



AMERICAN FOREIGN POLICY COUNCIL

# SPACE POLICY REVIEW

SEPTEMBER 2026 • NO. 12

## HIGHLIGHTS

**Launch costs have fallen more than twentyfold** in fifteen years, yet nearly every satellite still flies once and is discarded.

**Returnable satellites can be inspected, upgraded, and reflown**, strengthening resilience and supply chains.

China has already recovered Shijian-19, a **satellite rated for ten-plus flights**.

U.S. doctrine still treats satellites as disposable; **reuse should be treated as infrastructure**.

Under NSPM-17, Congress can act now: put reuse in doctrine, **fund space logistics, and streamline re-entry licensing**.

## THE RETURNABLE SATELLITE: THE MISSING PIECE OF U.S. SPACE RESILIENCE

BRIAN TAYLOR and MICHAEL NAYAK

Orbit has never been cheaper to reach than today, but nearly every satellite is still built to be used once, then abandoned. Static constellations can be held at risk by a widening set of counterspace weapons, disposable platforms are feeding the on-orbit debris population, and the supply chains behind space hardware are increasingly contested, throttling space capability delivered to orbit. We argue that controlled atmospheric re-entry and satellite reuse belong in the category of foundational infrastructure for space resilience and a circular orbital economy, addressing each of these problems. In current

military doctrine on space resilience, every named resilience attribute is bounded by the assumption that the satellite is one-time-use (disposable). The returnable satellite is the missing element of a resilient architecture, and amortized economics favor reusable systems across a wide range of assumptions.

### THE COST OF THROWING SATELLITES AWAY

When every kilogram to orbit was precious, satellites had to be built to the edge of fragility, and the mass of a heat shield, landing system, and reinforced

Brian Taylor is the Founder and Chief Executive Officer of Lux Aeterna, a Denver-based company building fully reusable satellite buses; he has previously worked at SpaceX and Amazon Kuiper, among other space companies.

Dr. Michael Nayak is a strategic advisor to Lux Aeterna, former DARPA Program Manager, space subject matter expert, and the Chief Technology Officer of the XPRIZE Foundation. The views expressed are the authors' own; the lead author's company develops reusable satellite buses.

structure to bring a satellite back to Earth was largely unaffordable. Today's cheap lift raises the mass that can be flown, bringing recovery systems back into focus. Garretson and Havard called reusable super-heavy launch a "Starship Singularity," a break that invalidates old assumptions about scarce and expensive lift.<sup>1</sup> This argument extends from the rocket to the satellite it carries: a *reusable* satellite, as opposed to a one-time use or *disposable* satellite, represents both the next step—reduction in cost, and a step-increase in space resilience and maintainable space defense infrastructure.

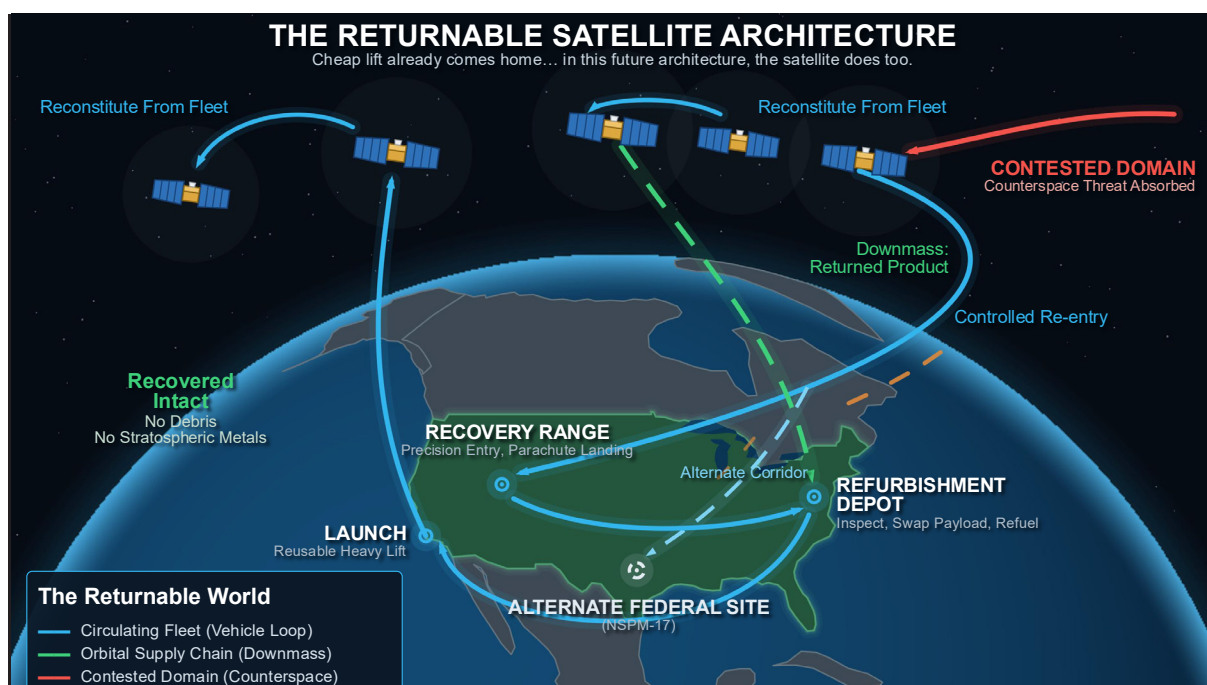
Successive State of the Space Industrial Base assessments have described a primary risk to American space leadership as today's misalignment between a fast-moving strategic narrative and a slow industrial base.<sup>2</sup> The disposable satellite model has calcified this misalignment and risk. By the time any satellite reaches orbit, it encodes an outdated understanding of both mission and adversary. Operators must accept on-orbit degradation, and use software or operational workarounds, to maximize service life and return out of sunk-cost hardware. A platform that has been jammed, dazzled, or compromised through software cannot be withdrawn from the domain and examined; firmware exploits remain on orbit for the life of the asset. Building and launching a replacement satellite is the only way to update the physical hardware, unless a different

capability exists: a circulating reusable fleet that is constantly being refreshed.

A handful of large and costly satellites in known orbits creates an attractive target set, because each node can be held at risk by comparatively inexpensive weapons.<sup>3,4</sup> The recognized answer to that problem is *proliferation*: spreading a mission across many satellites, such that no single loss matters. For example, when Cosmos 2251 accidentally collided with Iridium 33, only a momentary disruption in Iridium service occurred before other satellites in the constellation absorbed the traffic.<sup>5</sup> Today, the Department of War and the Intelligence Community have diversified into proliferated satellite architectures.<sup>6</sup> However, more satellites mean more on-orbit congestion.

