CHAPTER FOUR

CHINA'S REUSABLE ROCKET REVOLUTION: IMPLICATIONS FOR THE UNITED STATES AND ARTEMIS ALLIES

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Whoever controls space controls the world.

— Lyndon B. Johnson, 36th President of the United States, often attributed but likely apocryphal

Abstract

China's rapid advancements in reusable rocket technology have triggered a seismic shift in the balance of power in space exploration. While SpaceX's pioneering achievements have positioned the United States at the forefront, China's relentless pursuit of technological parity challenges this dominance. This chapter examines the complexities of China's reusable rocket revolution, analyzing its implications for the United States and its Artemis allies. This analysis explores how this new space race could reshape international cooperation, exacerbate resource conflicts, and redefine the future of space power. As the United States grapples with the growing influence of China's space capabilities, the chapter offers insights into strategic responses necessary to maintain leadership in this critical domain while navigating the risks and opportunities presented by this unprecedented competition.

Introduction

The dawn of the 21st century has witnessed a dramatic transformation in space launch capabilities, with reusable rocketry emerging as a revolutionary force. SpaceX's pioneering achievements in this domain have propelled the United States to a position of prominence, granting it a significant edge in cost efficiency and launch frequency. This advantage, however, is not

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uncontested. China, driven by ambitious space aspirations and a relentless pursuit of technological parity, is rapidly closing the gap, developing a suite of reusable rockets that threaten to erode the U.S.'s current dominance.

This burgeoning space race between two global powers has profound implications, extending far beyond mere technological competition. It challenges the geopolitical landscape of space, raising questions about the future of international cooperation, the potential for resource conflict, and the nature of space power itself. As China's reusable rockets take flight, the established norms and understandings that have governed space activities for decades are being tested.

This chapter examines the complexities of the evolving space landscape, focusing on the technical, political, and strategic dimensions of China's reusable rocket program. By employing theoretical frameworks that have shaped the U.S. approach to spacepower, such as Everett Dolman's realist perspective, David E. Lupton's typology of space force schools, and John J. Klein's maritime model, this analysis explores China's ambitions and achievements, assessing the challenges and opportunities this new era presents for the United States and its allies. Through this comprehensive analysis, the chapter aims to illuminate the stakes involved in this critical juncture of space exploration and provide insights into the potential trajectories of this high-stakes competition.

The Geopolitical Landscape of Space

To understand the implications of China's growing spacelift capabilities, it is essential to examine the theoretical foundations that have historically shaped the United States' approach to space and the evolving geopolitical landscape of this critical domain. The U.S. Air Force's doctrinal document, AU-18: The Space Primer, provides a framework for understanding space power through the works of

key theorists whose ideas continue to influence contemporary strategic thinking.[1]

One such theorist is Everett Dolman, a proponent of a realist perspective on space power. Dolman argues that space, like other domains of human activity, cannot remain a peaceful sanctuary indefinitely. He envisions a future where competition and conflict in space become inevitable as nations seek to secure their interests and assert dominance. Dolman advocates for the United States to proactively establish a leadership role in space, not through aggressive conquest, but by establishing a "benign hegemony"—a framework of rules and norms that would guide the behavior of all actors in space, promoting stability and cooperation while safeguarding American interests.[2]

Another influential theorist, David E. Lupton, offers a typology of four schools of thought on space forces, each representing a distinct perspective on the role of military power in space. The Sanctuary School, driven by an idealistic vision, envisions space as a weapons-free zone reserved for peaceful purposes. The Survivability School, more pragmatic in its outlook, emphasizes the vulnerability of space systems and the need to protect them from attack.[3] The High Ground School views space as a strategic vantage point, offering asymmetric advantages to those who control it. Finally, the Control School equates space control with air and sea control,[4] arguing that it is essential for achieving and maintaining space power.

