CHAPTER 4

CHINA'S REUSABLE ROCKET SURGE

Elliot Joseph Fox

Whoever controls space controls the world.

— Lyndon B. Johnson

Introduction

On December 21, 2015, a soot-streaked *Falcon 9* first stage descended in controlled triumph onto Cape Canaveral,[2] transforming what had long been science fiction into operational fact. With that landing, the paradigm of space access shifted—from expendable rocketry and episodic launches to reusable boosters, compressed timelines, and

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accelerated industrial learning curves. Reusability did not merely cut costs; it redefined cadence as a core metric of spacepower.[3]

China quickly recognized the implications. In less than a decade, it mobilized a fusion of state research centers, venture-backed firms, and provincial launch hubs to close the gap. By the mid-2020s, Chinese hop tests and precision landings were no longer novelties but signals of a system in rapid maturation, threatening the cost, tempo, and strategic lead that the United States had carved through innovation.[4]

This accelerating contest over reusable launch capability is not just a technical rivalry—it is a strategic realignment with cascading effects. It alters the economics of space exploration, disrupts fledgling space traffic management norms, and exposes the inadequacy of treaties designed for an era of low launch frequency.[5] As the domain grows more contested, congested, and commercially driven, the challenge of ensuring stability—while preserving strategic advantage—intensifies.

Framed through the foundational theories of spacepower—Everett Dolman's strategic realism,[6] David Lupton's doctrinal typologies,[7] and John Klein's maritime analogies[8]—this chapter analyzes China's reusable-rocket surge as both a technological leap and a geopolitical signal. It assesses the implications for U.S. space strategy, alliance structures, and the broader rules-based order in orbit. In doing so, it illuminates a key front in the broader competition for advantage in the emerging multipolar space age.

The Ideas that Shape the Heavens

When Everett Dolman wrote that space could never remain a sanctuary, he was thinking less about satellites than about strategy. However lofty the altitudes, he argued, space would ultimately mirror the competitive instincts found on land and sea. Dolman urged the United States to establish a *benign hegemony*—strong enough to deter adventurism, light enough to let commerce and science flourish.[9]

David Lupton approached the same challenge through doctrinal classification. Some strategists, he noted, envisioned a weapons-free orbital commons—the *Sanctuary School*. Others anticipated conflict and prioritized shielding vulnerable assets—*Survivability*. Further along the spectrum stood advocates of *High Ground* superiority, and ultimately *Control*, which treated space as an arena to be dominated like air or sea.[10]

John Klein extended this analogy with maritime precision. Ocean, he observed, had always been highways for commerce, laboratories for exploration, and—when diplomacy faltered—arenas for strategic rivalry. Space, vast and borderless, would follow a similar arc unless deliberate norms and habits of restraint took root.[11]

What all three theorists emphasized, in different ways, was the critical hinge of *access*. A nation able to reach orbit cheaply and frequently can deploy and replace constellations, experiment at scale, and harden resilience in a way its rivals cannot easily replicate.[12] For a decade, the United States—

primarily through the *Falcon 9* and its successors—held that edge. Today, China's engineers are moving rapidly to close it.

From Doctrine to Launchpad

The theories of Dolman, Lupton, and Klein have not remained in the realm of academic abstraction. They have been internalized—often implicitly—by institutions responsible for translating strategy into capability. Chief among these is the U.S. Space Force, which in its *Space Capstone Publication* (SCP) identifies access to space as a national imperative.[13] Spacelift, as outlined in the *AU-18 Space Primer*, is not merely a technical enabler; it is the bedrock upon which all other space-based capabilities depend.[14] Without the ability to launch, replace, and sustain assets in orbit, no command, control, or communications advantage can be assured.

