Applanix
POSPac PP-RTX™

White Paper

PP-RTX | Applanix POSPac Post-Processed Trimble CenterPoint® RTX™

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https://www.applanix.com/products/pospac8/pp-rtx.htm

Trimble®

Introduction

Trimble real-time CenterPoint RTX service was introduced in 2011 providing centimeter accurate positions for real-time applications. This service relies on the generation of precise orbit, clock information and atmospheric delay models for GNSS satellites (GPS, GALILEO, GLONASS, BEIDOU, QZSS) in real-time. It is based on a Trimble dedicated worldwide network of tracking stations.

POSPac Post-Processed CenterPoint RTX (PP-RTX) is a cloud based global GNSS correction service which utilizes Trimble's RTX technology to provide centimeter level post-processed positioning accuracy *without* base stations. PP-RTX is an alternative processing mode to the Single Base, Applanix SmartBase™ and Multi-Single Base correction methods for the GNSS-Inertial Trajectory generation.

Workflow

When using the ***IN-Fusion PP-RTX*** service, trajectory information is uploaded to the Trimble RTX-PP Server. This is then used to generate a set of RTX corrections unique to the mission area, which are transmitted back to POSPac. POSPac processes the corrections along with the raw GNSS and IMU data to generate the SBET with centimeter level accuracy, all without the need of a local base station.

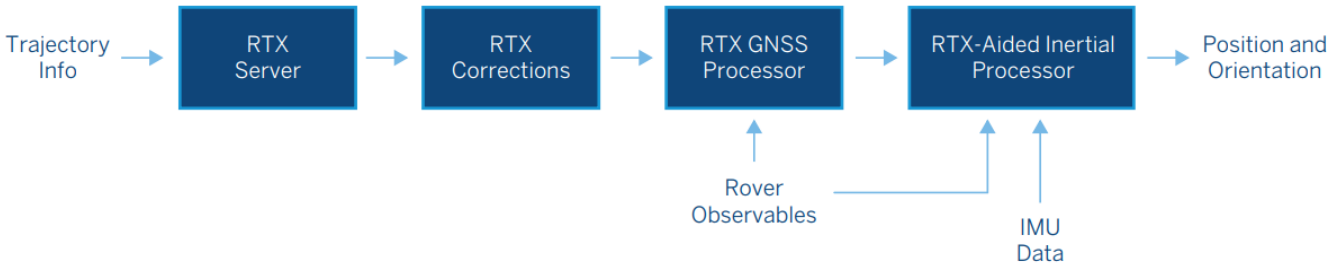

Fig 1: IN-Fusion PP-RTX Implementation in POSPac

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The next generation ***IN-Fusion+ PP-RTX 2*** service available in POSPac 9, (initially limited to uncrewed (UAV) airborne applications), directly downloads the correction data without the need to upload trajectory information to the RTX-PP server (one way direction). In addition, if an internet connection is not available, RTX corrections can be logged over the air from L-Band satellite using the Trimble GNSS-Inertial hardware products, and processed directly in POSPac. The new service also supports better use of the multi-frequency and multi-satellite constellations, including the new signals from the Beidou-III generation which contribute to improved robustness, reliability and reduced convergence time.

