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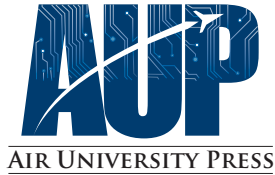
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Spacepower Strategy for Medium Powers *Applying Observations from the Maritime Domain*

LT COL JASON LAU, REPUBLIC OF SINGAPORE AIR FORCE



AIR UNIVERSITY



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Applying Observations from the Maritime Domain

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Foreword

The Kenney Papers series from Air University Press provides a forum for topics related to the Indo-Pacific region, which covers everything from the western shores of the Americas to the eastern coast of Africa and from Antarctica to the Arctic. Named for General George Churchill Kenney, Allied air commander in the Southwest Pacific during World War II and subsequently commander of Strategic Air Command and then Air University, this series seeks to provide a deeper understanding of the region, the geopolitics and geoeconomics that shape the theater, and the roles played by the US military in providing for a free and open Indo-Pacific.



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Abstract

Various spacepower theorists, such as John Klein, Everett Dolman, Namrata Goswami, Peter Garretson, and Brent Ziarnick, write about the similarities between the maritime domain and outer space. However, much of their literature focuses on great power competition between countries like the United States and Russia. What should medium powers—with limited autonomy—do to gain relevance and participate meaningfully in the space domain? Inspired by J. R. Hill's *Maritime Strategy for Medium Powers*, this paper analyzes the historical behavior of medium powers in the maritime domain, distilling several applications to inform medium power strategies for the space domain. Space access and exploitation should not be a distant fantasy for medium powers; they largely have the agency to overcome inherent constraints and should exploit all available instruments of power to achieve their desired ends.

Introduction

Medium powers are much like forgotten middle children. While the eldest child is usually given the responsibility of caring for his or her younger siblings, and the youngest child needs the most assistance, the middle child has an indifferent existence, neither important enough nor helpless enough to merit much attention.

Medium powers face the same conceptual neglect in academic expositions on seapower and spacepower. In a critique of Julian Corbett's seminal publication, *Principles of Maritime Strategy*, John Klein argues that Corbett "addresses the dynamic interaction of those states with the most power and capability with those states with less . . . but . . . fails to fully elucidate the proper strategy [for] medium powers."¹ How medium powers should develop and apply seapower and spacepower is a "missing link" in strategic analyses; this paper gives this category of states the attention they deserve.²

Spacepower for Medium Powers, Not Medium Space Powers

This paper does not address whether and how a medium space power should increase its spacepower, even though that is an important topic. Instead, it explains the significance of spacepower for medium powers, and it offers various ideas for medium powers to consider as they look to craft a spacepower strategy that serves their national interests.

Overall power stature is predominant in a state's actions to acquire domain-specific capabilities. The order is essential: A state does not set out to be a great space power and then decide to be a global superpower thereafter; a state identifies itself as a superpower first and then realizes a need to develop spacepower to support its national interests. Similarly, a state identifies as a medium power first and then decides to develop a corresponding amount of spacepower that would best support its national interests.

Furthermore, a state's capability in a given domain is only a constituent component of its overall power. While a superpower is generally highly capable in most domains, the same is not true for a medium power. A medium power need not necessarily be a medium maritime or space power; it could have more or less power in any given domain relative to its overall stature. For example, Estonia has an outsized influence on European cyber defense policy,

1. Julian Stafford Corbett, *Principles of Maritime Strategy* (Mineola, NY: Dover Publications, 2004); John J. Klein, *Space Warfare: Strategy, Principles, and Policy* (London: Routledge, 2006), 31.

2. Bleddyn E. Bowen, *War in Space: Strategy, Spacepower, Geopolitics* (Edinburgh: Edinburgh University Press, 2020), 24.

as it hosts the North Atlantic Treaty Organization's Cooperative Cyber Defence Centre of Excellence.³ Similarly, Vatican City has ideological and moral influence over Roman Catholics worldwide, even though it may not be very influential in other areas. Based on this logic, medium powers can have varying degrees of spacepower: one medium power could be a great space power, whereas another could be an emerging space power.

Studying a medium power's domain-specific actions from the perspective of its overall power status broadens the conceptual approach by incorporating an understanding of its inclinations and priorities. From a realist angle, this approach locates medium power states within the world of international politics. From a constructivist angle, self-identification as a medium power state with limited aims and means strongly influences strategic culture and national interests. Appreciating the pressures that a medium power is subject to and comprehending how it thinks about itself fosters a richer discussion and analysis of how medium powers should interface with their strategic environment.

Since many scholars have argued that the maritime domain bears the strongest similarity to the space domain, this paper uses the maritime domain as the focal anchor point for a comparative analysis of spacepower. Accordingly, studying the historical actions of medium powers in the maritime domain should provide valuable lessons for how they should act in the space domain.

This paper assumes that nation-states will remain the principal entities of political power.⁴ A discussion of medium powers would be irrelevant in a world where states have lost their political relevance, for example, in an alternative universe where people are global citizens and country borders do not exist.

Medium Powers

What distinguishes the medium power's view is its desire to possess, of itself, the wherewithal to maintain its existence as an entity.

