



Waypoint[®]

Best-in-class GNSS and GNSS+INS
processing software



Waypoint

EXCEPTIONAL POST-PROCESSING SOFTWARE

Enhance your GNSS Position, Velocity and Attitude Accuracy

For applications requiring highly accurate post-mission position, velocity or attitude, post-processing is an ideal solution. Post-processing maximizes the accuracy of the solution by processing previously stored Global Navigation Satellite System (GNSS) and Inertial Measurement Unit (IMU) data forward and reverse in time, and combining the results. The position, velocity and attitude solution can be smoothed and output at the required data rate and in the coordinate frame required. This process also provides the ability to assess the solution reliability and accuracy.

Combining GNSS with Inertial Navigation Systems (INS) extends the capability of traditional GNSS products by providing a full 3D attitude solution (roll, pitch, heading) and by providing a solution even during temporary outages in GNSS reception. However, real-time GNSS+INS system accuracy is limited by the quality of the IMU and the duration of GNSS outage periods. The performance of these systems can be greatly improved through post-processing. Inertial Explorer® significantly reduces the solution drift during GNSS outage periods and virtually eliminates the solution convergence time experienced in real-time operation.

For comprehensive information on NovAtel® SPAN® GNSS+INS technology, visit www.novatel.com/span

Waypoint Product Matrix

| | INERTIAL EXPLORER | GRAFNAV | GRAFNET* | GRAFNAV STATIC |
|-------------------------------------|-------------------|---------|----------|----------------|
| Multi-constellation GNSS Processing | + | + | + | + |
| GNSS+IMU Processing | + | | | |
| GNSS Heading | + | + | | |
| Precise Point Positioning | + | + | | + |
| Multi-base Station Support | + | + | | + |
| Software Development Kit | + | + | | + |
| Network Adjustment | | | + | |
| Kinematic Data Processing | + | + | | |

* GrafNet is bundled with GrafNav and GrafNav Static

Inertial Explorer

GNSS+INS POST-PROCESSING SOFTWARE

Post-Processing for Improved Accuracy

Inertial Explorer (IE) maximizes the performance of your GNSS+INS hardware by ensuring you get the position, velocity and attitude accuracy your application requires. The tightly coupled integration of GNSS and IMU data delivers precise results, even when lower grade inertial sensors are used. IE can produce results suitable for demanding applications such as mobile mapping, aerial and hydrographic surveying. IMU data from high end Fibre Optic Gyro (FOG) or Ring Laser Gyro (RLG) IMUs, and from lower grade sensor technology such as Micro Electrical Mechanical Systems (MEMS) can be processed.

Flexible Workflow Capabilities

IE has workflows to match your business and your expertise. A project wizard is available to allow new GNSS+INS users to become productive quickly. For more experienced users, a wealth of processing configuration options are available. Automated processing environment detection (aerial, ground vehicle and marine) allows appropriate GNSS+INS processing settings to be used automatically to simplify workflow and reduce the learning curve needed to start producing quality results.

