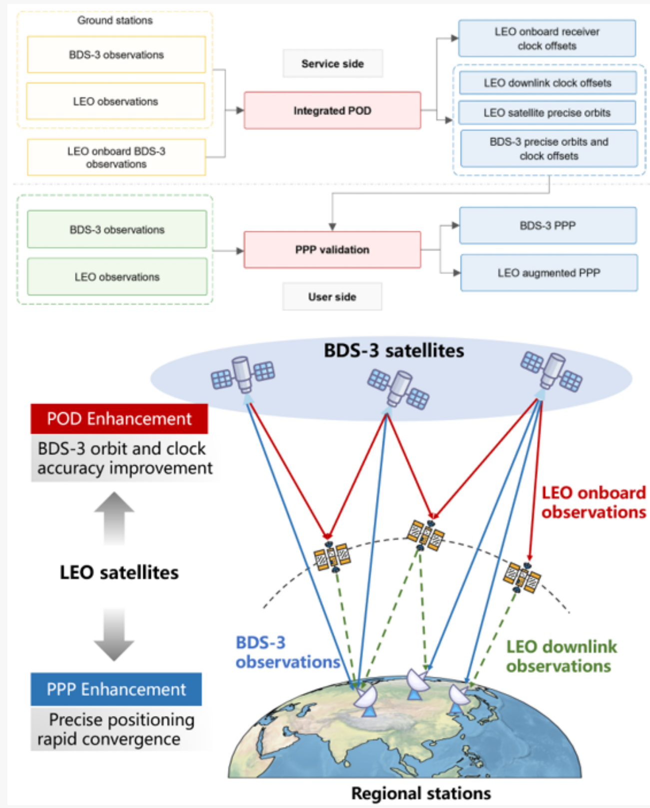
Multiple LEO satellites sharpen BeiDou-3 orbits and speed positioning

FAYETTEVILLE, GA, UNITED STATES, August 18, 2026 /EINPresswire.com/ -- A research team from Wuhan University and Beijing Future Navigation Tech Co., Ltd. has shown that a small group of low Earth orbit satellites can make regional satellite-navigation infrastructure work more like a global high-precision network.



Framework for the integrated POD and PPP.

High-precision positioning is becoming a core capability of next-generation Global Navigation Satellite Systems (GNSS), yet regional ground networks still constrain coverage, orbit determination accuracy and positioning speed. LEO satellites can help because they move rapidly, view navigation satellites from changing geometries and transmit stronger signals to users on the ground. Previous studies had separately explored using onboard GNSS observations to improve Precise Orbit Determination and using downlink navigation signals to accelerate Precise Point Positioning, but the two roles had not been jointly validated with real observations from the same spacecraft. Because of these challenges, deeper investigation is needed into unified service-side and user-side augmentation using real Low Earth Orbit satellite data.

Wuhan University and Beijing Future Navigation Tech Co., Ltd. researchers have developed and evaluated a method that uses LEO satellites to simultaneously augment BDS-3 precise orbit determination (POD) and precise point positioning (PPP). Published (DOI: 10.1186/s43020-026-00212-0) in Satellite Navigation on August 10, 2026, the study demonstrates how the technique improves BDS-3 orbit and clock products and speed the PPP convergence time using real LEO onboard and downlink observations, and supports a more flexible architecture for future high-precision navigation. This innovation could become a cornerstone technology for integrating LEO constellations with existing GNSS systems to enhance global positioning, navigation and timing performance.

The researchers analyzed five CENTISPACE™ LEO satellites flying at about 700 kilometers altitude and observations from a regional tracking network in China. Twenty-one stations were used for integrated POD, while 12 independent stations were reserved for PPP validation. The integrated adjustment used batch least-squares estimation over 48-hour orbital arcs and combined ground-based BDS-3 and LEO downlink data with observations recorded onboard the LEO satellites. By adding onboard BDS-3 observations from one, three and five LEO satellites, the team progressively extended tracking coverage and strengthened observation geometry. With five LEO satellites, tracking coverage exceeded 99% for both medium Earth orbit satellites and inclined geosynchronous orbit satellites. For BDS-3 medium Earth orbit satellites, average three-dimensional orbit error fell from 54.7 centimeters with regional stations alone to 11.4 centimeters, a 79.2% improvement. BDS-3 clock precision improved from 0.31 to 0.14 nanoseconds, while the LEO satellites themselves achieved about 4.9-centimeter three-dimensional orbit accuracy and 0.22-nanosecond average clock precision. The resulting products were then used in PPP tests using 12 ground stations in China. Average convergence time dropped from 22.4 minutes for BDS-3 alone to 12.5 minutes with one LEO satellite and 10.8 minutes with two, while three-dimensional positioning error after convergence decreased from 9.8 to 6.5 centimeters.

The authors said the study's key message is that LEO satellites can contribute on both sides of a high-precision navigation service: they can improve the orbit and clock products generated by the system, and they can also help users reach an accurate position faster. They said the real-observation tests are especially important because they move the idea beyond simulation and separate demonstrations. At the same time, the team emphasized that five satellites are not yet enough to guarantee continuous, high-quality global clock products under a regional ground network, leaving clear room for further constellation growth and processing improvements.

The findings support a more flexible architecture for future high-precision navigation, in which regional ground networks are reinforced by fast-moving space-based monitoring and augmentation signals. In practice, this could reduce dependence on globally distributed tracking stations while improving the orbit and clock products needed for BDS-3 services and shortening the time users wait for precise point positioning to converge. The authors also show where the approach still falls short: with only five LEO satellites, global satellite-clock products can remain discontinuous and some positioning solutions outside China fail to converge. As larger LEO constellations provide denser observations and stronger geometry, the framework could become a practical route toward more continuous, accurate and globally available BeiDou-3 precision services.

References

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