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GALILEO SPACE SERVICE VOLUME HARDWARE IN THE LOOP ANALYSIS FOR ELECTRIC LOW THRUST EARTH ORBIT RISING

Abstract

Global Navigation Satellite System (GNSS) system, is becoming more and more the fundamental backbone of the current and upcoming space applications. The attention currently focuses on GNSS Lunar navigation. However, what is known as the Space Service Volume (SSV) is also instrumental for another groundbreaking technology, the autonomous Earth Orbit Rising (EOR) from Low Earth Parking Orbits (LEO) to target MEO and GEO by using low thrust electric propulsion. Actually, several research programs and studies have indicated such an approach as the most sustainable and cost effective methodology to precisely locate and update new commercial navigation and telecommunication services. The GNSS based in orbit positioning is instrumental to setup on-board maneuvers planning and ion thrusters management, which can drastically reduce the burden and costs of ground network operations. This paper provides an assessment of the expected navigation performance that can be achieved in the Galileo SSV considering next generation EOR scenarios. The analysis benefits from the recent activities curried out at European Commission's Joint Research Centre (JRC) and aiming to renovate its SSV testing capabilities. The recently developed JRC Integrated SSV test bench (JRC-ISSVTB) allows to analyze SSV key performance parameters (KPI) with an improved level of representatives. Actually, the solution integrates all the available up-to-date information about the Galileo system, including antenna 3D pattern modelling ,and a GNSS Commercial Off The Shelf (COTS) receiver fed by high grade the RFCS simulator. A complete End-to-end testing campaign has been performed considering two representative scenarios, i.e. the LEO-MEO EOR of a Galileo Second Generation and the LEO-GEO EOR of an next generation SATCOM GEO platform. The assessment cover all the aspects from signal received power up to navigation performance of the on-board precise orbit Kalman filter. Electrical thrust introduces several navigation issues as the high orbit dynamic, due to the attitude steering law, and strong perturbation due to possible thrust uncertainties. Actually, the study demonstrate readiness of the Galileo SSV and the interoperable multiconstellation Galileo plus GPS SSV as support technology of EOR missions. Feasibility can be achieved even with single antenna configuration and limited improvements of the receiver sensitivity.The analysis will foster a simple adoption of GNSS capabilities in the first MEO-GEO layer of the SSV and identify relevant design drivers for next generation spaceborne receiver supporting EOR missions