—John Richard Hill
Maritime Strategy for Medium Powers

Namrata Goswami and Peter Garretson classify states into different power categories according to their influence and power projection capability. To them, great powers are “the most powerful states in the international system,

3. Camille Marie Jackson, “Estonian Cyber Policy After the 2007 Attacks: Drivers of Change and Factors for Success,” *New Voices in Public Policy* 7, no. 1 (April 19, 2013): 8, <https://doi.org/10.13021/NVPP.V7I1.69>.

4. Hill, *Medium Power Strategy Revisited*, 1.

capable of projecting military power overseas.”⁵ Medium powers are “states who are not great powers, but who play important roles in the international system by legitimizing alternate proposals for institutions and norms that constitute the global order, moderating conflict and ensuring a balance between the great powers.”⁶ Small powers are conspicuously absent from their definitions, although one can infer that these countries have virtually no agency and no desire to influence. Goswami and Garretson emphasize that medium powers act as “stabilizers and legitimizers of the world order.”⁷ However, they inadequately address the agency of medium powers to act independent of great power interests.

J. R. Hill’s method of classifying states differentiates states according to their level of autonomy. For Hill, three categories exist: superpowers, small powers, and medium powers. Superpowers are states whose power is so preponderant that they cannot be challenged, except by another superpower.⁸ In 1986, Hill recognized the United States and the Soviet Union as the only superpowers, and China as a prospective superpower. Small powers lie on the opposite end of the spectrum from superpowers. These countries cannot safeguard their vital interests independently and depend on external support for their survival.⁹ Hill cites Kuwait and Panama as examples of small powers that were unable to safeguard their sovereign integrity in the 1990s.¹⁰ Medium powers fall somewhere between small powers and superpowers, and are “sufficient only in parts.”¹¹ Hill classifies France, Japan, India, Australia, Brazil, Israel, and Britain under the category of medium powers.¹²

This paper adopts Hill’s power categories with several modifications. First, this paper revises Hill’s three categories—superpowers, medium powers, and small powers—and refers to states as *stronger, medium, or weaker powers*, to emphasize the fluid continuum of power and the potential for changes in relative power status. Power labels exist on a fluid continuum and should not be envisioned as discrete categories. States can cross from one level of power to another over time. For instance, India may one day become a superpower, and Russia may one day become a medium power.

5. Namrata Goswami and Peter A. Garretson, *Scramble for the Skies: The Great Power Competition to Control the Resources of Outer Space* (Lanham, MD: Lexington Books, 2020), 6.

6. Goswami and Garretson, *Scramble for the Skies*, 6–7.

7. Goswami and Garretson, *Scramble for the Skies*, 293.

8. J. R. Hill, *Maritime Strategy for Medium Powers* (New York: Routledge, 2021), 18; and Hill, *Medium Power Strategy Revisited*, 2–3.

9. Hill, *Maritime Strategy for Medium Powers*, 18–19.

10. Hill, *Medium Power Strategy Revisited*, 2.

11. Hill, *Maritime Strategy for Medium Powers*, 20.

12. Hill, *Maritime Strategy for Medium Powers*, 20–25.

This paper defines stronger powers in the same way that Hill defines superpowers, but it refines his definitions of medium and small powers to describe medium and weaker powers, respectively. Stronger powers, following Hill's definition, are those states that can only be challenged by another superpower. However, in today's context, the United States and China are the only undisputed stronger powers. Russia's recent challenge to the world order in Ukraine can be taken as evidence of its increasing desperation to retain its declining stronger power status.¹³ Weaker powers, in this paper's modified definition, are those that hardly exercise any coercive influence over other states and whose vital interests can be threatened by superpowers and medium powers. Kuwait, which was invaded by Iraq in 1990, and Cyprus, which was invaded by Turkey in 1974, are examples of weaker powers.¹⁴ *Medium powers, as defined by this paper, are less powerful than stronger powers and more powerful than weaker powers. They are neither helpless nor invincible and neither wholly dependent on external parties nor completely self-sufficient.*¹⁵ Iraq and Turkey are the medium powers in the previously cited examples. Iraq was repelled from Kuwait because the United States, a stronger power, intervened.¹⁶ However, the United States did not formulate a military response to expel Turkey after its invasion of Cyprus. Thus, no one could stop Turkey and the Turkish Cypriots from declaring the northern half of Cyprus as the Turkish Republic of Northern Cyprus.¹⁷

Two points are worth emphasizing here. First, third-party perceptions of a state's relative power influence interstate interactions. David Cooper describes medium powers as "states that are not major global powers [that] play a consequential role regionally and exert some degree of influence on global affairs."¹⁸ By his definition, physically small states like Luxembourg and Singapore can also be medium powers. For example, Luxembourg plays a central role in European affairs and hosts the European Court of Justice, the Secretariat of the European Parliament, and the European Investment Bank, while Singapore mediated tensions between China and Taiwan in 2015 and hosted the first-ever

13. Hill, *Maritime Strategy for Medium Powers*, 18.

14. Fred Halliday, "The Gulf War 1990–1991 and the Study of International Relations," *Review of International Studies* 20, no. 2 (1994), 110; and Maria Hadjipavlou, "The Cyprus Conflict: Root Causes and Implications for Peacebuilding," *Journal of Peace Research* 44, no. 3 (2007), 357.

15. Hill, *Medium Power Strategy Revisited*, 3; and Hill, *Maritime Strategy for Medium Powers*, 20.

16. Halliday, "The Gulf War 1990–1991 and the Study of International Relations," 111.

17. Aylin Güney, "The USA's Role in Mediating the Cyprus Conflict: A Story of Success or Failure?," *Security Dialogue* 35, no. 1 (2004), 34.