Spacelift is a strategic infrastructure. It determines whether a country can project power, ensure redundancy, test innovations at scale, and maintain an uninterrupted presence in orbit. Just as harbors and runways once defined the reach of maritime and air forces, launch systems now anchor the projection of spacepower.[15]

Reusable rocketry has transformed launch from a bottleneck to a force multiplier. The United States, through SpaceX's *Falcon* fleet, gained a first-mover advantage, reducing costs and drastically increasing launch cadence. But that advantage is no longer secure. China's emerging suite of reusable boosters threatens to neutralize the U.S. lead in

spacelift, creating new dilemmas for deterrence, alliance coordination, and domain awareness.[16]

As China's launch architecture matures, the strategic calculus shifts. In a domain where responsiveness equals resilience, and cadence confers coercive credibility, the ability to relaunch quickly may matter more than who launched first.

China's Reusable Rocketry Challenge: Technical Parity, Political Disruption

China's push into reusable launch technology poses a dual challenge to U.S. strategic interests—technical in nature, but politically consequential. While reusable rocketry promises broader access to orbit and commercial opportunity, it also threatens to fragment the emerging norms of space governance and test the cohesion of U.S.-led frameworks like the Artemis Accords.

This challenge unfolds along two critical axes: political and technical implications.

Political Implications: Pressure on the Artemis Accords

China's maturing launch capability—still largely state-controlled and often dual-use—complicates the normative ecosystem the United States and its partners have sought to build around the Artemis Accords. Several key provisions are implicated:[17]

- **Peaceful Use of Space (Section 3)**

  The Accords reaffirm the peaceful use of outer space. Yet the overlap between China's space agency and its military raises doubts about its adherence to this principle. Increased launch frequency, powered by reusability, could shift the domain toward securitization and strategic signaling.

- **Interoperability (Section 5)**

  Chinese spacecraft and infrastructure are developed outside Western ecosystems, limiting interoperability during emergencies and complicating joint ventures.

- **Space Resources & Deconfliction (Sec. 10 & 11)**

  Reusability increases cadence, raising the likelihood of orbital congestion, contested resource claims, and operational friction.

- **Orbital Debris (Section 12)**

  The acceleration of launches risks compounding the orbital debris crisis, especially absent best practices and transparency measures.

Technical Implications: Launch Cadence and Catch-Up

China's effort to match SpaceX's capabilities is gaining speed. In 2024 alone, SpaceX conducted 134 launches of the *Falcon* 9 and *Falcon* Heavy platforms, reflecting the maturity of its vertically integrated model.[18] This cadence underscores a technological and operational edge built over a decade through

flight demonstrators like *Grasshopper*, iterative prototyping, and commercial scaling.[19]

Today, Chinese startups—often state-backed and strategically aligned—are emulating this model. Many are reaching the hop-test phase, mirroring SpaceX's trajectory from the early 2010s. While a performance gap remains, the slope of China's progress is steep. The potential for parity, if achieved, would recalibrate strategic timelines and reshape force posture in orbit.

Rocket Factories on the Yangtze: China's Race for Reusability

China's fascination with reusability first drew public notice in 2017, when a Ministry of Science and Technology roadmap pledged "full industrial reusability" by 2035.[20] The ambition was sweeping: methane-fueled engines, flyback boosters, autonomous landing barges, and even nuclear-thermal upper stages to support cislunar logistics. At the time, China lacked a single vertical-takeoff, vertical-landing (VTVL) prototype.

That changed quickly. iSpace broke the starting line in July 2019, when its *Hyperbola-1* became the first privately built Chinese rocket to attempt orbit.[21] Three years later, Landscape's *Zhuque-2* achieved the world's first methane-fueled orbital launch.[22] Neither mission reused hardware, but both triggered a national surge in reusability experiments. By 2023, iSpace's *Hyerbola-2Y* had completed 100-meter and 1,000-meter hop tests.[23] Galactic Energy, CAS Space, Deep

Blue Aerospace, and state conglomerates SAST and CALT soon followed with their own VTVL demonstrations.

The shift was not just technical—it was industrial and cultural. Shenzhen-based venture capitalists began backing rocket startups with the same fervor once reserved for e-commerce and ridesharing. Reusable rocketry had become not only a national objective but a commercial race.

