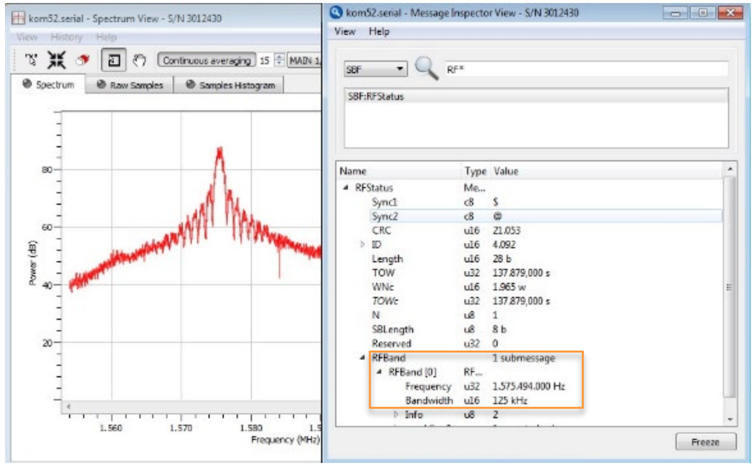
Spoofing is easy

Especially consumer/

L1

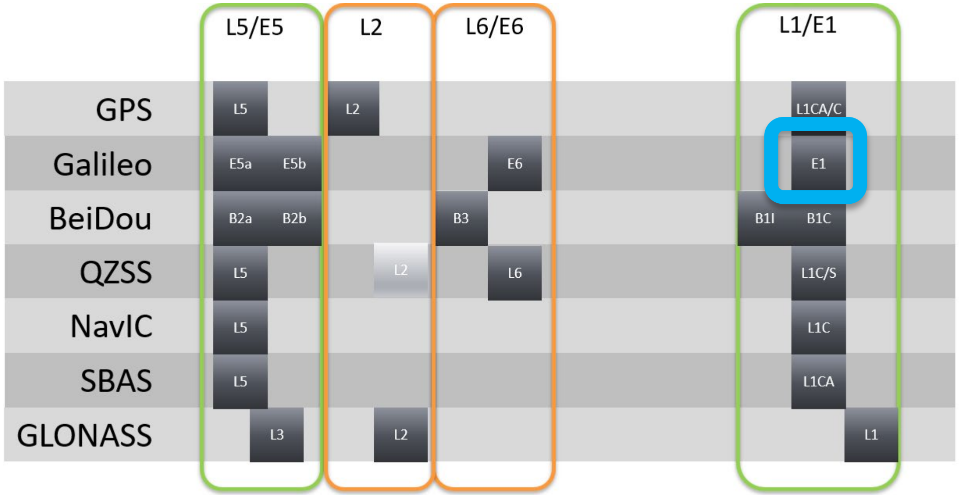
Septentrio :

- Several **built-in techniques** identify suspicious behavior
  - Built-in spectrum analysis
  - Signal characteristics & Timing
- And **compensate**
  - Reject suspected signal
  - Frequency diversity
- Continuously ongoing development

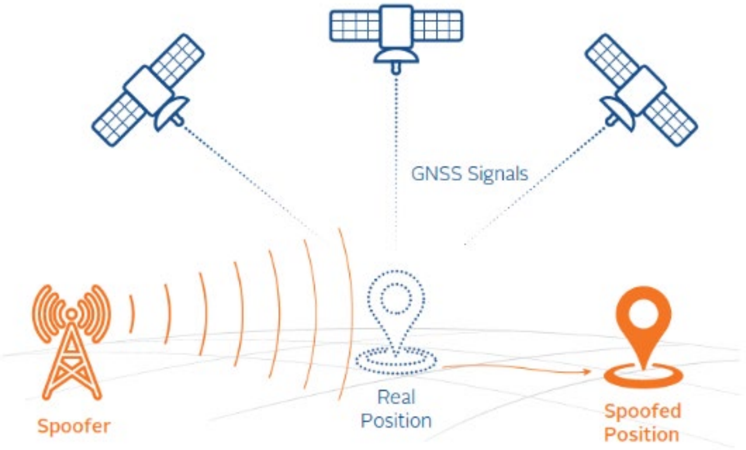


Galileo OSNMA

- **Open Service Navigation Message Authentication**
  - **Spoofer detection** by adding authentication (signature) of satellite nav message
  - **Galileo** protected
  - First ever signal-in-space authentication!
  - Free of charge
  - Backwards compatible



- Timeline:
  - 2023 Initial service



Septentrio GPS/GNSS receiver is the first to authenticate Galileo's newly developed end-to-end **OSNMA** encrypted signals.

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High navigation rate, Low latency

- While tracking all satellites and all signals, positioning, raw data and heading can be output at 100Hz.
- Bulldozer blade control cannot maintain a constant height without low latency.

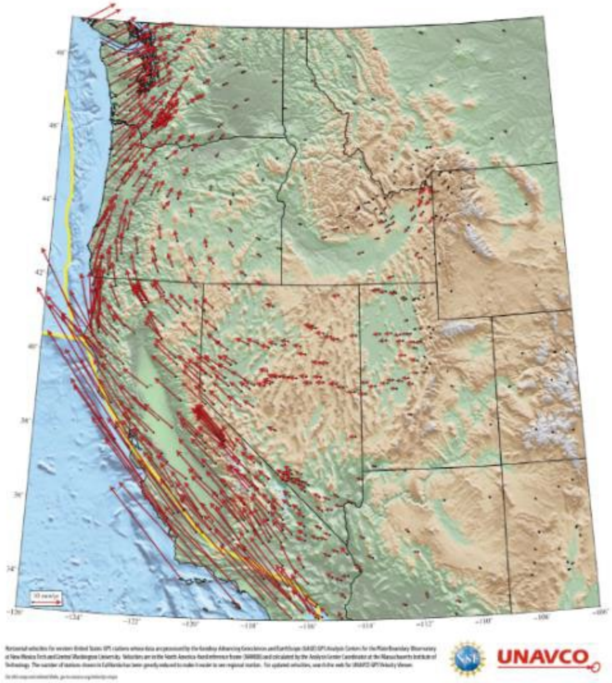
	X module 10Hz	mosaic
GPS+GLO+GAL	75 ms	6 ms
GPS+GLO	50 ms	5 ms
GPS+GLO+GAL	75 ms	5 ms
GPS+GLO	50 ms	4 ms

PolaRx5 series

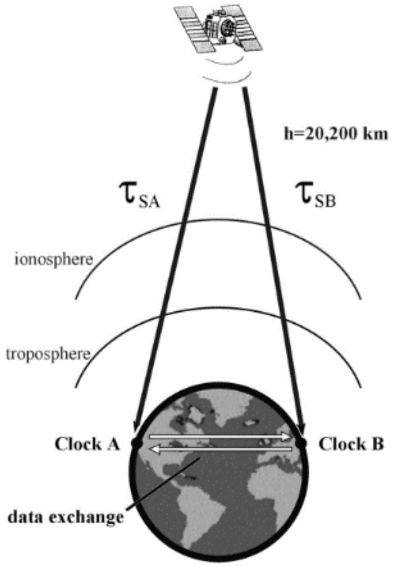
GNSS receivers for reference stations and scientific applications

