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Launch Is an Event, Sustainment Is the Campaign: Building an On-Orbit Sustainment Ecosystem

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Aerospace Education Programs

Sustaining the Space Fight

History repeatedly shows that wars are won not only by firepower but also the ability to sustain combat power over time.[1] That lesson now extends to space. Sustainment is not a support function; it is the margin of victory. U.S. military power depends on satellites for communications, missile warning, intelligence, navigation, and command and control—capabilities the U.S. Space Force (USSF) has acknowledged must be sustained not merely in peacetime, but through "any competition, crisis, or conflict."[2] Yet the dominant sustainment model in the space domain remains unchanged from the dawn of the space age: When a satellite fails, launch a replacement. That model is premised on conditions a peer adversary can and will challenge in any future conflict, including available launch capacity, time to reconstitute systems, and uncontested access to space.[3]

Although U.S. launch activity is accelerating rapidly, more launches do not automatically make reconstitution more resilient. Vandenberg Space Force Base is projected to grow from 65 launches in 2025 to approximately 1,800 by 2036, but that capacity would still depend on fixed launch infrastructure. The Objective Force Design 2040 identifies this site as a "potential center of gravity" vulnerable to disruption, attack, or congestion. In conflict, that dependence could limit the U.S. Space Force's ability to replace satellites precisely when rapid access to space is most needed.[4] The launch-replacement model is increasingly insufficient for high-value, maneuver-dependent national security missions. Yet U.S. and allied industries have not built enough on-orbit sustainment capacity to fill that gap, in part because government demand has been inconsistent. China, by contrast, can direct investments and missions through a state-controlled space sector. Targeted U.S. policy intervention is both necessary and urgent.[5]

Recognizing that launch alone cannot solve every sustainment problem, Space Systems Command (SSC) established the Space Access, Mobility, and Logistics (SAML) program in 2023 to develop capabilities such as on-orbit refueling and repair and logistics operations between Earth and the Moon. Funding for the program , however, has remained inconsistent. By fiscal year 2026, SAML received $14.5 million, $10 million less than the previous year, even as senior leaders warned that the Department of Defense/War (DOD/W) must move beyond a launch-centric model for space reconstitution.[6] There is still no orbital equivalent of a pre-positioned depot or U.S. Transportation Command, leaving a growing gap between the recognized requirement and fielded capability.

Launch Replacement on Its Own Is Not Enough

The current model is optimized for the space domain of the past. For many space systems, replacement through launch remains the most practical and effective strategy. This is especially true for rapidly produced, small, lower-cost satellites in low Earth orbit (LEO) mega-constellations, tactical communications layers, and redundant sensing architectures.[7] The advent of reusable launch vehicles and lower manufacturing costs has fundamentally shifted the economics of these distributed networks.[8] Because proliferated architectures feature built-in redundancy, they easily absorb individual satellite failures without compromising mission continuity. That model was viable when most U.S. space systems operated in a less contested environment and adversaries had a limited ability to hold them at risk on orbit. This condition no longer holds. Peer adversaries can now directly threaten the satellites that underpin U.S. military power.

Replacement is an insufficient model for mobility and maneuver moving forward. Considering new peer adversary threats to space, the replacement model is fundamentally insufficient for high-value geostationary orbit (GEO) national security assets, such as strategic missile warning, protected satellite communications, and other exquisite systems. These operationally critical national security systems are not only prohibitively expensive to replace but also irreplaceable on any crisis timeline. Lockheed Martin completed the Space-Based Infrared System (SBIRS) GEO-5 satellite in approximately five years, a pace the company characterized as record-setting. Its successor, the Next-Gen Overhead Persistent Infrared (OPIR) GEO satellite, entered environmental testing in August 2025 with no accelerated delivery schedule. These timelines reveal the core weakness of a replacement-first model: Even if launch capacity is available, the decisive constraint in conflict is the multi-year process required to design, build, integrate, certify, and deploy another spacecraft that meets the high standards of these no-fail national security missions. When a satellite of this class becomes non–mission capable, no launch manifest can reconstitute that capability within a conflict's decisive window.[9] For such systems, resilience is measured by both replacement capacity and the ability to remain mission-capable in orbit.