18. David A. Cooper, "Challenging Contemporary Notions of Middle Power Influence: Implications of the Proliferation Security Initiative for 'Middle Power Theory,'" *Foreign Policy Analysis* 7, no. 3 (2011), 319.

diplomatic summit between the United States and North Korea in 2018.¹⁹ Size is not necessarily commensurate to power status.

Second, while a country's capability is often the focus in an assessment of autonomy, its intention is another equally important consideration. A defining characteristic of the medium power is its recognition of its limitations and its desire to overcome them. According to Hill, "medium-ness depends on a state's perception of itself. . . . What distinguishes the medium power's view is its desire to possess, of itself, the wherewithal to maintain its existence as an entity."²⁰ It "regards itself as of sufficient weight and substance to be in charge of its own destiny . . . [and is not] content that [its] protection should be subject to the initiatives of an external guarantor."²¹ Self-identification as a medium power is associated with the intention of being independent and free of coercion; intention drives capability development, which enables the country to achieve a degree of autonomy.

A medium power with limited autonomy has two grand strategic objectives: (1) to survive and (2) to thrive on its own terms.²² There is a hierarchy: survival is prioritized before "betterment."²³ As the French general André Beaufre suggests, "the struggle for freedom of action is the essence of [national] strategy."²⁴

Three subsidiary political objectives serve the two grand strategic objectives: *security*, *political legitimacy*, and *economic sustainability*. The more secure a country is, the greater its independence of action. The greater its political legitimacy, the stronger its ability to influence other countries. The more resources it has, the wider its variety of policy options. These subsidiary political objectives align with Thucydides' reasons for war: fear, honor, and interest, which correspond to security, political legitimacy, and economic sustainability, respectively.²⁵ States use seapower and spacepower—alongside other mechanisms—to support these subsidiary political objectives of security, political legitimacy, and economic sustainability, which in turn serve the grand strategic objectives of survival and betterment.

19. Goswami and Garretson, *Scramble for the Skies*, 285; Ankit Panda, "Singapore: A Small Asian Heavyweight," Council on Foreign Relations, April 16, 2020, <https://www.cfr.org/backgroundunder/singapore-small-asian-heavyweight>.

20. Hill, *Maritime Strategy for Medium Powers*, 26.

21. Hill, *Maritime Strategy for Medium Powers*, 20.

22. Hill, *Maritime Strategy for Medium Powers*, 9.

23. Hill, *Maritime Strategy for Medium Powers*, 10, 13.

24. Jean-Luc Lefebvre, *Space Strategy* (Hoboken, NJ: John Wiley and Sons Inc., 2017), 6.

25. Thucydides, *The Landmark Thucydides: A Comprehensive Guide to the Peloponnesian Wars*, ed. Robert B. Strassler, trans. Richard Crawley (New York: Free Press, 2008), 43.

Why a Maritime Analogy for Space?

A maritime model matches more closely than air or naval theory the essence of space operations. . . . [T]he strategic space theory derived from a maritime model is congruent with current space-specific theory and observation.

—John J. Klein
“Corbett in Orbit”

Varied academics, including John Klein, Everett Dolman, Namrata Goswami, Peter Garretson, and Brent Ziarnick, write about the similarities between the maritime and space domains. An analogy provides a theoretical framework for thinking about issues in another domain.²⁶ Before deep-diving into an analysis of medium power actions in the maritime domain, it is helpful to consider why and how the maritime analogy is used to describe space. This section weaves together ideas from various scholars to create a coherent narrative of the similarities between the maritime and space domains.

Technological Advancements, Crossing New Frontiers, and New Opportunities for Commerce

In the fifteenth century, Portugal combined new navigational tools like the cross-staff with new ships like the caravel to embark on oceanic voyages far beyond its shores.²⁷ These voyages not only granted Portugal access to foreign commodities; they also spurred unprecedented economic growth within the Portuguese Empire.²⁸ In this century, Elon Musk has demonstrated the commercial viability of reusable space vehicles. With space containing “a billion times the mineral resources, and a billion times more energy [than Earth],” humanity is on the cusp of making yet another economic breakthrough, this time enabled by the exploitation of space resources.²⁹

Even now, before the realization of an intergalactic space mineral trade, space already enables the exchange of another type of commodity—information—in an unprecedented way. Alfred Thayer Mahan writes that seapower consists of three vital components: “[P]roduction, with the necessity of exchanging products, shipping, whereby the exchange is carried on, and colonies, which facilitate and enlarge the operations of shipping and tend to protect it

26. John J. Klein, “Corbett in Orbit,” *Naval War College Review* 57, no. 1 (2004), 71.

27. Goswami and Garretson, *Scramble for the Skies*, 9.

28. Goswami and Garretson, *Scramble for the Skies*, 16–17.

29. Goswami and Garretson, *Scramble for the Skies*, 9–10.

by multiplying points of safety.”³⁰ Brent Ziarnick argues that the same components exist in space: Satellite payloads produce imagery and navigation information, electromagnetic waves ship these products to Earth, and satellites act as colonies, insofar as they facilitate the production and transmission of information.³¹ Profit-seeking corporations looking to recoup the costs of their expensive investments have monetized the flow of information, restricting the transmission of desired data to willing buyers.

