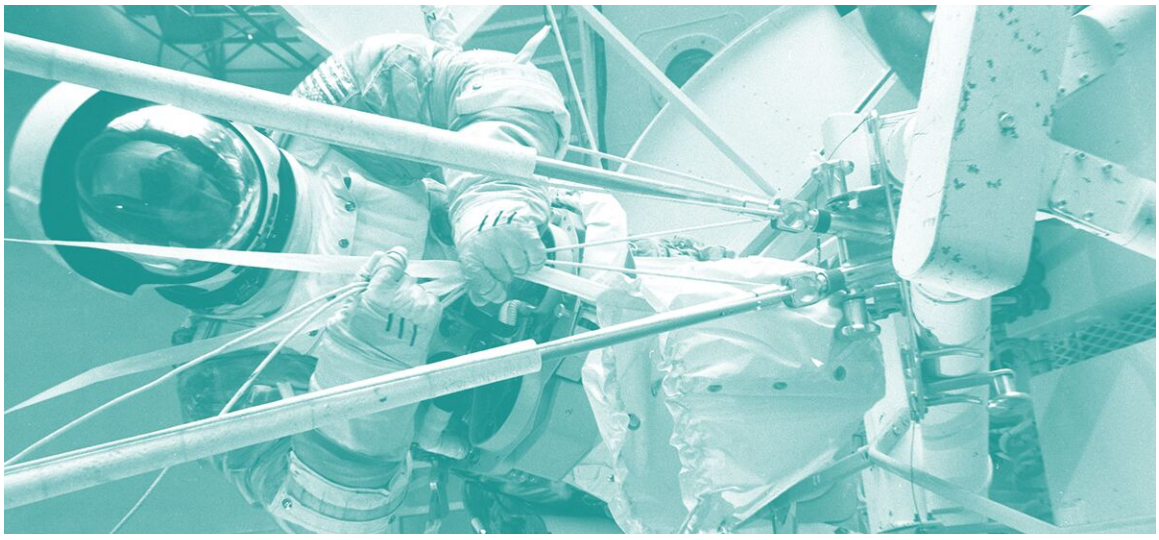
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PART III · THE SILICON SHIELD

The Orbital Economy Needs a Defense Plan

Daniel King, Soham Mehta



Astronauts Russell Schweickart and Edward Gibson rehearse an emergency Skylab repair underwater at Marshall Space Flight Center, Alabama, 1973. The rehearsal foreshadowed a challenge of the orbital economy: protecting infrastructure that is far easier to disrupt than to repair.

NASA / Marshall Space Flight Center.

SUMMARY

Nearly all FLOPs currently take place on Earth, but nearly all of humanity's future FLOPs will take place *off* Earth. Exactly when computing in space will scale remains uncertain, but key infrastructure may enter low Earth orbit sooner than policymakers expect.

In the future, far more than GPUs could migrate to orbit. Space-based solar power grids could beam energy back to terrestrial batteries supplying a myriad of industries, not just data centers. Companies like Varda and Space Forge plan to build autonomous orbital factories that leverage space's microgravity environment to manufacture delicate, valuable products like pharmaceuticals and semiconductors. As the American economy's center of gravity moves toward zero gravity, taking a robust orbital economy seriously means recognizing its fragility and proactively preparing to defend it. The Space Force should prepare for this transition by launching an Orbital Infrastructure Resilience Challenge to develop cost-effective

defenses, while clarifying to companies ahead of time which important commercial systems can expect military protection when they come under attack.