PolaRx5 family
Multi-Frequency Multi-Constellation Reference Stations

PolaRx5 and PolaRx5e
CORS and scientific reference stations



PolaRx5TR
Time transfer applications



PolaRx5S
Scintillation and ionosphere monitoring

* **CORS** : Continuously Operating Reference Station

PolaRx5 – Differentiating Features

Best-in-class Measurement Quality

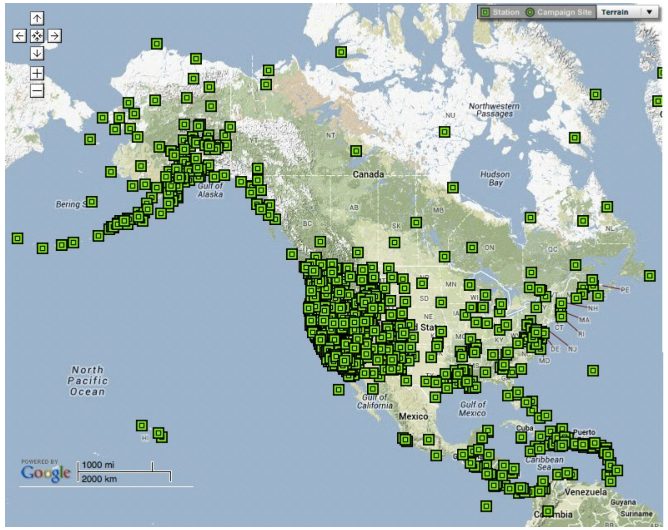
- High SNR, low cycle slips, high availability
  - Preferred UNAVCO GNSS Receiver
  - Evaluations 2015 http://kb.unavco.org/kb/file.php?id=745
- Provides GPS L1P and "real" raw data (no MP/smoothing)

APME+ Multipath estimation/mitigation

- Mitigates both code and carrier short-delay multipath
- Short-delay is most prevalent and damaging form of multipath
- Identifies amount of multipath present and can simultaneously provide unaltered data as well as with multipath eliminated
- Unaltered measurements, with no multipath estimated are provided also when APME is on (SBF MeasExtra)

The UNAVCO Endorsement

- UNAVCO is the largest single operator of GNSS reference stations: ~2,000 receivers (mostly NA)
- Septentrio selected as Preferred Vendor for GNSS Reference Stations since 2015 following 15 week RFP and technical evaluation period
- Key findings:
  - Best performance, esp. in multi-constellation testing
  - Scalable power consumption significantly lower than the competition
  - “Miles ahead” on interference mitigation
  - Superior technical support



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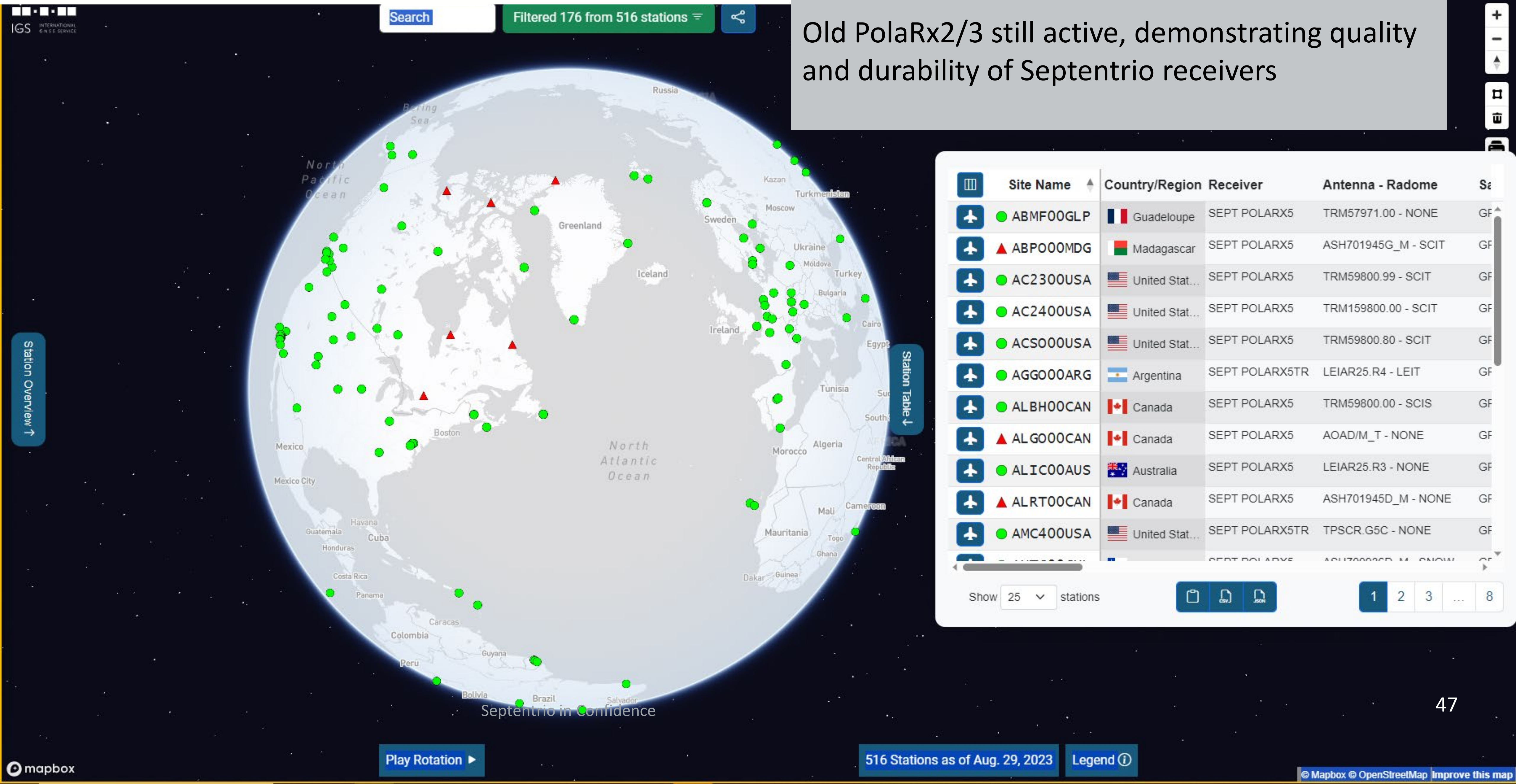
https://www.unavco.org/

IGS Network

http://igs.org/network

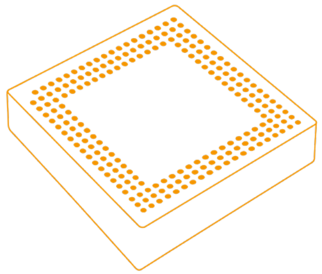
1/3 of IGS GNSS network are PolaRx receivers.

