Is Smaller Better?

By Capt. Justin Martirosian

For Your Consideration

Low cost, high availability and product delivery to tactical users are potential advantages of military SmallSats.

- Are SmallSats a promising solution to the Operationally Responsive Space paradigm or can legacy constellations be modified to meet future needs?
- How could SmallSats impact resilient space?
- Other than SmallSats, what are some alternative solutions to the ORS paradigm?

As use of technology on the battlefield increases, "on demand" delivery of space effects is becoming an expectation at echelons below the strategic level. Operationally Responsive Space (ORS) is one of many new challenges for the space community. How can the U.S. military provide space-based capabilities down to the operational level? SmallSats provide an economic and rapidly deployable means.

Operationally Responsive Space is defined by the Department of Defense (DoD) as "assured space power focused on timely satisfaction of the Joint Force Commander's needs."[1] The National Security Space Office in its ORS report outlines three desires from the commander, U.S. Strategic Command: rapidly exploit and infuse space technological or operational innovations; rapidly adapt or augment existing space capabilities when needed to expand operational capability; and rapidly reconstitute or replenish critical space capabilities to preserve operational capability.[2]

The ORS report distills these desires into two elements, anticipatory and reactionary. These elements are intended to provide assured space capabilities at a lower cost, in a more timely fashion than current legacy systems.

Responsive Space

In order to provide responsive space capabilities, assets available must be increased and constellation control must be decentralized. SmallSats are currently the most promising solution to the ORS paradigm. SmallSats, satellites with a mass less than 180 kilograms,[3] offer a satellite bus that is highly capable at significantly lower cost than traditional large buses.

Tactical and operational requirements include satellite imagery; position, navigation and timing; and satellite communication. Current national systems are shared across the DoD, limiting availability and restricting control of space capabilities to the strategic echelon, hindering responsiveness to tactical and operational needs.

Historically, control of space-based capabilities is retained at the strategic level, far above the warfighter. In order for the warfighter to receive space effects, a formal request for the capability must be made, requiring multiple approval steps. Employment of SmallSat constellations designed specifically to meet the needs of tactical or operational units allows decentralization of a constellation's control structure, giving the warfighter more autonomy and unprecedented access to space-based capabilities.

The DoD launched an experimental SmallSat in 2007, known as TacSat. The TacSat program sought to design satellites that were "good enough" for the warfighter, constrained the design life of the satellite to one year and focused on the use of existing technologies. By

requiring the use of current technology when developing specifications, both time and resources that would have been dedicated to research and development were reallocated to other project areas, decreasing overall design time and lowering cost dramatically. The limitation on operational/design life to one year means less focus on system redundancy, fuel capacity or the need for high-radiation resilient systems, again saving cost.

"Good Enough" Resolution

Currently the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command is experimenting with a MicroSat known as Kestrel Eye, released from the International Space Station in October 2017. Kestrel Eye is an "electro-optical microsatellite-class imagery satellite for tasking by the tactical ground component Warfighter."[4] Its ability to deliver tactically relevant imagery, downlinked directly to the user, provides an ability to gain situational awareness without a lengthy request, approval and delivery cycle.

Current cost estimates put Kestrel Eye at less than $2 million per spacecraft. Dramatically cheaper than legacy systems, Kestrel Eye demonstrates the potential feasibility for theater-optimized constellations in support of specific operations or organizations.

As technology becomes more accessible to the lower echelons, situational awareness increases, improving the autonomy of lower echelon leaders.

Although SmallSat constellations do not provide the same resolution as legacy systems, they can provide imagery much quicker. At the tactical level of war, it's not always about the resolution of the imagery, but how available and current the imagery is. SmallSats could provide "good enough" resolution in a timely manner that allows tactical leaders to plan and execute missions with greater confidence. Conceptually, SmallSat constellations tailored to specific mission requirements, launched in support of division-level operations, could be the end state of a SmallSat ORS solution.

Due to their size and relative simplicity, SmallSats can be rapidly produced en masse in order to meet any mission requirement. Pre-assembled SmallSat buses can be stored awaiting a host of possible payloads, decreasing the delay between the identification of a capability gap and deployment of the solution. This rapid deployment of operational capability lies in stark contrast to the current framework that can take upwards of a decade for research and development, assembly and launch.

The majority of SmallSats can launch from hosted dispensers in conjunction with resupply missions to the International Space Station or piggyback off of launches for other systems. This dramatically lowers the cost of launch and increases the frequency with which either constellations or individual satellites can be placed into orbit.

Cost Effective and Versatile

SmallSats provide a cost effective and versatile solution for the ORS paradigm. At $2 million per Kestrel Eye, it is hard to find a more cost-effective space solution. The overall time and cost reduction make the prospect of multiple SmallSat constellations more feasible than the introduction of new legacy system constellations. At the tactical and operational levels, resolution can be sacrificed for readily available imagery that provides critical situational awareness to the warfighter.

Rapidly deployable systems that form optimized constellations for specific areas of operations can change how we currently fight. With the total cost per satellite lower than legacy systems, constellations become more affordable and revisit rates increase for areas of interest.

SmallSats are not a one-size-fits-all solution. They provide another option, however, in the pursuit of a solution to the ORS paradigm. While there always will be a need for the

capabilities of larger systems, space planners should consider modularly customizable, rapidly deployable SmallSats as the future of Operationally Responsive Space.

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[1] Deputy Secretary of Defense, *Plan for Operationally Responsive Space: A Report to Congressional Defense Committees* (Washington: April 17, 2007).
[2] Ibid.
[3] Elizabeth Mabrouk, ed., NASA, Science Instruments, "What Are SmallSats and CubeSats?" Feb. 26, 2015, https://www.nasa.gov/content/what-are-smallsats-and-cubesats.
[4] U.S. Army Space and Missile Defense Command/Army Forces Strategic Command, "Kestrel Eye," fact sheet, https://www.smdc.army.mil/FactSheets/KESTRELEYE.pdf