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A MODELING APPROACH FOR THE PROFIT ANALYSIS OF CELLULARIZED SPACECRAFT ARCHITECTURES

Abstract

Purpose: This paper proposes a predominantly bottom-up modeling approach for the DARPA Phoenix satellite-repurposing program as developed by the MIT Phoenix Team. The Phoenix program was conceived "to develop and demonstrate technologies to cooperatively harvest and re-use valuable components from retired, non-operating satellites in [graveyard] geostationary Earth orbit and demonstrate the ability to create new space systems at greatly reduced cost." The hypothesis behind the program is that new types of partial-functionality nano-satellites called "satlets" can be attached to the repurposed components to form an aggregate system capable of performing new missions. This paper poses a novel modeling approach to determine the economic viability of the satlet concept and to help determine the most appropriate cellularized architecture for the Phoenix mission set.

Methodology: In this paper, a model is presented which calculates the detailed satlet and aggregate system architecture costs and revenues. The Phoenix mission profits can then be computed, which assists in finding optimal architectures for given missions. This model includes the computation of aggregate system performance and cost, and has been developed by analyzing prior market, cubesat, and cost model examples. A novel approach in assessing cost and profit was required because of the cellularized architecture and the novelty of the satlet concept.

Results and Conclusions: The MIT Phoenix Team developed a market and profit analysis tool that was used in an automated pareto-optimization analysis of the satlet architecture space. The analysis determined that a level of heterogeneity can generally reduce the cost and leverage morphological reconstruction and cellularization. Designs with two to three satlet types were found to be best suited for the Phoenix mission. The economic analysis conducted indicates that the heterogeneous satlet concept is a viable method for creating satellite systems for repurposing existing orbiting components. The market

and profit analysis tool is being used to narrow the design trade space for the optimum satlet architecture using an autonomous trade space exploration tool.

Note: The views expressed are those of the authors and do not reflect the official policy or position of the Department of Defense or the U.S. Government.