Paper ID: 80068
oral
student

IAF SPACE OPERATIONS SYMPOSIUM (B6)
Mission Operations, Validation, Simulation and Training (3)

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PERFORMANCE EVALUATION OF PRECISE POINT POSITIONING USING HIGH PRECISION LEO GNSS RECEIVER

Abstract

TUBITAK UZAY has gained significant experience in design, manufacturing and operations of Earth orbiting satellites since 2003. As part of the ongoing projects, in order to satisfy the operational requirements such as achieving desired satellite imagery geolocation accuracy and verifying the electrical propulsion performance, the precise GNSS receiver and the developed PPP algorithm on TUBITAK UZAY's ground software are used to determine the position of the satellite accurately. In this paper, in order to simulate the satellite PPP operation, the space and ground segment systems are presented. Receiver-GNSS Simulator includes the GNSS receiver and simulator setup representing the space segment. GNSS receiver employed in this study is dual frequency Lion 1300 Navigator designed by Airbus for LEO (Low Earth Orbit) satellite system. The Spirent GNSS simulator allows to apply different orbit scenarios with and without electrical thrust firing. The GNSS receiver is powered through a power supply and the communication with the receiver is established with an interface software running on a PC through Mil-bus interface. The GNSS receiver is capable of generating PVT (Position, Velocity and Time) data and raw pseudo-range measurements. All PVT and raw measurements data are obtained through the interface software. Pre-defined scenarios are generated according to the mission profile of the Sun-Synchronous LEO satellites via Spirent GNSS simulator. Satellite parameters such as initial position and velocity, mass, surface area, solar pressure coefficient and air drag coefficient are applied to the Spirent simulator. The goals of the test setup include checking whether the receiver generates the desired raw GNSS measurements to be used in PPP on-ground software and checking the accuracy of receiver position solution. Scenario duration is about one orbital period of the satellite. The electrical propulsion system is modelled as a constant acceleration input with 10 minutes firing duration. In ground software system, the binary raw data taken from interface software is converted to desired format that can be used in PPP. After that, various pre-process methods are applied to the raw measurements to reject invalid data. Pre-processed measurements and satellite initial parameters are given to the PPP software along with precise ephemeris taken from the Spirent Simulator. In PPP software, the estimation method is based on Kalman Filter along with Nonlinear Least Square. The aim of this study is to reach better positional accuracy on-ground operations than on-board receiver results and to verify the performance of the electrical propulsion system.