

Getting Spacy, Getting Low

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1. Introduction

Houston, we have a problem.

Many satellites still have many years of useful life, but like many humans, they are being taken out by unexpected diseases (read “component failures,” “accidents,” or “reentry” in lieu of “diseases” for space craft). However, like humans, they can get by with a little help from their friends (sorry, Beatles). In this case the friends of satellites are a recently invented type of unmanned space craft with capability to:

- Grab a dead or dying satellite, and
- Use the space craft’s (highly efficient) thrusters to move the disabled space craft to a different orbit:
 - Either lower to rapidly reenter the atmosphere in a safe region (like in seldom-used part of a large ocean)
 - Or higher to continue its mission.

In the latter case, it would be good if the assisting space craft could also repair and refuel the satellite to extend its active lifetime.

Below I will call this rescue satellite a Ferry-Satellite (in honor of my local SF Bay Ferries). The “lower vs. higher altitude” choice is dictated by the answer to two questions (1) is the space-craft’s disability triggered only by a thruster or fuel issue? (2) Is the issue one that will allow the serviced thruster/fuel to maintain stable orbiting and reasonable functions for some useful amount of time once it is moved to a stable orbit?

The “move to higher/ more stable orbit” choice is also chosen by a consideration of the potential value of the potential future function of the satellite.

2. Potential Other Ferry-Satellite Functions

It would be good if the Ferry-Satellite was more than a single “one-trick-pony.” More inventive readers than I can probably define other functions for the Ferry-Satellites, and thus justify a long-lived satellite-family, but relocating satellites to different orbits might, on its own, be a useful capability in the future. Also keep in mind that securely grabbing a satellite that was not designed to be grabbed is not a trivial task. This might, for instance dictate interchangeable tools and an orderly “tool-box.”

The good news is that NASA and their contractors are already planning their version of the above Ferry-Satellites:

Several advanced spacecraft are now being developed and deployed to repair, refuel, upgrade, and relocate satellites in Earth orbit, marking a shift from the traditional “throwaway” satellite model to sustainable, in-orbit servicing.¹

2.1. Northrop Grumman Mission Robotic Vehicle (MRV)

Launched in July 2026 aboard a SpaceX Falcon 9, the MRV is a mobile robotic mechanic for satellites in geosynchronous and low Earth orbit. It carries:

- *Two articulated robotic arms (each with 7 degrees of freedom) for inspection, repair, and tool manipulation.*
- *Interchangeable tools for tasks like replacing failed components, unfolding jammed solar arrays, or removing debris.*
- *Three Mission Extension Pods (MEPs) — small propulsion modules that can be installed on aging satellites to extend their operational life.*
- *Propulsion and navigation systems for rendezvous, docking, and orbital maneuvers.*

The MRV can also relocate satellites, perform upgrades, and assist in robotic assembly in space.

2.2. DARPA Robotic Servicing of Geosynchronous Satellites (RSGS)

DARPA is the U.S. Defense Advanced Research Projects Agency, an independent R&D agency focused on high-risk, high-reward technological innovations for national security.

The Defense Advanced Research Projects Agency (DARPA) was established in 1958 in response to the Soviet Union’s launch of Sputnik, which highlighted the need for the United States to prevent strategic technological surprises and maintain a competitive edge in defense technology.

Unlike traditional military research offices, DARPA focuses on transformational breakthroughs rather than incremental improvements, aiming to create technologies that can fundamentally change military and civilian capabilities

A U.S. Navy-led program integrating the MRV platform with a highly dexterous robotic servicing suite for geosynchronous orbit (GEO). It carries:

- *Two multi-axis robotic arms for on-orbit upgrades, inspections, anomaly resolution, and satellite relocation.*
- *Electric propulsion for a ~10-month journey to GEO, with servicing demonstrations planned for 2027.*
- *Rendezvous and proximity operations suite with multiple cameras, sensors, and infrared imaging for safe approach.*
- *Designed to extend the life of expensive GEO satellites (often hundreds of millions of dollars) by refueling and repairing them.*

¹ Reference text is provided by my Microsoft Bing Browser in response to the query: *A spacecraft that can repair or relocate satellites in earth orbit.*

2.3. Space Inventor + Astroscale Japan In-Orbit Servicing Architecture

A joint Danish–Japanese initiative combining modular smallsat platforms² with proven rendezvous and docking infrastructure.