Humankind’s Dependency on the Maritime and Space Domains

Such is the value of the material and intangible commodities provided through the maritime and space domains that humanity now depends on access to both domains. Maritime trade provides many states with essential goods that may be otherwise unobtainable.³² Similarly, with the proliferation of satellite-enabled television, communications, navigation, and weather forecasting, “all things relating to finance, logistics, industry, tourism, the media, science have all become spatiodependent.”³³

Militarization following Commercialization

As states became reliant on seaborne commerce, they first equipped commercial ships for defense and later created navies to protect their access to maritime trade.³⁴ Commercialization without militarization resulted in piracy. Thus, militarization of the domain inevitably followed commercialization of the domain.³⁵

The same phenomenon appears to be manifesting in the space domain. Writing in 1958, Donald Cox and Michael Stoiko foresaw the need to establish a UN Space Force to enforce peace in outer space.³⁶ While the UN Space Force has not materialized, the United States, China, and Russia have all established their own space forces, with the new space economy on the verge of exponential growth. In 2015, China established the People’s Liberation Army Strategic

30. A. T. Mahan, *The Influence of Sea Power Upon History 1660–1783*, Twelfth Edition (Boston: Little, Brown and Company, 1918), 28.

31. Brent David Ziarnick, *Developing National Power in Space: A Theoretical Model* (Jefferson, North Carolina: McFarland & Company, Inc., Publishers, 2015), 16–21.

32. Hill, *Maritime Strategy for Medium Powers*, 48.

33. Lefebvre, *Space Strategy*, 74, 76, 102.

34. Mahan, *The Influence of Sea Power*, 26; and Karl P. Mueller, “Totem and Taboo: Depolarizing the Space Weaponization Debate,” *Astropolitics* 1, no. 1 (January 2003): 18, <https://doi.org/10.1080/1477-760391832499>.

35. James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, 3rd ed. (Stanford, CA: Stanford University Press, 2019), 18.

36. Donald Cox and Michael Stoiko, *Spacepower: What It Means to You*, 1st ed. (Philadelphia: John C. Winston Company, 1958), 175.

Support Force and Russia restructured the Russian Air Force into the Russian Aerospace Forces.³⁷ In 2019, the United States followed suit by creating the United States Space Force, with the mandate to “protect the interests of the United States in space [and] deter aggression in, from, and to space.”³⁸

Strategic Concepts for Mastery of the Domain: Chokepoints and Lines of Communication

While states have interests requiring protection at sea and in space, the vastness of the domains mandates a concentration of resources on critical areas. Naval theorists devised two concepts to focus the Navy’s scope of responsibility: maritime chokepoints and Sea Lines of Communication (SLOCs).

States must protect chokepoints because of their elevated importance over other areas in the same domain. In the maritime context, strategists characterize a chokepoint as a waterway that is (1) influential to the interests of various states, (2) narrow enough to be closed, and (3) not readily replaceable by alternative routes in the event of closure.³⁹ Historically, there are seven major chokepoints in and among the various oceans and seas: “Gibraltar, Bab el Mandeb, Hormuz, the Danish Straits, the Turkish Straits, and the Suez and Panama Canals.”⁴⁰ Besides chokepoints located on the waters, terrestrial chokepoints, such as naval bases and maritime ports, also affect access to the maritime domain and need to be protected.⁴¹

Parallel to the concept of chokepoints is the idea that a state has maritime lines of communication that it needs to control. Because the sea is useful primarily as a medium for transportation, a state should focus on protecting relevant maritime lines of communication that provide it with access to and use of the domain. Accordingly, naval operations can be used to attack or defend SLOCs. One state can gradually deprive another into submission by occupying strategic chokepoints and denying an adversary’s control of its SLOCs.⁴²

Space strategists appropriated the concepts of chokepoints and lines of communication for the space domain. Writing in 1961, Dandridge Cole introduced the idea of chokepoints in space when he argued that “there are strategic areas in space which may someday be as important to space transportation as the

37. Bowen, *War in Space*, 175–76.

38. Goswami and Garretson, *Scramble for the Skies*, 138.

39. Lewis M. Alexander, “The Role of Choke Points in the Ocean Context,” *GeoJournal* 26, no. 4 (1992), 504.

40. Alexander, “The Role of Choke Points in the Ocean Context,” 506.

41. Klein, *Space Warfare*, 28.

42. Klein, *Space Warfare*, 22–24.

Panama Canal is to ocean transportation.”⁴³ Everett Dolman suggests the same, averring that “the state that most efficiently occupies or controls these positions can ensure for itself domination of space commerce and, ultimately, terrestrial politics.”⁴⁴ Low-earth orbit, the geostationary belt, and Lagrange Points are some of the space-based chokepoints, while launch, monitoring, and control sites are some of the terrestrial chokepoints affecting access to space.⁴⁵ These space-related chokepoints share the same characteristics as maritime chokepoints: they are vital to national interests, capable of being closed off, and lack a viable alternative route.