The numbers reveal the momentum. In 2023, SpaceX launched 97 times—already a remarkable cadence, with one booster turning around in just 19 days. By 2024, the company had scaled even further, completing 134 launches. In contrast, China's government-commercial ecosystem managed 37 launches in 2023, all on expendable platforms. Yet by early 2025, Landspace and iSpace each claimed they were within 12 months of achieving orbital reflight. If either succeeds—and if CALT's *Long March 10* reaches partial reusability by 2027—the U.S. launch advantage could narrow significantly before the decade ends.

The strategic implications go beyond raw numbers. Reusability lowers the cost per kilogram to orbit, but it also increases tempo, operational resilience, and technology refresh rates. In a contested domain like space, cadence is capability, and capability shapes deterrence. As China closes the gap, the United States and its partners must reassess how launch frequency, recovery infrastructure, and industrial surge capacity factor into broader strategies of space control and assurance.

China's Thriving Reusable Rocket Industry: A Competitive Landscape

China's push for reusable launch capabilities is no longer the domain of a single state program. It now features a dense constellation of commercial startups, state-backed ventures, and institutional spinoffs[24]—each racing to become the nation's SpaceX. While success is far from guaranteed, the volume and variety of experimentation increase the probability that one or more firms will break through. In an industry where scale compounds advantage, even a single successful venture could dramatically shift global launch dynamics.

Key players include:

- **Landspace**

  Conducted a successful suborbital test of its *Zhuque-3* methalox rocket in January 2024.[25] Orbital launch is targeted for Q3 2025,[26] with a projected payload of 12.5 metric tons (reusable mode).[27]

- **iSpace**

  After a successful *Hyperbola-2Y* hop test in 2023, it aims to launch *Hyperbola-3*—an 8.5 ton reusable vehicle—by mid-2026, supported by a new engine production facility.[28]

- **CAS Space**

  A spinoff from the Chinese Academy of Sciences, CAS Space is developing *Kinetica-2*, with reusability

planned by 2028 and capacity to lift 12 tons low Earth orbit.[29]

- **Galactic Energy**

  Completed a hop test of *Pallas-1* in August 2023.[30] A reusable variant is expected in 2025, followed by a three-core version capable of 14 tons to orbit.[31]

- **Deep Blue Aerospace**

  Building on the *Nebula-1* hop test (2022, 2024), it plans a launch in 2025 and follow-on tests of *Nebula-2* in 2026.[32]

- **Space Epoch (Sepoch)**

  Successfully conducted a hop test of the *Yuanxingzhe-1* (YXZ-1) in May 2025. Designed for soft water landings, higher-altitude tests are planned for late 2025.[33]

- **SAST & CALT**

  State-owned entities under CASC. SAST conducted gimbaled hop tests in 2024[34] and 2025.[35] CALT is developing a crew-rated reusable rocket, currently in the static fire testing phase.[36]

This industrial diversification is strategic. Rather than relying on a single "national champion," China is hedging its bets—accelerating learning curves and spreading development risk. In this model, success by any one actor could decisively expand China's launch capacity, compress timelines, and challenge Western assumptions about lead time and technological dominance.

Beyond Commercial Gains: Strategic Risks, Competitive Stakes

China's rapid advances in reusable launch technology and its expanding commercial space sector are not merely markers of scientific achievement—they are instruments of strategic positioning. While they promise broader access to orbit, they also blur the lines between civil, commercial, and military space programs.

Recent milestones—such as the assembly and sustained operations of the *Tiangong-3* space station, a lunar sample return, and the first robotic landing on the moon's far side—demonstrate a highly capable system driven by long-term ambition. By April 2025, China had completed a flawless crew rotation at *Tiangong*, launching three astronauts aboard a Shenzhou spacecraft that docked with the station after a 6.5-hour flight.[37] The new crew replaced astronauts who had spent 175 days in orbit, reflecting a cadence now comparable to the International Space Station. Far from symbolic, *Tiangong* is expanding: China plans to double its size by the early 2030s, adding inflatable modules, a co-orbital space telescope, and greater docking capacity for future missions and international payloads.[38] Born of exclusion from the U.S.-led International Space Station architecture, it has evolved into a strategic platform for enduring presence and influence in low Earth orbit.

