TECHNICAL PUBLICATION

IN-Fusion+ PP-RTX | Mobile mapping open sky

Introduction

Introduced in 2011, Trimble® CenterPoint® RTX correction service provides centimeter-accurate positions for real-time applications. This service depends on generating precise orbit, clock information and atmospheric delay models in real-time for GNSS satellites (GPS, GALILEO, GLONASS, BEIDOU, QZSS). It operates through Trimble's dedicated worldwide network of tracking stations.

Trimble POSPac Post-Processed CenterPoint RTX™ **(PP-RTX)** is a cloud-based global GNSS correction service that employs Trimble's RTX technology to deliver centimeter-level post-processed positioning accuracy without the need for base stations. PP-RTX is emerging as the preferred, state-of-the-art processing mode for GNSS-inertial trajectory generation, with methods like single base, Applanix SmartBase™, and multi-single base now serving as legacy alternatives, still depending on application.

The latest iteration of PP-RTX is **Trimble IN-Fusion+™ PP-RTX**, capable of handling multi-frequency and multi-satellite constellations, including the new signals from the Beidou-III generation.

IN-Fusion+ PP-RTX contributes to enhanced robustness, reliability and reduced convergence time.

Fig 1: Trimble MX60 I Mobile Mapping

Background

This 2026 demonstration study focuses on mobile mapping data in open sky terrain utilizing the [Trimble MX60] mobile mapping solution. The MX60 employed in this study is equipped with two lidar sensors (left/right), a spherical camera and an AP50+ GNSS-INS system from Trimble Applanix. The objective of this exercise is to showcase the absolute accuracy in the 3D point cloud by utilizing the **IN-Fusion+ PP-RTX** processing mode in [POSPac Complete].

To establish a reference, the traditional single base (IN-Fusion+ single base) processing mode is employed. The assumption is that the single base mode, leveraging a nearby base station, would yield the best possible GNSS-INS trajectory solution for lidar georeferencing (point cloud).

Test area

Located in Biberach, Germany, the open-sky test site resides within an industrial zone. The data acquisition process involved three separate missions — each consisting of three 1.2 km loops (runs) for lidar collection.

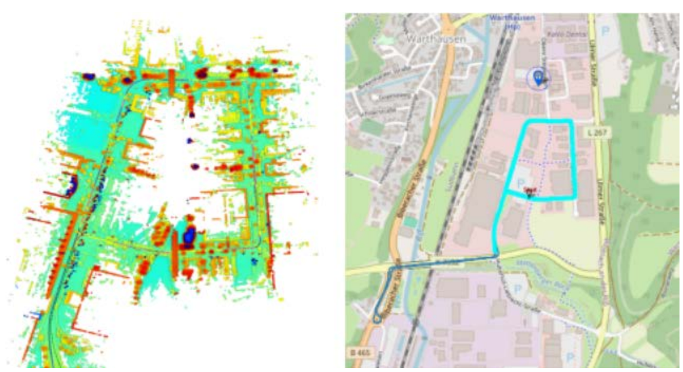

Fig 2: Left - Trajectory - bright blue lidar covered, Right - Point Cloud by Elevation

Ground control points (GCPs) were strategically placed and surveyed by establishing a dense reference network using GNSS technology and a Trimble terrestrial 3D laser. All surveyed GCPs are referenced in the ETRS89 frame. To mitigate potential datum defects, the same base station was utilized for both the GCP surveys and the GNSS-INS trajectory post-processing (single base mode). Furthermore, maintaining baseline lengths below 5 Km — an exceptional standard in mobile mapping — minimizes the GNSS error budget and eliminates datum-related complications.

A combination of vertical-only road markings and checkerboard targets comprised the GCPs. Because the checkerboard targets supported both horizontal and vertical data collection, vertical control utilized a larger set of 33 points compared to the 13 points used for horizontal control.

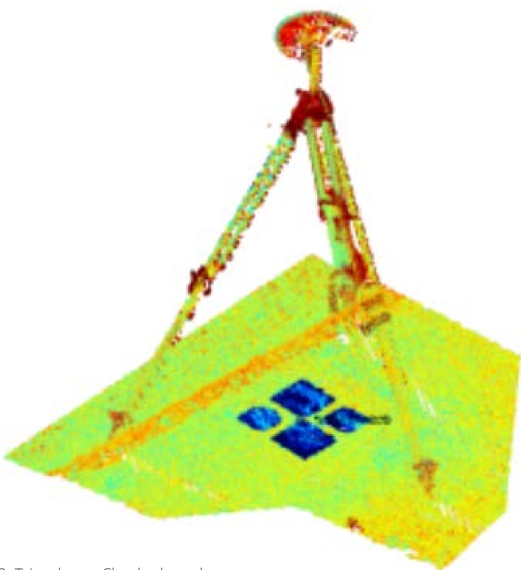

Fig 3: Tripod over Checkerboard

Data evaluation

The GNSS-INS trajectory, also referred to as SBET (smoothed best estimate of trajectory), underwent post-processing in both the **IN-Fusion+ single base and IN-Fusion+ PP-RTX** modes. In both scenarios, we achieved 100% fixed ambiguity epochs. All lever arms, such as GNSS offset, IMU offset and DMI offset, were considered known parameters and kept fixed during post-processing to minimize errors and noise. Prior to the study, the MX60 system underwent boresight calibration to address any misalignment between the IMU and lidar sensors.