John J. Klein, a proponent of the maritime model of space power,[5] draws parallels between the vast expanse of space and the Earth's oceans. He emphasizes that space, like the ocean, is a vital medium for commerce, communication, and exploration.[6] Klein argues that understanding the non-military aspects of space is crucial for developing a comprehensive and effective space strategy that balances national security interests with the broader needs of human civilization.[7]

Building on these diverse theoretical perspectives, the newly established U.S. Space Force (USSF) has articulated a spacepower doctrine recognizing access to space as a national imperative.[8] The Space Capstone Publication (SCP), a foundational document of this doctrine, highlights space's myriad benefits, from mass communication and navigation to economic growth and national security.[9] According to the *AU-18 Space Primer*, spacelift—the ability to launch and deploy assets into space—is essential to accessing outer space and is the bedrock upon which all other space capabilities rest.[10] Spacelift is not merely a means of transportation; it is the key to controlling and exploiting the space domain, enabling the projection of power, the protection of national interests, and the pursuit of scientific and commercial endeavors.[11]

Reusable rocketry has revolutionized spacelift, dramatically expanding the United States' capacity to access and utilize space. This technological breakthrough has enabled a new era of space activity, marked by increased frequency and affordability of launches, opening up opportunities for scientific discovery, commercial ventures, and military applications. However, this technological leap forward also presents a strategic challenge. If reusable rockets can transform the United States' space capabilities, it stands to reason that other nations could reap similar benefits. China's rapid progress in developing its reusable rocket technology raises the specter of a new space race with far-reaching consequences for the geopolitical balance of power in the 21st century. As China's spacelift capabilities grow, the United States must grapple with the implications of this new reality, adapting its strategies and policies to ensure continued dominance in the space domain while managing the risks of escalating competition and potential conflict.

China's Multifaceted Challenge in Reusable Rocketry

China's aggressive pursuit of reusable rocket technology presents a dual political and technical challenge to the United States and its

allies, with potential ramifications extending beyond the purely technical realm. While the rapid advancements in reusable rockets offer the promise of increased access to space and economic benefits, they also raise significant concerns regarding the geopolitical landscape, the future of international cooperation, and the potential for conflict. This challenge can be analyzed from two key dimensions: political and technical.

Political Implications: Disrupting the Artemis Accords

China's expanding space capabilities, fueled by reusable rockets, pose significant challenges to the Artemis Accords, a multilateral agreement to foster a peaceful and cooperative exploration of the Moon. Several key provisions of the Accords are directly affected:[12]

- *Peaceful Use of Space (Section 3)*: The Artemis Accords emphasize the peaceful use of outer space. However, China's close ties between its military and space program raise concerns about its commitment to this principle. Increased Chinese activity in space, facilitated by reusable rockets, could make it more challenging to ensure that space remains a domain for scientific exploration and cooperation rather than military competition.
- *Interoperability (Section 5):* The Accords call for interoperability among space systems to enable emergency assistance and collaboration. However, China's independent development of spacecraft and launch vehicles hinders interoperability with Artemis partners, making potential cooperation in critical situations difficult.
- *Space Resources and Deconfliction (Sections 10 & 11):* The increased launch cadence enabled by reusable rockets has implications for managing space resources and deconflicting space activities. With more frequent launches and a higher volume of spacecraft in orbit, the risk of

interference and resource competition increases, potentially leading to conflict.

- *ORBITAL DEBRIS (SECTION 12):* While the proliferation of reusable rockets is beneficial in many ways, it also raises concerns about orbital debris. The increased frequency of launches and the potential for rapid deployment of multiple satellites could exacerbate the existing problem of space debris, posing a threat to the long-term sustainability of space activities.