SPACE INFRASTRUCTURE CURRENTLY FACES A BRUTAL ASYMMETRY: IT IS EXPENsive to build and difficult to service, but comparatively easy to disrupt. Kinetic anti-satellite weapons (ASATs) launched from Earth—"direct-ascent" ASATs—can be much lighter than satellites and need not be placed in a sustained orbit, "making them the simplest type of satellite interceptor weapons to design, build, and test."[1] While orbital assets must conserve propellant to maintain maneuverability over their entire lifespan—for debris avoidance and eventual deorbiting—a direct-ascent ASAT needs only enough fuel for one collision. For now, the unit economics of space are trending in a reassuring direction: the manufacturing efficiencies developed for massive telecommunications constellations have driven down the cost of the average Starlink satellite to just a fraction of the cost of a Chinese ASAT.[2] However, if the orbital installations of the future are filled to the brim with radiation-hardened AI accelerators and advanced robotics, this will no longer be true. Indeed, just the computing hardware that SpaceX expects to put aboard its first Starmind satellite will match or exceed the cost of an ASAT, and that's before factoring in the cost of launch, power systems, and cooling.[3] Orbital vehicles are also sitting ducks by terrestrial standards: a direct-ascent ASAT can reach low Earth orbit in just 5–15 minutes and use onboard guidance to make last-minute corrections to its trajectory, leaving little room for satellites to make evasive maneuvers.[4]

The recent wars in Ukraine and Iran offer a terrestrial reminder of what happens when one side of a conflict has a decisive cost and mobility advantage. The Iran war's total cost for the U.S. surpassed $11.3 billion within six days in part because, while Iran's Shahed drones cost about $35,000 apiece, the Patriot missile used to intercept them can cost $4 million—a defense-to-offense ratio exceeding 100:1.[5] Ukraine has used mass-produced drone swarms to strike Russian infrastructure and bombers parked on the tarmac thousands of miles from the front while largely bypassing stagnant Russian defenses limited to the most obvious attack routes.[6] America cannot af-

1 Air University, *AU-18 Space Primer*, 3rd ed. (2023), 30–31; Zachary Burdette, "The U.S.-China Military Balance in Space: Implications for Future Warfare in the Pacific," *International Security* 49, no. 4 (Spring 2025).

2 Burdette, "U.S.-China Military Balance in Space," 105–109.

3 NVIDIA, "SpaceXAI Adopts NVIDIA Vera CPU to Accelerate Agentic AI at Massive Scale," August 24, 2026; Anton Shilov, "Nvidia's Memory Costs Soar 485%, Latest AI Systems Now Cost $7.8 Million to Build," *Tom's Hardware*, May 21, 2026; Burdette, "U.S.-China Military Balance in Space," 105–109.

4 Burdette, "U.S.-China Military Balance in Space," 100–102; Defense Intelligence Agency, *Challenges to Security in Space* (2019), 9.

5 Mark F. Cancian and Chris H. Park, "Iran War Cost Estimate Update: $11.3 Billion at Day 6, $16.5 Billion at Day 12," Center for Strategic and International Studies, March 13, 2026; Fareed Zakaria, "In Iran, the Future of War Is Coming into View," *Washington Post*, March 20, 2026.

6 Tom Balmforth and Max Hunder, "To Attack Russian Air Bases, Ukrainian Spies Hid Drones in Wooden Sheds," *Reuters*, June 1, 2025; Dan Peleschuk and Tom Balmforth, "Ukrainian Mid-Range Strikes Deal Double Blow to Russia's War Effort," *Reuters*, May 19, 2026.

ford to replicate this painful dynamic in space. We cannot expect exquisite cost-burning machines to sustainably defend against cheap, repeatable attacks on our orbital assets.

However, even this analogy to missile defense breaks down upon closer inspection because the reality in space is far bleaker: there are no mature methods to physically deflect direct-ascent ASATs today.[7] The American dogma in space resilience has largely accepted that individual satellites may be shot down and instead emphasizes resilience, recommending that networks spread functionality across many satellites, diversify orbits, and maintain the ability to replenish attrited satellites quickly.[8] Luck would have it that this simply works with the current economics of space—for now, the likes of Starlink can cheaply tolerate the loss of individual satellites. But a looming need to protect less fungible, more expensive targets means that we must seriously consider developing active defenses, even ones that today seem speculative.

