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CENTRALIZED POWER DISTRIBUTION SYSTEM FOR A MULTI-SPACECRAFT GEO ECOSYSTEM

Abstract

The advent of long-duration missions in geostationary orbit requires a rework of the usual power distribution systems that guarantee reliability, efficiency and longevity. In this article, we examine the intrinsic challenges of designing a centralized power distribution system for an ecosystem of multiple spacecraft in geostationary orbit named the Hestia Hub. This unmanned megastructure aims to host payloads in a geostationary orbit for half a century. This project presents many challenges, including the degradation of electrical components over time, the need to maintain a constant power supply for the various payloads, and the overriding need for a power distribution system that remains operational and adaptable for over 50 years.

That is why we propose a strategic solution centered on the deployment of an upgraded version of the Power Distribution and Control Unit (PCDU). The initial phase involves the integration of an EVO PCDU, complemented by an identical unit on standby in warm redundancy, to guard against unforeseen failures. During this period, the reliability and performance of the control and distribution unit can be thoroughly evaluated and monitored. Recognizing the limitations of current technology over the life of the proposed mission, our strategy calls for a mid-course reinforcement. Specifically, 20 years into the mission, three additional ECDPs will be deployed in the Hub. This will not only ensure the redundancy required for the mission, but also allow units to be replaced when they reach the end of life. The transition between PCDUs is designed to be gradual and meticulously planned to avoid power interruptions and guarantee a continuous power supply to all hosted payloads.

This article provides an analysis of the technical specifications and operational benefits of the EVO PCDU, detailing the logic behind our warm redundancy approach and phased deployment strategy. In addition, we explore the logistical challenges and solutions associated with transporting and integrating new PCDUs into existing space infrastructure in mission environments. Our approach aims to set a new benchmark for the reliability and resilience of power distribution in space, offering insights and methodologies that could have a significant impact on the planning and execution of future long-duration space missions.

Through this exploration, we aim not only to present a viable solution to the power distribution challenges of an unprecedented GEO mission, but also to contribute to the wider discourse on sustainable and reliable space infrastructure.