These developments are increasingly dual-use. China's investment in on-orbit satellite servicing, for instance, supports both civilian maintenance and potential counterspace

operations. The same roadmap that outlines commercial launch goals—China's "2017–2045 Space Transportation System Development Roadmap,"—also includes plans for nuclear propulsion and large-scale space resource extraction. These are not notional concepts: they are supported by R&D investments and a pattern of steady delivery against ambitious timelines.

Lunar Resources, Return of Strategic Geography

Among China's most consequential ambitions is its pursuit of lunar resources, particularly water ice at the lunar South Pole. This ice is not just a scientific curiosity—it is an enabler of logistics. Split into hydrogen and oxygen, it provides breathable air, potable water, and, critically, rocket fuel production. Such resources could anchor in-space manufacturing, life support systems, and long-term operations beyond Earth's orbit.

Beijing's *Chang'e* series of robotic missions has steadily expanded its reach, with *Chang'e 7* and Artemis missions intended to operate near Shackleton Crater,[39] where strategic geography meets technological ambition. This terrain is not just desirable—it may become the logistical hinge of an Earth-Moon economy.

International law offers guidance but little precision. The 1967 Outer Space Treaty prohibits sovereignty but guarantees access.[40] The Artemis Accords builds on those principles with proposals for transparency and safety zones—but China is not a signatory. If two landers arrive within line of sight of the

same crater, whose prospecting drills take precedence? No precedent exists. In such a vacuum, even the perception of advantage—gained through faster, cheaper launches or earlier emplacement, could harden suspicion into strategic friction. [41]

China's terrestrial behavior further complicates this picture. Its assertiveness in maritime and border disputes has often leveraged ambiguity and aggressive behavior to expand de facto control. If such tactics are exported to the lunar surface, they could fracture the fragile consensus underpinning space governance and accelerate the militarization of the final frontier.

U.S. Strategies to Counter China's Reusable Rocket Challenge

The rise of China's reusable launch ecosystem is both a technical achievement and a geopolitical signal. Beijing's pursuit of reusability compresses timelines, erodes Western assumptions of uncontested advantage, and challenges the norms of access, cadence, and control that have defined U.S. dominance in orbit for decades.

The U.S. response must be multidimensional. It blends commercial incentives with diplomatic coalition-building and normative leadership with quiet crisis planning. While China centralizes its space ambitions through state-backed industrial policy, the United States leans on a different model: one rooted in open innovation, alliance cohesion, and institutional resilience. What follows is a survey of the strategic pathways

to sustain U.S. leadership, reinforce a rules-based order in space, and mitigate the risks of unbounded competition.

Sustaining Technological Leadership through Competitive Innovation

To preserve its edge in orbital access, the United States must continue cultivating a dynamic and diversified commercial space sector. While China's state-backed firms pursue reusability through coordinated national investment, the U.S. advantage lies in its entrepreneurial ecosystem, layered competition, and first-mover momentum.

At the heavy-lift end of the spectrum, SpaceX's *Starship* and Blue Origin's *New Glenn* promise significant gains in payload capacity and launch economy. These vehicles could redefine deep space logistics and further consolidate the United States' lead in cadence and scalability. Simultaneously, smaller firms such as Rocket Lab,[42] Relativity Space, and Stoke Space are advancing reusable architectures that increase responsiveness, reduce costs, and harden resilience. Their flexibility and speed—traits often absent in China's top-down system—should be seen as national strategic assets.[43]

Building a Coalition of Space Norms: The Artemis Accords

China's refusal to join the Artemis Accords leaves the United States with both a challenge and an opportunity. While Beijing forges bilateral partnerships and promotes alternatives to Western-led frameworks,[44] Washington can strengthen its hand by expanding and deepening the Artemis coalition.

Launched in 2020, the Accords articulate principles grounded in the 1967 Outer Space Treaty, updated for 21st-century realities.[45] They promote peaceful use, interoperability, transparency, debris mitigation, and responsible resource utilization. Just as NATO provides a security architecture for terrestrial cooperation, the Artemis Accords can evolve into the backbone of a normative framework for lunar and cislunar activity.