Technical Implications: Launch Cadence and Technological Parity

The technical challenge posed by China's reusable rocket program centers on achieving a high launch cadence, a critical factor in spaceflight dominance. SpaceX, the undisputed leader in reusable spaceflight, has set a formidable benchmark with its Falcon 9 rocket. In 2023 alone, SpaceX conducted over 90 launches of the Falcon 9 and five launches of the Falcon Heavy, a testament to the efficiency, reliability, and cost-effectiveness of its reusable technology.[13] This unprecedented launch frequency, far surpassing any other nation, underscores the significant gap China must overcome to achieve parity in this domain.[14]

SpaceX's success in reusable spaceflight was not achieved overnight. It resulted from a decade-long development process that began in the 2010s. SpaceX initially focused on the Falcon 1, a smaller rocket with a lower payload capacity, while simultaneously developing the larger Falcon 9. The company also invested in a vertical launch and landing demonstrator called Grasshopper, which played a crucial role in validating and refining the technology for reusable rockets.[15]

In pursuit of reusable launch capabilities, China is actively emulating a similar development path as SpaceX, with multiple space startups working on their own versions of reusable rockets.

Several of these startups are already at a stage comparable to SpaceX's Grasshopper program, indicating that China is actively investing in the necessary research and development to catch up with the United States in reusable spaceflight.

China's Ambitious Space Program and Rapid Technological Development

China's bold ambitions in space exploration and rapid technological progress are evident in its long-term strategic planning. The "2017-2045 Space Transportation System Development Roadmap" outlines the country's ambitious goals, including the full reusability of all Chinese rockets by 2035,[16] and the development of nuclear space propulsion by 2040. These advancements would enable China to conduct large-scale space resource exploration and development, potentially leading to ambitious projects like asteroid mining and space-based solar power plants.[17]

While these goals may seem far-fetched, it is crucial to remember that many of these concepts were initially explored by the United States in the 1960s and 1970s. However, with renewed interest and investment in space exploration globally,[18] both the United States and China are revisiting these ideas. In fact, the United States is currently developing a flight-capable nuclear rocket with a target launch date of 2027.[19]

China's Thriving Reusable Rocket Industry: A Competitive Landscape

China's push for reusable launch capabilities is not solely a government endeavor. Multiple private companies, often in partnership with the government, drive this effort. These companies are actively developing and testing reusable rocket prototypes, signaling a vibrant and competitive landscape in China's space industry. The sheer number of startups, each with the potential to

replicate SpaceX's success, significantly increases the likelihood of China achieving a dominant position in space launch capabilities.

Some notable examples include:

- *LANDSPACE*: This company made headlines in January 2024 with the successful test flight of a suborbital prototype of their Zhuque-3 methalox (methane-liquid oxygen) rocket.[20] Targeting an orbital launch by 2025, the Zhuque-3 boasts an impressive projected payload capacity of 21 metric tons for expendable launches and 12.5 metric tons with launch site recovery.[21] Landspace's innovative approach to vertical takeoff and vertical landing (VTVL) technology highlights its commitment to reusable launch capabilities.
- *ISPACE*: Beijing Interstellar Glory Space Technology Ltd., also known as iSpace, demonstrated significant progress in reusable rocket technology through two successful test flights of its Hyperbola-2Y methalox-powered vehicle in late 2023. These suborbital flights paved the way for their ambitious Hyperbola-3 project, a reusable rocket designed to deliver payloads of up to 8.5 metric tons to low Earth orbit (LEO) with a remarkable target launch cadence of 25 launches per year.[22]
- *CAS SPACE*: As a spinoff of the state-owned Chinese Academy of Sciences (CAS), CAS Space has emerged as a major player in China's reusable rocket development. Their current focus is on the Kinetica-2, a multi-stage, liquid-fueled rocket with a payload capacity of 12 metric tons to LEO and 7.8 metric tons to sun-synchronous orbit (SSO). They aim to achieve full reusability by 2028,[23] a feat that could significantly reduce launch costs and increase access to space.
- *GALACTIC ENERGY*: This startup is making waves with its Pallas-1 rocket, a kerosene-liquid oxygen-powered launch

vehicle that completed a hop test in August 2023.[24] With a planned first orbital flight in the third quarter of 2024, Galactic Energy is on track to introduce a reusable version of the Pallas-1 by 2025, followed by a more powerful three-core variant capable of delivering 14 metric tons to LEO after 2026.[25]

Growing Concerns: Beyond Commercial Implications

China's burgeoning commercial space sector and rapid advancements in reusable rocket technology offer potential benefits for space access but also raise significant geopolitical and national security concerns. These concerns are not solely rooted in speculation. Still, they are grounded in China's recent achievements and its stated future ambitions, which warrants a closer examination to fully understand the potential risks and challenges they pose for the United States and the international community.