Old PolaRx2/3 still active, demonstrating quality and durability of Septentrio receivers



Site Name	Country/Region	Receiver	Antenna - Radome	Sa
ABMF00GLP	Guadeloupe	SEPT POLARX5	TRM57971.00 - NONE	GF
ABPO00MDG	Madagascar	SEPT POLARX5	ASH701945G_M - SCIT	GF
AC2300USA	United Stat...	SEPT POLARX5	TRM59800.99 - SCIT	GF
AC2400USA	United Stat...	SEPT POLARX5	TRM159800.00 - SCIT	GF
ACSO00USA	United Stat...	SEPT POLARX5	TRM59800.80 - SCIT	GF
AGGO00ARG	Argentina	SEPT POLARX5TR	LEIAR25.R4 - LEIT	GF
ALBH00CAN	Canada	SEPT POLARX5	TRM59800.00 - SCIS	GF
ALGO00CAN	Canada	SEPT POLARX5	AOAD/M_T - NONE	GF
ALIC00AUS	Australia	SEPT POLARX5	LEIAR25.R3 - NONE	GF
ALRT00CAN	Canada	SEPT POLARX5	ASH701945D_M - NONE	GF
AMC400USA	United Stat...	SEPT POLARX5TR	TPSCR.G5C - NONE	GF

mosaic series



GNSS modules for large scale hi-accuracy applications

Small size with a wide array of HW / SW Interfaces

mosaic has a wide array of hardware and software interfaces in a **compact size** 3 x 3 cm LGA form factor working in a **industry temperature** environment. The USB device could be truned to 1 virtual ETH and 2 UARTs according to customer's OS. Together with 4 physical UARTs, 1 physical Ethernet, every interface could be used for SBF, NMEA, RINEX, RTCM, CMR input / output. If you use Ethernet interface, you could also use internal **UDP**, **TCP** Server/Client, **full-feature-ntrip** Caster / Server / Client. SDIO interface is very useful for **data logging** to a max. 32G TF card independent of your applications.

Package

Type : SMT solderable LGA
Size : 31 x 31 x 4 mm
Weight : 6.8 g

Environmental

Operational : -40 to +85 ° C
Storage : -55 to +85 ° C

Protocols

Septentrio Binary Format (SBF)
NMEA 0183, v2.3, v3.03, V4.0
RINEX v2.x, v3.x
RTCM v2.x, v3.x (MSM included)
CMR v2.0 (out/in), CMR+ (input only)

Interfaces

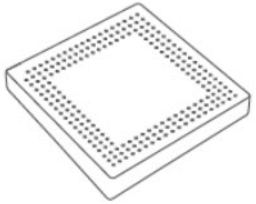
4 UART (LVTTL, up to 4 Mbps)
Ethernet (RMII/MDIO), 10/100 Mbps
USB device (2.0, HS)
SDIO (mass storage)
2 GPIO user programmable
2 Event markers
1 Configurable PPS out