In a contested environment, these systems must maneuver to survive. However, fuel-limited spacecraft are subject to a compounding vulnerability: Every evasive maneuver, orbital repositioning, or dynamic retasking action consumes finite propellant and shortens operational lifespan. Without replenishment, commanders are forced to choose between preserving satellite life and preserving mission effectiveness. Future operations will require the ability to "maneuver without regret," or reposition, evade threats, and sustain station-keeping without sacrificing

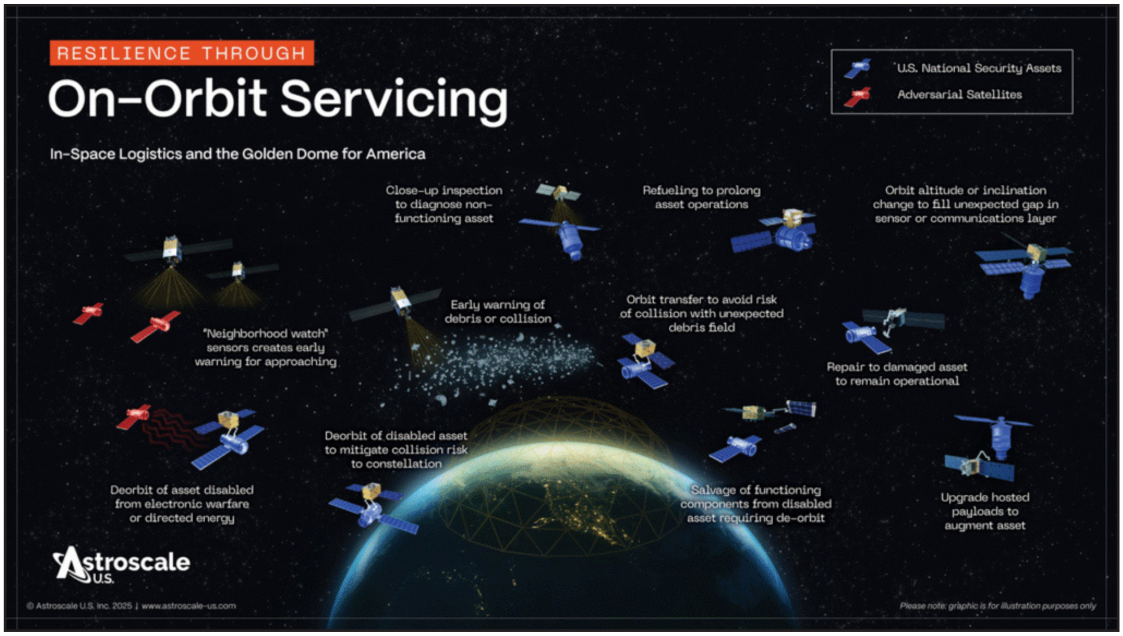

Figure 1: Representative on-orbit servicing mission profile. The challenge is no longer purely technical; it is also a question of industrial scalability and operational adoption.

Credit: Astroscale U.S., "Resilience Through OnOrbit Servicing: InSpace Logistics and the Golden Dome for America," infographic, 2025.

service life.[10] Meeting that requirement will depend on an on-orbit sustainment ecosystem capable of preserving or restoring spacecraft capability after launch. In this paper, on-orbit sustainment refers to the broader military requirement to preserve or restore spacecraft capability in orbit, while on-orbit servicing refers to refueling, life extension, repair, and relocation. Figure 1 illustrates several servicing functions that would make a sustainment ecosystem possible.

The individual technologies for this ecosystem are already emerging. Both government and industry are developing them separately, building the capabilities needed for ongoing operations such as life extension, refueling, and servicing. These capabilities are progressing at different rates, but they have not yet been integrated and scaled to support critical military operations in space. Table 1 highlights representative programs, what each provides or is designed to demonstrate, and the remaining gap.

Together, these programs show that the United States is advancing several elements of on-orbit sustainment, although they are at different levels of maturity. The challenge now is combining those emerging capabilities into an integrated, reliable, and scalable ecosystem that can support national security operations.