A satellite built without the structure to survive recovery leaves its operator with only two choices: leave it in orbit to be tracked and dodged, or let it burn up in the atmosphere. In 2024, the Federal Communications Commission mandated that low Earth orbiting satellites can only remain in orbit for 5 years after completion of their mission, to slow the accumulation of derelict hardware.<sup>7-10</sup> This requires saving propellant to lower a satellite's altitude all the way to deorbit. Lower orbits that minimize this propellant penalty, therefore, are growing even more congested.

**Figure 1. The Returnable Satellite Architecture**



SOURCE: BRIAN TAYLOR AND MICHAEL NAYAK

| COMPONENT CLASS                      | TYPICAL LEAD TIME<br>(PRE-2020) | PANDEMIC-PEAK LEAD TIME |
|--------------------------------------|---------------------------------|-------------------------|
| Commodity semiconductors             | ~13–15 weeks                    | 27–52 weeks             |
| Radiation-hardened / space-grade ICs | 6–12 months                     | 12–24 months            |
| Compute (memory, MPSoCs, GPUs)       | 3–4 months                      | 6–12 months             |

**Table 1.** Representative expansion of component lead times during the 2020–2022 supply-chain disruption. Semiconductor and compute figures reflect distributor lead-time data compiled by Susquehanna Financial Group; space-grade figures reflect industry and government reporting.<sup>21–25</sup>

This congestion has operational effects. In 1978, Kessler and Cour-Palais showed that above a given spatial density, collisions among orbiting objects can become self-sustaining and produce fragments faster than they decay.<sup>11</sup> Liou and Johnson demonstrated that the population in Low Earth Orbit has entered that regime in some altitude bands: the debris count will keep climbing even if every launch stopped.<sup>12</sup> The European Space Agency now tracks over a million objects between 1 and 10 cm, and ~13,600 tons of material on orbit, spread across more than 650 historical fragmentation events.<sup>5, 13–17</sup>

Proliferated architectures also increase supply-chain burdens. Disposable satellites come off serial production lines that draw on a narrow industrial base,<sup>i</sup> so disruptions to that base directly limit what can reach orbit. Supply chains for key components are contested and thin, a key concern inside the national-security enterprise. Proliferated constellations such as Starlink, Amazon Leo, and OneWeb, on top of government systems such as the Space Development Agency transport, tracking, and moving-target indication layers, demand component volumes well beyond present capacity.<sup>18</sup> Additionally, no single body is responsible for detecting or responding to a constrained supply chain<sup>19</sup> across the space enterprise.<sup>ii</sup> The COVID-19 pandemic exposed how brittle this industrial base is (Table 1). Supply-chain choke points also constrain the growth of the space economy by raising the cost of doing business,

slowing new capability deployment, and deterring investors accustomed to the short-term returns of other frontier technology sectors.

Proliferation works, and we do not propose replacing it. However, adding the ability to recover and reuse hardware already proliferated on orbit would address several of these issues directly. For example, reusability would lower the mission impact of any single supply-chain choke point. A returnable satellite architecture *reduces* the per-mission draw on the industrial base, since refurbished and reflown hardware does not call for new parts. A circulating fleet converts a series of one-off procurements into steady, predictable demand. The smaller per-mission draw can relieve immediate constraints, while the steadier demand signal allows suppliers to invest in capacity and move down a learning curve. This lowers per-unit cost, instead of rationing scarce units. As another example, satellite reusability also opens new feedback loops: the root cause behind a degraded sensor or on-orbit anomaly can now be determined by inspection, instead of merely inferred from telemetry.

### WHAT ALREADY FLIES: REUSABILITY AS AN EMERGING SECTOR

Examining SpaceX’s success with reusable launch, whoever first delivers routine, high-cadence return from space will set three things: (1) the operational

i. Examples include a small number of suppliers for solid rocket motors, radiation-hardened electronics, on-orbit compute, rare-earth elements for battery chemistries, permanent magnets in actuator and reaction-wheel motors, and electric propulsion.

ii. The National Reconnaissance Office tracks supply-chain items, but only those critical to its own missions.<sup>20</sup>

| PROGRAM / VEHICLE | ORGANIZATION (COUNTRY)       | CLASS                         | STATUS                                             |
|-------------------|------------------------------|-------------------------------|----------------------------------------------------|
| Shijian-19        | CAST / CNSA (China)          | Reusable returnable satellite | Recovered Oct. 2024; platform rated for >10 reuses |
| Delphi            | Lux Aeterna (US)             | Reusable satellite bus        | Demo launch planned 2027                           |
| W-series          | Varda Space (US)             | Single use return capsule     | Multiple recoveries flown                          |
| Starfall          | SpaceX (US)                  | Reusable cargo return capsule | First demo flight June 2026                        |
| Nyx               | The Exploration Company (EU) | Reusable capsule              | Partial re-entry demonstrated 2025                 |
| PHOENIX           | ATMOS Space Cargo (DE)       | Return capsule                | First re-entry attempted 2025                      |
| Arc               | Inversion Space (US)         | Return / cargo capsule        | Precursor flown; first flight near term            |
| X-37B             | USSF and Boeing (US)         | Reusable spaceplane           | Eight missions; thousands of days on orbit         |
| Dream Chaser      | Sierra Space (US)            | Cargo spaceplane              | Pre-flight testing                                 |
| Shenlong          | CNSA (China)                 | Reusable spaceplane           | Multiple multi-month missions                      |
| Pushpak (RLV-TD)  | ISRO (India)                 | Winged RLV demonstrator       | Three autonomous landing experiments, 2023–2024    |

CREDIT: BRIAN TAYLOR AND MICHAEL NAYAK

**Table 2.** Selected reusable and return-capable orbital systems (status as of mid-2026).<sup>26–36</sup>

tempo competitors have to match, (2) the industrial standards that suppliers and ranges build to, and (3) the norms that regulators will eventually codify. Those that can recover, inspect, and refl y satellite hardware will learn faster from failures, refresh payload generations faster, and bring compromised or anomalous objects home for analysis. Treating reusable return as a foundational capability is therefore a question about resilience, economics, and position in a contested strategic domain.

