

## Precise GNSS Positioning: Past, Present & Future

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### ABSTRACT

*We are witnessing the launch of a surge of new navigation satellite systems, with a significant increase in satellites and signals. This heralds the transition from a GPS-dominated era – that has served the geodesy and precise positioning community for over 30 years – to a multi-constellation Global Navigation Satellite System (GNSS) world. The first civilian applications of GPS were for geodetic surveying and geodetic science. From those first precise positioning applications of GPS have evolved today's techniques based on carrier phase tracking and relative positioning, in which receivers were deployed on reference stations to provide the datum and to facilitate the mitigation of spatially-correlated measurement biases. The evolution of precise differential positioning techniques during the 1980s and 1990s also led to the establishment of geodetic services. Several technological developments led to the mainstreaming of precise positioning techniques such as Real-Time Kinematic (RTK), that are now used for almost all engineering, construction, surveying and machine guidance applications. Recently Precise Point Positioning (PPP) has become a viable alternative technique, and several commercial services have been launched. On the other hand, there is increased interest in the role that Space Based Augmentation Systems (SBAS) can play for non-aviation applications. These disparate developments are occurring just as precise positioning is poised to become mainstream, and the influence of the surveying, geodetic mapping and precise navigation communities will grow as new classes of users embrace the new GNSS technology and confront issues such as datums, reference station infrastructure, integrity, and others. This presentation examines the implications of techniques such as PPP for traditional positioning and navigation applications using multi-constellation GNSS, but also speculates on what type of GNSS techniques – PPP or SBAS – and what type of commercial or scientific services, will be used for future positioning applications of driverless cars and other advanced Intelligent Transport System (ITS) applications.*

**KEYWORDS:** GNSS, SBAS, ITS, IGS, RTK.