Allies and adversaries recognize the same problem. Recognition that launch replacement alone cannot sustain high-value orbital assets has produced two divergent international responses. U.S. allies are building government-backed commercial on-orbit sustainment programs to address capability gaps that markets have been slow to fill. China does not need to wait for commercial demand to develop. Instead, its state-directed space sector is advancing rendezvous, proximity operations, docking, and the ability of one spacecraft to approach, maneuver near, and connect with another spacecraft. These capabilities can support satellite servicing but also be used against another spacecraft.

In Europe and Japan, governments are actively subsidizing commercial firms to position on-orbit sustainment as a strategic national priority. The Japan Aerospace

Capability	Representative Program | Organization	What it demonstrates or provides	Current Status	Remaining Operational Gap
Refueling	**Tetra-5** satellite system: U.S. Space Force, Air Force Research Laboratory, Orion Space Solutions, & Redwire Refueling demonstration with Astroscale, U.S. Provisioner, Orbit Fab, & **Tetra-6** satellite system: U.S. Space Force, Orion Space Solutions, & Redwire	Tests commercial refueling interfaces & the full sequence needed for on-orbit refueling, including rendezvous, docking, fuel transfer, & undocking.	Demonstration missions for Tetra-5 are scheduled for early 2027. Demonstration for Tetra-6 also in 2027.	Has not yet demonstrated reliable, repeatable refueling in orbit or validated the capability for operational use.
Relocation & orbital mobility	**Mira** orbital transfer vehicle: Impulse Space	Transports, hosts, deploys, & repositions payloads in orbit.	Flight proven in LEO across three missions. Upgraded vehicle designed for a GEO launch, ready in 2027.	Has not yet demonstrated maneuver or relocation operations in GEO.
Life extension & servicing vehicle	**Life Extension In-Orbit–Prime (LEXI / LEXI-P)**: Astroscale	Designed as a reusable GEO servicer that can dock with multiple client satellites to provide life extension, inspection, situational awareness, & end-of-life relocation.	In advanced development & ground testing. Launch, ready in 2027.	Has not yet demonstrated docking or life-extension services in orbit. Its multi-client service model therefore still requires operational validation.
Life extension	**Mission Extension Vehicle-1 (MEV-1)**: Northrop Grumman SpaceLogistics	Docks with existing satellite & provides external propulsion to maintain its orbit & extend life without refueling.	Demonstrated. MEV-1 completed a five-year life extension for the Intelsat 901satellite.	Has not demonstrated servicing of a U.S. national security satellite & does not provide refueling or robotic repair.
Repair / robotic servicing	**Robotic Servicing of Geosynchronous Satellites (RSGS)**: DOD/W Defense Advanced Research Projects Agency (DARPA) & Northrop Grumman SpaceLogistics	Designed for robotic inspection, repair, & servicing of satellites in GEO. It can also install Mission Extension Pods to provide external propulsion & extend satellite life.	Launched July 21, 2026 aboard the Mission Robotic Vehicle. Yearlong transfer to GEO with on-orbit servicing demonstrations to follow.	The mission must first complete on-orbit demonstrations before the capability can be assessed for routine national security or commercial servicing.

Table 1: Representative programs advancing on-orbit sustainment capabilities.

Sources: **Tetra-5/6** | Sandra Erwin, "Space Force to Test Satellite Refueling Technologies in Orbit," *Space News*, March 31, 2025, updated April 3, 2025. **Mira** | Impulse Space, "Mira: The Agile Spacecraft." **MEV-1 |** Jeffrey Hill, "Intelsat, Northrop Grumman Complete 5-Year IS-901 Life-Extension Mission," *Via Satellite*, April 9, 2025; **LEXI-P** | Astroscale, "Satellite Life Extension in GEO: How Our LEXI Servicer Maximizes Satellite Value," March 20, 2026; **RSGS/MRV** | Joey Roulette, "Blue Origin Zeroes In on Rocket Engine Issue as Source of New Glenn Explosion," *Reuters*, August 5, 2026; and DARPA, "Robotic Servicing of Geosynchronous Satellites Lifts Off," July 21, 2026.