John Klein adapts the concept of SLOCs to the space domain by referring to Celestial Lines of Communication (CLOCs). CLOCs occur “in and through space [and are] used for the movement of trade, material, supplies, personnel, space craft, electromagnetic transmissions, and some military effects.”⁴⁶ Just as SLOCs can be attacked or defended, CLOCs, too, can be disrupted or protected. Klein suggests that “the primary objective of space warfare is to protect and defend one’s own lines of communications, while limiting the enemy’s ability to use his.”⁴⁷ That much of the communication to and from space is currently nonphysical and intangible is an essential distinction between the space and maritime domains, as the communicated object will determine the strategy for control and denial.⁴⁸ For instance, if the object of denial in space is the flow of information, a physical blockade using satellites, modeled after a conventional naval blockade, will not be very effective; a better strategy may be to jam satellite transmissions.⁴⁹ Nonetheless, the concept of CLOCs helps identify space as a communication medium and focuses attention on protecting or denying the transmission and reception of the communicated product.

Given the similar emphases on lines of communication and chokepoints, David Lupton argues that “space control is very much like past and present concepts of sea control.”⁵⁰ Consequently, developments in the maritime domain will be used as an intellectual springboard to contemplate how states, specifically medium powers, should seek to make use of space.

43. Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (Portland, Oregon: Frank Cass, 2002), 147.

44. Dolman, *Astropolitik*, 33.

45. Dolman, *Astropolitik*, 64–66, 28.

46. Klein, *Space Warfare*, 51.

47. Klein, *Space Warfare*, 51.

48. Klein, *Space Warfare*, 51–52.

49. Klein, *Space Warfare*, 58.

50. David E. Lupton, *On Space Power: A Space Power Doctrine* (Maxwell Air Force Base, Alabama: Air University Press, 1998), 64.

Medium Powers in the Maritime Domain

Medium-ness implies a certain level of development, and to achieve that level of development requires either the exploitation of a very large indigenous base, or the cross-fertilisation that is brought about by maritime use and intercourse . . . medium-ness and maritime-ness are linked.

—John Richard Hill

Maritime Strategy for Medium Powers

Having demonstrated the similar historical milestones and strategic concepts shared by the maritime and space domains, this section dives into a deeper analysis of the maritime domain by defining seapower and studying the strategic environment, ends, ways, means, and risks of seapower for medium powers. This section highlights six important observations, each of which is considered in the context of the space domain later in this paper.

Understanding Seapower

According to Milan Vego, seapower “describes the entirety of the use of the sea by a nation [and includes] political, diplomatic, economic, and military aspects of sea use.”⁵¹ Or, as John Klein writes, it is the “measure of one nation’s ability to use the seas and oceans in defiance of enemies or rivals.”⁵² As seapower grew in importance and naval conflicts became increasingly common, naval theorists attempted to quantitatively and qualitatively differentiate the amount of seapower various states possessed, to facilitate comparative analyses.

Ship-counting is one way to classify states into different categories of seapower; the assumption is that the state with more vessels has more seapower. In 1976, Mark Janis identified five classes of navies: fifth-class navies, with no major surface combatant vessels such as destroyers or frigates; fourth-class navies, with between one and 10 major surface combatant vessels; third-class navies, with more than 10 major surface combatant vessels; and first- and second-class navies, with more than 10 major surface combatants *and* aircraft carriers.⁵³ The problem with such a classification is that it only enables a static comparison between the aggregate resources held by different states, without consideration of the context of the conflict, the capability of the ships, and the quality of the

51. Milan N. Vego, “On Naval Power,” *Joint Force Quarterly* 50 (Quarter 2008), 8.

52. Klein, *Space Warfare*, 16.

53. Nien-Tsu Alfred Hu and James K. Oliver, “A Framework for Small Navy Theory: The 1982 U.N. Law of the Sea Convention,” *Naval War College Review* 41, no. 2 (1988), 38.

crew.⁵⁴ While having more vessels may contribute to a more considerable potential for naval force, “the potential power of a navy does not always correspond to actual outcomes of disputes.”⁵⁵ Iceland’s gunboats, while inferior in potential, were able to overcome the might of the British Royal Navy to secure the country’s claim to exclusive fishing rights.⁵⁶ Therefore, numerical superiority alone does not necessarily translate into superior seapower.

A second method is to classify navies according to their functional responsibilities; the assumption is that navies with broader responsibilities will be better equipped.⁵⁷ Alfred Hu and James Oliver describe three categories of navies: small, oceangoing, and global. Small navies have the narrowest scope of responsibility. They are “primarily designed, planned, prepared, and constructed to protect and enforce the national rights, as conferred by the 1982 United Nations Law of the Sea Convention, within the 200-mile limit national (economic) waters.”⁵⁸ Oceangoing navies have the same responsibilities as small navies but are further required to extend their force beyond the 200-mile limit and can only cope with a single contingency at that distant range. Finally, global navies must be able to protect their many global interests simultaneously.⁵⁹ Small, oceangoing, and global navies broadly correspond to brown-water, green-water, and blue-water navies, respectively.⁶⁰ While consideration of functional capability is a more holistic metric, it still does not address the multivariate aspects of seapower, which extend beyond military ability. For instance, a country that can utilize diplomacy or the informational instrument of power to guarantee its access to the seas has a degree of seapower, but this is not captured by a categorization that focuses on naval responsibilities—these various ways of obtaining seapower are explored and detailed in the subsequent subsection that contributes to Observation #4 (see below).

Observation #1: Seapower describes a state’s use of the sea—states can be classified according to their capabilities and areas of responsibility.

