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Space-based PNT (Position, Navigation, Timing) Architectures, Applications, and Services (1)

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USE OF MEO-LEO INTER-SATELLITE LINK MEASUREMENTS FOR ON-BOARD AUTONOMOUS ODTS OF GNSS SATELLITES

Abstract

In the last years, GNSS (i.e., GPS, Beidou and Galileo Second Generation) systems have introduced Inter-Satellite Link capabilities. The purpose of these links is two-fold: to enhance mission data dissemination and Monitoring and Control (MC) capabilities on one hand and to improve the accuracy and the robustness of the Orbit Determination and Time Synchronization (ODTS) processes on the other using Inter-Satellite Ranging (ISR) measurements. These latter measurements are not provided to the final user, but they are used inside the system, either on ground or on-board the satellites, to enhance the ODTS process to improve the precision of the Clock and Ephemeris Data (CED) in the broadcasted navigation messages.

The possibility of calculating precise on-board ODTS solutions is of high interest since it would make the satellites independent from ground over long periods.

This paper presents an analysis consisting in the implementation of an autonomous on-board ODTS algorithm for a MEO constellation that exploits ISR measurements and the evaluation of its performance. The use of LEO satellites as anchoring method for the algorithm is herein discussed and was selected for the performance evaluation.

A trade-off and sensitivity analysis is also presented for some of the system parameters involved, including: the MEO constellation size, the number of LEO satellites used as anchoring, the impact of the errors on the initial state vector both of LEO and MEO satellites and on the observables, the observation and propagation time windows width, and the contact plans.

Finally, limitations in the selected system architecture and possible solutions are identified, as well as future steps for algorithm enhancement.