Exploration Agency (JAXA) Space Strategy Fund designates on-orbit refueling as a world-leading national capability objective. Astroscale's ELSA-d mission has already demonstrated some of the technologies required for satellite servicing, completing the first successful commercial magnetic capture and rendezvous with a simulated defunct satellite in 2021.[11] The mission demonstrated the ability to approach and capture another spacecraft, a core building block for Japan's broader servicing ambitions.[12] France has taken a similar approach. Its National Space Strategy 2025–2040 frames in-orbit services as essential to strategic autonomy, with the French National Centre for Space Studies (CNES) awarding two geostationary servicing missions under the France 2030 program in March 2026.[13] The European Space Agency reinforces this allied investment posture by funding ClearSpace-1, a contracted active-debris-removal mission that will help demonstrate the technologies and operating practices required for commercial spacecraft servicing in Europe.[14]

China's approach bypasses many of the market-development challenges facing U.S. and allied firms. Through the state-owned China Aerospace Science and Technology Corporation (CASC) and China Aerospace Science and Industry Corporation (CASIC), the government provides financing, assigns missions, and strategic direction. In effect, the state serves as both the customer and producer, eliminating the need to wait for enough commercial demand to justify demonstrations. The result has been a rapid sequence of operational demonstrations. In January 2022, China's Shijian-21 satellite docked with the defunct Beidou-2 G2 navigation satellite in GEO and towed it into a graveyard orbit above the geostationary belt.[15] By 2024, the activity had expanded beyond a single demonstration: The Secure World Foundation's 2025 Global Counterspace Capabilities documented five Chinese satellites conducting proximity operations in that year alone.[16]

In June 2025, Shijian-21 and Shijian-25 conducted repeated close approaches in GEO that U.S. officials and independent analysts assessed as consistent with a possible docking and refueling demonstration, although fuel transfer could not be independently confirmed.[17] Aldoria, a European commercial space-surveillance company that tracks satellites with a global network of optical sensors, observed the Shijian-21 and Shijian-25 repeatedly separate and return to close proximity between January 6 and 12, 2026.[18] Taken together, this progression shows that China is moving beyond isolated technology demonstrations and building operational experience with complex spacecraft interactions in GEO. The pace and scale of that activity are particularly significant because China can continue testing and refining these capabilities without waiting for the commercial market to mature. These different approaches expose the central U.S. challenge. The technology needed for on-orbit sustainment is advancing, and the operational need is increasingly clear, but the United States has not developed the operational capacity to prove, at scale, the capabilities national security missions require. Allies are using government investment to develop these capabilities, while China directs funding, missions, and development without waiting for commercial demand. Understanding why the U.S. on-orbit servicing market has not scaled is therefore essential to closing the sustainment gap.

Why the U.S. On-Orbit Servicing Market Has Not Scaled: Structure, Conduct, & Performance

The U.S. on-orbit servicing market is developing, but it does not yet provide the full range of capabilities the U.S. Space Force says it will need to sustain operations in a prolonged conflict. Current programs are advancing refueling, life extension, mobility, and robotic servicing, but the emerging requirement is broader. U.S. Space Force planning calls for repeatable inspection and repair, orbital resupply, reusable transfer vehicles, propellant distribution, interoperable servicing and fuel-handling standards, and, eventually, orbital depots capable of supporting operations across multiple orbits.[19] Examining the on-orbit servicing market's structure, firm conduct, and performance helps explain why these individual capabilities have not yet developed into an integrated sustainment system.

Market structure is developing unevenly across missions and orbits. Although a growing number of firms are developing on-orbit servicing technologies, operational experience remains concentrated among a relatively small number of providers.[20] As a result, commercial on-orbit servicing has not developed evenly across missions or orbital regimes. Market maturity varies sharply by orbit because servicing has developed fastest where commercial demand and government requirements overlap. Figure 2 provides context for where representative satellites and missions operate by orbit.