Maximize Uptime

Feature Rich

Easy-to-integrate

Lightweight



mosaic

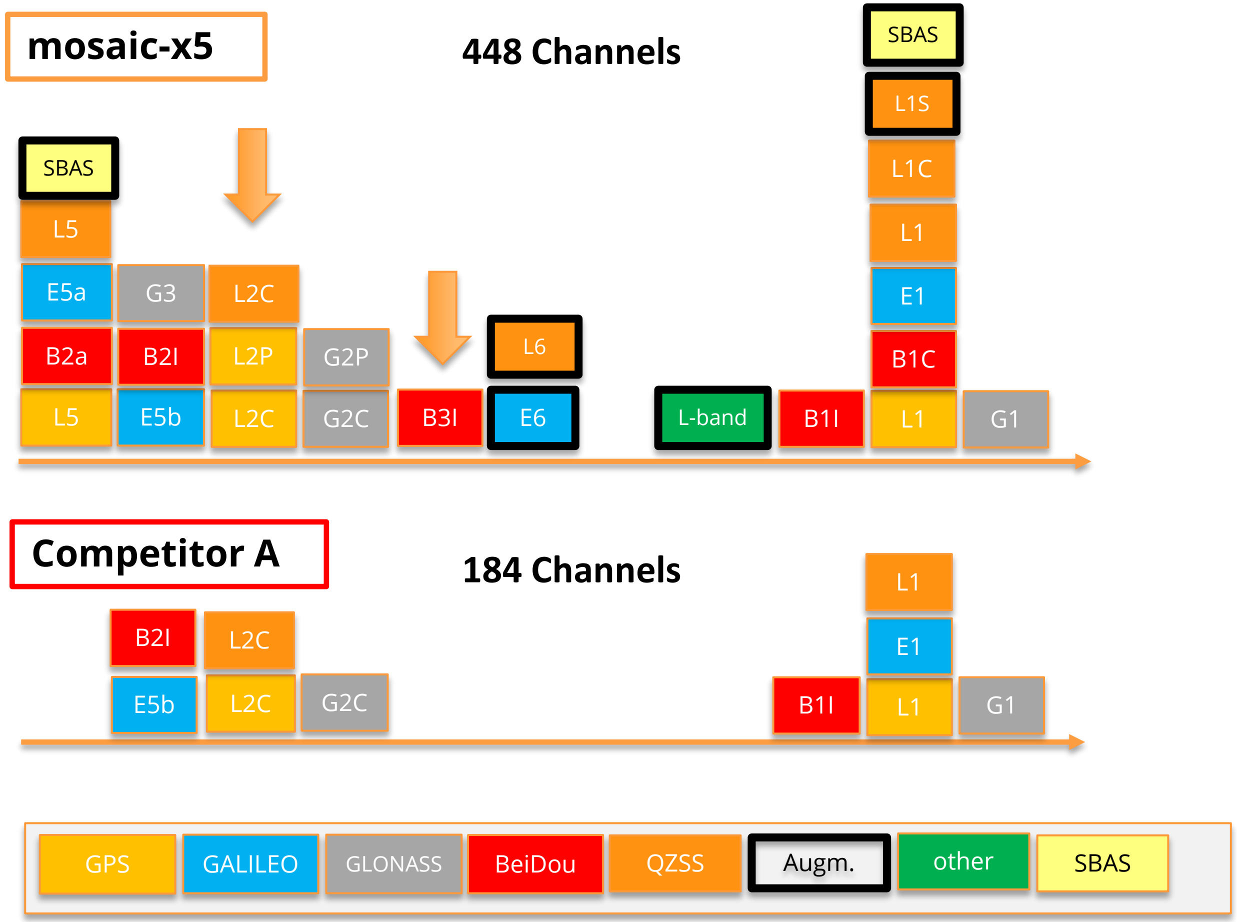
GNSS modules

mosaic-CLAS the last from mosaic expansion

GNSS Performance	Dual Antenna Heading	Timing	CLAS
			

mosaic-CLAS, only in Japan

Available Signals > competition



	mosaic-x5	Competitor A
Channels	448	184
L2P	◯	×
E5a	◯	×
B3I	◯	×

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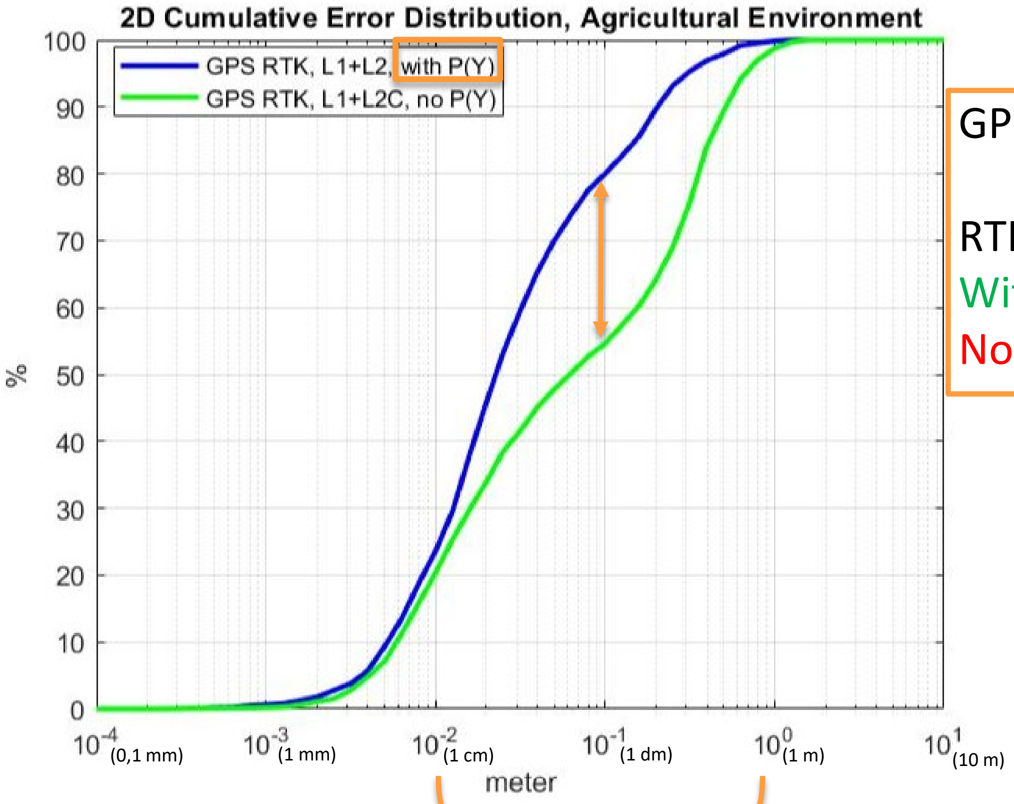
RTK Availability
with(out) P(Y) tracking

Test performed in an orchard in Torino, Italy on which the processing is based.



GPS L2P(Y) Code

RTK Fix :
With L2P : 80%
No L2P : 56%

P-Code greatly increases the chances of having RTK for accuracies from 1cm-1m (most applications)

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(Whether or not L2P (Y) Code reception is supported has a large effect on the RTK Fix rate.)

mosaic-go Evaluation Kit Product description

58 gramms

mosaic-go : 3 variants

1. mosaic-go is based on **mosaic-X5** one antenna connector

2. mosaic-go heading is based on **mosaic-H** Dual antenna connector

3. mosaic-go CLAS is based on **mosaic-CLAS** one antenna connector

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Documentations

Mosaic-go DataSheet are available from Septentrio web site:

Mosaic Hardware Hardware manual (Ver 1.8) includes :

- Complete description of mosaic-go (both for standard version and heading version)

How to Video and mosaic-go introduction is available on Septentrio support site

https://shop.septentrio.com/en/shop/mosaic-go-gnss-module-receiver-evaluation-kit

7 Evaluation Kit: mosaic-go

The mosaic-go Evaluation Kit is composed of the mosaic module soldered on an interface board inside a metallic housing.

Mosaic-go part number:
Single-antenna version, incorporating mosaic-X5: **410386** (including accessories).
Dual-antenna version, incorporating mosaic-H: **410397** (including accessories).

Dimensions: 71 x 59 x 12 mm ± 1 mm
Weight: 58 g ± 1 g

7.1 Interfaces

7.1.1 USB

This micro-B connector is used to access the mosaic-go over USB.

It can also be used to power the mosaic-go. See also section 7.4.

7.1.2 RSV USB

This connector is reserved and should not be used.

7.1.3 RF_IN1 and RF_IN2

These are the main and auxiliary antenna connectors, connected to the ANT_1 and ANT_2 pins of the internal mosaic. See section 3.2 for details.

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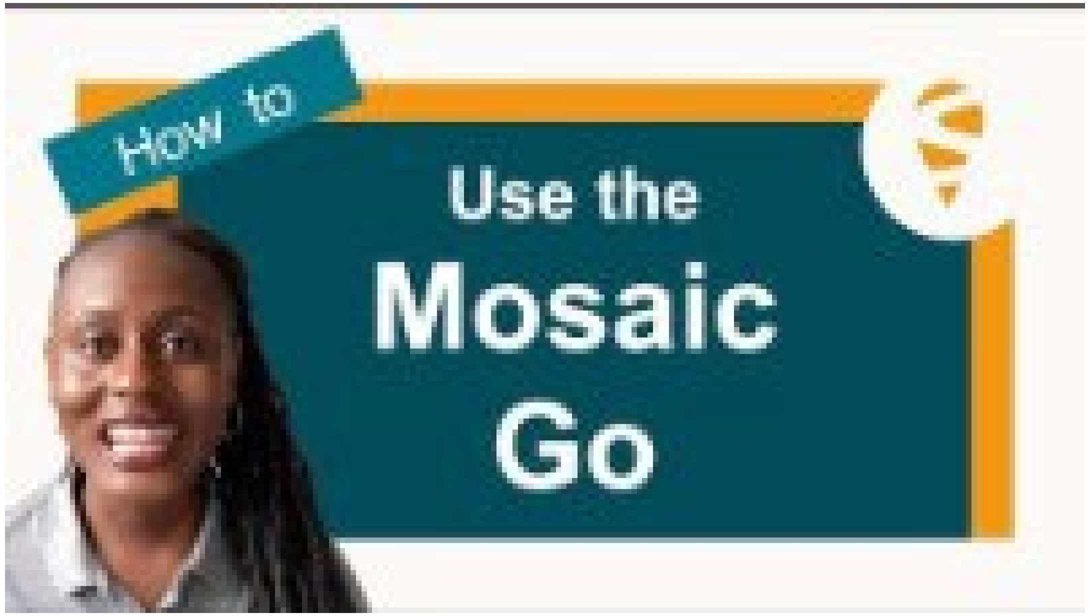