There is no absence of ideas for more active space defense, but few are anything more than mere proposals. Researchers have suggested equipping satellites with lasers that could blind an incoming interceptor, deploying dedicated "bodyguard" satellites capable of disrupting or firing back at an attacker, and using robotic spacecraft to seize or divert threatening spacecraft operating nearby.[9] But there are essentially no unclassified programs to seriously test any of these. The U.S. has made a few serious forays into orbital defense in 2026, but these have been limited to demonstrations of maneuverability rather than active defense.[10] France has one of the foremost publicly acknowledged active-space-defense programs, but the orbital economy is advancing more quickly still. SpaceX says its Gigasat Factory could enable production and deployment of thousands of AI satellites beginning as soon as late 2027, while Starcloud plans two new 8-kilowatt compute satellites in 2027 and is developing a much larger 200-kilowatt spacecraft around anticipated Starship availability in 2028 or 2029.[11] Yet in 2027, France's TOUTATIS program—one of the most concrete public efforts to test a space defense laser—will still be launching two small spacecraft for demonstration.[12] And it is intended for co-orbital threats already operating in low Earth orbit, rather than fast-moving direct-ascent ASATs launched from Earth. France's YODA is a parallel pro-

7 Todd Harrison, Kaitlyn Johnson, and Makena Young, *Defense against the Dark Arts in Space: Protecting Space Systems from Counterspace Weapons* (Center for Strategic and International Studies, 2021); Clayton Swope, "How Can the U.S. Government Safeguard Commercial Satellites from Threats?" Center for Strategic and International Studies, 2025.

8 U.S. Department of War, *Space Policy Review and Strategy on Protection of Satellites* (2023), 8; Space Systems Command, "Race to Resilience."

9 Harrison, Johnson, and Young, *Defense against the Dark Arts in Space*, 18–20.

10 Space Systems Command, "US Space Force Demonstrates Responsive Launch for VICTUS HAZE Mission, Begins On-Orbit Operations," June 22, 2026; U.S. Space Command, "Live-Fly Exercise Advances Maneuver Warfare Concepts, Contested Logistics and Coalition and Commercial Integration across Space Domain," September 8, 2026.

11 SpaceX, "AI Satellite: Starmind"; Tim Fernholz, "Starcloud Raises $170 Million Series A to Build Data Centers in Space," *TechCrunch*, March 30, 2026; Tim Fernholz, "Starcloud Raises $250 Million for Orbital Data Centers as Launch Options Dry Up," *TechCrunch*, August 21, 2026.

12 Ministère des Armées et des Anciens combattants, "U-Space sélectionne le lanceur de MaiaSpace pour la mission TOUTATIS de l'Agence de l'innovation de défense," November 28, 2025; MBDA, "MBDA at the New Frontier: Securing Sovereignty in Space," September 15, 2025.

gram for geostationary orbit, similarly focused on co-orbital threats that maneuver to approach a prey satellite. Originally scheduled for 2025, YODA may now be delayed to as late as 2029.[13] If development continues at this pace, valuable orbital infrastructure will arrive at scale before we can defend it.

In other words, we need a moonshot. America needs to protect the wave of valuable commercial infrastructure soon to enter orbit. But company self-interest provides an insufficient incentive to deliver all the defensive technologies needed. Partly, this is because their benefits become salient only when catastrophe is averted, not because they add quarterly revenue. Moreover, companies have a natural hesitancy around building anything that resembles weaponry for their own use. Meanwhile, the government is in a much better position to do this, but some of these capabilities it cannot credibly provide —yet.