The task is twofold: expand membership beyond traditional allies, and embed the Accords into operational planning, infrastructure sharing, and technical collaboration. Doing so would raise the cost of norms violations, reinforce collective resilience, and shape a more inclusive—but rules-based—extraterrestrial order. It would also counterbalance China's efforts to define alternative governance structures.

Competing in the "Astropolitical" Domain

The contest over reusability—and over orbital governance—unfolds in what some scholars term the astropolitical domain.[46] It is a domain marked by strategic anarchy but ripe for institutional innovation. Like maritime and cyber domains, space remains underregulated and difficult to police. But this very ambiguity makes it an arena where norms, if established early and reinforced consistently, can shape strategic behavior.

The Artemis Accords reflect a liberal-institutionalist vision of space: one that favors transparency, cooperation, and rules-based stability over opaque bilateralism or coercive control. They embody a "decidedly American" approach to

governance—open, scientifically grounded, built on coalitions, and focused on peaceful dispute resolution. This stands in contrast to China's model, which is more centralized, security-oriented, and state-directed.

Astropolitics will not be won through doctrine alone. It demands sustained diplomacy, public-private alignment, and the strategic use of transparency as deterrence. Just as freedom-of-navigation patrols assert maritime norms, regular publication of launch data, debris mitigation compliance, and lunar coordination protocols can signal U.S. leadership and preempt destabilizing ambiguity.

Washington's Dilemma

For U.S. planners, China's reusable rocket surge lands somewhere between validation and provocation. It vindicates decades of investment in commercial innovation—yet it also compresses warning time. Concepts once confined to strategic theory—space traffic coordination, debris liability, cislunar search and rescue—are now frontline operational concerns.

The response taking shape in the Pentagon and on Capitol Hill is multifaceted, if not always cohesive. Funding continues for *Starship*, *New Glenn*, and a slate of independent small-lift and medium-lift vehicles,[47] guided by the logic that redundancy is its own form of deterrence. Diplomatically, Washington is expanding the Artemis coalition—from Europe to Southeast Asia[48]—on the premise that shared rules are cheaper than contested orbits.

Yet even the most enthusiastic multilateralism cannot wish Beijing away. Quiet talks on debris mitigation and lunar deconfliction, tentative as they are, now rank alongside hypersonic hotlines as necessities of great power prudence. The space domain is no longer a sanctuary or a science project—it is a shared operating environment, with all the instability and interdependence that implies.

Competitive Stewardship, Not Containment

The objective is not to contain China's rise in space but to shape the environment in which it unfolds. Reusability is not just about rockets—it is about who sets the tempo, who defines the rules, and who earns the trust of the international community.

By fostering innovation at home and multilateralism abroad, the United States can preserve its strategic edge, safeguard the orbital commons, and prove that leadership in space is compatible with openness, restraint, and shared advancement.

The Way Forward: Balancing Competition and Cooperation in Orbit

China's rise as a space power—marked by its reusable launch surge and expanding lunar ambitions—presents a strategic inflection point. For the United States and its allies, the response must be neither reactive nor rigid. Instead, it must combine innovation with restraint, competition with communication, and coalition-building with foresight.

Sustaining leadership in this domain will require deliberate choices across four key axes:

1. **Invest in Innovation as a Strategic Imperative**

   Preserving U.S. leadership begins with technological primacy. This means continued investment not only in private space lift programs like *Starship*, *New Glenn*, and *Neutron* but also in next-generation technologies: faster turnaround times, reusable upper stages, space refueling, in-orbit servicing, and in-situ resource utilization (ISRU). These capabilities are not just enablers of exploration—they are the foundations of orbital tempo, deterrence, and resilience in an increasingly contested domain.

2. **Strengthen Alliances through Purposeful Cooperation**

   The Artemis Accords provide a framework—but turning principles into practice requires deeper operational integration with allies. Joint research, multilateral missions, and shared standards for space traffic management and resource extraction can convert normative alignment into strategic synergy. Partners like Japan, Canada, Australia, India, and ESA members are not just contributors—they are amplifiers of U.S. credibility and capacity.

