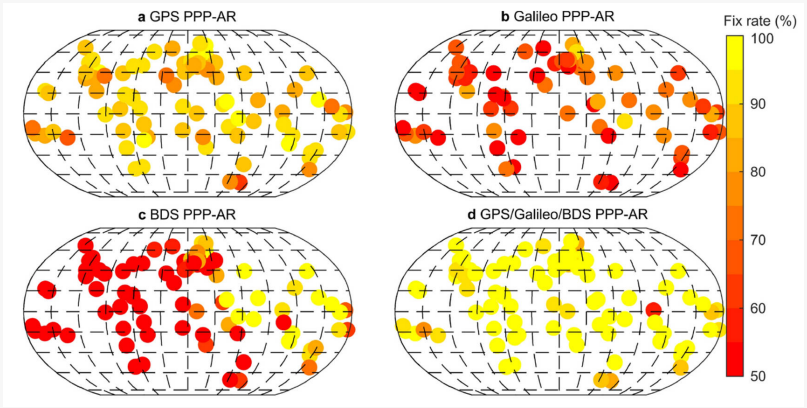
Next-gen GNSS delivers real-time positioning with centimeter accuracy

GA, UNITED STATES, July 19, 2025 /EINPresswire.com/ -- In an era of growing demand for real-time precision navigation, researchers have unveiled a powerful leap forward in satellite-based positioning. Leveraging new-generation Global Navigation Satellite Systems (GNSS) constellations and signals, a novel approach to Precise Point Positioning with Real-Time Kinematic (PPP-RTK) achieves centimeter-level accuracy with remarkable speed. By combining multi-frequency signals from multiple satellite systems and applying advanced bias corrections and atmospheric modeling, the method dramatically shortens convergence time—sometimes achieving near-instant fixes. From controlled experiments to on-road vehicle tests, the study confirms that PPP-RTK technology is ready to meet the precision needs of modern applications such as autonomous driving and smart infrastructure.



Fix rates of kinematic PPP-AR at global stations calculated with different systems.

Precise Point Positioning (PPP) has long held promise as a standalone, high-accuracy positioning technique, but its slow convergence and complexity in ambiguity resolution have limited widespread use. Over the past decade, Global Navigation Satellite Systems (GNSS) modernization—including upgraded Global Positioning System (GPS), Galileo Navigation Satellite System (Galileo), and BeiDou systems—has introduced multi-frequency, high-precision signals. These enhancements have expanded opportunities for precise positioning, yet challenges remain, especially in environments with obstructed views or fast-changing motion. High-fidelity corrections and real-time performance are critical for sectors like smart transportation, robotics, and disaster response. Due to these challenges, further in-depth research is needed to refine PPP solutions and meet the demands of real-world, dynamic applications.

A collaborative research team from Wuhan University and affiliated institutions has published a major study (DOI: 10.1186/s43020-025-00169-6) in the July 2025 issue of Satellite Navigation. The team developed and validated an enhanced PPP and PPP-RTK framework using next-generation GNSS signals and satellite augmentation services. The study evaluated the performance of BDS-

3's PPP-B2b and Galileo's HAS services across a variety of experimental settings, revealing dramatic improvements in positioning accuracy, convergence time, and reliability. These breakthroughs offer a practical roadmap for deploying real-time high-precision navigation at global scale.

The researchers constructed an integrated Precise Point Positioning with Real-Time Kinematic (PPP-RTK) system incorporating real-time atmospheric corrections, observable-specific bias (OSB) products, and multi-constellation satellite data. Through extensive global experiments, they demonstrated that a combined GPS/Galileo/BeiDou configuration reduced static convergence time to under 5 minutes while achieving horizontal accuracy below 2 cm. In dynamic tests—including a real-world vehicular trial in Wuhan—PPP-RTK achieved sub-5 cm accuracy with instant or near-instant convergence, even under rapidly changing observation environments. These systems proved especially effective when paired with atmospheric modeling techniques like Kriging and distance interpolation. With fix rates exceeding 98%, the results underscore PPP-RTK's readiness for mission-critical applications in rapidly changing environments. Additionally, the study evaluated augmentation services: the BeiDou PPP-B2b and Galileo High Accuracy Service (HAS). Both were found to significantly accelerate convergence (to under 15 minutes and 100 seconds, respectively) and deliver decimeter-level accuracy in kinematic scenarios.

“This study marks a turning point in the quest for real-time, high-accuracy positioning,” said Dr. Xiaodong Ren, lead author and professor at Wuhan University. “By merging advanced GNSS signals, atmospheric corrections, and real-world testing, we've demonstrated that PPP-RTK can deliver fast, stable, and highly accurate results—even in the most demanding environments. These capabilities are essential for the next generation of autonomous systems, from self-driving cars to drones and beyond.”

The ability to achieve centimeter-level positioning accuracy—quickly and without reliance on dense base station networks—opens doors for a wide range of smart technologies. PPP-RTK has the potential to reshape industries such as precision agriculture, surveying, transportation logistics, and unmanned systems. This study provides a robust framework and empirical validation for real-world adoption of high-precision GNSS applications. As satellite constellations and augmentation services continue to evolve, PPP-RTK is poised to become the foundation of global positioning solutions—reliable, scalable, and ready for deployment in tomorrow's connected world.

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