The mix of commercial and government demand, satellite value, and operating conditions across the orbital regimes helps explain why commercial servicing has matured fastest in GEO. Expensive, long-lived commercial satellites provide the clearest near-term business case for extending operational life, while many high-value national security missions in the same orbit create a separate government need for persistence, maneuver, and servicing. That combination has supported the most mature on-orbit servicing market to date, including Northrop Grumman's operational Mission Extension Vehicles (MEV). Additionally, Astroscale and Orbit Fab are developing complementary life-extension and refueling services for the same market.[21] Other orbit regimes present weaker commercial incentives or greater technical challenges. In LEO, proliferated constellations often make replacement more practical than servicing. In medium Earth orbit, highly elliptical orbit, and cislunar space, servicing requires more specialized capabilities in more demanding operating environments.

These orbital market differences are reinforced by barriers that make it difficult for new providers to enter the market or existing firms to expand into less-mature missions. On-orbit servicing companies must finance expensive flight demonstrations; prove that rendezvous, docking, and propulsion systems work reliably; and build a record of successful operations before customers will entrust valuable satellite systems to them. Many regulatory and liability frameworks were created when satellites generally operated independently and rarely approached or

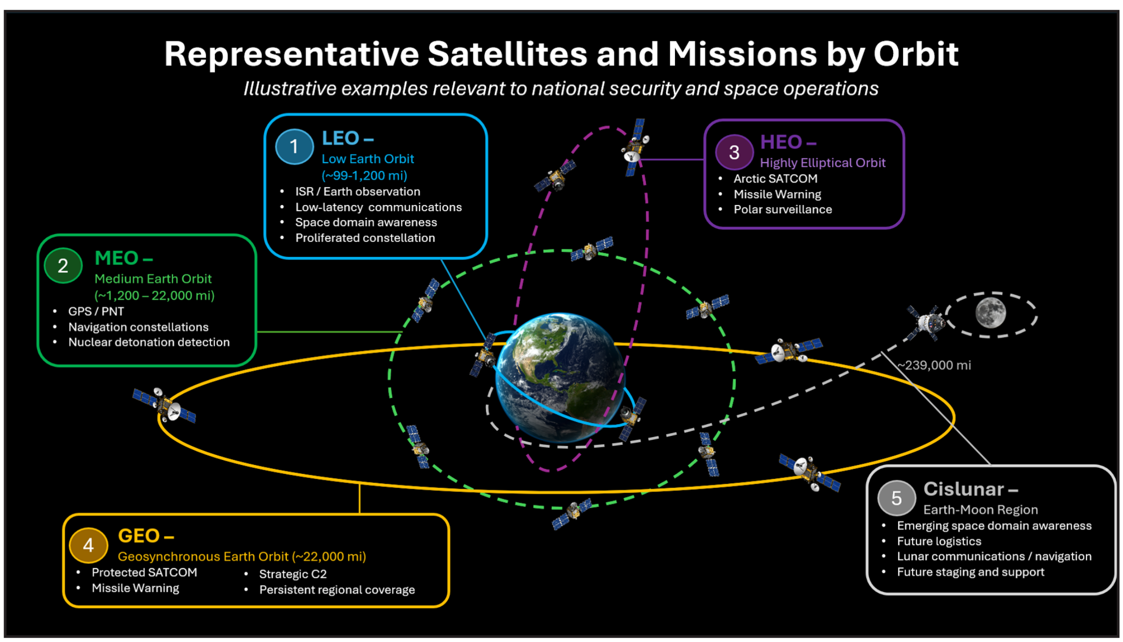

Figure 2: Representative satellites and missions by orbit.

Credit: Image by Charles Galbreath and Allison Barkalow. Data pulled from U.S. Space Force, *Space Doctrine Publication 3-0: Operations* (Washington, DC: Headquarters, U.S. Space Force, July 19, 2023), pp. 14–15; U.S. Government Accountability Office (GAO), *Missile Warning Satellites: Space Development Agency Should Be More Realistic and Transparent About Risks to Capability Delivery*, GAO-26-107085 (Washington, DC: GAO, January 28, 2026, revised February 2, 2026); GAO, *DOD Satellite Communications: Reporting on Progress Needed to Provide Insight on New Approach*, GAO-25-107034 (Washington, DC: GAO, March 4, 2025); NASA, "SCaN Glossary"; GPS.gov, "Space Segment"; Air Force Research Laboratory, *A Primer on Cislunar Space* (Kirtland AFB, NM: AFRL, 2021); DARPA, "Ten-Year Lunar Architecture (LunA-10) Capability Study."

interacted with one another. Servicing spacecraft now need to maneuver near other satellites, dock with them, transfer fuel or equipment, and, at times, move between orbits—activities the existing regulatory and liability framework was not designed to routinely govern.