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https://www.youtube.com/watch?v=n1u5QZG4jls

Septentrio WEB Shop https://shop.septentrio.com/en/shop

PRODUCTS

Results 1 - 6 of 6

745,00 €

mosaic-go CLAS GNSS module receiver evaluation kit

Highly accurate GPS / GNSS receiver module, designed for the Japanese market

Complete multi-frequency, multi-constellation GNSS module receiver evaluation kit: GPS, GLONASS, Galileo, BeiDou, QZSS, NAVIC, Dedicated for the Japanese market

More info >

645,00 €

mosaic-go GNSS module receiver evaluation kit

Highly accurate GPS / GNSS receiver module

Complete multi-frequency, multi-constellation GPS module receiver evaluation kit: GPS, GLONASS, Galileo, BeiDou, QZSS, NAVIC

More info >

745,00 €

mosaic-go heading GNSS module evaluation kit

Highly accurate GPS / GNSS receiver module

Complete multi-frequency, multi-constellation GNSS module receiver: GPS, GLONASS, Galileo, BeiDou, QZSS, NAVIC

More info >

1.495,00 €

mosaic-H GNSS heading module development kit with 2 GNSS antennae

Highly accurate GPS / GNSS receiver module

Highly accurate GNSS - GPS heading module receiver evaluation kit for sale. Tracks GPS, GLONASS, Galileo, BeiDou, QZSS.

More info >

1.195,00 €

mosaic-T GNSS timing module receiver development kit with GNSS antenna

GPS / GNSS Timing receiver module

Complete multi-frequency, multi-constellation GNSS module receiver: GPS, GLONASS, Galileo, BeiDou, QZSS, NavIC

More info >

1.195,00 €

mosaic-X5 GNSS module receiver development kit with GNSS antenna

Highly accurate GPS / GNSS receiver module

Complete multi-frequency, multi-constellation GNSS module receiver: GPS, GLONASS, Galileo, BeiDou, QZSS, NAVIC

More info >

ArduSimple

https://www.ardusimple.com/simplertk3b-receivers/

simpleRTK3B Pro
Up to 100Hz RTK and down to 6mm accuracy with the most affordable L1/L2/L5 board in the market. Powered by Septentrio Mosaic-X5.

RTK3B Boards

simpleRTK3B Pro

From USD $661.25

Select options

simpleRTK3B Heading
Dual antenna L1/L2/E5b RTK rover made simple for Position+Attitude up to 50Hz. Powered by Septentrio Mosaic-H.

RTK3B Boards

simpleRTK3B Heading

From USD $862.50

Select options

simpleRTK3B mPCIe
The Septentrio Mosaic for embedded computers. In standard Mini PCI Express form factor.

RTK3B Boards

simpleRTK3B mPCIe

From USD $688.85

Select options

simpleRTK3B Micro
The Septentrio Mosaic for small PCB integrators. In a re-usable through hole form factor so you don't risk it if something goes wrong with your PCB design or assembly.

RTK3B Boards

simpleRTK3B Micro

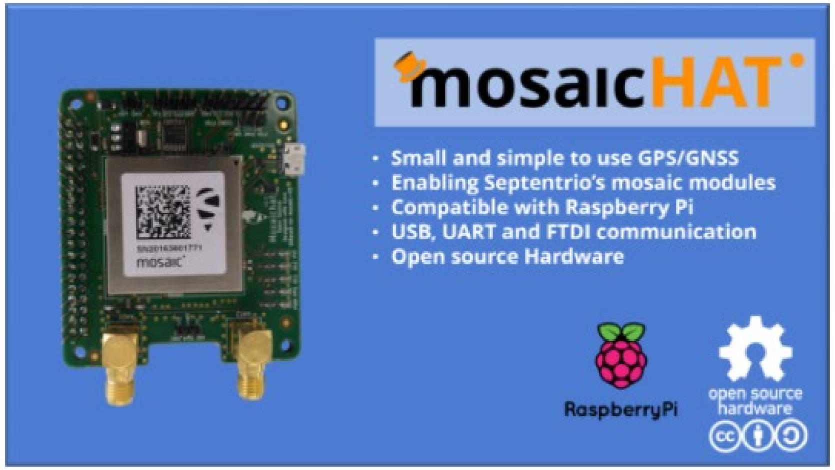
From USD $688.85

Select options

mosaicHAT

An open source GNSS HAT for Raspberry Pi

mosaicHAT: A GNSS HAT for Raspberry PI
Author: (Jamal Sa'd) jamalhazem127@gmail.com
Maintainer: (Septentrio gnss github user) githubuser@septentrio.com
External website: https://github.com/septentrio-gnss/mosaicHAT
License: Creative Commons Attribution Share-Alike License. and Open Source HW



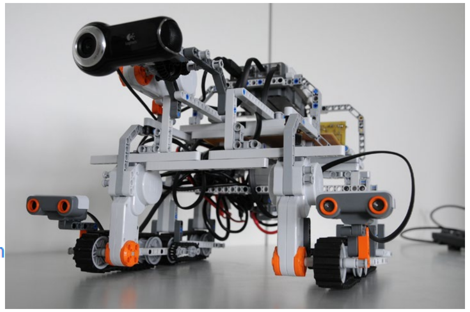
Click to watch this video introducing mosaicHAT

All documented

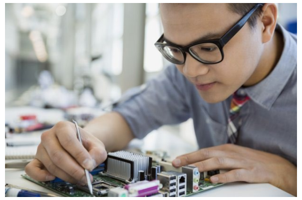
Table of contents

Intro for new people
What is mosaic, Septentrio, etc,.