54. James Cable, “The Diffusion of Maritime Power,” *International Relations* 7, no. 4 (October 1982), 2153, <https://doi.org/10.1177/004711788200700401>.

55. Hu and Oliver, “A Framework for Small Navy Theory,” 38.

56. Cable, “The Diffusion of Maritime Power,” 2140.

57. Hu and Oliver, “A Framework for Small Navy Theory,” 39.

58. Hu and Oliver, “A Framework for Small Navy Theory,” 46.

59. Hu and Oliver, “A Framework for Small Navy Theory,” 46.

60. Brandon J. Weichert, *Winning Space: How America Remains a Superpower* (Alexandria, VA: Republic Book Publishers, 2020), 204.

The Strategic Environment for Medium Powers in the Maritime Domain

With an understanding of seapower, the logical follow-on question is how much seapower a medium power should strive to develop. Before that question can be answered, the medium power's strategic environment must be considered. Medium powers are by no means a monolithic bloc. As every medium power has a unique strategic environment, the following discussion is an abstraction, outlining only the broadest similarities shared by medium powers in their respective strategic environments.

Several factors characterize the strategic environment for medium powers at sea: developments in maritime shipping technology, revised sea laws, and the threat of adversarial navies and sea pirates. Developments in maritime shipping technology played a significant role in creating new commercial opportunities for medium powers. Besides the sailing and navigation technologies developed in the fifteenth century, another critical milestone was the invention of the steamship in the early nineteenth century.⁶¹ Between 1870 and 1913, the steamship—with its ability to maneuver independently regardless of wind patterns—resulted in a tripling of the per capita volume of trade and a near-doubling of the global export-to-gross domestic product (GDP) ratio.⁶²

The 1982 Law of the Sea Convention was another seminal development in the maritime domain. The convention reflected the reality of growing maritime capabilities and sought to regulate interstate interactions at sea by defining the boundaries of a state's territorial sea and Exclusive Economic Zone (EEZ). Specifically, creating an EEZ up to 200 nautical miles from a state's coastline presented medium powers with a new economic opportunity but also forced them to cover a larger area of responsibility. For some medium powers, this development resulted in a fundamental reorganization of their navies and coast guards.⁶³ The EEZ also gave medium powers a legal justification to prevent stronger powers from dominating the exploitation of sea resources. For example, in 1972, the Ecuadorean navy successfully arrested American vessels fishing for tuna on the high seas within 200 miles of the Ecuadorean coast.⁶⁴

However, as naval capabilities improved and states became more reliant on maritime trade, medium powers were also exposed to resurgent threats on and from the sea. Piracy became an ever-present challenge, especially along choke-points like the Nigerian coast and the Malaccan Strait. Naval wars, naval bombardments, and seaborne invasions again became real possibilities, as

61. Luigi Pascali, "The Wind of Change: Maritime Technology, Trade, and Economic Development," *American Economic Review* 107, no. 9 (2017), 2828.

62. Pascali, "The Wind of Change," 2821–23.

63. Hu and Oliver, "A Framework for Small Navy Theory," 42–45.

64. Cable, "The Diffusion of Maritime Power," 2142.

demonstrated by the British naval fleet's liberation of the Falkland Islands in 1982. States became susceptible to collateral damage from conflicts between other states or even mishaps such as oil spills.⁶⁵ These vulnerabilities were challenges that medium powers had to overcome.

Despite these challenges, medium powers responded not by withdrawing from engagement in the domain but by redoubling their efforts at developing maritime and naval capabilities. Nonengagement was not an option, as it would stunt their growth fundamentally and precipitate their eventual decline. After the Chinese government stopped Zheng He's voyages in 1433, China declined from a tribute-collecting maritime power into an inward-looking country threatened by sea pirates and larger navies.⁶⁶ By the sixteenth century, China could not compete with Portugal and the rest of Europe in maritime trade.⁶⁷ As J. R. Hill writes, "medium-ness implies a certain level of development, and to achieve that level of development [often] requires . . . the cross-fertilisation that is brought about by maritime use and intercourse."⁶⁸ Even if there was no immediate need for a navy, medium powers invested in developing one, because latent threats could eventuate quickly, whereas no one could develop military capabilities overnight.⁶⁹

Observation #2: Technological developments, legal changes, and realized threats characterized the maritime strategic environment for medium powers; non-engagement was not an option.

Relating Seapower and the Medium Power's Principal Ends

As stated, a medium power's grand strategic objectives are to survive and thrive on its own terms. Additionally, the subsidiary political objectives of security, political legitimacy, and economic sustainability underlie and serve these grand strategic objectives.

Medium powers use seapower, along with other methods, to advance their security, political, and economic interests. As a broad generalization, they used their SLOCs to facilitate seaborne trade during peacetime and naval operations

65. Hill, *Maritime Strategy for Medium Powers*, 57–61.

66. Wei Yang, "Admiral Zheng He's Voyages to the 'West Oceans,'" *Education About Asia* 19, no. 2 (2014): 28–30; Zhongping Chen, "Toward a Global Network Revolution: Zheng He's Maritime Voyages and Tribute-Trade Relations between China and the Indian Ocean World," *China and Asia* 1, no. 1 (February 11, 2019): 39–40, 24–25, <https://doi.org/10.1163/2589465X-00101002>; and Simão Santiago Madeira, "Why China Ceased to Be a Sea-Power by Mid-15th Century," *European Guanxi*, June 22, 2022, <https://www.european-guanxi.com/>.