These barriers can deter even established firms. In 2019, Maxar's Space Systems/Loral withdrew from DARPA's Robotic Servicing of Geosynchronous Satellites program after concluding that it could not identify an economically viable path that met the company's return requirements, choosing instead to direct capital toward other priorities.[22] These barriers affect the entire market, but they are especially difficult for smaller firms and new entrants with less capital, fewer opportunities, and less ability to absorb development risk. As a result, companies have stronger incentives to concentrate their resources where demand is the strongest and technical risk is lower rather than invest in less-mature missions without reliable commercial or government demand.

Market conduct reflects the need to build trust and demand. Given these structural constraints, companies in the on-orbit servicing market face the basic chicken-and-egg demand problem: Satellite operators hesitate to pay for services that have not been proven in orbit, and providers struggle to attract the investment to build those services without committed customers.[23] As a result, firms have relied on three primary strategies to reduce risk, build demand, and establish a viable market.

1. **Demonstrations establish credibility.** Proven performance carries unusual importance in space because customers have few opportunities to test a new provider without putting expensive spacecraft or critical missions at risk. The U.S. Space Force follows a similar approach in national security launches, requiring providers supporting its critical missions to prove successful launch records and undergo a thorough certification and mission assurance process before they are authorized to handle national security payloads.[24] On-orbit servicing firms face an analogous challenge: They must convince their customers to allow another spacecraft to approach and interact with their operational asset. Northrop Grumman established operational experience with a commercial life extension in GEO, while Astroscale's ELSA-d demonstrated repeated rendezvous and magnetic capture before a thruster anomaly prevented the completion of its planned deorbit mission.[25] These missions show why flight demonstrations matter even when the results are mixed. Successful operations build confidence, while anomalies expose technical and operational weaknesses that can be corrected before future missions. Each mission adds to the experience providers need to improve reliability, refine procedures, and demonstrate readiness for more demanding servicing missions.

2. **Interoperability versus proprietary advantage shapes competition.** Common interfaces could allow servicing companies to serve more satellites and are important to the integrated logistics system the U.S. Space Force ultimately wants. Individual firms, however, have incentives to develop technical solutions that differentiate their services. Northrop Grumman's MEV, for example, uses its own docking system to capture existing satellite features rather than relying on a common interface. Industry efforts such as the Consortium for Execution of Rendezvous and Servicing Operations (CONFERS) seek to develop shared practices for safe rendezvous and servicing, but firms ultimately respond to customer requirements and competitive incentives.[26] This creates a tension between

what is commercially advantageous for an individual provider and the interoperability needed for a broader on-orbit sustainment system. Without stronger demand for interoperable systems from the DOD/W or commercial industry, companies may benefit more from protecting their own solutions than from investing in compatibility across the broader market.

3. **Government partnerships reduce development risk and shape what firms develop.** In on-orbit servicing, government partnerships do more than provide funding; they also influence which capabilities progress from concept to operational testing. Programs such as DARPA's Robotic Servicing of Geosynchronous Satellites and the U.S. Space Force's Tetra missions give firms opportunities to mature technologies tied directly to government needs, including robotic servicing and refueling.[27] This is especially important for capabilities whose primary value may be national security rather than near-term commercial return. As a result, government demand can steer industry toward parts of the broader sustainment system that firms might otherwise delay or avoid developing on their own, but government support alone does not guarantee a self-sustaining market.