User documentation



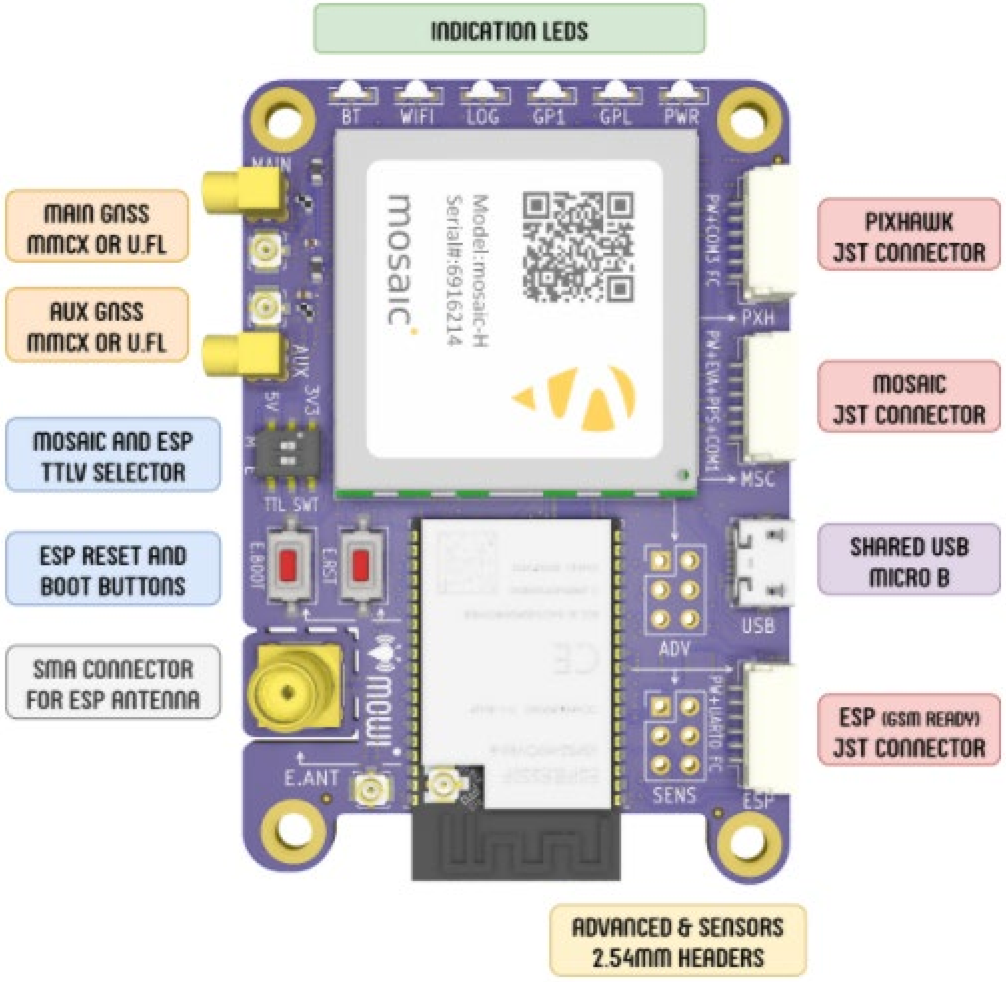
Designers

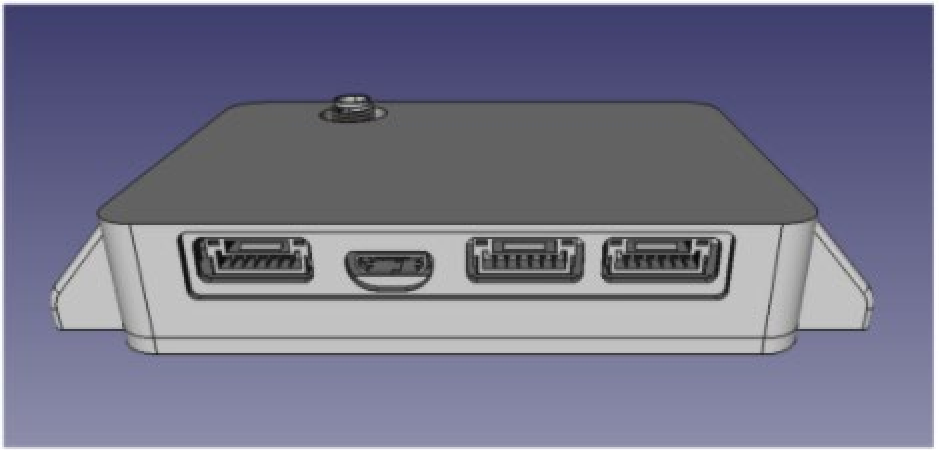


https://www.youtube.com/watch?v=5LeuElfyvIg

mowi

https://github.com/septentrio-gnss/mowi





Pains when starting projects

Engineer wants **compatibility**
Engineer searches for **open source**
Engineer wants **ease** of test
Engineer wants to **source easily**

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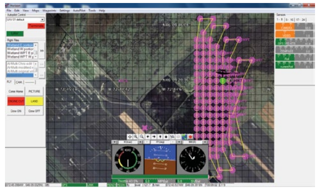
What we are doing to expand ecosystems?

OPEN SOURCE HW

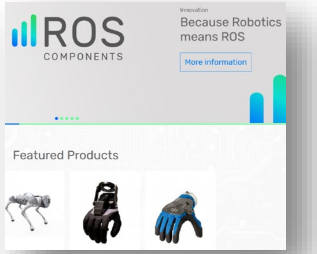
- mosaicHAT
- Mowi

OPEN SOURCE SW (DRIVERS)



- PX4
- Ardupilot
- ROS

CHANNELS

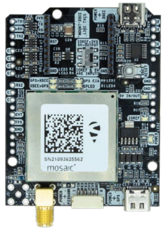


- Digikey
- ROS Components
- Spectroworks
- ....

MOSAIC HW ENABLERS

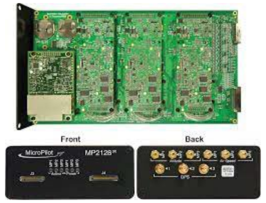
(EVAL SYS)

- Ardusimple
- Sparkfun
- GNSS Store (Elthes)
- Mikroelectronica



CO-MARKETING

- Micropilot
- Xsens
- …



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https://www.septentrio.com/en/learn-more/community

NMEA Navsat driver This package provides a ROS interface for GPS devices that output compatible NMEA sentences. The driver is generic enough to work with several GNSS receiver types including Septentrio GNSS receivers. Please also take a look at the ROSaic project which offers full support for SBF.
Solution: ROS Driver
Product link: All Septentrio Products
Tags: #opensource, #ROS, #robotics #autonomous #rosdriver #nmea
Visit partner website

ROSaic is an open-source ROS driver for mosaic and other Septentrio GNSS receivers. The ROS driver is a ROS node that makes the Septentrio GNSS hardware accessible from ROS (Robotics Operating System). Robot Operating System is robotics middleware. Although ROS is not an operating system, it provides services designed for a heterogeneous computer cluster such as hardware abstraction, low-level device control, implementation of commonly used functionality, message-passing between processes, and package management. This page contains links to many resources to assist integration of GNSS in ROS, with the help of ROSaic.
Solution: ROS driver
Product link: mosaic-X5, mosaic-H, AsteRx-m3, AsteRx-i3, AsteRx SB3, AsteRx SBi3, AsteRx U3
Tags: #opensource, #ROS, #robotics #autonomous #ROSdriver
Visit partner website

The **Pixhawk** flight controller board is a flexible autopilot intended primarily for manufacturers of UAV commercial systems. Its HW can be used with Septentrio receivers specially when in combination with Ardupilot SW.
Solution: Pixhawk
Product link: mosaic-X5, mosaic-H, AsteRx-m3, AsteRx-i3
Tags: #opensource, #autopilotsw, #uavs #flightcontroller
Visit partner website

PX4 autopilot is one of the largest commercially adopted open-source navigation control stacks, enabling an innovative community to build and maintain drone hardware and software in a scalable way. Septentrio AsteRx-m3 and mosaic receivers are compatible with PX4 autopilots, with both single antenna and dual antenna configurations, which offer either heading and pitch or heading and roll angles on top of accurate GNSS positioning. With this open-source copy of the official PX4 repository you can get started with Septentrio receivers working seamlessly with PX4.