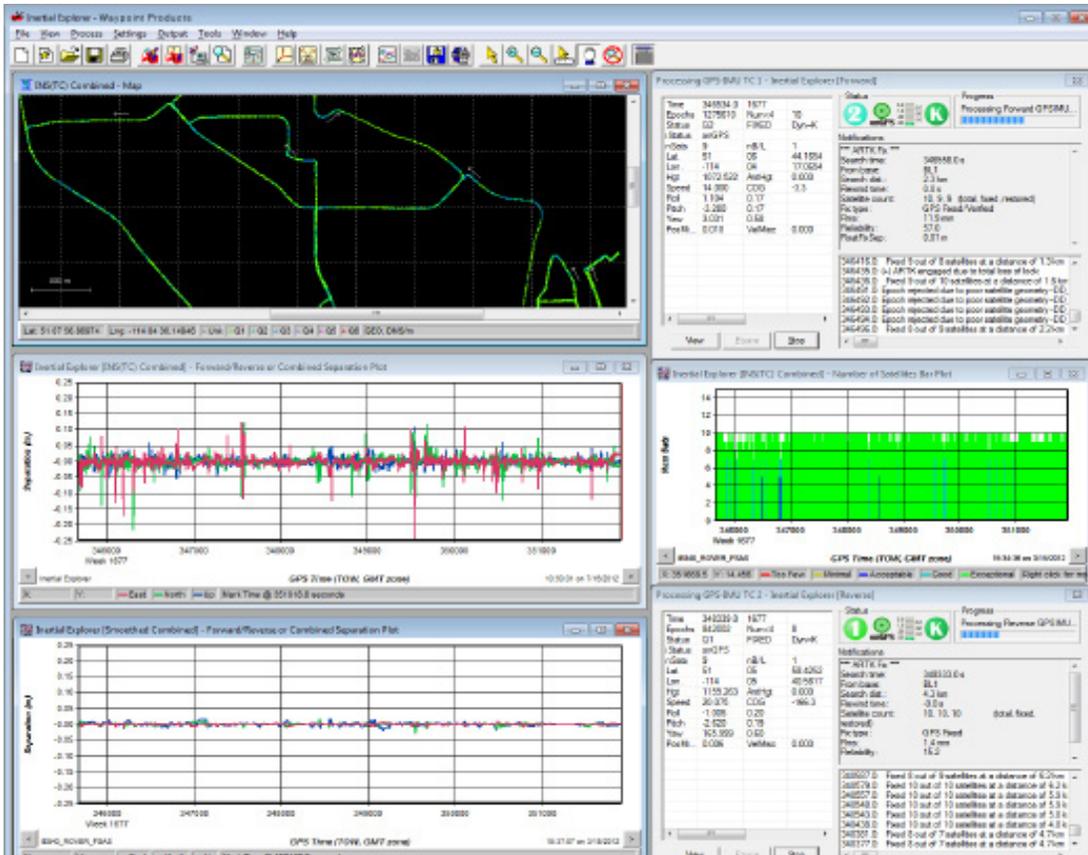
Features such as automated alignment, robust automatic ZUPT detection and the application of various updates ensure the best possible accuracies are achieved, even in conditions challenging to GNSS signal reception.

IE provides maximum flexibility to suit your application and preferences, including support for both tightly and loosely coupled processing, multiple base station support for large project areas, and tightly coupled Precise Point Positioning (PPP) for applications that do not require a base station.

IE also provides access to over 50 quality control plots to help gauge solution accuracy and to provide added confidence. If problem areas are identified, Inertial Explorer provides access to powerful reprocessing options and the best customer support in the industry to help ensure your success.

Steady State Post-Processed Performance¹

| IMU | POSITION ERROR ² (M) | | VELOCITY ERROR (M/S) | ATTITUDE ERROR (DEGREES) | | |
|--------------------|---------------------------------|----------|----------------------|--------------------------|-------|---------|
| | 2D | Vertical | 3D | Roll | Pitch | Heading |
| ISA-100C | 0.01 | 0.02 | 0.02 | 0.003 | 0.003 | 0.004 |
| LN200 ³ | 0.01 | 0.02 | 0.02 | 0.005 | 0.005 | 0.007 |
| AG58 | 0.01 | 0.02 | 0.02 | 0.005 | 0.005 | 0.008 |
| FSAS | 0.01 | 0.02 | 0.02 | 0.004 | 0.004 | 0.013 |
| CPT | 0.01 | 0.02 | 0.01 | 0.008 | 0.008 | 0.035 |
| AG62 | 0.01 | 0.02 | 0.02 | 0.004 | 0.004 | 0.009 |



The feature rich Graphical User Interface of Inertial Explorer enables project configuration, monitoring of the processing and solution quality control.

1. For full velocity and attitude outage performance information, consult the NovAtel IMU data sheets.
2. 1 ppm should be added to all values to account for additional error due to baseline length.
3. LN200 attitude accuracy derived with comparisons to aerotriangulation—please see our paper "Aerial Photogrammetry Test Flight Results" for additional information: <http://www.novatel.com/Documents/Papers/D11716.pdf>
4. Requires separate photogrammetric adjustment package to determine camera exterior orientation angles.