China’s work in returnable, reusable satellites is fairly advanced. In 2024, the third flight of *Shenlong*, a

reusable orbital spaceplane, stayed in orbit for over 250 days and released multiple sub-satellites to test persistent orbital presence and proximity operations.<sup>26,27</sup>

In October 2024, China recovered Shijian-19 and described it as the country’s first reusable and returnable satellite. The China Academy of Space Technology rates this platform for more than ten flights, and has called it the precursor to a “fifth generation” of recoverable satellites.<sup>28</sup>

Table 2 summarizes recoverable or reusable orbital vehicles that have flown, or are in advanced development, across several countries and mission classes.

Despite these entrants, against a space economy projected to grow from ~\$630B in 2023 toward \$1.8T by 2035,<sup>37</sup> with 11,000 active satellites already on orbit,<sup>18</sup> *downmass*, or mass brought back to Earth, is smaller than the mass lifted into orbit by over two orders of magnitude.<sup>iii</sup> *A shift from returning product from space to returning the platform itself—a closed fleet-style operating loop—has yet to occur.* Lux Aeterna’s Delphi demonstrator, planned for 2027, is one example of a bus designed from initial concept for recovery and reuse.

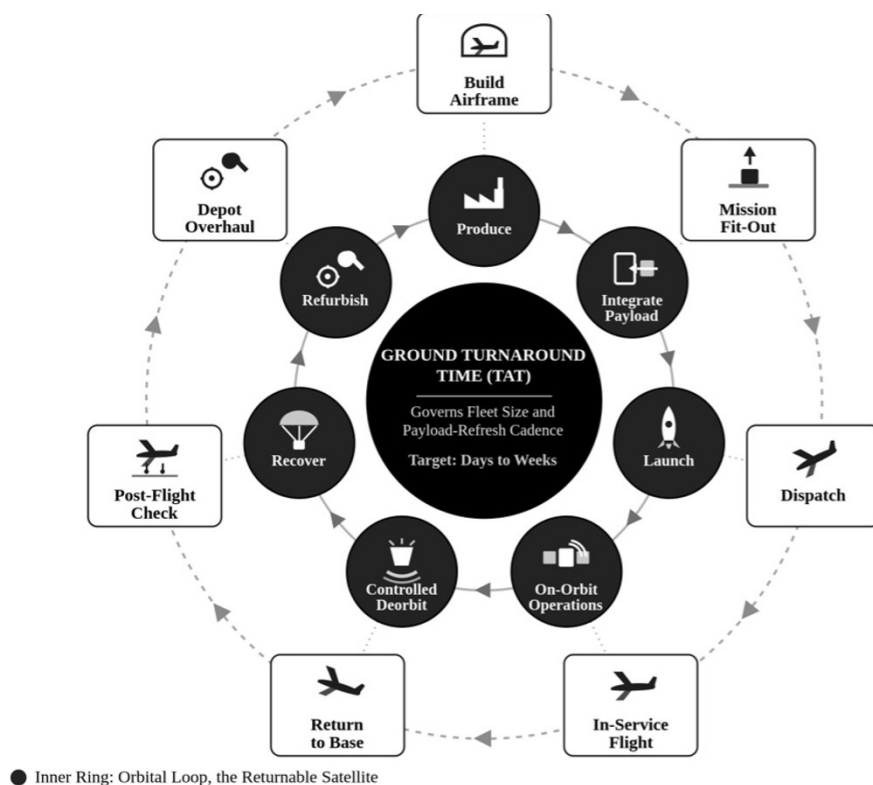
## HOW REUSE WORKS

The case for the returnable satellite begins with the same cost revolution that motivated reusable launch systems: *reusability delivers value only when turnaround is both rapid and inexpensive.*<sup>38</sup>

A returnable satellite flies a closed loop. It is integrated with a payload, launched, and operated on orbit for days to years. It then performs a controlled deorbit, survives re-entry behind a heat shield, is recovered at a designated range, and refurbished to fly again. This mirrors the depot cycle for aircraft. The key variable is *turnaround time (TAT)* on the ground, which sets how many satellites must be built to sustain a given flight rate, and how quickly a new payload generation can reach orbit.

This closed operating loop also decouples the payload from the satellite. Certain parts of a satellite system are slowly evolving, such as power, propulsion, guidance, and communications. A reusable satellite keeps these the same across a series of missions. Meanwhile, the rapidly evolving parts of the system such as sensors, experiments, onboard compute, electronic-warfare suites, antenna apertures, or firmware

**Figure 2. Closed Operating Loop of a Returnable Satellite**



SOURCE: BRIAN TAYLOR AND MICHAEL NAYAK

iii. Authors’ estimate.<sup>18, 34, 35, 37</sup> Global launch has recently placed ~1,000 tons of mass into orbit each year; routine return capacity is dominated by Cargo Dragon, which brings back ~2–3 tons per flight across a small number of flights per year, supplemented by dedicated commercial capsules returning ~100s of kg per mission. Downmass capacity is therefore smaller than upmass by about two orders of magnitude.

can be swapped or upgraded between flights. In a contested space environment, where a sensor, waveform, or payload can become defeatable well inside the design life of the bus carrying it, this decoupling limits what becomes obsolete. It allows a reusable architecture to stay ahead of a fast-moving threat or market, without needing to rebuild the spacecraft each time.

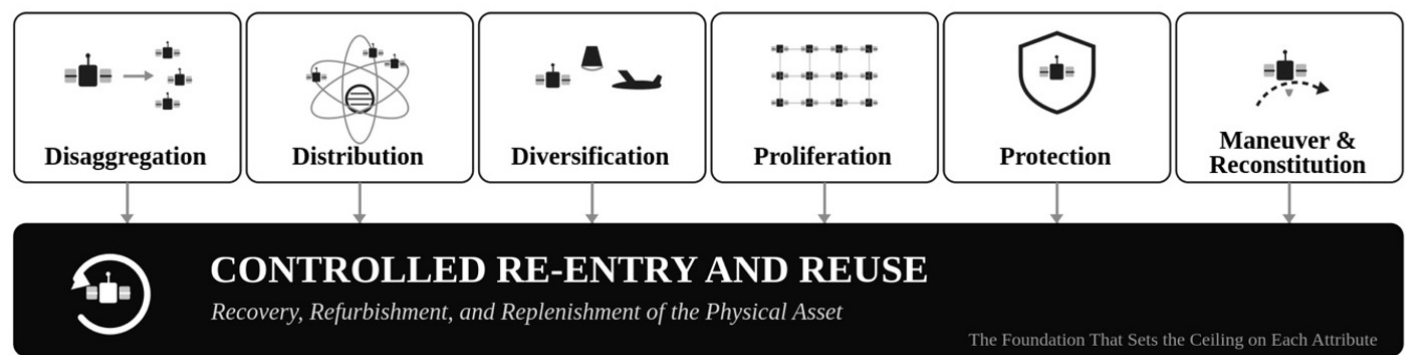
On Earth, a fleet of aircraft or ships is sustained by inspecting, repairing, overhauling, and replacing parts, rather than the overall vehicle. These fleets have high reliability numbers because their critical components are instrumented, and predictive tools schedule maintenance before a part fails. Since a disposable satellite cannot be recovered, the proliferated fleet it belongs to has no depot cycle. With returnable satellites, *unit-level* reliability ceases to be a bottleneck to *mission-level* reliability. A space operator can replace one asset on station with another, and bring degrading units home before they fail. A fleet that maximizes reuse will minimize the need for new components with long lead times or fragile supply chains. Return creates spacecraft that can behave like airframes on a fixed maintenance cycle, and not like consumables. In other words, *building a depot cycle for orbit turns a sequence of one-off deliveries into a circulating fleet, and creates conditions for a future circular orbital economy.*