Solution: PX4 Driver on GitHub
Product link: mosaic, AsteRx-m3
Tags: #opensource, #autopilotsw, #uavs #flightcontroller
Visit partner website

Summary

- **High accuracy GNSS is a good place to be as a young engineer**
  - **Use will only increase.**
  - **GNSS is the key enabling technology to automate outdoor tasks.**
  - **LEO PNT being developed to complement GNSS**
- **Septentrio is a good choice**
  - Most accurate and reliable GNSS position and timing solutions in the most demanding industrial and scientific environments.
  - Web interfaces, tools and utilities, raw data, IMU/INS fusion.
  - Protection against interference.
  - Support for open-source eco-systems

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Thank you - Questions

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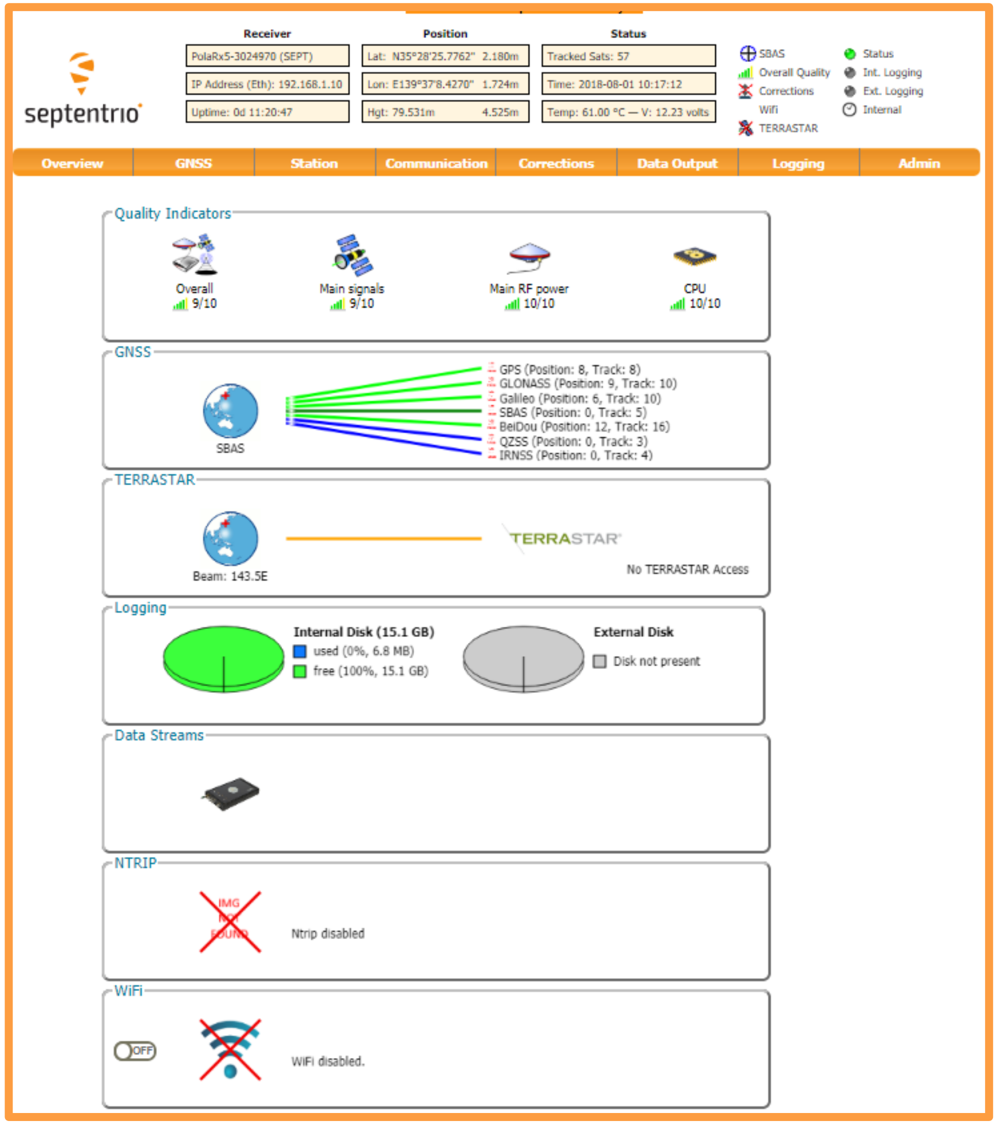
Back-up

Live Demo of a PolaRx5 CORS in Yokohama (25km away)



mosaic-x5 superiority （2）

https://www.gsi.go.jp/common/000229425.pdf
The translation of this PDF is, please click the PDF file

測地分野での応用に向けた低価格 GNSS 機器の性能評価
小門 研亮 （Kensuke KOKADO）
国土地理院

長距離基線においては使用しているアンテナ及び受信機による性能差がより顕著となり，ZED-F9P と低価格アンテナの組み合わせで大きな性能低 下が見られた（図1）.

ZED-F9P は多周波対応であるもの の，L2 帯については L2Cのみの対応であり，一部の GPS 衛星の L2 信号を受信することができない．そのため，**電 離層遅延補正が他の受信機に比べて適切に実施できてい ない可能性がある**．電離層遅延補正の有無による標準偏 差及び FIX 率を比較すると，ZED-F9P を使用する場合の み，電離層遅延補正の効果が小さい結果となった.