POWERFUL FEATURES FOR DIVERSE APPLICATIONS

Airborne, ground and marine mapping applications require robust results, efficient quality control and streamlined workflow for fast, accurate end product delivery. IE is also a popular tool for calculating a truth solution when evaluating positioning or navigation performance.

OPTIMIZE YOUR WORKFLOW

- » Simultaneous GNSS, IMU and DMI (wheel sensor) raw data conversion if using NovAtel SPAN GNSS+INS hardware
- » Simultaneous GNSS and IMU processing and simultaneous forward and reverse processing
- » Download utility provides access to thousands of publicly available base stations
- » Import GNSS data from multiple receiver manufacturers
- » Heading updates decoded automatically from NovAtel's ALIGN® help maximize accuracy in low dynamic applications
- » Flexible export tool permits reproduction of most ASCII file formats
- » Output w-p-k angles for photogrammetric applications

» Solve for camera IMU orientation difference given w-p-k angles from an external source⁴

» Inertial Explorer removes up to 95% of position error over GNSS outages as compared with a real-time solution

» Model wave dynamics with NovAtel's Heave option

» Optionally solve the IMU to GNSS lever arm

» Preloaded error models for most popular IMUs as well as customer created error models

MAXIMIZE YOUR ACCURACY

» Multi-pass processing optimizes attitude accuracy for low dynamic surveys

» Raw data and solution specific quality control plots

» IMU-only processing when provided regular external coordinate updates

» Extensive control over GNSS and IMU processing options

» DMI data input to further maximize performance in challenging environments

» Automatic ZUPT detection to help maximize performance in challenging environments