- *Standardized docking plates and power/data interfaces for integration into host satellites during manufacturing.*
- *Capable of repair, propellant replenishment, and safe relocation of disabled spacecraft in low Earth orbit.*
- *Aims to extend mission lifetimes, defer costly replacements, and support debris mitigation.*

2.4. Other Notable Capabilities

- *LINK (Katalyst Space) and Northrop Grumman MEVs (Mission Extension Vehicles) have already demonstrated refueling and life-extension in orbit.*
- *Chinese missions have tested refueling, and European programs focus on sustainability and debris removal.*

2.5. Why This Matters

These spacecraft can:

- *Extend satellite lifespans by replacing failed components or adding propulsion.*
- *Reduce launch costs by avoiding full replacements.*
- *Mitigate orbital debris by safely relocating or deorbiting satellites.*
- *Enable new mission models where satellites are designed from the start as serviceable infrastructure*

In short, the MRV, RSGS, and similar systems represent the cutting edge of in-orbit satellite servicing, with the ability to repair, relocate, and upgrade spacecraft — transforming space operations from a disposable model to a sustainable, maintainable one.

2.6. DARPA’s RSGS Robotic Servicing Launched in 2026

DARPA’s Robotic Servicing of Geosynchronous Satellites (RSGS) program has successfully launched its first privately owned, operational in-space servicing mission in geosynchronous Earth orbit (GEO) on July 21, 2026 from Cape Canaveral Space Force Station, Florida, aboard a SpaceX Falcon 9 rocket.

² A “smallsat platform” is a complete spacecraft bus and supporting systems designed for small satellites (typically under 1,200 kg), providing power, thermal control, attitude control, communications, and payload integration, often with mission-specific upgrades

2.6.1. Mission Overview

The Mission Robotic Vehicle (MRV), developed by SpaceLogistics (a Northrop Grumman company) and equipped with DARPA's highly dexterous robotic servicing system, is the first long-life U.S. spacecraft designed for multiple in-space servicing, assembly, and manufacturing (ISAM) missions.

The RSGS robotic payload features:

- *Dual robotic manipulator arms with seven high-strength joints, interchangeable tools, and specialized tool drives for complex tasks*
- *Mission Extension Pods (MEPs) to install propulsion "jet packs" that can extend satellite life by six or more years*
 - *Modular tools, sensors, and advanced lighting for delicate mechanical interventions.*
 - *Autonomous flight software for safe close-proximity operations.*

Planned Operations -- Once in GEO, the MRV will demonstrate:

- *On-orbit upgrades and inspections.*
- *Anomaly resolution for malfunctioning satellites.*
- *Satellite relocation to other orbits*

Strategic Impact -- *DARPA's RSGS program is a government-private partnership aimed at shifting from a "disposable" satellite model to one of sustainable, upgradable, and resilient space infrastructure. By enabling commercial and U.S. government satellites to be serviced in orbit, RSGS will:*

- *Reduce space debris.*
- *Extend asset lifetimes.*
- *Create a new commercial market for in-space servicing*

NASA's contributions to the mission leverage its legacy of servicing missions including the Hubble Space Telescope servicing missions and the Robotic Refueling Missions on the International Space Station. NASA support to RSGS program includes the development of dynamic simulation and analysis tools, software analysis for performance verification, and a team of flight robot operators who will support highly technical procedures in orbit.

Hundreds of satellites are in geosynchronous orbit. Of those, fully functional satellites are often decommissioned early because they run out of fuel or their equipment becomes obsolete. RSGS establishes a critical U.S. capability to extend the lifetime of spacecraft in orbit, allowing for more innovative and cost-effective mission designs.

2.6.2. History

DARPA began a program called **Spacecraft for the Universal Modification of Orbits (SUMO)** in 2003 to demonstrate the feasibility of autonomous proximity operations and grappling of a customer satellite by a space robotic system.

SUMO was designed to integrate machine vision, robotics, mechanisms, and autonomous control algorithms to perform autonomous rendezvous and grapple of a variety of interfaces traceable to future spacecraft servicing operations

The “Universal” in the name emphasized that the system could work with satellites that had not been designed for servicing, making it applicable to a wide range of current and future missions.

Laboratory Demonstration: The program was implemented at the Naval Center for Space Technology (NCST) at the U.S. Naval Research Laboratory in Washington, DC, using the Proximity Operations Test Facility, which provided precise six-degree-of-freedom motion control for both the servicer and customer spacecraft platforms. A robotic arm mounted to a simulated spacecraft was used to demonstrate the ability to grapple and move objects in simulated space environments.

Outcomes and Legacy: A successful laboratory demonstration in 2005 validated the technologies and led DARPA to fund the development of a space-qualified robotic arm

This work laid the groundwork for later programs, including the Robotic Servicing of Geosynchronous Satellites (RSGS), which began in 2016. RSGS builds on SUMO’s achievements by aiming to send a robotic spacecraft to geosynchronous Earth orbit to inspect, repair, and relocate satellites

Broader Impact: SUMO’s success demonstrated that autonomous robotic servicing could be developed and tested in a controlled environment, reducing the risks and costs of later space missions. It also contributed to the development of technologies that could extend the life of expensive satellites, reduce space debris, and enable in-orbit manufacturing and assembly

In short, SUMO was a critical stepping stone in DARPA’s long-term vision for autonomous, robotic satellite servicing, bridging laboratory research with the eventual deployment of operational robotic spacecraft in space.