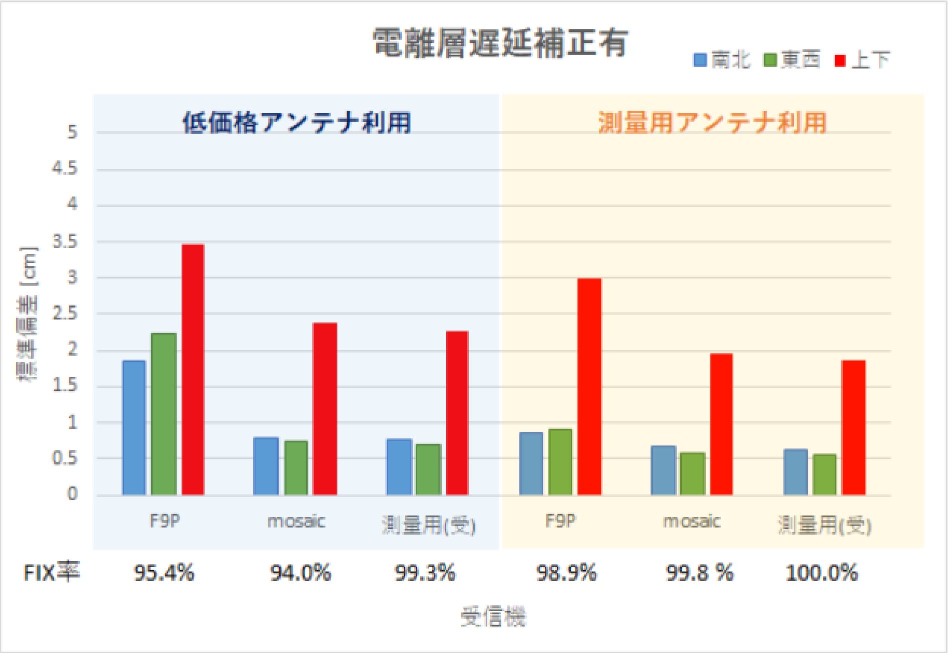


図１　長距離基線におけるキネマティック解析結果

まとめ
ZED-F9P を使用した場合は測量用受信機よりも長距離基線の標準偏差が大きくなる傾向が見られ，**電離層遅延補正に課題がある**ことを確認した.

一方，**mosaic は測量用受信機とほぼ同等の性能が得られており，地殻変動監視や測量の分野においても十分な性能を有していることを確認**した.

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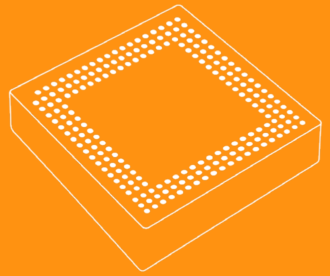
Back-up Slides

Septentrio Technology



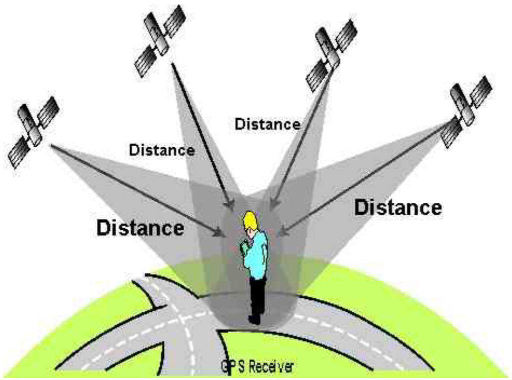
- Accurate
- Multi Constellation
- AIM+ Interference Mitigation
- High-Quality Measurements
- High Update Rates Low Latency
- Low Power
- Base Rover
- Proven Performance
- Lightweight
- Easy-to-integrate

Agenda

- GNSS Receiver Basics
  - What is a GNSS receiver?

- Septentrio GNSS Receivers
  - Company Profile
  - Why, where and how Septentrio GNSS receivers are adopted at markets and in society?
  - Try the GNSS receivers of Septentrio !

What is a GNSS receiver?

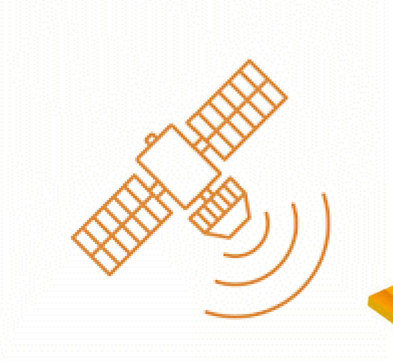


What is a GNSS Receiver?

Device used to determine precise position and time using signals from GNSS satellites

A GNSS receiver works by receiving signals from multiple satellites in orbit and using these signals to calculate the receiver's precise **P**osition, **V**elocity, and **T**ime.

The basic principle behind the operation of a GNSS receiver involves measuring the time it takes for signals to travel from satellites to the receiver, and then using the information from multiple satellites to determine the receiver's location.



- To determine its position, the receiver needs signals from at least 3 satellites (for 2D positioning) or 4 satellites (for 3D positioning).
- The receiver uses the distances obtained from the signals to each satellite to create spheres or spheres of possible locations.
- The point where these spheres intersect is the receiver's precise location.

A GNSS receiver is...

In summary, a GNSS receiver works by receiving signals from multiple satellites, measuring the time it takes for the signals to travel, calculating distances, and then using these distance measurements to determine its precise **P**osition, **V**elocity, and **T**ime.

The receiver's ability to **track multiple satellites** from different constellations **enhances its accuracy and overall performance.**

Of course, a GNSS receiver needs a good antenna for better accuracy and performance.

+

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However, there are Obstacles for GNSS receivers. You need to consider those obstacles in selecting the GNSS receiver adequate for the application.

1. Urban Canyons:

- Tall buildings and urban infrastructure can block or reflect satellite signals, causing signal multipath.
- Multipath occurs when signals bounce off buildings or other surfaces before reaching the receiver's antenna, leading to inaccurate distance measurements.

2. Foliage and Tree Cover:

- Dense tree cover and foliage can attenuate or weaken satellite signals as they pass through leaves and branches.
- This can result in reduced signal strength and accuracy, especially in forested areas.

3. Topography:

- Mountains, hills, and valleys can obstruct satellite signals or cause signal shadows.
- Receivers in valleys may have limited visibility to satellites above the surrounding terrain.

4. Urban and Natural Terrain Features:

- Natural features like cliffs and large rock formations, as well as man-made structures like tunnels and bridges, can obstruct signals and cause signal blockage or degradation.

5. Electromagnetic Interference (EMI):

- Electronic devices, power lines, and other sources of electromagnetic radiation can introduce interference that affects the receiver's ability to accurately process satellite signals.

6. Atmospheric Effects:

- The Earth's atmosphere can delay satellite signals, causing errors in the distance measurements.
- Ionospheric and tropospheric delays can be particularly problematic for high-accuracy applications.

However, there are Obstacles for GNSS receivers. You need to consider those obstacles in selecting the GNSS receiver adequate for the application.

7. **Signal Spoofing and Jamming:**
    - Malicious persons can generate counterfeit signals to deceive GNSS receivers (spoofing).
    - Jamming involves transmitting powerful radio signals to overpower GNSS signals, leading to signal loss.
8. **Indoor and Underground Environments:**
    - GNSS signals are significantly attenuated indoors and underground, making it challenging for receivers to obtain accurate signals in such environments.
9. **Rapid Movement:**
    - High-speed movement, such as in aviation or driving at high speeds, can lead to signal tracking difficulties and loss of lock on satellites.
10. **Satellite Constellation Geometry:**
    - Poor arrangement of satellites in the sky (low satellite elevation angles) can lead to weaker signals and reduced accuracy due to increased signal multipath.
11. **Satellite Availability:**
    - When too few satellites are visible in the sky, the receiver's ability to triangulate or trilaterate accurately decreases, leading to degraded accuracy or a complete loss of position.
12. **Receiver Sensitivity and Quality:**
    - Low-quality or outdated receivers might have reduced sensitivity, making them more susceptible to signal degradation in challenging environments.