

## RANGRS SPACE LOGISTICS EFFORTS

RESILIENT AUTONOMOUS NAVIGATION GUIDANCE AND ROBOTIC SYSTEMS

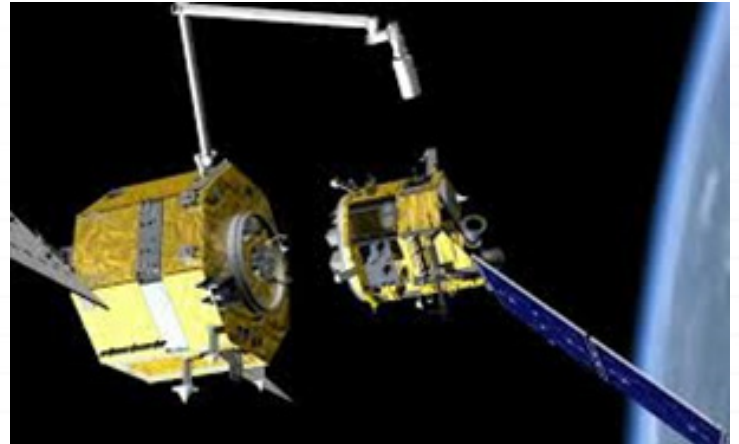
### What is Space Logistics?

Within the Air Force Research Laboratory's Space Vehicles Directorate, the RANGRS program researchers are the thought leaders and technology integrators. This team of scientists and engineers is uniquely prepared to establish space logistics and create a sustainable logistics chain for space-domain operations in future United States Space Force operations. In every warfighting domain, logistics chains are critical to maintaining an operational capability. For instance, an F-16 requires refueling, and the process for getting that fuel from the ground to the fuel tank of a jet involves a complex chain of events.

Current space operations do not have a designated method for sustainable resupply or reequip on-orbit. Since satellite designers build and integrate components that live through the entire lifespan of the satellite itself, the components are generally much less powerful to support a long lifetime. Therefore, the replacement and repair of components will increase satellite performance drastically.

### Why RANGRS?

The RANGRS team is equipped to lead the future of space logistics largely due to its connections with organizations, including Naval Research Lab (NRL), DARPA, and various commercial partners, that have worked for decades on technologies enabling space-born logistics. This provides the team with access to technological information and spacecraft component specifications, which are critical to making logical conclusions on space logistics.



*The Orbital Express mission, meant to demonstrate on-orbit servicing of a specific vehicle (Photo by DARPA)*

### The Study

The first "deliverable" RANGRS will produce is a report outlining the "what, where, when, why, and how" of Space logistics, including research into the parallels seen in logistics chains witnessed in other warfighting domains. RANGRS will compile a comprehensive collection of information regarding the technology deemed capable of enabling a space logistics chain. Perhaps most importantly, RANGRS will define what a sustainable space logistics chain actually may look like in operation. The team will also perform a proper cost-benefit analysis to quantify the worth of space logistics.

The study is arguably the largest contribution the program is bringing to space logistics efforts. While others have contributed in many other technological demonstrations, such as Orbital Express, RANGRS intends to look at the design of a full logistics chain. The program anticipates completing the full study in 2022.

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## Flight Experiments

Upon conclusion of the space logistics study, RANGRS will start deploying flight tests to demonstrate specific capabilities and conceptual operations of space logistics. These demonstrations will span across multiple flights, demonstrating different aspects of the space logistics chain. Upon successful demonstration of these flight experiments, AFRL will transfer the capabilities and conceptual operations to industry. Industry, in turn, will work with AFRL and the USSF to transition these developments to the operational warfighter.



*A concept for a generalized two-arm servicer for satellite repair and refuel  
(Photo by Tethers Unlimited)*

## Current Status

RANGRS is currently conducting the space logistics study and compiling all information necessary to generate any type of conclusions. Additionally, the team has written multiple flight proposals in anticipation of the study conclusion. In the meantime, the program is continuing to perform in-house research and contract-out component development work to advance technology and tools that enable space logistics.



*An F-16 Fighting Falcon refuels, thereby demonstrating its dependence on a logistics chain. (U.S. Air Force photo by Master Sgt. Austin M. May)*

## About AFRL

The Air Force Research Laboratory (AFRL) is the primary scientific research and development center for the Department of the Air Force. AFRL plays an integral role in leading the discovery, development, and integration of affordable warfighting technologies for our air, space, and cyberspace force. With a workforce of more than 11,000 across nine technology areas and 40 other operations across the globe, AFRL provides a diverse portfolio of science and technology ranging from fundamental to advanced research and technology development. For more information, visit: [www.afresearchlab.com](http://www.afresearchlab.com).



*Currently, when a satellite is launched and becomes operational, the USSF does not upgrade or repair the satellite as it is "locked" in its final form. Space Logistics aims to change that paradigm. (U. S. Air Force Photo by Senior Airman Dalton Williams)*