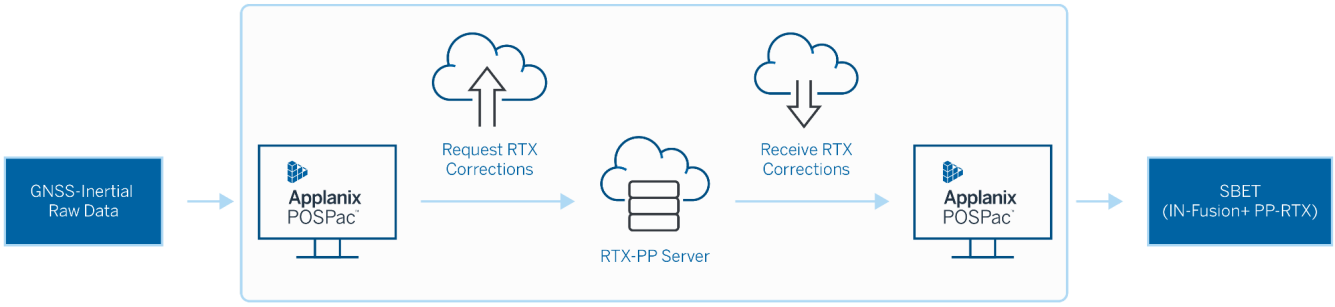

Fig 2: IN-Fusion+ PP-RTX 2 Implementation in POSPac

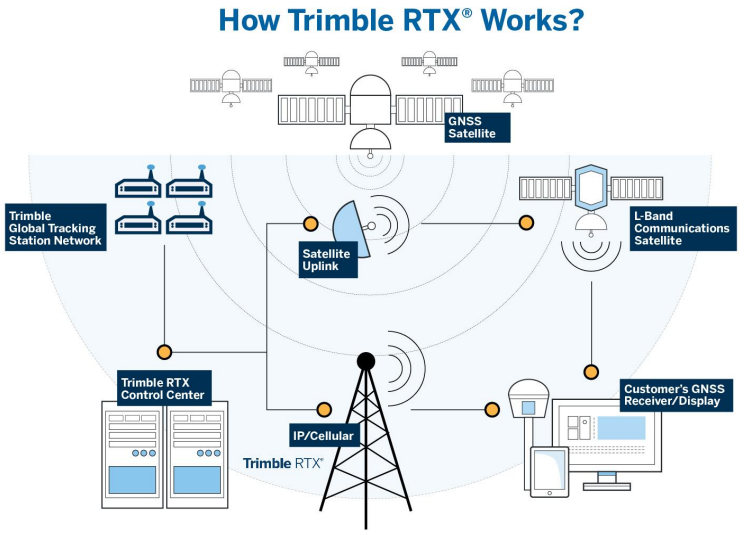

Fig 3: Real-Time CenterPoint RTX Corrections

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Global and Fast Region

The Trimble CenterPoint RTX services are split into two regions:

- Fast Region (Central Europe and North America)
- Global Region (Rest of World)

The Global Region corrections are based on a global ionospheric model, while the Fast Region uses a denser network of reference stations to compute a regional ionospheric model for atmospheric corrections.

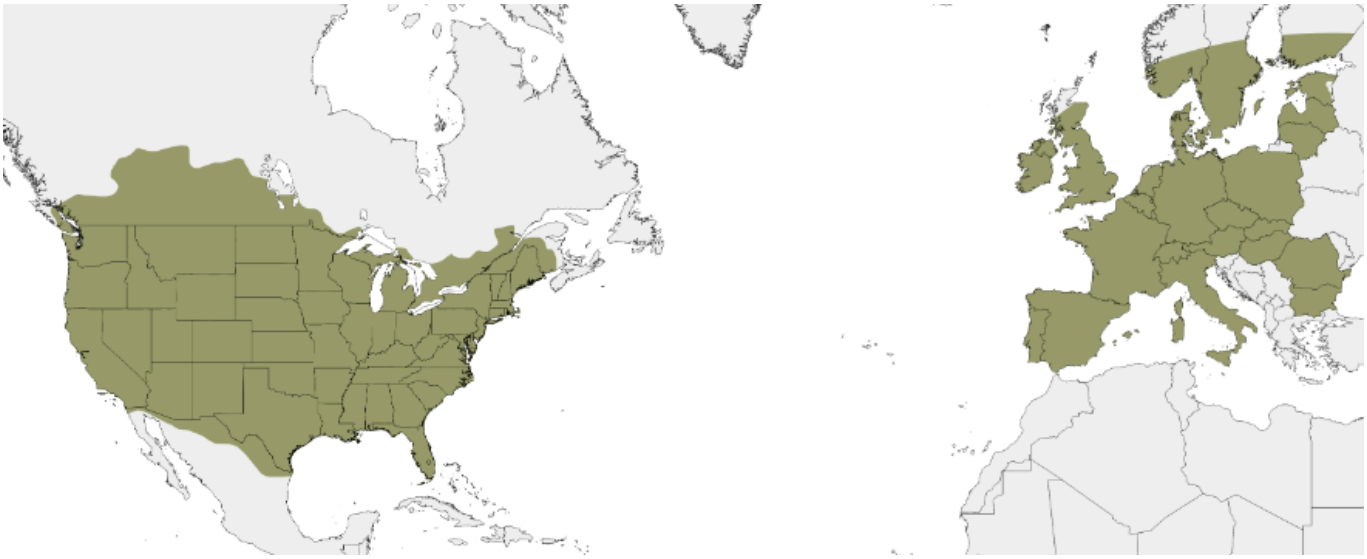

Fig 4: Fast and Global CenterPoint RTX Regions

Convergence Time

The convergence time is the amount of time it takes for the PP-RTX position accuracy to reach its final centimeter level accuracy, hence the time span of the trajectory itself must be longer than the convergence time to achieve full accuracy. Since the PP-RTX solution is processed in the forward and reverse direction and then combined, all convergence effects are removed.