GrafNav

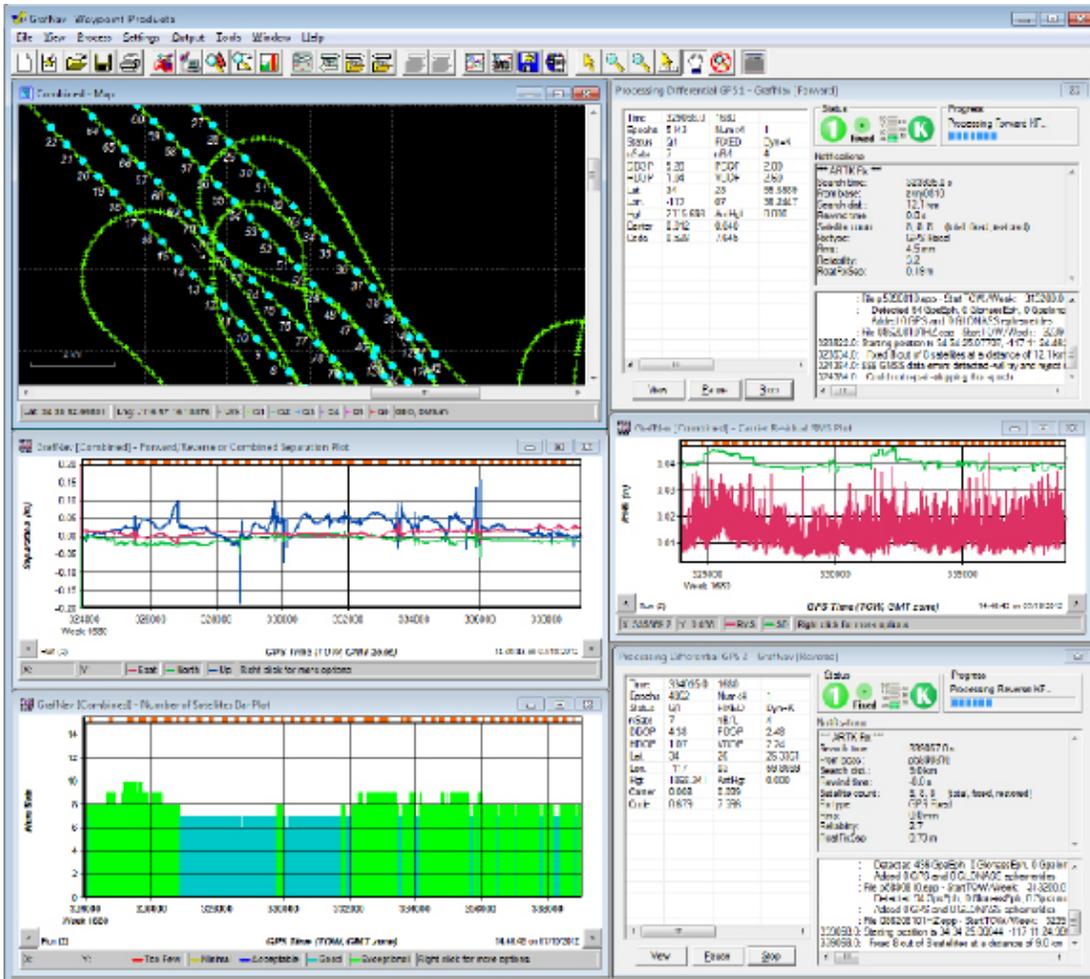
GNSS RECEIVER INDEPENDENT POST-PROCESSING SOFTWARE

Enhanced GNSS Accuracy

GNSS technology is used to compute position and velocity for a variety of real-time applications, including vehicle navigation and tracking. The real-time accuracy of GNSS however, is limited by real-time transmission of correction data. Further, in many applications where absolute position accuracy is critical, the position information is not required in real-time. For these applications, the accuracy of the GNSS position and velocity solution can be greatly improved by post-processing.

Powerful, Highly Configurable Processing

GrafNav post-processing software is a powerful, highly configurable processing engine that allows for the best possible static or kinematic GNSS accuracy using all available GNSS data. Support of data formats from most single and multi-frequency commercial receivers means GrafNav will likely work with your existing hardware. A full suite of data and solution visualization and diagnostic tools is available for quality assurance. Precise satellite clock and orbit data can be downloaded from within GrafNav to achieve sub-10 cm position accuracy using PPP with kinematic trajectories. No matter the type of project, GrafNav can be configured to optimize your results. The software can easily make use of project specific base station data, or use publicly available reference station data to achieve centimetre level position accuracy. GrafNav also supports multi-base processing for projects that cover large areas. A float static solution is available for long and/or noisy baselines. Built-in ionospheric processing improves accuracies for dual-frequency users.



The GrafNav Graphical User Interface can be configured to show what is most critical for the project trajectory, processing status, or a range of project quality control metrics.

1. Quoted accuracy assumes minimal loss of lock, good satellite geometry, dual frequency data.

OPTIMIZE YOUR WORKFLOW

- » Multiple base processing for up to eight base stations
- » Public base station and PPP clock and orbit data download utility
- » Simultaneous forward and reverse processing
- » Settings and results are automatically saved for every processing run
- » Interpolation of coordinates for station markers and camera trigger events
- » Resampling, concatenation and splicing of raw GPS data
- » Full geoid support for the US, Canada, Japan, Australia, Mexico, France, UK, Ireland and more
- » Choose from popular datums and map projections or customize your own

ADVANCED FEATURES MAXIMIZE RESULTS

- » NovAtel CORRECT™ with RTK carrier phase positioning for accurate results on long baselines and in difficult conditions¹
- » Long baseline dual-frequency ionospheric processing

- » GPS, GLONASS, Galileo, BeiDou and QZSS data processing
- » Advanced tropospheric state for long baseline surveys
- » Forward, reverse and combined data processing options
- » Simultaneous forward and reverse processing
- » Precise Point Positioning module
- » Multi-pass Precise Point Positioning processing for minimum convergence time on shorter duration data sets

