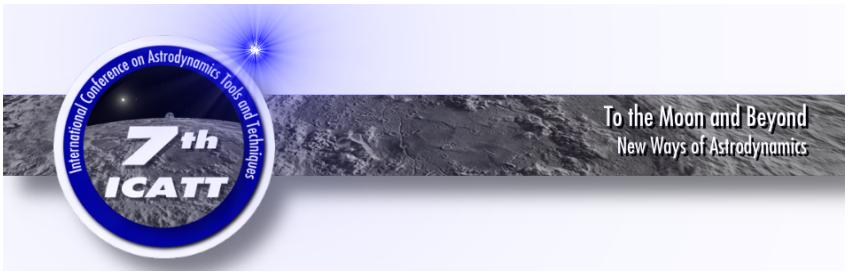

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MOLTO-OR: A Multi-Objective Low-Thrust Optimization Tool for Orbit Raising

Friday, 9 November 2018 13:30 (30 minutes)

Commercial and scientific satellites located in Geostationary Equatorial Orbit (GEO) that are not placed there by the launch vehicle are often injected in a parking orbit. They are transferred therefrom to GEO using their own on-board propulsion system. The classical strategy relies either on Chemical Propulsion (CP) or Electrical Propulsion (EP). The former guarantees very short transfer times, whereas the latter attains propellant savings at the cost of longer on-orbit delivery times. Intermediate performances may be obtained by allowing both propulsion subsystems to coexist on a Combined-Chemical-Electric (CCE) platform.
Therefore, the design and optimization of orbit raising missions has to be treated as a multi-objective optimization problem. The goal is to determine the set of optimal trajectories along with the optimal propulsion subsystem. For such purpose we present the optimization tool MOLTO-OR (Multi-Objective Low-Thrust Optimizer for Orbit Raising). It incorporates models for EP, CP and CCE platforms and realistic effects on the space environment, such as eclipse effects, Earth oblateness perturbations and solar-cell degradation due to passage though the Van-Allen radiation belts. Additionally, complex operational constraints such as slew-rate limitations, avoidance of the Geostationary ring or phasing to a certain orbital slot can be imposed. MOLTO-OR is based on a two-step sequential algorithm. In the first step, the low-thrust control law is derived from a Lyapunov function and the chemical maneuvers are regarded as instantaneous impulses. A heuristic algorithm computes the set of Quasi- Pareto-Optimal solutions trading off propellant mass consumed, time of flight and radiation damage. In the second step, candidate solutions are deemed as initial guesses to solve the Nonlinear Programming Problem resulting from direct transcription of the problem.
A full overview of the capabilities and features of MOLTO-OR will be given. The effec- tiveness of our methodology to generate not only rapid performance estimates for preliminary trade studies, but also accurate calculations for the detailed design, will be highlighted.

Summary

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