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Simulation study on LEO orbit determination with two-way high-low SST in a future GNSS constellation

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The orbits of LEO's are usually determined by GPS tracking with a precision of 1-2 cm concerning SLR residuals. How to get rid of systematic errors is still discussed as an open problem for future GNSS satellites.
The project GETRIS (Geodesy and Time Reference in Space) is based on the idea of having a system network consisting of two-way high-low SST links between LEO, MEO and GEO satellites to reduce the orbital errors of these systems as well as systematics to a great extent.
In this connection, we simulated GPS-LEO and additional GEO-LEO links for several LEO satellites in different altitudes. Analysis ensured that at least five GEO satellites are needed in this constellation. The processing was performed in the ionosphere free linear combination L3. The simulation was done in different complexities. Next to a null test, we added successively noise and systematics in the GNSS tracking. We applied white noise with a standard deviation of 2 mm for GPS phase tracking and 3 μm (about 9 μm for L3) for GEO-LEO tracking. The systematic error was simulated by omitting the phase center variations in GPS-LEO tracking, whereas no systematic error was modulated on GEO-LEO tracking.
We show that the quality of LEO orbit determination with such additional GEO-LEO links is increasing up to millimeter range. Besides, we also determine the quality of the GEO orbits benefitting from the link network. We discuss the conditions which are required for a 1 mm orbit determination accuracy and discuss application areas like time transfer, data transfer and the gravitational field recovery, benefitting from an increased orbit determination and ranging performance.