China's Recent Achievements and Future Ambitions

China's recent space achievements, such as the rapid assembly of the Tiangong-3 space station and successful lunar missions, including the first robotic landing on the far side of the moon and a lunar sample return mission, demonstrate a high degree of sophistication and efficiency. This, combined with investments in dual-use technologies like on-orbit satellite servicing—which has both maintenance and potential counterspace applications—raises concerns about China's ability to leverage its space capabilities for military purposes.

In addition to these achievements, China's ambitious long-term space program, outlined in its "2017-2045 Space Transportation System Development Roadmap," further underscores its determination to become a leading space power. The roadmap envisions developing a fully reusable space transportation system by

2035, followed by nuclear space propulsion and large-scale space resource exploration and development by 2040. While ambitious, these goals are plausible given China's track record of rapid technological progress and significant investments in space research and development.

China's Strategic Interests in Lunar Resources

One of the most concerning aspects of China's space ambitions is its explicit interest in lunar resource exploration. The moon, particularly the lunar South Pole with its potential deposits of water ice, is a crucial target for future space exploration and resource utilization. Water ice, if accessible, could be a game-changer, providing resources for life support, fuel production, and industrial processes. China's Chang'e missions, a series of robotic lunar exploration missions, have demonstrated its commitment to lunar exploration and its interest in securing access to potential lunar resources.

Shackleton Crater, a permanently shadowed region at the lunar South Pole, is believed to harbor significant amounts of water ice. It is a prime target for the U.S.-led Artemis program and China's Chang'e 7 lander.[26] While the scientific value of exploring this region is undeniable, the overlapping interests of the two nations raise concerns about resource competition and potential conflict. The Outer Space Treaty, while promoting the peaceful and shared use of space resources,[27] lacks robust enforcement mechanisms and has not been tested in scenarios involving direct competition for valuable resources.

Furthermore, China's choice of Shackleton Crater, a site of interest to both countries, underscores the potential for competition and conflict over lunar resources. This, coupled with China's history of territorial disputes on Earth, raises questions about its commitment to adhering to international law in the space domain, particularly when valuable resources are at stake.[28] The convergence

of strategic interests at Shackleton Crater underscores the potential for a new era of resource-driven competition in space, with implications for international relations, economic development, and national security.

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

The United States has several strategies to address the multifaceted challenge posed by China's rapid advancements in reusable rocket technology. These strategies encompass technical, commercial, and diplomatic approaches to maintain U.S. leadership in space while fostering international cooperation and mitigating potential conflict.

Fostering Competition in the Commercial Space Sector

To maintain its competitive edge in space launch capabilities, the United States must continue to foster innovation and competition within its commercial space sector. This includes providing sustained support for developing super heavy-lift rockets like SpaceX's Starship and Blue Origin's New Glenn, which promise to significantly increase payload capacity and reduce launch costs. While China also plans to test heavy reusable rockets, the United States can leverage its technological lead and entrepreneurial spirit to remain at the forefront.