SUPPORTED FORMATS

- » NovAtel (all formats)
- » Leica System 500/System 1200/MC1000/GX1230
- » RINEX 2.0, 2.11 and 3.0
- » Javad (all formats)
- » Ashtech Real-Time, B-File and DNSP
- » NavCom OEM and Sapphire
- » Septentrio SBF
- » Trimble DAT and RT
- » U-Blox Antaris

GrafNet

GNSS RECEIVER INDEPENDENT STATIC PROCESSING AND NETWORK ADJUSTMENT SOFTWARE

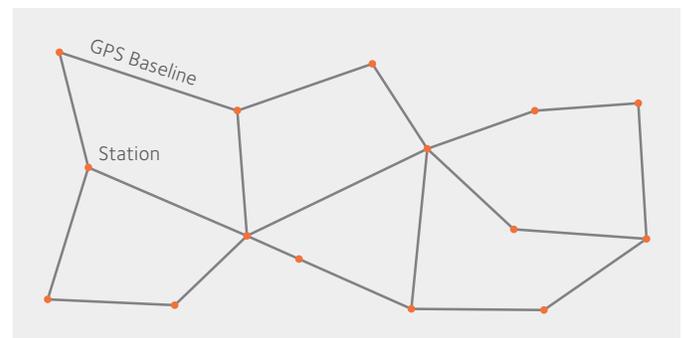
Multiple Processing Options

GrafNet is a batch static baseline processor and network adjustment package. It creates a single network by tying all the ends of static GNSS baselines together. It can be used to establish or check base station coordinates for later use within GrafNav or to survey entire static networks. Within minutes, GrafNet processes the entire project, containing multiple stations, in a single operation. When the processing is completed, GrafNet color codes the baselines so irregular baselines are isolated from the project and are easily analyzed. Statistics are available on each baseline misclosure and on the adjustment as a whole. GrafNet allows three types of static baseline processing solutions:

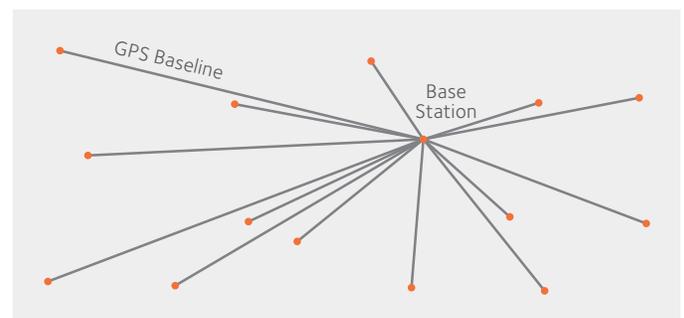
- » Fixed static
- » Float
- » Ionospheric free

Closed Loop and Radial Networks

GrafNet can process both closed loop networks as well as radial networks as demonstrated in the diagrams below. As with GrafNav, multiple receiver types are supported and data from publicly available reference stations can be included in the project through the built-in download manager.



Closed loop Network



Radial Network

The screenshot displays the GrafNet software interface with several key components:

- Map View:** Shows a network of points and baselines on a map. A point labeled 'CTRL1' is visible.
- Processing Status Windows:**
 - Waiting on Differential GPS 1 - 1 to 9 (1) [Forward]:** Shows a 'Fixed' status (blue 'F' icon) and 'Calculating Fixed Static' progress. Statistics include Time: 514395.0, Epochs: 133, Status: Q1, nSats: 9, DDOP: 2.62, HDOP: 2.21. Notifications mention 'Fixed Static (BL1 to 9)'. Reliability: 27.881 PASSED.
 - Processing Differential GPS 2 - 1 to CTRL1 (1) [Reverse]:** Shows a 'Fixed' status (green 'F' icon) and 'Calculating Fixed Static' progress. Statistics include Time: 403335.0, Epochs: 1875, Status: Q3, nSats: 10, DDOP: 1.62, HDOP: 1.13. Notifications mention 'Fixed Static (BL1 to CTRL1)'. Reliability: 0.0045 PASSED.
- Data Manager Table:**