## CHANGE THE DOCTRINE THAT ASSUMES THE SATELLITE IS DISPOSABLE

The Department of War (then Defense) first codified space resilience in 2011, defining it as the ability of an architecture to keep supporting missions through hostile action or adverse conditions. It named six *attributes* for an architecture to achieve resilience: (1) disaggregation, (2) distribution, (3) diversification, (4) proliferation, (5) protection, and (6) deception.<sup>39, 40</sup> Former U.S. Space Force Chief of Space Operations Gen. Chance Saltzman’s theory of Competitive Endurance reframed them around three tenets, (1) avoiding operational surprise, (2) denying an adversary first-mover advantage, and (3) conducting responsible counter-space operations.<sup>41, 42</sup> *Space Warfighting: A Framework for Planners* decomposes space superiority into orbital warfare, electromagnetic warfare, and space-domain awareness; it treats sustained maneuver and the regeneration of lost capability as planning assumptions.<sup>43, 44</sup>

U.S. Space Command’s *Space Warfighting Environment 2040* (SWE2040)<sup>45</sup> extends these expectations to a projected future operating environment, and names survivability, maneuver, resilience and rapid reconstitution as foundational requirements.<sup>iv</sup> Despite projecting that orbital architectures will move from fixed to dynamic, it stops unfortunately short of the obvious conclusion. Every on-orbit sustainment mechanism that it contemplates keeps the physical asset in

Figure 3. Recognized Resilience Attributes



iv. Specifically: “survivability through numbers, mobility through sustained propulsion and servicing, replaceability through commercial capacity, and resilience through hybrid architectures that do not rely on any single platform or partner.”

orbit, and asks more of it without questioning whether it should be expendable in the first place. Reusable launch is used as an example of compressed innovation, but that logic is not extended to the payload the launch rocket carries. Its answer to attrition is “replaceability through commercial capacity”,<sup>45</sup> which makes resilience a function of how fast American factories can build.

In other words, current space doctrine neglects an unexploited edge: the role of reusable satellites as foundational infrastructure by which to achieve resilience. Each of the named attributes is limited by the fact that space hardware cannot be brought back, repaired, and returned to the fleet. For example, *reconstitution* aims to replace losses quickly, but a warehouse of spare satellites is simply idle capital until a crisis arrives.<sup>46-48</sup> A reusable fleet inverts this concept. Reconstitution changes from being triggered by loss to continuous: the fleet is always partly on orbit, partly in transit, and partly on the ground being refreshed. Warfighting units can rehearse weekly what they would otherwise have to improvise in a crisis, and a wartime surge case differs only in tempo from the steady state. Reusable satellites as part of a space mobility and logistics portfolio would add new capabilities of teardown, failure analysis, recalibration against a reference standard, and rapid upgrades.

The six recognized attributes form the visible layer of resilience, while controlled re-entry and reuse form the foundation that determines how much resilience each of them can deliver. Reuse does not substitute for the recognized attributes; it merely changes *how much of each one an architecture can actually buy*. A reusable architecture proliferates without proliferating cost, reconstitutes from an active rotation and not from a dead stockpile, and can maneuver aggressively because propellant is replenished on the ground. This is why we treat reuse as foundational.

## THREE OBJECTIONS

A vehicle that returns to Earth must carry a thermal protection system, a reinforced structure, a landing system, and propellant for a controlled deorbit. It also transits the most expensive part of the gravity well

twice. This recurring penalty “tax” on payload fraction does not disappear, but its price has fallen by an order of magnitude with the lower prices of space launch today.<sup>49,50</sup> Cheaper lift, in other words, can pay for the structure that will bring the satellite home. If the delivered product is data or energy,<sup>v</sup> no down-mass is required. A recovery investment here buys only the option to renew the platform. Reuse, and a Closed Operating Loop, is therefore likely strongest where the hardware is scarce, expensive or rapidly improving.

Reuse also adds ways for a mission to fail that a disposable satellite does not have: controlled entry, precision guidance to a recovery range, deployable structures that survive entry loads, and repeated cycling across re-flights. All of these are complex mechanical design problems, with solutions that have multiple points of failure. However, entry and recovery are repeated instrumented events: each recovered article feeds into the qualification of the next article. Over multiple flights, failure mechanisms become known, and engineering tolerances can be increased. This is analogous to the many failures inherent in early jet engines, yet today, jet passenger travel is one of the most reliable forms of transportation.

Concentrating scarce components in a smaller number of circulating buses concentrates risk, and an adversary’s aimpoint may shift toward the vehicles carrying the valuable parts. The remedy for concentration is one the space community already accepts: proliferation. Return then adds what proliferation alone does not: the ability to bring degraded nodes back, to increase the precision of space-to-ground product delivery, and for valuable space-qualified components to re-enter the supply chain.

