Space Logistics Drives SDA Architecture

Col. Jeremy Raley
USSF - AFRL/RV

Col. Joseph Roth
USSF - SSC/SZI

Abstract

Space warfighing operations by the U.S. Space Force (USSF) are critically dependent on high quality, proliferated, and timely Space Domain Awareness (SDA). Strategic drivers for capability provided by the Space Force are increasingly pointing towards the need for more capable, agile, and resilient constellations. One way to enable those capabilities for current and future constellations is through space-based logistics.

Dynamic space operations – high-cadence operations and satellite movement – are a force multiplier and force enabler for the Space Force and the Combatant Commands it supports. Just as in every other warfighting domain, high-quality and timely logistics are critical to an agile combat force. Space-based logistics, including refueling, servicing, and service-life extensions, as well as agile space access capabilities, are key enablers for dynamic space operations. Logistics in, to, and through the space domain will require a new level of SDA. This includes the ability to detect, ID, and track closely spaced objects – both cooperative and in duress – from the ground and in space utilizing both resolved, metric, and non-traditional SDA techniques.

Air Force Research Laboratory (AFRL) and Space Systems Command (SSC) are the science, technology, research, development, and prototyping organizations for the Space Force and are at the forefront of this new technical challenge. Our organizations are leveraging a long history of collaborative research and development (R&D) and prototyping, especially around agile and reconfigurable space vehicles – principally launch ring adapters – to bring this revolution to pass. This technology was initiated in the late 1990s at AFRL leading to space experiments in the 2000s and 2010s demonstrating the power of this reconfigurable ring concept. This has further transitioned to SSC as the Rapid On-Orbit Space Technology and Evaluation Ring (ROOSTER) “freight train to space” capability which has launched three rings since 2020 and is on track to launch many more through the rest of the decade and beyond. Leveraging this tight R&D to prototyping to transition back to industry to an enterprise-wide fleet strategy led by SSC leveraging this game changing technology shows how collaboration and coordination, especially in the aerospace hub of Albuquerque, New Mexico, leads to revolutionary warfighting capabilities.

These reconfigurable rings bring enormous capability for dynamic space operations. Rings can be loaded with excess fuel, refuellable spacecraft, spacecraft tankers which can bring fuel to other satellites, proliferated sensors including space-based environmental monitoring, and other R&D, prototype, or operational systems. SSC has invested in the TETRA line of spacecraft prototypes to increase the industry base for small-to-medium size spacecraft which can launch on a reconfigurable ring. AFRL and SSC are partnered on TETRA-5 set to launch on ROOSTER 4 in 2026 to demonstrate refuellable versions of these moderate size spacecraft.

All of these new logistics capabilities will drive needed changes in the SDA architecture to enable responsible use. The SDA requirement to refuel or service a satellite is more complex and demanding than many other Space Force missions. AFRL and SSC are investing in research to support these SDA needs and are excited to partner with industry on novel concepts here at Advanced Maui Optical and Space Surveillance Technologies (AMOS).