67. Chen, "Toward a Global Network Revolution," 26.

68. Hill, *Maritime Strategy for Medium Powers*, 46–47.

69. Hill, *Maritime Strategy for Medium Powers*, 64.

when in active conflict.⁷⁰ Seapower, as embodied by the navy, also conferred legitimacy on a country's political elites. For instance, public displays of naval capability targeted at internal audiences enhanced political power, as did foreign diplomatic engagements targeted at external audiences.⁷¹

To enable the medium power to support these subsidiary political objectives through the domain of the sea, it had to accomplish a maritime domain-specific end: the securing of its SLOCs.⁷² It is unrealistic and unbeneficial for a medium power to strive for the highest degree of capability in any domain, because of its limited means and the significant opportunity costs. For example, a land-locked country like Austria should not attempt to develop a blue-water navy, due to the inherent impracticalities of such an endeavor. Power acquired or developed in a domain must serve a state's national interests. Therefore, a medium power, with limited ambitions and narrow self-interests, had to secure its own SLOCs. The securing of SLOCs manifested differently depending on how and to what extent individual countries depended on the sea; for instance, countries heavily reliant on seaborne trade for essential goods would invest more in their navies.⁷³ Those that failed to do so, like Somalia, would have their maritime shipping ravaged by pirates.⁷⁴

Observation #3: Within the maritime domain, the medium power's specific objective is to secure its SLOCs.

How Medium Powers Sought to Secure Their SLOCs

Medium powers used a combination of diplomatic, economic, and military instruments of power to secure their SLOCs. First, medium powers used naval diplomacy to develop international relations and deter seaborne aggression. By making port calls worldwide, medium powers fostered goodwill and demonstrated their naval capabilities, while simultaneously signaling to the international community their commitment to uphold maritime traditions and be responsible players at sea.⁷⁵ For example, European Union states deployed forces to counter piracy off the Horn of Africa and disrupt human

70. Lars Schoultz, *National Security and United States Policy Toward Latin America* (Princeton University Press, 1987), 191, <https://www.jstor.org/stable/j.ctt7zvwx0.14>.

71. Erik Gartzke and Jon R. Lindsay, "The Influence of Sea Power on Politics: Domain- and Platform-Specific Attributes of Material Capabilities," *Security Studies* 29, no. 4 (August 7, 2020), 602–3, <https://doi.org/10.1080/09636412.2020.1811450>.

72. Klein, *Space Warfare*, 23.

73. Mahan, *The Influence of Sea Power*, 519.

74. Sebastian Bruns, "Multipolarity Under the Magnifying-Glass: Establishing Maritime Security Off the Horn of Africa," *Sicherheit Und Frieden (S+F) / Security and Peace* 27, no. 3 (2009), 175.

75. Hill, *Maritime Strategy for Medium Powers*, 98.

trafficking in the Mediterranean Sea.⁷⁶ They also selectively committed military components to coalition forces in defense of countries under attack, to engender future reciprocation in the event that they were the ones being attacked. For instance, in 1990–1991, Australia contributed naval forces to the coalition effort to counter Iraq after it invaded Kuwait, despite being far removed from the conflict.⁷⁷

Second, medium powers leveraged niche economic capabilities to create interdependent relationships that disincentivized aggression against them.⁷⁸ The most pertinent example of this was the triangular trade of the eighteenth and nineteenth centuries, which created a mutual dependency between three major regions of the world: the Americas, which derived its slaves from Africa; Western Europe, which derived its raw materials from the Americas; and Africa, which derived its manufactured products from Europe.⁷⁹ Countries from these regions were unwilling to disrupt maritime trade since it would ultimately affect their own interests.

Finally, medium powers used their limited military capabilities to obtain localized and temporally bound control of the sea in areas of national interest.⁸⁰ Intrinsic to this strategy is the notion that no party has pervasive and perpetual command of the sea, because of the vastness of the maritime domain and the necessity to disperse naval forces, even for stronger maritime powers.⁸¹ Medium powers could therefore achieve a favorable asymmetry of forces by focusing on the segments of the sea that were the most important to them. During peacetime, their coast guards performed constabulary duties, and their navies maintained a “fleet-in-being” to retain localized control of their SLOCs.⁸² At different intensities of competition or conflict, medium powers had to conduct minor or major naval operations, ranging from counterpiracy actions to shore bombardment, to achieve the same control.⁸³ When they were too weak to maintain control of their SLOCs, they used their forces to selectively dispute the stronger power’s command of the sea, through harassing and nui-

76. Oscar L. Larsson and J. J. Widen, “The European Union as a Maritime Security Provider—The Naval Diplomacy Perspective,” *Studies in Conflict & Terrorism*, April 6, 2022, 2, <https://doi.org/10.1080/1057610X.2022.2058863>.

77. Hill, *Medium Power Strategy Revisited*, 6.

78. Hill, *Maritime Strategy for Medium Powers*, 64.

79. Ronald Findlay, *The “Triangular Trade” and the Atlantic Economy of the Eighteenth Century: A Simple General-Equilibrium Model*, Essays in International Finance, No. 177 (Princeton, NJ: International Finance Section, Department of Economics, Princeton University, 1990), 2.