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- Fast Region: Convergence time is 1 to 2 minutes
- Global Region:
    - ***IN-Fusion PP-RTX***: Convergence time is 15 - 20 minutes
    - ***IN-Fusion+ PP-RTX 2***: Convergence time is < 3 minutes with Beidou-III

Please refer also to the document "*Technical Note for IN-Fusion+ PP-RTX 2*" accessible from our Customer Support Hub for details about how to properly configure a system to take advantage of PP-RTX 2.

With reduced convergence time in the Global Region, ***IN-Fusion+ PP-RTX 2*** thus allows higher accuracy GNSS-Inertial processing for short uncrewed (UAV) flights without using a dedicated base station.

Performance

The accuracy when using PP-RTX processing in POSPac is < **3 cm** horizontal RMS error and < **6 cm** vertical RMS error. This is independent of the region as long as the solution has converged.

Requirements

In order to make use of the PP-RTX mode in POSPac, the following requirements apply:

- Valid PP-RTX Subscription (accompanied by a term or perpetual GNSS-Inertial processing license with aligning end dates for term or perpetual maintenance)
- Internet Connection[1]
- Minimum of 10 - 15 minutes rover data in the Fast Region or using ***IN-Fusion+ PP-RTX 2*** for UAV processing in the Global Region with new Beidou-III signals
- Rover must be using a calibrated GNSS antenna and associated model set in POSPac
- Clean GNSS observables must be available throughout the mission (minimal cycle slips)

[1] License check only with ***IN-Fusion+ PP-RTX 2*** if CenterPoint RTX corrections have been logged in real-time

Applications

Crewed Airborne:

Due to the mission size, crewed airborne projects can exceed the maximum of 20 km distance from a single base station required for a precise GNSS-Inertial solution. PP-RTX has no such limitation and is hence ideal for crewed aerial surveys. Since PP-RTX is a global service, it eliminates the cost and headache of setting up or procuring local base stations in different countries or remote locations.

Uncrewed Airborne (UAV):

Short flights (10 – 30 minutes) can be processed using ***IN-Fusion PP-RTX*** while in Fast Region coverage, or with ***IN-Fusion+ PP-RTX 2*** processing in the Fast or Global Regions as long as the proper signal tracking has been enabled. Longer flights (> 30 minute) can be processed in either region, and with either PP-RTX or PP-RTX 2 to obtain the same level of accuracy. This is particularly useful for BVLOS applications or longer linear flights such as those associated with corridor mapping. PP-RTX is also ideal for UAV mapping applications in remote regions such as mountainous and forested areas where existing base stations are not present, and setting up a base station can be difficult.

Land Application:

PP-RTX currently requires clean GNSS observables with minimal cycle slips and interruptions. Since land applications are typically exposed to frequent GNSS disruptions (buildings, vegetation, tunnels) in urban environments, the PP-RTX service will not achieve full accuracy. For missions in rural areas with no or only a few GNSS occlusions, it may produce adequate results. Contact Trimble Applanix for more details.

Marine Application:

The POSPac PP-RTX service can be used for all POS MV systems and applications. For offshore projects and remote coastal line surveys, it is the only cost-effective method for achieving centimeter level position accuracy. Surveys in ports or missions close to the mainland, POSPac PP-RTX eliminates the cost needed to procure or set up local base stations.

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Benefits

The core benefits of using PP-RTX in POSPac are:

- Worldwide coverage
- Data are available within minutes after mission completion
- CM level accuracy, approaching that of RTK
- Eliminate the need of base station data
    - From own setup
    - From various download sources
    - From commercial provider procurement
- Reliable 24/7/365 monitored cloud service
- Single button or automated functionality
- Improves efficiency and productivity

The additional benefits of using the new ***IN-Fusion+ PP-RTX 2*** processing mode for UAV applications are:

- Faster convergence time, especially in the Global Region for short UAV trajectories
- No trajectory information required to be uploaded to the PP-RTX Server
    - Correction data are obtained via an internet connection in download mode only, or from logged real-time over-the-air corrections
- Higher success rate for fixed ambiguity solution

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Performance Test Results: *IN-Fusion+ PP-RTX 2*

Uncrewed airborne data are characterized by a short time span (10 - 15 minutes), low altitude with respect to the ground and high dynamics. ***IN-Fusion+ PP-RTX 2*** processing of uncrewed airborne data (UAV) dramatically reduces the convergence time in the Global RTX region when using Beidou-III signals. Figure 3 compares the horizontal and vertical position solution of ***IN-Fusion PP-RTX*** and ***IN-Fusion+ PP-RTX 2*** in the forward pass for one dataset in the Global Region.

