DEVELOPMENT PLAN FOR AUTONOMOUS AEROBRAKING

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ABSTRACT

Aerobraking is a proven method of using atmospheric drag on a spacecraft to reduce orbital energy, modifying a highly elliptical orbit to a near circular orbit without the expensive mass of propellant. Although more efficient than an all-propulsive option, aerobraking carries with it months of extra staffing and the additional cost of DSN coverage throughout the aerobraking operations phase. This cost will be reduced with the implementation of autonomous aerobraking. By moving the ground predictions and apoapsis maneuver planning to onboard the spacecraft, millions of dollars will be saved and risk of human error will be reduced. In addition, aerobraking will be more efficient in that the optimal maneuver decision would be implemented onboard rather than waiting for an orbit that is preferable to staffing hours.

Allowing for a spacecraft to have capability to design optimal aerobraking maneuvers to stay within the pre-determined aerobraking periapsis corridor (dynamic pressure, heat rate, or temperature) involves several key capabilities. Most previously ground-based simulation activity would be moved to the spacecraft. A reduced scope ground-based simulation and prediction process would continue to provide weekly and overall mission status while also providing a priori conditions and a reset capability for the autonomous onboard process. The spacecraft would calculate its own ephemeris since all aerobraking activities are referenced to the spacecraft periapsis and apoapsis. The spacecraft would design and execute any required maneuvers.

A three-year plan for autonomous aerobraking development is described in this paper. A standalone maneuver planning tool will be developed, used to determine both daily maneuver options and mission runouts. This will allow for emergency pop-up maneuvers. An onboard ephemeris estimator will be developed, thereby reducing the number of ephemeris uploads to the spacecraft. A high-fidelity simulation will be utilized that includes all ephemeris predictor models, instrumentation, and flight-like processor to demonstrate the feasibility of performing all required operations within the time allowed. After this three-year study plan is completed, it is proposed to fly autonomous aerobraking in a "shadow-mode" on an aerobraking spacecraft, on which all maneuvers would be designed onboard but not executed so that the capability can be tested and verified against the current ground based system.