Equally important is nurturing smaller, agile space startups like Rocket Lab and Relativity Space, which are pioneering innovative reusable launch technologies.[29] These companies often bring fresh perspectives and disruptive solutions to the table, pushing the boundaries of what is possible in spaceflight. By supporting a diverse range of large and small companies, the United States can ensure a continuous flow of new ideas and technologies to drive progress in space exploration and utilization.[30]

Strengthening International Cooperation: The Artemis Accords

In an era of increasing geopolitical competition, strengthening international cooperation in space exploration and utilization is more crucial than ever. The Artemis Accords, a U.S.-led initiative introduced in 2020, offer a potential framework for such collaboration. Grounded in the principles of the Outer Space Treaty of 1967, the Accords outline a shared vision for responsible, transparent, and sustainable space activities.[31]

Key Principles of the Artemis Accords:

- *Peaceful Purposes*: Reaffirms the commitment to using space for peaceful purposes, as the Outer Space Treaty mandates.
- *Transparency*: Encourages openness and information sharing about space activities to foster trust and predictability.
- *Interoperability*: Promotes compatibility between space systems to enable collaboration and assistance in emergencies.
- *Sustainable Use of Resources*: Establishes guidelines for the responsible extraction and utilization of space resources, ensuring their availability for future generations.
- *Registration of Space Objects*: Commits signatories to register space objects to enhance safety and accountability.
- *Release of Scientific Data*: Encourages the open sharing of scientific data obtained during space missions to advance knowledge and understanding.
- *Preserving Heritage*: Advances the protection of historical sites and artifacts in space for future generations.

- *DECONFLICTION OF ACTIVITIES*: Establishes procedures to prevent harmful interference between space missions and activities.
- *ORBITAL DEBRIS MITIGATION*: Promotes measures to minimize the creation of space debris and mitigate its impact on space operations.

While China is not a signatory to the Artemis Accords, the United States can leverage this framework to build a coalition of like-minded nations committed to upholding these principles. By expanding the membership of the Artemis Accord and deepening cooperation among signatories, the United States can foster a more stable and predictable space environment, deter potential conflict, and establish norms of behavior that benefit all nations.

The Accords can serve as a platform for coordinating space activities, sharing information, developing joint capabilities, and peacefully resolving disputes. By strengthening this framework and promoting its principles, the United States can mitigate the risks associated with China's rise in space and foster a global community of spacefaring nations committed to peaceful exploration and the responsible use of space resources.

Navigating the "Astropolitical" Landscape

Much like the international political arena, the space domain can be viewed through international relations theory. It is characterized by a degree of anarchy due to the limitations of existing space law and the challenges of enforcing it in a vast and complex environment. However, it is also a domain where liberal institutionalism, emphasizing cooperation, adherence to international law, and the role of international organizations, can play a significant role.

The Artemis Accords represent a prime example of this approach. They embody a "decidedly American" form of astropolitics that seeks to build liberal institutions and relationships

within the existing rules-based international order. By promoting transparency, cooperation, and adherence to international law, the Artemis Accords offer an alternative to the potentially destabilizing effects of unrestrained competition in space.

The Way Forward: A Balanced Approach to Competition and Cooperation

The rise of China's reusable rocket industry presents a complex challenge that demands a nuanced and multifaceted response from the United States and its allies. To maintain leadership in space while mitigating the risk of conflict, a balanced approach is essential, one that skillfully combines technological innovation, diplomatic engagement, and international cooperation.

1. *Invest in Innovation*: The United States must prioritize investment in research and development to preserve its technological edge in space. This includes continued support for developing advanced launch vehicles, such as SpaceX's Starship and Blue Origin's New Glenn, but also targeted investment in emerging technologies like reusable upper stages, space refueling, and autonomous rendezvous and docking capabilities. By fostering a thriving environment for innovation, the United States can ensure its continued dominance in space capabilities and maintain a competitive advantage.
2. *Strengthen Alliances and Partnerships*: Collaboration with like-minded nations is crucial for promoting a stable and secure space environment. The Artemis Accords is a valuable framework for international cooperation, and the United States should actively engage with key partners like Japan, Canada, the European Space Agency, and Australia to fortify these agreements and expand their scope. This includes establishing joint research, conducting joint

missions, and developing common standards for space operations.

