



## **Some aspects of improving Multi-GNSS real-time precise point positioning services**

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### Abstract

Multi-GNSS is expected to achieve a real-time precise point positioning service with better accuracy and reliability than GPS-only service. In this contribution, we address several critical challenges in implementing a GPS+GLONASS+BeiDou+Galileo service to provide global users with centimeter-level positioning in real-time based on the software system developed at GFZ. The specific issues of improving GLONASS orbit quality by resolving ambiguity over long baselines, estimation of inter-system/frequency biases, ambiguity resolution in real-time clock estimation and positioning, and computation efficiency are discussed and investigated in detail. Experimental validation is carried out based on the data streams of the IGS/MGEX network. The real-time orbit and clock products are assessed by comparison with the IGS/MGEX final products, and orbits are also assessed by overlapping day boundaries and satellite laser ranging. The phase bias (uncalibrated phase delay) products are evaluated by comparison with the post-processing results. It is demonstrated that multi-GNSS can contribute significantly to improving the global real-time precise point positioning service in terms of convergence time and accuracy.

**Keywords:** Multi-GNSS, Real-Time, Precise Orbit Determination, Precise Point Positioning, Ambiguity Resolution, Inter-System/Frequency Bias, Algorithm Efficiency