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"Wasted performance" minimization of the multi-purpose mini-satellite platform for an EO mission using a dynamic simulation-based model

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Abstract: With growing interest in low-cost, high performance and short time-to-flight satellites, the idea of using multi-purpose satellite platforms has drawn many attentions. However, under certain conditions in which the required capability of a mission is slightly more than the capabilities of a specified variant of a multi-purpose platform, it must jump to the next higher capability variant. Correspondingly, lots of unnecessary performance or capability might be imposed. In this paper, the main goal is to minimize the wasted performance in the design of an Earth Observation (EO) satellite based on a multi-purpose platform. To this end, a dynamic simulation-based model has been developed with the capability of simulating the satellite performance characteristics, EO mission requirements and supportable performance by the platform under various circumstances and throughout the satellite lifetime. To minimize the wasted performance we face with an optimization problem containing a complicated non-linear, non-convex and multi-modal design space which is enveloped by constraints of the mission requirements and supportable performance of the platform. A novel criterion as an objective function has been introduced aiming at the incompatibility reduction between the capabilities of a certain multi-purpose platform variant and the EO mission requirements. This objective function considers all the performance variations during the entire mission lifetime rather than solely the worst case. Through this, the mission and orbital characteristics have been determined by which there would be no need to jump to the higher performance variant in order to satisfy the EO mission requirements.

Keywords: multi-purpose platform - Earth Observation mission – mini-satellite - Electrical power subsystem - multi-modal optimization – Optical payload

1. Introduction

The "faster, better, cheaper" design philosophy causes space programs to focus on using smaller spacecraft with more number of launches and lower costs [1]. Align with this purpose, to shorten the design, manufacturing and test cycle and to increase the reliability-to-cost ratio in an ideal space system, the notion of utilizing common standard components (multi-purpose platform concept) has drawn great attention [2].

A product platform involves a set of common parts, interfaces, and procedures that are shared across a family of related products [3]. This product can be a satellite or spacecraft. In a satellite these common elements involve payload supportive subsystems well known as the satellite bus [4]. A specific satellite design for a certain mission results in achieving a design with better performance, smaller dimensions, and lower costs (as a result of smaller size). However, employing multi-purpose space platforms in a

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