

# Research Brief

## Distributed Satellite Constellations Offer Advantages Over Monolithic Systems

U.S. satellite systems provide a range of military and civilian services including surveillance, global navigation, weather monitoring, and data relay. These systems are typically arranged in *monolithic* constellations—a few satellites are positioned at different points around the globe with one satellite occupying each orbital location. Since 1995, the U.S. Air Force has been interested in the potential advantages of using *distributed* satellite constellations for certain military applications. These systems would replace one large satellite with a cluster of small satellites in a single orbital location. A new study by RAND Project AIR FORCE confirms that, once the technology becomes available, distributed satellite systems will perform better and cost less to launch and operate than equivalent monolithic satellites.

- ***Distributed constellations may weigh less and cost less to launch.*** Most satellite program costs come from the acquisition and launch of the units. Small satellite clusters can reduce acquisition costs by requiring less payload and supporting structure than their monolithic counterparts. Smaller satellites will cost less to launch because they are lighter and can fill available launch vehicles more nearly to capacity than larger satellites.
- ***Distributed satellites may perform better during deployment.*** Monolithic constellations often cannot provide an acceptable level of service until most of the units are in orbit. This process can take a significant portion of the system's lifespan because fewer large satellites can be launched at one time. Smaller satellites can be launched more quickly and can be arranged to provide a high level of service before the entire cluster is in place.
- ***Distributed satellite constellations may be able to fail more gracefully.*** Satellites stop working because of age, malfunction, accident, or attack. When a monolithic satellite fails, the entire system may lose its capability. Small satellite clusters can continue to provide service even when a few units have failed. Furthermore, ground spares may be launched more quickly and inexpensively than in the monolithic case.
- ***Distributed satellite constellations may be more survivable in an attack.*** These systems can absorb more point attacks for the same reasons that they fail more gracefully. They can also maneuver more easily than monolithic systems to avoid area denial attacks and to reorganize themselves to provide service from their new orbital location.

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This research brief summarizes the findings of RAND Project AIR FORCE work that is fully described in *Establishing and Sustaining Constellations of Distributed Satellites: A Space-Based Radar Example*, Bob Preston, Mel Eisman, and Michael Brown, RAND Corporation, MR-1650-AF, 2004, 58 pp. Restricted distribution: not for public release.

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