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MISSION ANALYSIS AND ORBIT CONTROL STRATEGY FOR A SPACE MISSION ON A POLAR TUNDRA ORBIT

Abstract

Highly Elliptical Orbits (HEO) are highly eccentric orbits used for covering high latitude regions and are currently inclined by 63.4 deg (inclination value that avoids rotation of the apses). Tundra Orbit is a well-know HEO orbit with a period equal to the Earth rotation period (23h 56m 04s), an eccentricity in the range 0.2-0.3 and an argument of perigee such that the apogee subpoint is in the required hemisphere. This kind of orbit can typically provide communication and Earth observation services in Northern zone. The Observation Systems & Radar Business Segment (BSOSR) of Thales Alenia Space Italy (TAS-I) has been involved in the definition of a platform for an Earth Observation space mission based on a new kind of Tundra Orbit, called Polar Tundra, which has the period and eccentricity of the classic Tundra Orbit but it is inclined by 90 deg (instead of the classic 63.4 deg). This kind of orbit was selected since it allows a better coverage of the polar regions (greater coverage percentages and higher elevation angles) and requires smaller on-board sensor aperture angles with respect to the classic Tundra Orbit. The paper will deal with the Polar Tundra Orbit design by considering a medium-class spacecraft. Specifically, the results of detailed numerical simulations and coverage analysis to identify an optimal set of orbital elements are presented. The performed analysis indicates the possibility of eliminating out-of-plane manoeuvres and limiting the variations of the remaining orbit parameters due to orbit perturbations (i.e. Earth gravity field, Solar and Lunar gravitational effects, Solar Radiation Pressure). Moreover, a specific station-keeping strategy is developed in order to minimize the propellant required for orbit maintenance, and the needed total velocity change budget throughout the 15-year satellite's operational lifetime is evaluated. Numerical simulations are performed to highlight differences and advantages with respect to the classical Tundra Orbit and to evaluate the increased coverage provided by the Polar Tundra Orbit.