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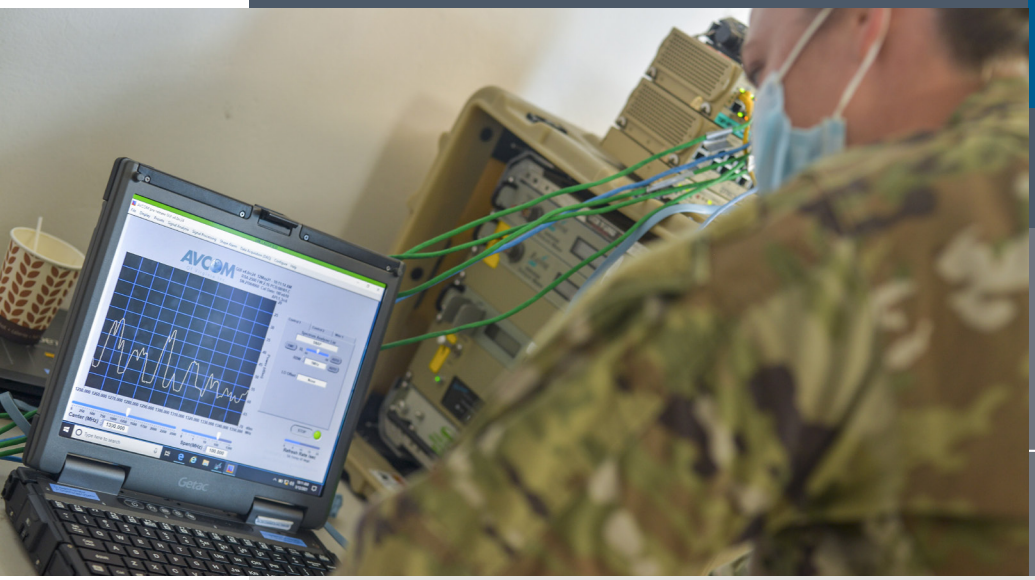

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The Military Use of Small Satellites in Orbit

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Key Takeaways

- Small satellites offer unique economic opportunities, due to their shorter development time, their lower cost as well as their manufacturing in assembly line style processes.
- Many small satellite applications envision systems comprised of constellations of hundreds or thousands of satellites, which offer a number of advantages, such as the increase in temporal resolution, or revisit rate, as well as formation flying.
- Military users can take advantage of commercial systems for military purposes – leveraging existing capability without the need to develop new systems internally. Militaries must look for ways to harness these trends to their advantage, both by making use of commercial offerings, and by examining military-specific opportunities.
- Military leaders envision a time when battlefield imagery could be requested and received by commanders on the ground and used for real-time decision-making. The U.S. Army's Project Convergence experimented with this capability in October 2020.

Introduction

The number of small satellites in orbit has increased rapidly over the last decade, and the growth of this sector is expected to accelerate even more in coming years. In 2011, fewer than 100 satellites weighing less than 600 kilograms (kg) were launched into Earth's orbit. In 2020, more than 1,200 such satellites were launched – the vast majority of which were owned by commercial entities.[1] Licenses have been issued to allow the launch of thousands more. These trends have important implications for military users around the world. Small satellites offer unique capabilities and economic opportunities, but also pose new threats. This briefing provides an overview of benefits, weaknesses, and strategic implications of small satellite technology, discusses current government and commercial efforts in this area, and addresses potential future developments.

Due to technological innovation and ongoing miniaturization of key components, small satellites are now capable of providing high-quality data and services across many different mission areas, including remote sensing; communications; position, navigation, and timing; and on-orbit rendezvous and proximity operations. Satellites carrying out these missions have been developed by government and commercial entities, and many further developments are underway. While the technical capabilities of an individual small satellite are typically less than those of a large, complex satellite of the same type, there are a number of attributes of small satellites that make them advantageous.

Shorter Development Time

Small satellites typically focus on one relatively narrow payload technology or application, unlike large satellites that may carry many complex sensors or payloads. Their decreased size and complexity make it possible to develop the satellites much more quickly. While a large, one-of-a-kind satellite may take years to design and build, small satellites can be developed in a fraction of that time – in some cases, just days. Shorter development times have a number of important implications, including allowing for rapid refresh of satellites on orbit and increased training opportunities.

Rapid Refresh and Technology Upgrade

Because small satellites can be developed quickly, it is possible to replace on-orbit assets on a much shorter timeframe. Unlike traditional large satellites that may be designed to last a decade or more, small satellites are often expected to operate for just one to three years. Technologies can be tested on orbit, and this knowledge and experience can be incorporated into future designs. Rapid refresh also makes it possible to incorporate broader technological improvements. Given the rapid development in electronics and

1. "Smallsats by the Numbers 2021", BryceTech, August 2021, available at: https://brycetech.com.

space technology, the ability to use cutting edge technology, rather than technology that is a decade or more old, is significant. This type of technological edge can be particularly relevant for military applications.

Increased Training Opportunities and Process Improvement

The relatively short development cycle for small satellites creates important opportunities for training. With the long development timelines of traditional space systems, an engineer or program manager may only see a handful of satellite programs go from design to operation over the course of their career, which limits opportunities to learn and apply lessons from one program to another. The short development cycle for small satellites removes this barrier, allowing space professionals to experience the full design, development, and operations cycle many times, applying lessons learned and improving these processes.

Lower Cost

The relative simplicity of small satellites and their short development time typically results in lower costs. While traditional, large satellites typically cost hundreds of millions or even billions of dollars to develop, small satellites can be built for tens of millions of dollars or less. For example, while the Maxar WorldView-4 satellite, weighing 2,500 kg, cost $850 million to build and launch, each of Dove satellites developed by Planet weighs about 5 kg and is estimated to cost less than $1 million.[2] This reduction in cost has obvious advantages in terms of commercial feasibility and reduced government spending. In addition to its budgetary advantages, the lower cost of small satellites enables the development of large constellations, which enables new capabilities and applications.

Manufacturing at Scale

Because small satellites are often deployed in large constellations, with relatively short lifespans requiring fast refresh rates, it makes sense to mass produce them using efficient, assembly-line style processes. In 2019, OneWeb Satellites, a joint venture between Airbus and OneWeb, opened a factory that will ultimately be capable of building two satellites a day.[3] Increased commercial small satellite development has helped to drive increased availability of commercial off-the-shelf parts for these systems.[4] These trends produce positive feedback loops, further decreasing the cost and development time for small satellite systems.

2. W. Scott, “Maxar Space Solutions Brings a Commercial Mindset to Government Space Missions”, Maxar.com, April 8, 2019, available at: https://blog.maxar.com.
3. J. Foust, “OneWeb Satellites Inaugurates Florida Factory”, SpaceNews.com, July 22, 2019, available at: https://spacenews.com.
4. D. Vergun, “Nanosatellites Could Play Pivotal Role in Defense Against Enemy Missiles”, Defense.gov, July 12, 2021, available at: www.defense.gov.