| Data Objects | Session(s)... | Name | SD(mm) | Reliability | RMS(mm) | SoIType | Time(h:m) | Dist(km) | Status | From | To | # |
|----------------|---------------|----------------|--------|-------------|---------|-------------------|-----------|----------|--------|------|-------|---|
| Project | | | | | | | | | | | | |
| Observations | | 1 to 6 (1) | 1.4 | --- | 14.0 | L1L2-IonoNewFixed | 06:48:15 | 5.76 | Good | 1 | 6 | 1 |
| Stations | | 1 to 8 (1) | 3.0 | --- | 13.4 | L1L2-IonoNewFixed | 01:56:45 | 5.83 | Good | 1 | 8 | 1 |
| Sessions | | 1 to 9 (1) | 3.9 | 27.90 | 4.5 | L1L2-IonoFixed | 00:33:15 | 5.42 | Good | 1 | 9 | 1 |
| Control Points | | 1 to CTRL1 (1) | 1.6 | --- | 24.9 | L1L2-IonoNewFixed | 07:48:45 | 6.11 | Good | 1 | CTRL1 | 1 |
| Baselines | | 1 to CTRL1 (2) | 1.3 | --- | 23.4 | L1L2-IonoNewFixed | 09:30:00 | 6.11 | Good | 1 | CTRL1 | 2 |
| | | 6 to 8 (1) | 5.6 | 12.10 | 5.1 | L1L2-NewFixed | 00:19:30 | 3.82 | Good | 6 | 8 | 1 |
| | | 6 to CTRL1 (1) | 0.8 | --- | 9.4 | L1L2-NewFixed | 06:48:15 | 2.19 | Good | 6 | CTRL1 | 1 |
| | | 8 to 9 (1) | 1.9 | 26.90 | 4.2 | L1L2-Fixed | 00:33:15 | 0.51 | Good | 8 | 9 | 1 |
| | | 8 to CTRL1 (1) | 1.6 | --- | 8.2 | L1L2-NewFixed | 01:56:45 | 1.83 | Good | 8 | CTRL1 | 1 |
| | | 9 to CTRL1 (1) | 2.0 | 15.60 | 8.0 | L1L2-Fixed | 00:33:15 | 1.59 | Good | 9 | CTRL1 | 1 |

After baseline processing and network adjustment, baseline statistics and a color coded plan view make it easy to find outliers.

FLEXIBLE, HIGH QUALITY SOLUTIONS

Support for native receiver formats from multiple manufacturers means GrafNet will likely work with your existing hardware. Multiple quality control features are built-in so the quality of the solution is never in question. The base station download utility allows access to thousands of publicly available reference stations.

GRAFNET FEATURES

- » Static network processing
- » Data Manager for easy project manipulation
- » Accurate fixed static solutions and long range iono-free processing
- » Included network adjustment
- » Trivial baseline removal
- » Manual and automatic loop closure computation
- » Quality control plots for individual baselines
- » Final results exported in a similar manner to GrafNav
- » Full support for combined scale factor

Waypoint SDK

GNSS AND GNSS+INS POST-PROCESSING DEVELOPMENT KIT

Automate your GNSS or GNSS+INS Post-Processing

The Waypoint Software Development Kit (SDK) gives you complete control over the GrafNav and Inertial Explorer post-processing functions. Base station downloads, data conversion, data processing, solution output and quality control can all be customized to meet the requirements of any application.

Speed Up and Automate Survey Quality Control

With complete access to the trajectory information, the Waypoint SDK allows you to set the rules for determining if the survey meets your accuracy requirements.

Whether you have just a few systems or hundreds of them, automated post-processing with the Waypoint SDK improves results, while saving time and money by increasing the speed of your workflow.