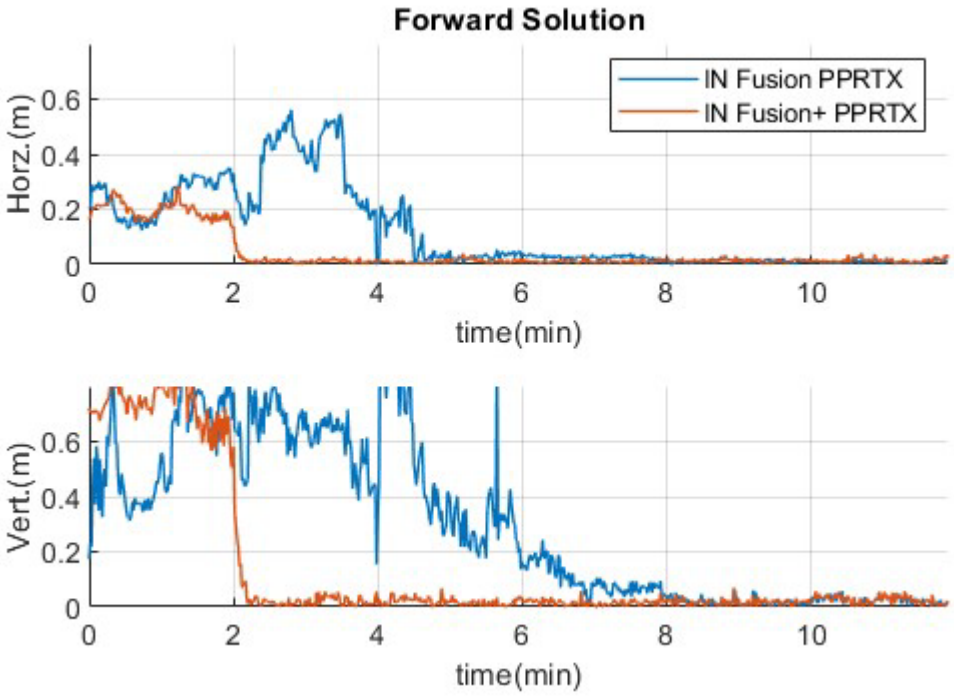

Fig 5: FWD Convergence PP-RTX Modes IN-Fusion vs. IN-Fusion+, Global Region

The convergence time improves from 8 minutes down to 2 minutes in this dataset, allowing the smoothed SBET solution to create centimeter level convergence-free positioning accuracy over the entire mission time span.

The addition of the Beidou-III satellites is the key factor here. They are used in the ***IN-Fusion+ PP-RTX 2*** mode vs. ***IN-Fusion PP-RTX*** and improve the convergence time

significantly by reducing DOP and making the residual atmospheric delay errors observable much faster. This makes the new PP-RTX 2 processing mode suitable for short uncrewed airborne (UAV) missions in both the Global Region and in the Fast Region.

Furthermore, 66 short UAV datasets were used (equivalent to 25h of data) from the Global RTX Region to compare the accuracy results between POSPac v8 ***IN-Fusion PP-RTX*** and POSPac v9 ***IN-Fusion+ PP-RTX 2*** positioning with the improved convergence time. The reference in all cases was a single base station with a short baseline length to ensure 1 - 2 centimeter precision. As the results in Table 1 show, the position accuracy for short UAV trajectories in the Global Region has improved by 100% using PP-RTX 2, lowering the 3D RMS from 12 cm down to 6 cm.

Component	RMS IN-Fusion PP-RTX	RMS IN-Fusion+ PP-RTX
North [cm]	4.4	1.2
East [cm]	2.3	0.9
Down [cm]	9.4	5.5

Table 1: NED RMS Comparison IN-Fusion PP-RTX vs. IN-Fusion+ PP-RTX 2, Global Region, Short trajectories

Conclusion

POSPac Post-Processed CenterPoint RTX (PP-RTX) as a worldwide cloud-based correction service is an adequate GNSS-Inertial processing mode in POSPac for various applications in open sky environments additionally to Single Base, Applanix SmartBase and Multi-Single Base processing . The Beidou-III signals processed with the new ***IN-Fusion+ PP-RTX 2*** mode (new processing option in POSPac v9) improve the convergence time, robustness and quality, which means short uncrewed airborne missions can now also be processed with high reliability outside the Fast RTX region. The new processing option also eliminates the need to upload trajectory information and can work on corrections logged in real-time if no internet connection is available.

For more information

For more information, contact our Customer Support Team (techsupport@applanix.com) or visit our Customer Support Portal.