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Geodesy and Time Reference in Space (GETRIS) and the impact on LEO POD

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The accuracy and precision of precise orbit determination (POD) of low Earth orbiting satellites (LEO) is limited by the one-way ranging technique on which the GNSS systems are based (unsynchronized clocks, phase center variations and offsets of the sending and receiving antennas) and by GNSS orbit errors. These effects lead to systematic errors in LEO orbits. The question that is answered by the ESA study GETRIS is: How can a highly accurate and precise GEO-based two-way ranging method support GNSS tracking? The reduction of systematic errors in LEO POD by exploiting the synergy between ranging, data- and time-transfer is assessed in a concept consisting of precise two-way GEO-LEO tracking (as used for data transfer) and an ultra-stable oscillator synchronized from ground on-board of the geostationary satellite (GEO). The capability of GEO-LEO tracking is examined in two steps. A first step revealed that a constellation of at least five GEO satellites is necessary to reduce introduced systematic GNSS tracking errors. With optical two-way tracking an accuracy of the LEO orbit at the millimeter level can be reached if GEO orbit errors can be neglected. In a second step the influence of the accuracy of the GEO orbit on LEO POD was examined. GEO orbits where simulated based on tracking side lobes of GNSS signals and taking successively VLBI tracking and microwave tracking from ground stations into account. With the derived precise GEO orbits the systematic effects on LEO POD can be reduced, but systematic jumps occur at the north and south pole, where the GEO-LEO constellation changes. A further increase in orbit determination accuracy can be achieved when considering synchronization of GNSS, GEO and LEO clocks as pseudoranges are then converted to biased ranges. The benefits for satellite altimetry, SAR and gravity field recovery missions are discussed.