The closest competing approach is *on-orbit servicing*.<sup>51-54</sup> A software-defined payload can retask a radio or a processor within the envelope of the silicon already flown, and a servicer can refuel, relocate or replace a module designed for replacement. However, neither can substitute a new-generation focal plane, perform destructive failure analysis, recalibrate an instrument against a terrestrial reference, or requalify a bus for a different mission. Physical renewal of the

---

v. Notional examples: orbital compute or power beaming.

satellite itself generally requires a returnable architecture. The 2026 failure of Katalyst Space's LINK recovery satellite, to boost the decaying orbit of the Neil Gehrels Swift Observatory, illustrates how the two approaches can complement each other. Had LINK been recoverable, it could have been brought home and repaired, or a second identical article drawn from a circulating fleet and reflight inside Swift's remaining orbital window. As it happened, both spacecraft were stranded on orbit.<sup>55</sup>

However, reusability may raise the ceiling on the servicing sector the same way it would elsewhere in the architecture: a diversified architecture would reserve on-orbit servicing and maintenance for the highest-value space assets, make the servicing element itself recoverable and reflitable, and augment both with cheap mass drawn from commercially owned and operated platforms. This makes reusability and on-orbit servicing complementary, even if not substitutable.

## WHAT THE NUMBERS SAY

Spacecraft are usually compared on first-flight cost per vehicle. This comparison works when every vehicle flies once. For a reusable system, since the first flight carries the full build cost and each later flight spreads that cost out, the meaningful quantity is cost per kilogram delivered, averaged across the life of the vehicle. Disposable satellites are typically not built at constant unit cost either. Building in batches makes each unit cheaper, because fixed engineering costs spread across the production run and parts get cheaper in volume.

Here we develop that comparison, normalized to the first flight of a reusable bus. We assume communications satellites reach approximately 60% of first-unit cost by the fourth unit, and remote-sensing satellites about 70% by the sixth. In comparison, a reusable bus starts higher, since it carries the additional mass and cost of a heat shield and landing hardware; its advantage comes almost entirely from flying again.

The number that decides the outcome is the *replacement fraction*: the share of the original build cost that must be spent again to make a recovered vehicle ready for its next flight. This covers replaced parts, labor to take the vehicle apart and put it back together, and the cost to recertify it for flight. This fraction is estimated here by analogy to aircraft depot overhaul and to reusable rocket refurbishment; since neither analogy is yet

anchored in flight data for satellites, this is the least constrained input in our model.

The replacement fraction follows a "U" across the life of the vehicle. Early on, learning dominates: each flight reveals parts that did not need replacing and inspections that did not need doing, reducing work required. Later, wear dominates: heat shield recession, seal and fastener fatigue, and accumulated cycles on structure and propulsion push the work back up. We model this starting near 60% of build cost on the first cycle, falling to ~35% by the third or fourth as learning accumulates, then rising until it meets a *scrap threshold*, at which point the vehicle is retired. For this analysis, the scrap threshold is set at 70% of a new build. On that schedule the reusable curve crosses an equivalent disposable bus at the *second flight* and a cost-optimized communications bus by the third, reaches its minimum near the tenth flight, and settles at about *one-third* of the first-flight cost. The build investment generally becomes a small part of the per-flight cost once the vehicle has flown a handful of times.

Turnaround time governs how many vehicles a reusable fleet needs. While a disposable program consumes one new vehicle per mission, a reusable fleet needs only as many vehicles as the ground process forces into simultaneous circulation. Sustaining 52 missions a year takes approximately 2 vehicles at a two-week turnaround, 5 at a month, and 13 at three months. Two weeks is likely achievable for refurbishment alone; with launch integration included, a realistic landing-to-relaunch interval is 5-6 weeks, which puts a returnable fleet at about 5 vehicles. This can be compared to 52 new disposable satellites required over the same year to maintain a weekly cadence. *Even with maximally efficient automotive-style processing, returnable satellites end up economically ahead.*

Overall, three features of this non-dimensionalized analysis are notable. The steepest cost reduction occurs within the first few flights, which matters to any funder, public or private, deciding whether to fund the second vehicle. The floor beneath each reusable curve is set largely by the price of launch, so reusable satellites and reusable rockets compound in a way neither reaches alone. Each curve also has a cost-optimal life, near ten flights in our model, beyond which accumulated wear tends to raise the average cost again. These values are directional: learning rates, reuse fractions, and refurbishment costs will vary by mission class and by design.

Nevertheless, amortized economics favor reuse across a wide range of assumptions. Flight data from early reusable demonstrators will be needed to anchor this model in real return data.

## RECOMMENDATIONS FOR POLICYMAKERS

These recommendations arrive at a favorable moment: on August 20, 2026, the White House National Space Transportation Policy (NSPM-17) treated re-entry, for the first time, as more than a residual of launch.<sup>56</sup> It sets a national goal of 1,000 launches and re-entries per year by 2030, designated re-entry sites, space re-entry management integrated into airspace modernization, and a space transportation industrial base strategy. The recommendations that follow are therefore matters of implementation and not of new authority.

### 1. Name Reuse as a Resilience Attribute in

**Doctrine.** Doctrine shapes acquisition; unnamed attributes will not be acquired. The Department of War and the Space Force should treat recovery,

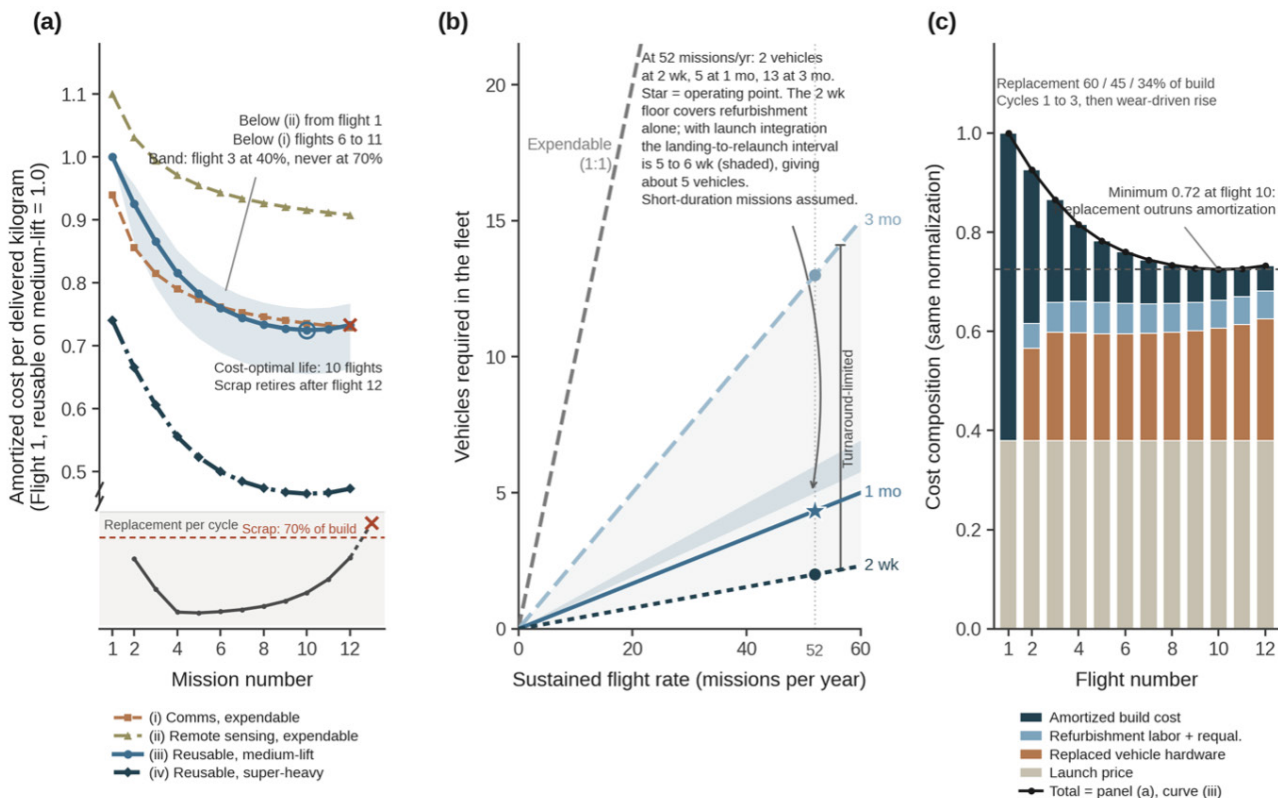
refurbishment, and replenishment (or “reuse”) as an explicit attribute of resilient space architectures, alongside disaggregation, proliferation, protection, and maneuver. In the annual National Defense Authorization Act or its accompanying conference report, the House and Senate Armed Services Committees (HASC/SASC) should direct the Department of War to report on three specific questions:

