SPACE POWER SYMPOSIUM (C3)
Space-Based Solar Power Architectures – New Governmental and Commercial Concepts and Ventures (1)

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SPS-ALPHA: THE FIRST PRACTICAL SOLAR POWER SATELLITE VIA ARBITRARILY LARGE PHASED ARRAY (A 2011-2012 NASA NIAC PROJECT)

Abstract

The vision of delivering solar power to Earth from platforms in space has been known for decades. However, early SPS architectures were technically complex and unlikely to prove economically viable. There were several reasons: low technology maturity; excessive mass, due in part to the need for huge, high-voltage power management and distribution; the cost of developing a monolithic SPS much larger than the International Space Station (ISS); the need for 100s of astronauts and 1000s of robots for SPS construction in space factories at various orbits, and others. Some of these early issues – particularly regarding technical feasibility – were addressed by NASA's space solar power (SSP) studies and technology research in the mid-to-late 1990s. However, ten years ago a number of key technical and economic uncertainties remained. The innovative advanced concept proposed here is a new approach to enable a technically feasible, economically viable and programmatically executable Solar Power Satellite (SPS): "SPS-ALPHA", a hyper-modular SPS by means of an Arbitrarily Large PHased Array (ALPHA). SPS-ALPHA is different from both current satellites and past SPS concepts in several ways. It is a biologically inspired concept: in a manner analogous to a hive of bees, a large number of individual modules (each individually "intelligent") will physically assemble to form a single satellite. To deliver energy to Earth, SPS-ALPHA would be based in a geosynchronous Earth orbit, where it would intercept sunlight using a collection of individual thin-film mirrors, convert that sunlight across a large RF aperture into a coherent microwave beam and transmit it to targets on Earth. SPS-ALPHA might also be based in Earth orbit, or elsewhere, such as at Earth-Moon Libration points, Lunar orbit, Sun-Earth Libration points, Mars orbit, and would deliver abundant and affordable solar power to Earth or to enable ambitious future space exploration and development. This paper will present the preliminary results from the 2011-2012 NIAC Phase 1 SPS-ALPHA project, including: (1) an initial end-to-end systems analysis of the SPS-ALPHA concept in order to determine its technical feasibility; (2) details of the key technology challenges inherent in the architecture (including figures of merit for each critical technology area); (3) an initial evaluation of the economic viability of the concept (as a function of key performance parameters); and, (4) a preliminary roadmap for the further research and development of the SPS-ALPHA concept.