Market performance shows value but not yet scale. The on-orbit servicing market has demonstrated that servicing can extend satellite life and create value for customers, but it has not yet shown it can deliver a broader range of services routinely, affordably, and at scale. Northrop Grumman's MEV provides the clearest example. MEV-1 extended the operational life of the Intelsat 901 satellite by five years, allowing the operator to continue using an otherwise functioning satellite rather than replace it.[28] For national security missions, similar life-extension and replenishment capabilities could preserve high-value spacecraft, extend their operational life, and reduce the consequences of using finite fuel to maneuver.[29]

But proving the technology works is not enough. It also must be affordable, timely, and relevant to what customers really need. NASA's On-orbit Servicing, Assembly, and Manufacturing 1 (OSAM-1) mission illustrates the difficulty of maturing ambitious servicing capabilities when development takes years and customer requirements continue to evolve. OSAM-1 was designed to rendezvous with, refuel, and relocate Landsat 7, a satellite that was not originally designed for servicing, while also demonstrating robotic assembly. The program's cost and schedule had also become significant challenges. NASA's Independent Review Board estimated that the program would cost $2.38 billion to complete and would most likely not be ready for launch until March 2028, well beyond its original cost and schedule expectations. The board also concluded that the market had evolved during the program's development, particularly as national security space moved toward spacecraft designed with prepared refueling interfaces rather than relying on complex servicing of legacy satellites.[30] The board ultimately recommended discontinuing the mission, and NASA subsequently decided to cancel OSAM-1.[31] OSAM-1 does not represent the entire on-orbit servicing market, but its experience shows how rising costs, long development timelines, and changing customer requirements can prevent technically feasible concepts from becoming practical, affordable services.

Performance remains uneven across the broader capability set because commercial demand does not support every capability required for the integrated sustainment system. GEO life extension has demonstrated a commercial use case, while repeatable repair, orbital resupply, reusable transfer vehicles, propellant distribution, and supporting logistics infrastructure remain much less mature.[32] For satellite systems with strong national security value rather than near-term commercial return, government remains an important customer and development partner.[33] Government support can move these capabilities toward operational use, but government-backed development alone does not create a durable market. Without complementary commercial demand, providers may have fewer opportunities to standardize services, reduce costs, and build the operational experience needed for recurring operations. The market has shown that on-orbit servicing can work and create value, but it has not yet demonstrated that the broader range of services necessary for a sustainment ecosystem can be delivered dependably and at the scale national security missions may require.

Summary

Taken together, the structure, conduct, and performance of the on-orbit servicing market explain why individual capabilities are advancing faster than the broader sustainment system identified in U.S. Space Force planning. Commercial incentives have produced the greatest maturity where demand is strongest, while demonstrations and government partnerships are helping firms build experience and advance less-established capabilities. These efforts are producing real progress, but they have not yet created capabilities able to support sustained military operations across multiple missions and orbits. In this market, the gap does not mean the market is inefficient. Some capabilities the U.S. Space Force may need, particularly those valued for resilience, mobility, or orbital logistics, may not generate enough near-term commercial demand to develop on their own. The gap between commercial demand and military need is what makes targeted action necessary.

Why Government Action Is Necessary & What It Should Do

The market is producing useful servicing capabilities, but it is unlikely to produce the integrated logistics network the U.S. Space Force desires without deliberate government action. Changes in the launch market help explain why. Reusable launch vehicles, higher launch cadence, and proliferated satellite architectures have driven costs from roughly $54,000 per kilogram during the Space Shuttle era to about $3,000 per kilogram on a reused Falcon 9, helping make large constellations and routine satellite replacement economically viable.[34] For operators of smaller, lower-cost spacecraft, particularly in LEO, replacing a degraded satellite is more attractive than paying for an on-orbit servicing solution. That is a rational market response. However, it also directs investments toward the lower-risk markets where replacement makes sense rather than toward the broader repair, mobility, and logistics capabilities the U.S. Space Forces says it will need for sustained operations.[35]

The need for government action is also urgent because the United States is developing this logistics network while China continues to advance comparable servicing and refueling capabilities that could also have several military applications. The People's Liberation Army expects space to play a central role in future conflict and is developing counterspace capabilities intended to disrupt, degrade, or deny an adversary's use of space-based information and services.[36] Those effects would place greater demands on U.S. spacecraft to maneuver, recover from disruption, and remain mission-capable despite attack, making an on-orbit sustainment network increasingly important to maintaining combat power. The U.S. government must therefore act if it expects industry to produce the integrated on-orbit logistics network needed to compete with a state-directed adversary. At the same time, government action should create the demand

and market conditions needed to attract private investment and allow these capabilities to develop into a deeper commercial market rather than remain dependent on government funding.[37] The following recommendations identify where government action can help build that network while preserving a commercially driven market.