- Are recovery, refurbishment, and replenishment represented in current resilience taxonomies and force-design guidance?
- Which major programs of record have evaluated a returnable-fleet alternative within their analyses of alternatives, and with what result?
- Where does the Department assess the cost and cadence crossover point to be, at which a circulating fleet becomes preferable to disposable replacement?

### 2. Fund Space Mobility, Logistics, and

**Reconstitution as a Core Capability.** Congress and the Space Force should baseline funding for space

Figure 4. Fleet economics of reuse, normalized to the first reusable flight. Values are illustrative and do not represent any specific company model.



SOURCE: BRIAN TAYLOR AND MICHAEL NAYAK

access, mobility, logistics, and rapid reconstitution as core mission areas. Industrial-base assessments have noted that these are currently treated as discretionary or residual line items, vulnerable to cuts even as doctrine elevates them.<sup>2, 57</sup> A returnable fleet is one physical instantiation of these mission areas, and a stable demand signal is needed to realize its potential.

**3. Bridge the Transition Gap for Return-Enabling Technology.**

The Department of War should use non-dilutive funding mechanisms such as APFIT,<sup>vi</sup> and private-funds matching mechanisms such as Prototype Other Transaction Authority and SBIR/STRATFI/TACFI<sup>vii</sup> or Strategic Breakthrough programs, to advance those dual-use technologies that enable controlled return, including thermal protection and precision entry guidance, from demonstration into operational capability.<sup>58</sup> Programs that have attracted private investment are strong candidates for matched public investment that accelerates the transition without substituting for the market.

**4. Build a Predictable, High-Cadence Re-entry Regulatory Regime.** The current per-flight licensing regime treats each mission as a discrete event requiring bespoke analysis every time.<sup>59</sup> The Federal Aviation Administration should immediately modify its commercial reentry licensing process so that return operations are handled through predictable, expedited type approvals that draw on previous heritage and repeatable mission profiles. Designated recovery ranges (e.g., as directed by NSPM-17) should also hold standing authorizations.<sup>56</sup>

**5. Name Reuse in the Contested Logistics Critical Technology Area and Harden the Space Supply Chain.** The Department of War should name “recovery and reuse” as a component of the Contested Logistics Critical Technology Area for space, due to its potential for mitigating supply chain concerns. A circulating reusable fleet can reduce per-mission draw on that base and convert one-off procurements into the predictable demand a healthy industrial base requires. The executive branch and Congress should invest in the industrial base that supplies orbital systems, particularly where concentration is a documented single point of failure, as in compute, propulsion, and radiation-hardened electronics.<sup>2, 60</sup>

**In summary: spaceflight has solved half of an economic and strategic problem with launch vehicles that return and refly routinely. The satellites they carry are the other half; today, their disposable nature creates an architecture difficult to reconstitute when attacked, and an orbital environment filling with debris. Solving this problem can close supply chain gaps with the return of high-demand material from space, and incentivize the logistics to power a future orbital economy. Recovering, refurbishing, and reflying the physical asset converts the average spacecraft from a consumable into a circulating element of a resilient fleet. Policy should recognize controlled re-entry and reuse as foundational infrastructure, and fund, regulate and field them accordingly.**

