ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations (IP)

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LATE-LIFE RECONFIGURATION MANEUVERS OF THE RAPIDEYE CONSTELLATION FOR THE REVERSAL OF LTAN DRIFT

Abstract

The RapidEye constellation consists of five Earth observation satellites which collectively records approximately 5.5 million square kilometers of high resolution multispectral imagery per day and have been operating for 8 years, exceeding their 7.25 year design life. The satellites were launched in 2008 into a retrograde, sun-synchronous orbit and phased such that they provide revisit capability to regions between +/- 84 degrees latitude. Originally, the local time of ascending node (LTAN) value of their orbit was 11 PM, which resulted in imaging times on the descending portion of the orbit around 11 AM local time. But due to the initial orbital injection dispersion, the LTAN of each RapidEye satellite drifted at a slightly different rate. While altitude and phase of the constellation were carefully controlled, the LTAN value was not. In 2016, the LTAN spread of the RapidEye constellation was more than 10 minutes and was rapidly accelerating. Differences in LTAN threatened to impact the satellite's ground track spacing, their global image coverage, and the ability of the ground stations to successfully track consecutive satellites. An in-house tool was developed at Planet to design the thrust sequences necessary to arrest and reverse the LTAN drift. Using analytical models for the evolution of the inclination of each satellite—the principal driver in LTAN drift—the tool provided accurate results while being more computationally efficient than a high-fidelity orbit propagator. As a result, it was possible to experiment with different thrusting sequences and optimize the maneuver design over many iterations. The final thrust solutions for each satellite were validated using System Toolkit (STK) and NASA's General Mission Analysis Tool (GMAT). An LTAN maneuver campaign was planned and executed for the RapidEye constellation. In an effort to minimize impact on nominal imaging operations and to allow the European Space Agency (ESA) Space Debris Office enough time to perform a collision risk assessment, thrusts were scheduled for every 3rd day and only over the Pacific Ocean. Due to the necessary gaps between maneuvers and low thruster forces (0.016-0.019 N), the reconfiguration campaign took 86 days to fully complete. The maneuvers successfully altered the LTAN drift of each satellite so that their LTAN values will converge in mid-2021, thus recovering the RapidEye constellation from a critical orbital state.