Exploiting the synergy between optical two-way and microwave one-way ranging in a GNSS constellation: A simulation study

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The progress for satellite precise orbit determination (POD) and navigation depends on the future ranging and time transfer capabilities. This leads to the need for high-precision links as well as high-precision clocks. In a simulation study, we performed scenarios using the synergy between L-band observations as well as high-precision dual one-way Optical Inter-Satellite Links (OISL) and ground-space based dual one-way links, called Optical Two-Way Links (OTWL). Having the observation technique combinations, we show the POD capabilities within a MEO+GSO constellation for the GSO and MEO satellites. While first using Passive Hydrogen Masers (PHM) on all satellites in the constellation, we compare the solutions regarding clock estimation and prediction with solutions using the ACES (Atomic Clock Ensemble in Space) clock as a high-precision clock example.

This brings us close to the concept of GETRIS (GEodesy and Time Reference In Space). This is based on the idea to have high-precision clocks carried by geosynchronous orbit (GSO) satellites. With high-precision optical links, the connection to Medium Earth Orbit (MEO) and Low Earth Orbit (LEO) satellites, but also to far Earth satellites shall be established. The goal is to achieve a GSO satellite based reference in space. The orbit accuracies should be at the same level as the ground stations accuracy – a few millimeters.