## ENDNOTES

1. Garretson, P. A., and Havard, S., "The Starship Singularity," *Space Policy Review*, No. 2, American Foreign Policy Council, Washington, DC, Feb. 2023.
2. Olson, J., Butow, S., Garretson, P., Williams, A., and Metcalf, A. (eds.), *State of the Space Industrial Base 2023: A Time to Build*, Defense Innovation Unit, U.S. Space Force, and Air Force Research Laboratory, 2024.
3. Samson, V., and Cesari, L. (eds.), *Global Counterspace Capabilities: An Open Source Assessment*, Secure World Foundation, Broomfield, CO, Apr. 2025.
4. Swope, C., Bingen, K. A., Young, M., and LaFave, K., *Space Threat Assessment 2025*, Aerospace Security Project, Center for Strategic and International Studies, Washington, DC, Apr. 2025.
5. Johnson, N. L., "The Collision of Iridium 33 and Cosmos 2251: The Shape of Things to Come," Paper IAC-09.A6.2.4, 60th International Astronautical Congress, Daejeon, Republic of Korea, 2009 (NASA NTRS 20100002023).
6. Plumb, J., Statement on Space Policy before the Subcommittee on Strategic Forces, U.S. House Armed Services Committee, Washington, DC, 1 May 2024.
7. Federal Communications Commission, *Mitigation of Orbital Debris in the New Space Age*, Second Report and Order, FCC 22-74, IB Docket Nos. 18-313 and 22-271, Washington, DC, 2022.
8. NASA, *Process for Limiting Orbital Debris*, NASA-STD-8719.14C, Washington, DC, 2021.
9. International Organization for Standardization, *Space Systems: Space Debris Mitigation Requirements*, ISO 24113:2023, Geneva, 2023.
10. United Nations Committee on the Peaceful Uses of Outer Space, *Guidelines for the Long-Term Sustainability of Outer Space Activities*, UN Doc. A/74/20, Annex II, Vienna, 2019.
11. Kessler, D. J., and Cour-Palais, B. G., "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt," *Journal of Geophysical Research*, Vol. 83, No. A6, 1978, pp. 2637–2646. doi:10.1029/JA083iA06p02637
12. Liou, J.-C., and Johnson, N. L., "Instability of the Present LEO Satellite Populations," *Advances in Space Research*, Vol. 41, No. 7, 2008, pp. 1046–1053. doi:10.1016/j.asr.2007.04.081
13. Kelso, T. S., "Analysis of the 2007 Chinese ASAT Test and the Impact of its Debris on the Space Environment," *Proceedings of the AMOS Technical Conference*, Maui, HI, 2007.
14. NASA Orbital Debris Program Office, "Chinese Anti-Satellite Test Creates Most Severe Orbital Debris Cloud in History," *Orbital Debris Quarterly News*, Vol. 11, No. 2, 2007, pp. 2–3.
15. Pardini, C., and Anselmo, L., "The Short- and Long-Term Effects of the Microsat-R Anti-Satellite Test and Other Debris-Generating Events," *Acta Astronautica*, Vol. 188, 2021 (also arXiv:2111.12196).
16. NASA Orbital Debris Program Office, "Direct-Ascent Anti-Satellite Test Creates Significant New Debris," *Orbital Debris Quarterly News*, Vol. 26, No. 1, 2022, pp. 1–3.
17. European Space Agency Space Debris Office, *ESA's Annual Space Environment Report 2025*, GEN-DB-LOG-00288-OPS-SD, Issue 9.0, ESA/ESOC, Darmstadt, Germany, 2025.
18. Satellite Industry Association and BryceTech, *State of the Satellite Industry Report 2025*, Washington, DC, 2025.
19. U.S. Government Accountability Office, *Defense Industrial Base: Actions Needed to Address Risks Posed by Dependence on Foreign Suppliers*, GAO-25-107283, Washington, DC, 2025.
20. Office of the Director of National Intelligence, *Intelligence Community Directive 731: Supply Chain Risk Management*, Washington, DC, 7 December 2013.
21. "Space Force Assessing Supply Chain Ahead of Potential Tariff Concerns," *Via Satellite*, 10 April 2025.
22. "Space Boom Strains Supply Chain, Industry Report Warns," *SpaceNews*, 17 March 2026.
23. Susquehanna Financial Group semiconductor lead-time data, reported in "Semiconductor Average Lead Time Breaks Half-Year Barrier," *The Register*, 14 April 2022.
24. Susquehanna Financial Group semiconductor lead-time data (FPGA lead times at a 52-week ceiling), reported in "Lead Times Fall by a Day," *Electronics Weekly*, July 2022.
25. The Impact of Electronic Component Shortages on the Global Space Industry," *EDN*, 25 January 2022.
26. Secure World Foundation, *Shenlong Orbital Test Vehicle Fact Sheet*, Broomfield, CO, June 2025; Jones, A., "China's Secretive Reusable Spaceplane Lands After 267 Days in Orbit," *SpaceNews*, 2024.
27. "The Strategic Implications of China's Divine Dragon Spaceplane," *The Diplomat*, Jan. 2024.
28. Jones, A., "Shijian-19 Reusable Satellite Lands After 2 Weeks in Space," *SpaceNews*, 11 Oct. 2024; China National Space Administration, *Shijian-19 Payload Handover Ceremony*, Beijing, 24 Oct. 2024.
29. Indian Space Research Organisation, *RLV LEX-03: Reusable Launch Vehicle Landing Experiment*, Aeronautical Test Range, Chitradurga, India, 23 June 2024.
30. Foust, J., "Varda Capsule Lands in Utah," *SpaceNews*, 22 Feb. 2024.
31. Sierra Space, "Dream Chaser Spaceplane Successfully Completes Critical Pre-Flight Milestones," Press Release, Louisville, CO, 13 Nov. 2025.
32. Foust, J., "The Exploration Company Claims Partial Success of Mission Possible Reentry Spacecraft," *SpaceNews*, June 2025.
33. ATMOS Space Cargo, "Mission Completion Update: PHOENIX 1," Aalen, Germany, 2025.
34. Federal Aviation Administration, *Environmental Assessment for SpaceX Starfall Reentry Vehicle Operations in the Pacific Ocean*, Federal Aviation Administration, Washington, DC, May 2026.
35. "SpaceX Launches Reentry Capsule Demo Mission Called Starfall," *Spaceflight Now*, 23 June 2026.
36. Foust, J., "Lux Aeterna Emerges from Stealth with Funds for Fully Reusable Satellite Platform," *SpaceNews*, 25 June 2026.