The Space Force should therefore launch an Orbital Infrastructure Resilience Challenge to solicit competitive solutions for defending modern orbital infrastructure and then back the most promising prototypes with a promise for eventual procurement. This is something that the Space Force is well positioned to do because it already has a template: its innovation arm, SpaceWERX, uses small-business funding to turn early commercial technologies into operational capabilities.[14] Its Orbital Prime program, for example, posed the problem of active debris remediation to stimulate the market for in-space servicing, assembly, and manufacturing.[15] Its newer In-Domain Orbital Logistics Challenge similarly uses government demand to pull forward capabilities whose commercial markets are not yet mature.[16]

This challenge should demand functional outcomes without necessarily privileging the use of a specific technology. Entrants competing on the same problem may opt to employ warning or maneuver technologies; others may choose to defend systems actively and directly, whether kinetically, robotically, or otherwise. Ultimately, the Space Force should evaluate entries based on whether they can keep important services available under attack. It should assess each intervention's endurance against a volume of attacks and its offense-defense cost exchange. It should also assess the expected effect on uptime of the orbital service being defended.

To provide the ideal demand signal, a challenge of this sort should present a credible commitment to down-the-line procurement. Firms will not invest in serious capabilities unless they have the confidence that their product will sell, and a competition that ends at show-and-tell does little to this end. The Space Force should stipulate in advance that systems meeting the challenge metrics will be eligible for follow-on

13 Ministère des Armées et des Anciens combattants, "Our Military Space Operations"; Yannick Chenevard and Jean-Louis Thiériot, *Rapport no. 2695* (Assemblée nationale, 2026).

14 SpaceWERX, "About SpaceWERX."

15 SpaceWERX, "Orbital Prime."

16 Space Systems Command, "Space Systems Command to Launch Servicing, Mobility, and Logistics SpaceWERX Challenge," May 20, 2026.

demonstrations but, more importantly, for actual contracts or integration into Space Force programs.

But beyond the technological, the challenge of space defense requires us to delegate obligations. The government should draw clear lines between military and commercial responsibility. The Department of War (DOW) took one step in this direction in its 2024 Commercial Space Integration Strategy, which says that, "in appropriate circumstances," military force may be used to protect commercial assets.[17] This vague language does little to define the operational boundary to which military aid does or does not extend. DOW should specify which commercial assets qualify for this protection, what their commercial operators are expected to do to protect themselves, and what support should be expected from the government during an attack. Even casting aside the notion of responsibility, the mere *expectation* that the military will or will not intervene is essential knowledge for the companies building this infrastructure and for military leaders; they are the ones who, in the future, will be stuck fighting with the tools that they design today.

Building on the general policy of DOW, the Space Force should establish pre-negotiated protection arrangements for commercial systems whose loss would carry serious national-security or economic consequences. The Commercial Augmentation Space Reserve (CASR) offers a useful model for structuring such a commercial-military relationship: participating firms agree in advance on how and under what conditions they will provide additional commercial capacity to the government when needed.[18] DOW should build on this with a reciprocal commitment: how and under what conditions a select group of commercial operators could expect the government to come to *their* aid. The receipt of such protection could be conditioned on companies' already adopting certain best practices in areas such as redundancy, cybersecurity, information sharing, and plans for restoring lost service. The government should specify the circumstances under which it would intervene, such as by providing classified warnings, operational support, or active defense. Under this regime, both DOW and private firms would know where their responsibilities end and where their counterparts' begin. Crucially, it would state in no uncertain terms which security gaps companies are on their own to close.

Infrastructure in the post-AGI economy will migrate to orbit whether or not cost-effective defenses exist at the ready. While building resilience into this stack has preempted aggressors so far, prioritizing efficient defenses will pave the way for future investment in the exquisite opportunities of the outer space economy. The challenge of orbital defense looms in the coming years. By launching an Orbital Infrastructure Resilience Challenge and establishing reciprocal commercial-military commitments, America can make the most of this critical period.

17 U.S. Department of War, *Commercial Space Integration Strategy* (2024), 3.

18 Space Systems Command, "Commercial Space Office."

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