3. **Engage China Where Prudence Allows**

   Competition with China is structural—but unmanaged rivalry is unstable. Limited engagement on crisis deconfliction, orbital safety, and shared scientific

interests—whether bilateral or via forums like COPUOS—can reduce miscalculation and signal strategic intent. Engagement is not endorsement; it is insulation against escalation. Even amid distrust, technical dialogue on space debris or planetary defense can serve shared survival.

4. **Adapt to a Multipolar Space Order**

   Uncontested U.S. dominance in space is giving way to a multipolar reality—one where state and commercial actors alike project influence. This demands strategic flexibility: resilient launch infrastructure, enhanced space situational awareness, and clear rules of engagement for potential conflict scenarios. The challenge is not just to deter rivals, but to shape an ecosystem where responsibility outpaces rivalry.

These strategies offer both promise and complexity. Investing in space technology can unlock economic gains but requires sustained political will. Deepening alliances strengthen collective leverage but must navigate divergent national interests. Engaging China may reduce risk—but demands vigilance to protect sensitive capabilities. Preparing for multipolarity requires vision: not just to compete, but to shape.

If pursued with foresight, the United States and its allies can ensure that space remains not just a contested frontier but a domain of shared exploration, strategic stability, and human progress. The stakes are high, but so are the rewards for responsible leadership.

Conclusion: Strategic Leadership in a Reusable Era

China's advancements in reusable rocket technology mark a pivotal shift in the evolution of spacepower. The rapid democratization of launch—faster, cheaper, and more routine—is transforming space from a realm of scientific ambitions into a contested domain of strategic consequence. In this emerging order, cadence and capability are metrics—they are instruments of power.

Beijing's growing space ambitions, fueled by a maturing ecosystem of reusable launch vehicles and long-range propulsion roadmaps, are not merely technical milestones. They reflect a deliberate effort to reshape the balance of power in orbit, redefine norms of behavior, and challenge existing frameworks of cooperation and control. This trajectory carries profound implications for global stability, economic resilience, and the strategic freedom of the United States and its allies.

While the United States retains a decisive lead in launch cadence and commercial innovation, preserving that edge is not automatic. It demands sustained investment in next-generation technologies, robust public-private partnerships, and deeper integration with trusted allies. The Artemis Accords offer a framework for building a values-based coalition—one capable of reinforcing transparency, deterring coercion, and setting the terms of responsible conduct in space.

Limited engagement with China—on debris mitigation, crisis deconfliction, and technical safety—may lower risk. Yet

engagement is not an end in itself. The overriding imperative is leadership: in setting norms, assembling coalitions, and defining the tempo and terms of a multipolar space order.

The stakes are high. The risk of complacency is real. But with resolve, foresight, and alliance-driven strategy, the United States can navigate this inflection point—and ensure that space remains not only a frontier of discovery, but a domain defined by access, stability, and enduring strategic advantage. As Washington charts its course through this moment of strategic transition, one truth endures: in space, timing is power—and clarity is peace.

Afterword: The Cadence Race

History's first space race was linear—a sprint to the Moon in which each side counted milestones and flags. The second, unfolding now, is rhythmic. Victory accrues not to the nation that lands first but to the one that launches again and again until orbital replenishment feels as routine as airlift. On present trends, the United States will keep its lead for several more years, yet China's learning curve slices steeply upward.

Whether that curve bends toward partnership or rivalry will depend less on manifesto language than on launch manifests: who flies, how often, and toward what end. If Dolman's benign hegemony and Klein's maritime model are to coexist with Lupton's more cautionary schools, cadence must be matched by clarity—clear intentions, clear norms, and reliable channels of risk reduction. Space, like the sea before

it, can nourish commerce and discovery only so long as its busiest lanes remain predictable.

The decade ahead, then, is decisive. Rockets lifting off coastal pads in Florida and Hainan already carry that future in their tanks. Somewhere in the echo of their engines lies the answer to a question as old as exploration itself: Can competition pace itself without stumbling into conflict? Humanity's next great frontier awaits the verdict.

Endnotes

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