Software Integration

Nearly all of the functionality contained in Waypoint's GrafNav and Inertial Explorer software can be accessed within the Waypoint SDK. This allows you to embed GNSS or GNSS+INS processing functionality into your software, provide an optimized workflow for your customers and increase the value of your software products. For your programming convenience, two separate interfaces are available:

- » C++/WIN32
- » .NET 4.0 or higher

GRAFNAV AND INERTIAL EXPLORER FUNCTIONALITY

- » Static and kinematic processing
- » Forward/reverse and triple-pass processing
- » Tightly coupled GNSS+INS processing and tightly coupled PPP+INS processing
- » Data decoding of multiple receiver and IMU formats
- » Trajectory smoothing
- » Local base station, multi-base station and PPP
- » GPS, GLONASS, BeiDou, Galileo and QZSS support
- » Data download for reference stations and precise satellite orbit and clock data
- » Easy import of NovAtel SPAN data
- » Flexible solution export
- » Data and solution quality and assurance tools
- » Coordinate system and datum support

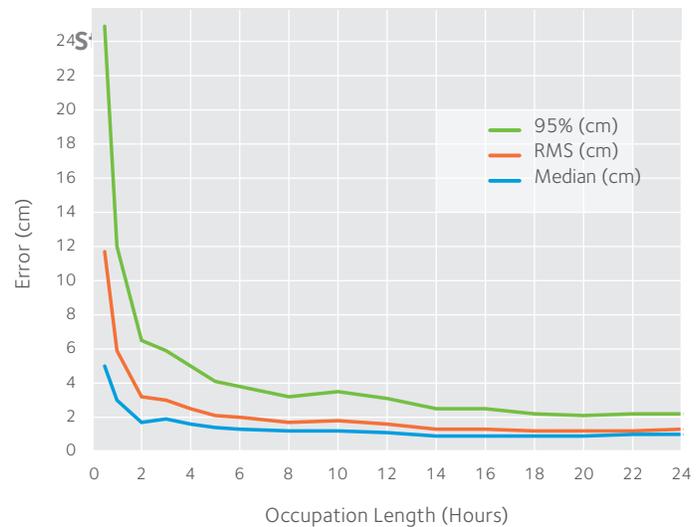
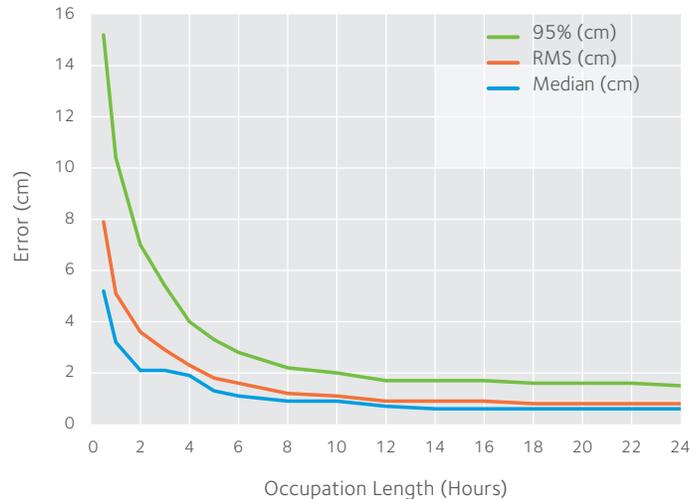
SYSTEM REQUIREMENTS

- » Microsoft Visual Studio 2010 or later
- » Microsoft Windows XP, Vista, 7, 8 and 10
- » 2 GB RAM or more

SOFTWARE LICENSING

- » Software based licensing with support for remote/virtual desktop
- » Flexera licensing
- » One time software activation through the Internet
- » Term based licensing with scalable pricing option

Static Horizontal Precise Point Positioning Accuracy



These graphs show the results of 36,000 processing runs using 1000 different CORS stations. GrafNav's SDK was used to automate all processing.



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SE Asia & Australia 61-400-883-601

Upgrade/Support

Any software updates released within one year from purchase are available at no charge. Technical support by phone and e-mail is also free for one year after date of purchase.

Version 5 Specifications subject to change without notice.

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Refer to www.novatel.com for latest specification revisions.

Printed in Canada

D18034 September 2016