3. *ENGAGE WITH CHINA*: While competition with China in the space domain is inevitable, establishing a constructive dialogue is equally important to promote transparency, build trust, and establish norms of behavior in space. This could involve bilateral discussions on space traffic management, debris mitigation, and the responsible use of space resources, as well as multilateral forums like the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). While engaging with China presents challenges due to geopolitical tensions, the United States should prioritize open communication and identify areas for potential collaboration, such as scientific research and planetary defense.
4. *PREPARE FOR A MULTIPOLAR SPACE ENVIRONMENT*: The era of unchallenged U.S. dominance in space is evolving as more nations develop their space capabilities. The United States must adapt to this new reality by preparing for a multipolar space environment where multiple actors, both state and non-state, wield significant influence. This requires a shift in strategic thinking toward a more flexible and adaptive approach that can effectively respond to a wide array of challenges and opportunities. This includes developing a robust and resilient infrastructure, enhancing space situational awareness capabilities, and establishing clear rules of engagement for potential conflicts in space.

The pursuit of these strategies presents both opportunities and challenges. Increased investment in space technology could drive economic growth and create new jobs, but it also requires substantial funding and political will. Strengthening international partnerships can enhance collective capabilities but requires navigating complex geopolitical dynamics and competing national interests. Engaging

with China could foster cooperation and reduce the risk of conflict, but it also necessitates balancing cooperation with competition and protecting sensitive technologies. Finally, preparing for a multipolar space environment requires a long-term vision and strategic foresight as the space domain becomes increasingly crowded and contested.

By embracing this balanced approach and prioritizing these key strategies, the United States and its allies can navigate the challenges posed by China's rise in space and ensure a future where space remains a domain for peaceful exploration, scientific discovery, and the betterment of humanity. The stakes are high, but the rewards of a collaborative and responsible approach to space exploration are even greater.

Conclusion

China's advancements in reusable rocket technology mark a pivotal moment in space exploration. The proliferation of affordable and reliable space access has the potential to democratize space, ushering in an era of unprecedented scientific discovery, commercial innovation, and economic growth. However, this technological revolution also carries inherent risks, particularly when viewed through the escalating geopolitical competition between the United States and China.

China's ambitious space program, bolstered by its rapidly maturing reusable rocket capabilities, signals a paradigm shift in the global space landscape. The implications of this shift are profound, reaching far beyond technical achievements and extending into the realms of international relations, economic competition, and national security.

While still holding a leading position in space technology, the United States must act decisively to maintain its edge and adapt to a new era of multipolar space activity. This requires a multifaceted approach that balances competition with cooperation, innovation

with diplomacy, and ambition with responsibility. Delaying action or underestimating the significance of China's advancements could have far-reaching consequences, potentially ceding a critical domain to a strategic competitor and jeopardizing the long-term interests of the United States and its allies.

The United States must prioritize investments in cutting-edge space technologies, strengthen alliances and partnerships with like-minded nations, and engage in open and constructive dialogue with China to establish norms of behavior and reduce the risk of conflict. These actions, while not without their challenges, are essential for ensuring a future where space remains a domain for peaceful exploration, scientific discovery, and the betterment of humanity.

The path forward is not one of unyielding competition but rather a delicate maneuver of cooperation and competition. While undoubtedly rivals in space, the United States and China also share common interests in space debris mitigation, planetary defense, and scientific research. By recognizing these shared interests and working collaboratively, both nations can contribute to a more stable and sustainable space environment while also pursuing their own national objectives.

The stakes are high, and the decisions made today will have a lasting impact on the future of space exploration and humanity's place in the cosmos. By embracing a balanced approach that combines technological innovation, diplomatic engagement, and international cooperation, the United States can navigate the challenges posed by China's rise in space and seize the opportunities presented by this new era of exploration. This path, while demanding, offers the promise of a future where space serves as a catalyst for human progress, innovation, and cooperation, rather than a theater of conflict and division.

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