Make the appropriate future national security spacecraft service-ready. The U.S. Space Force should incorporate serviceability into acquisition requirements for spacecraft where refueling, repair, or life extension offers a clear operational or lifecycle value. Preparing spacecraft with compatible servicing features would lower the technical difficulty and risk of future servicing missions. Additionally, it would give commercial providers a larger, more predictable customer base. NASA already distinguished "prepared" spacecraft as those intentionally designed with servicing interfaces, and current American Institute of Aeronautics and Astronautics (AIAA) standards efforts are developing common approaches for prepared capture and power/data interfaces.[38] The trade-off is added design integration, mass, and potentially cost for features that may never be used. But adopting standards too early could lock programs into interfaces that are still evolving. The U.S. Space Force should therefore apply serviceability selectively and use ongoing demonstrations and standards work to validate which interfaces should be more broadly adopted.

Develop and validate interoperable servicing standards with allies and industry. The U.S. Space Force should work with industry and selected allies to develop and test common technical and operating standards for on-orbit servicing. Interoperability could expand the number of spacecraft and customers commercial providers can support while also allowing allied and commercial capabilities to contribute to a more resilient logistics network. The U.S. Space Force's 2025 International Partnership Strategy already calls for interoperable capabilities and deeper allied integration, while DARPA's CONFERS and AIAA standards efforts provide an existing foundation for common servicing practices and interfaces.[39] The trade-off is that common standards require coordination across governments and firms and may conflict with proprietary designs, export controls, classification, or rapidly evolving technology. The near-term objective should therefore be to validate interoperability through demonstrations and limited mission sets before pursuing broader adoption.

Create a pathway for mature commercial on-orbit logistics services to provide assured capacity during crisis or conflict. Commercial Augmentation Space Reserve (CASR) provides a useful model because it is designed around voluntary participation, pre-negotiated contracts, training, and surge access to commercial capacity during crisis or conflict.[40] This could provide firms with a clearer long-term government demand signal while allowing the capabilities to remain commercially operated rather than building a separate government-owned logistics fleet. This approach would require recurring readiness and contracting resources even when the reserve is not activated. The principal risk is applying a reserve construct before the market is mature enough to support it, which could result in the U.S. government subsidizing providers that lack recurring commercial demand. CASR, or a similar mechanism, should therefore follow successful demonstrations and certification rather than substitute for them.

Conclusion

Battles are won by weapons; wars are won by the ability to sustain them. While this logic now extends to orbit, the United States is not yet prepared. Launch replacement remains effective for many missions, especially proliferated LEO constellations, but it is insufficient for high-value, fuel-limited GEO systems. These assets are neither redundant nor replaceable on crisis timelines, and they are increasingly vulnerable targets. The technologies and commercial services needed to support on-orbit sustainment are emerging, but they have not yet been integrated or scaled into the dependable logistics network the U.S. Space Force says it will need during conflict. Commercial incentives are producing the greatest maturity where demand is strongest, while higher-risk repair, resupply, mobility, and logistics capabilities continue to depend heavily on government demand and development support. China, meanwhile, is building operational experience with complex GEO proximity operations and possible refueling-related activities while also developing counterspace capabilities intended to disrupt or degrade an adversary's use of space.

If the U.S. Space Force wants an integrated on-orbit logistics network, deliberate government action is necessary. Making appropriate future national security spacecraft service-ready can reduce barriers to servicing and expand the potential market for commercial providers. Developing and validating interoperable standards with allies and industry can increase the number of spacecraft and customers those providers can support.[41] Creating a pathway for mature commercial logistics services to provide assured capacity during crisis or conflict can give the U.S. Space Force access to those capabilities without building a separate government-owned logistics fleet. Together, these actions can help move emerging capabilities toward a commercially supported logistics network that is available when national security missions require it. The window to act is open, but it will not remain open indefinitely. Tomorrow's war may not be won in space, but it could be lost there.[42]

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