The resulting SBETs from both single base (SiB) and PP-RTX processing were utilized to generate independent point clouds in Trimble Business Center (TBC) office software. The accuracy evaluation comprised two phases. Phase 1 focused on vertical performance using 33 GCPs, while Phase 2 concentrated on horizontal performance using marked GCPs (13).

Vertical performance

The 33 surveyed points are evenly distributed along the 1.2 km loop. Delta height extraction between the vertical GCP and the point cloud (LAS) was automated. Since the data acquisition comprised three missions, each with three loops, residuals were derived individually for every loop. Observed performance variations between loops within a mission were statistically insignificant and inconsequential to the final conclusions. The table below illustrates a downward trend in the magnitude of vertical errors from Mission 1 to Mission 3. **By Mission 3, the vertical RMS error for PP-RTX dropped to a remarkable 0.8 cm.**

Vertical Performance (cm)								
	Mission 1		Mission 2		Mission 3		All Missions	
	SiB	PP-RTX	SiB	PP-RTX	SiB	PP-RTX	SiB	PP-RTX
RMS	1.4	2.6	1.8	1.5	0.9	0.8	1.4	1.6
StdDev	0.7	0.9	0.8	0.8	0.7	0.8	0.8	0.8
Mean	-1.1	-2.5	-1.7	-1.3	-0.6	-0.1	-1.1	-1.3

An analysis of the combined results across all missions reveals that PP-RTX and single base deliver nearly indistinguishable performance. Any minor variances observed are negligible and fall within the range of expected statistical noise. The empirical data suggests that PP-RTX serves as a highly effective alternative to single base. While single base benefited from a local reference in Mission 1, PP-RTX demonstrated superior accuracy in Missions 2 and 3. This indicates that PP-RTX can deliver survey-grade vertical accuracy with a sub-2 cm RMS, without the logistical requirement of a local base station.

Horizontal performance

The 13 checkerboards were evenly distributed along the 1.2 km loop. Delta east and north extraction between the checkerboards (GCPs) and the point cloud (LAS) was performed in manual survey mode within TBC. Since measuring points in a point cloud is a task that requires specific skill, the horizontal performance statistics are also influenced by expected operator measurement error. As with the vertical analysis, performance variations between loops within a mission were statistically insignificant and are not shown separately.

Horizontal Performance (cm)								
	Mission 1		Mission 2		Mission 3		All Missions	
	SiB	PP-RTX	SiB	PP-RTX	SiB	PP-RTX	SiB	PP-RTX
RMS 2D	1.5	2.7	1.5	2.7	1.3	2.4	1.5	2.6
StdDev 2D	0.9	1.1	1.0	1.2	0.8	1.2	0.9	1.2
Mean 2D	1.2	2.5	1.2	2.4	1.1	2.1	1.2	2.3

Table 2: Horizontal Ground Accuracy Single Base vs. PP-RTX of all Missions

While the 2D standard deviation for all missions is around a remarkable 1 cm, with no significant difference between single base and PP-RTX post-processing mode, the RMS value for the horizontal performance in PP-RTX mode is biased by a "global-to-local datum offset" (25 mm). The bias mainly resides in the east component, shown in the trajectory difference plot below:

A slight offset of 25 mm is potentially caused by a datum shift between the global CenterPoint RTX service and the local reference station utilized for SBET processing and GCP surveys. Despite this, the PP-RTX post-processing exhibited exceptional precision and stability in horizontal performance across every mission. These results remained highly consistent through all loops and missions conducted during the study.

3D performance

In evaluating the total 3D performance (standard deviation), the error for both contemporary PP-RTX post-processing and conventional single base processing stays under 15 mm.

Conclusion

The 3D absolute accuracy realized through PP-RTX processing not only exceeds our typical performance specifications but also validates the robust capabilities of the advanced IN-Fusion+ engine featured in POSPac Complete.

In summary, the empirical results from the Biberach missions in March 2026 underscore the exceptional reliability and precision of the PP-RTX solution. Evaluation of the standard deviation as a primary metric for consistency reveals a high degree of repeatability across every mission, yielding an overall horizontal standard deviation of 1.2 cm and a vertical standard deviation of 0.8 cm. These statistics demonstrate that PP-RTX maintains a remarkably tight and stable positioning trajectory. While a 25 mm systematic shift was observed due to the nature of global RTX reference frames versus local ETRS89 coordinates, the sub-1.5 cm standard deviation proves the trajectory's absolute stability.

Ultimately, by eliminating the logistical complexity and hardware costs of local base station deployment, PP-RTX — now a standard inclusion in POSPac Complete and RTX Complete — provides a highly efficient, cost-effective path to centimeter-level accuracy that matches the performance of traditional base-station workflows.

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For more information

For more information, contact our Customer Support Team (techsupport@applanix.com) or visit our Customer Support Portal. For more information on the Trimble MX products, please visit https://geospatial.trimble.com/en/products/hardware/mobile-mapping.

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