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IAF SPACE POWER SYMPOSIUM (C3)
Space Power System for Ambitious Missions (4)

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A CONTROL FRAMEWORK FOR AUTONOMOUS SMART GRIDS FOR SPACE POWER APPLICATIONS

Abstract

With the National Aeronautics and Space Administration's (NASA) rising interest in lunar surface operations and deep space exploration, there is a growing need to move from traditional ground-based mission operations to more autonomous vehicle level operations. In lunar surface operations, there are periods of time where communications with ground-based mission control could not occur, forcing vehicles and a lunar base to completely operate independent of the ground. For deep space exploration, communication latency times increase to greater than 15 minutes making real-time control of critical systems difficult, if not near impossible. These challenges are driving the need for an autonomous power control system that has the capability to manage power and energy to ensure critical loads have the necessary power to support life systems and carry out critical mission objectives.

This paper presents a flexible, hierarchical, distributed control methodology that enables autonomous operation of smart grids and can integrate into a higher level autonomous architecture. There are layers associated with this system. At the lowest layer, referred to as the reactive layer, is the actual electrical power system hardware. The reactive layer has the ability to regulate voltage and protect the electrical power system from damage from faults, such as a short. This system can operate at extremely high control update rates and integrates with the second layer. The central control layer monitors electrical power system data for faults and ensures safe operation of the electrical power system. If a fault is found, the central control layer immediately re configures the electrical power system to provide as much power as possible to the highest priority loads. In addition, the central control layer manages the amount of power and energy available for the vehicle within the constraints of the power generation - e.g solar arrays, Kilopower, etc. - and energy storage devices - batteries, fuel cells, etc. The central control layer works with third layer, a vehicle manager, to determine the priority of the loads and determine how much power can be delivered now and into the future. This paper will contain a more detailed discussion of energy management techniques, fault management, reconfiguration strategies, software implementation strategies, and testing strategies.