- 2025.
37. World Economic Forum and McKinsey & Company, *Space: The \$1.8 Trillion Opportunity for Global Economic Growth*, Geneva, 2024.
38. Pielke, R., and Byerly, R., "Shuttle Programme Lifetime Cost," *Nature*, Vol. 472, 2011, p. 38. doi:10.1038/472038d
39. U.S. Department of Defense, *Fact Sheet: Resilience of Space Capabilities*, Office of the Secretary of Defense, Washington, DC, 2011.
40. Pawlikowski, E., Loverro, D., and Cristler, T., "Disruptive Challenges, New Opportunities, and New Strategies," *Strategic Studies Quarterly*, Vol. 6, No. 1, 2012, pp. 27–55; see also Air Force Space Command, *Resiliency and Disaggregated Space Architectures*, White Paper, 2013.
41. United States Space Force, *Spacepower: Doctrine for Space Forces*, Space Capstone Publication, U.S. Space Force, Washington, DC, June 2020.
42. Saltzman, B. C., *Competitive Endurance: A Proposed Theory of Success for the U.S. Space Force*, White Paper, U.S. Space Force, Washington, DC, Jan. 2024.
43. United States Space Force, *Space Force Doctrine Document 1: The Space Force*, Washington, DC, 3 Apr. 2025.
44. United States Space Force, *Space Warfighting: A Framework for Planners*, Washington, DC, Apr. 2025.
45. U.S. Space Command, *The Space Warfighting Environment 2040: Framing the Future for the Joint Warfighter*, Joint Force Development and Training (J7), Future Concepts Branch, 2026.
46. Firefly Aerospace, "Mission Complete: Alpha FLTA003 VICTUS NOX," Cedar Park, TX, 2023.
47. Space Systems Command, "Space Systems Command Awards Tactically Responsive Space Contracts in Support of VICTUS HAZE Mission," U.S. Space Force, 11 Apr. 2024.
48. Albon, C., "'Victus Haze' Responsive Space Mission Pushed to 2026," *Air & Space Forces Magazine*, 2025.
49. Jones, H. W., "The Recent Large Reduction in Space Launch Cost," *48th International Conference on Environmental Systems*, ICES-2018-81, Albuquerque, NM, 2018 (NASA NTRS 20200001093).
50. Roberts, T. G., "Space Launch to Low Earth Orbit: How Much Does It Cost?," Aerospace Security Project, Center for Strategic and International Studies, Washington, DC, 2022.
51. Intelsat and Northrop Grumman, "Historic First Docking of Mission Extension Vehicle with Intelsat 901 Satellite," Press Release, 26 Feb. 2020.
52. NASA, "Update on the Status of NASA's OSAM-1 Project," Washington, DC, 1 Mar. 2024; NASA Office of Inspector General, *NASA's On-Orbit Servicing, Assembly, and Manufacturing 1 (OSAM-1) Project*, Report IG-24-002, 2023.
53. Saleh, J. H., Lamassoure, E., and Hastings, D. E., "Space Systems Flexibility Provided by On-Orbit Servicing: Part 1," *Journal of Spacecraft and Rockets*, Vol. 39, No. 4, 2002, pp. 551–560. doi:10.2514/2.3844
54. Long, A. M., Richards, M. G., and Hastings, D. E., "On-Orbit Servicing: A New Value Proposition for Satellite Design and Operation," *Journal of Spacecraft and Rockets*, Vol. 44, No. 4, 2007, pp. 964–976. doi:10.2514/1.27117
55. NASA, "NASA Updates Next Steps for Commercial Swift Boost Mission," News Release, Washington, DC, 19 Aug. 2026; Foust, J., "Pegasus Launches Swift Reboost Mission," *SpaceNews*, 3 July 2026.
56. The White House, The National Space Transportation Policy, National Security Presidential Memorandum NSPM-17, Washington, DC, 20 Aug. 2026.
57. Gleason, M., and Hays, P., *Enabling a New Space Paradigm: Harnessing Space Mobility and Logistics*, Center for Space Policy and Strategy, The Aerospace Corporation, El Segundo, CA, 2023.
58. SpaceWERX, "STRATFI / TACFI Program," U.S. Space Force, accessed 2026.
59. Federal Aviation Administration, *Streamlined Launch and Reentry Licensing Requirements*, 14 CFR Part 450, Washington, DC, 2020.
60. The White House, ≠ (NSM-22), Washington, DC, 30 Apr. 2024; Cybersecurity and Infrastructure Security Agency, "Critical Infrastructure Sectors," CISA, 2024.

# SPACE POLICY REVIEW

## ABOUT THE SPACE POLICY INITIATIVE

For America, space represents the next great strategic frontier. Yet the United States now faces growing competition in that domain from countries like Russia and China, each of which are developing technologies capable of targeting U.S. space assets. As such, defining a strategy for ensuring space security, sustainability, and commerce needs to be a strategic priority for the U.S. AFPC's top-notch array of experts form a robust team that make a major contribution to crafting space policy by providing policymakers with the ideas and tools they need to chart a course in this emerging domain.

For regular insights from space thought leaders tune into SPI's Space Strategy podcast (available at <https://anchor.fm/afpcspacepod>). SPI co-directors: Richard M. Harrison and Peter A. Garretson.

## THE AMERICAN FOREIGN POLICY COUNCIL

For more than four decades, AFPC has played an essential role in the U.S. foreign policy debate. Founded in 1982, AFPC is a 501(c)(3) non-profit organization dedicated to bringing information to those who make or influence the foreign policy of the United States and to assisting world leaders with building democracies and market economies.

AFPC is widely recognized as a source of timely, insightful analysis on issues of foreign policy, and works closely with members of Congress, the Executive Branch and the policymaking community. It is staffed by noted specialists in foreign and defense policy, and serves as a valuable resource to officials in the highest levels of government.

## AFPC MISSION STATEMENT

The American Foreign Policy Council seeks to advance the security and prosperity of the United States by:

1. Providing primary source information, as well as policy options, to persons and organizations who make or influence the national security and foreign policies of the United States;
2. Arranging meetings and facilitating dialogue between American Statesmen and their counterparts in other countries; and
3. Fostering the acceptance and development of representative institutions and free market economies throughout the world in a manner consistent with the Constitution, the national interest, and the values of the United States.



### The American Foreign Policy Council

509 C Street NE  
Washington, DC 20002  
(202) 543-1006  
Fax: (202) 543-1007  
[www.afpc.org](http://www.afpc.org)

**Mr. Herman Pirchner, Jr.**  
*President*

**Mr. Ilan Berman**  
*Senior Vice President*

**Mr. Richard M. Harrison**  
*Vice President of Operations and Director of  
Defense Technology Programs*

**Mrs. Annie Swingen**  
*Vice President for External Relations*

**Dr. S. Frederick Starr**  
*Distinguished Fellow for Eurasia and Chairman  
of the Central Asia-Caucasus Institute*

**Dr. Svante E. Cornell**  
*Senior Fellow for Eurasia and Director of  
Research & Publications of the Central Asia-  
Caucasus Institute*

**Ms. Laura Linderman**  
*Senior Fellow for Eurasia and  
Director of Programs of the Central  
Asia-Caucasus Institute*

**Ms. Anna Harvey**  
*Research Fellow and Program Officer*

**Ms. Calla O'Neil**  
*Research Fellow and Program Officer*

**Mr. Alexander John Paul Lutz**  
*Research Fellow and Program Officer*

### BOARD OF ADVISORS

Amb. Paula J. Dobriansky, PhD.  
Hon. Christopher Ford, PhD.  
Amb. James S. Gilmore, III  
Hon. Newt Gingrich  
Hon. Michelle S. Giuda  
Sen. Robert Kasten, Jr.  
Hon. Ellen E. McCarthy  
Amb. Richard McCormack  
Gov. Thomas J. Ridge  
Dr. William Schneider, Jr.  
Hon. Manisha Singh  
Hon. Dov Zakheim