Mass Produced Flock of Propulsion Units for Interplanetary and Interstellar Mission Cost Reduction

Chris Y. Taylor
Jupiter R&D LLC
2429 Bissonnet St. #717
Houston TX, 77005
(832)477-1437
chrisytaylor@yahoo.com

Considerable cost savings on interplanetary, near-interstellar, and interstellar missions may be possible by replacing big, conventional in-space transfer stages with a flock of small, standardized, mass-produced propulsion units that cooperate to propel the payload. This cooperation could be accomplished by repeatedly transferring fuel between half empty units to produce half as many fully fueled units, then abandoning the remaining empty units. Alternatively, the propulsion units could dock with each other in cross-feeding bimese configurations during the propulsion burns, undock, abandon the empty units, and have the remaining fully fueled units redock with each other to repeat the process. The flock concept could be applied to a wide range of propulsion technologies, although some (such as nuclear rockets) may have a minimum size requirement that limits the potential savings. The cost savings produced might allow ambitious “stretch goal” missions to be accomplished within the foreseeable future.

Similar flock concepts have been proposed as a way to reduce cost for Earth-to-orbit missions, such as a variation of the Black Horse rocketplane design and Novatia Lab’s FLOC rockets. While these low cost to orbit concepts had useful advantages they were hampered by the difficulty of proximity operations in the atmosphere and the very limited amount of time during ascent to accomplish them. In space flocks of cooperating propulsion units would have similar advantages but would not be subject to the same time and environmental limitations.

Advantages of using the flock concept include: greatly reduced development cost due to much smaller vehicle size, cost savings due to mass-production and learning curve during production cycle, the same design can be used with a wide range of payload sizes and delta-Vs by varying the number of vehicles in the flock, mass production and reuse of a design may enable high vehicle reliability, and that mission reliability can be increased by launching extra propulsion to replace any failed flock members mid-mission.

Possible disadvantages of the concept include: a lower propellant mass fraction for some propulsion types due to smaller tank sizes, reduced propellant mass fraction from duplicating some subsystems (guidance, navigation, attitude control, etc.) on each unit in the flock, the need for engine restarts, and additional complexity to the mission planning and operations.

Specific examples briefly examined in this paper to illustrate the concept and estimate potential cost savings are: a nano-propulsion flock to expand the university nanosat trend, and a comparison between a flock of small mass-produced antimatter rockets and a more conventional baseline antimatter rocket concept to achieve a fast interstellar rendezvous mission.