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A TRANSFORMABLE SATELLITE CONSTELLATION DESIGN FOR SPACE-BASED MISSILE SENSORS

Abstract

Satellite constellations are often designed to offer a specific amount of ground coverage for a target region on the Earth's surface using a minimum number of satellites on orbit. In many cases, the target region is both unchanged during the constellation's lifetime and critical to its mission. In other cases, however, such as a space-based sensor layer designed to "detect and track missile launches from locations anywhere on the globe" (U.S. Department of Defense 2019), the target region may change during the constellation's lifetime, effectively changing the mission of the constellation after it has been deployed. This paper presents a transformable satellite constellation design capable of offering both symmetrical, moderate coverage as a traditional Walker-δ constellation (Walker 1984) and asymmetrical, enhanced coverage as a modified Walker-δ constellation after a series of orbital maneuvers. This paper expounds on several constraints of space-based sensors described by previous space-based sensor constellation models (Roberts 2018). These constraints include increased lag time for the satellites to detect a target projectile, increased lag time for the satellites to slew their sensors to hone in on a target, and a decreased period of observation due to reduced heat signature of a projectile after its boost phase. Through descriptive figures and animations, several examples of constellation transformations are shown, corresponding to a selection of missile threat scenarios.