80. Hill, *Maritime Strategy for Medium Powers*, 81.

81. Bowen, *War in Space*, 63.

82. Hill, *Medium Power Strategy Revisited*, 40; Hu and Oliver, “A Framework for Small Navy Theory,” 45; Klein, “Corbett in Orbit,” 65; and Hill, *Maritime Strategy for Medium Powers*, 96.

83. Klein, “Corbett in Orbit,” 65; and Hill, *Maritime Strategy for Medium Powers*, 124, 139–43.

sance operations.⁸⁴ These actions disrupted the stronger powers' naval activities and could be sufficiently unsettling, if continued for some time, to convince the stronger powers to withdraw from the region in dispute.

Medium powers often developed their naval capabilities by building what they could and buying what they could not, given their limited defense industrial base and aptitude for development. By necessity, their limited naval fleet was likely to prioritize brown-water issues and favor a defensive orientation.⁸⁵ To deter attacks from stronger powers or balance against stronger, threatening states, a medium power often had to ally itself with another stronger power. For example, during the Cold War, Japan, Australia, and New Zealand signed a security treaty with the United States, while India signed a security treaty with the Soviet Union.⁸⁶ Using these diplomatic, economic, and military instruments, medium powers maintained their limited control over their SLOCs.

Observation #4: A state should use all its instruments of power to secure its SLOCs.

Conditions for the Generation of Seapower and the Medium Power's Means

In his seminal text titled *The Influence of Sea Power Upon History, 1660–1783*, Alfred Thayer Mahan lists several general conditions affecting the development of seapower: geographical position, physical conformation, the extent of territory, population size, national character, and character and policy of governments. He argues, among other things, the benefits of being positioned on trade routes, the vulnerability of a country with a long coastline if it had a small population, the importance of a seafaring orientation among the people, and the need for sustained political support to develop naval power.⁸⁷

While his ideas are still relevant today, Mahan approached the topic by describing what he believed to be inherent and natural characteristics of countries. These factors alone do not account for all aspects of seapower generation. Equally important are internal but more controllable factors supporting a state's development of seapower, such as political stability, economic prosperity, and military expenditure. Inherent weaknesses can be mitigated; for example, a state that lacks a natural harbor can reclaim land to construct an artificial harbor. Recognizing that certain factors are pliable infuses a medium power with the belief and agency to influence its future, instead of leaving it resigned

84. Klein, *Space Warfare*, 28.

85. Hill, *Maritime Strategy for Medium Powers*, 209–10, 146.

86. Hill, *Maritime Strategy for Medium Powers*, 68–69.

87. Mahan, *The Influence of Sea Power*, 29–58.

helplessly to an inevitable fate. Natural characteristics and pliable attributes collectively constitute a state's means of generating seapower.

Observation #5: A state's means of generating seapower include its inherent characteristics and other more pliable factors.

The Primary Risk: Developing Too Much or Too Little Seapower

In developing seapower, a medium power's primary challenge is determining the appropriate reach for its ambitions. Some of the core issues that the medium power will need to decide include the distance from its home base that it intends to conduct operations, the types of operations it will conduct within its area of interest, and the amount of support from partners and allies that it will need.⁸⁸ Naturally, a medium power is likely to be more resource-constrained and will need to have realistic aspirations.⁸⁹ As Hill suggests, "it is only by . . . a proper assessment of limits and risk that the medium power can hope to attain a realistic maritime strategy within its means."⁹⁰

If a country develops more seapower than necessary and takes on too many responsibilities, sustaining its naval fleet may be difficult in the long run. After more than a century of global naval dominance, the United Kingdom experienced an "imperial overstretch" and had to refocus the priorities of its Royal Navy back on the waters of Europe around the start of the twentieth century.⁹¹ Joseph Chamberlain, the secretary of state for the colonies of the United Kingdom, feared that high taxes would provoke a public revolt, as the naval expenses of the British Empire were astronomical even as the British economy was performing poorly.⁹² In a way, the United Kingdom's overreliance on the maritime domain for control of its expansive empire created an asymmetric vulnerability for itself.⁹³ The overcommitment of resources to develop seapower and overreliance on the maritime domain to control its interests eventually led to the decline of the British Empire and its regression from a stronger power into a medium power.

However, if a medium power decides to develop too little seapower, it risks compromising its national sovereignty with the threat of naval invasion. China

88. Hill, *Maritime Strategy for Medium Powers*, 149–51.

89. Hill, *Medium Power Strategy Revisited*, 3.

90. Hill, *Maritime Strategy for Medium Powers*, 227.

91. Phillips Payson O'Brien, "The Titan Refreshed: Imperial Overstretch and the British Navy before the First World War," *Past & Present*, no. 172 (2001), 147, 151.

92. O'Brien, "The Titan Refreshed," 147.

93. John J. Klein, *Understanding Space Strategy: The Art of War in Space*, 1st ed., Space Power and Politics (Abingdon, Oxon: Routledge, 2019), 114.

suffered this experience in the First and Second Opium Wars and the First Sino-Japanese War. In the former, the British forced China to cede Hong Kong and open numerous treaty ports in coastal cities. In the latter, China relinquished Taiwan and the Diaoyu Islands to the Japanese and paid 230 million taels of silver in reparations.⁹⁴ Consequently, Chinese naval strategy since the 1980s specified command of the sea in waters within the first island chain as a central objective.⁹⁵ With its growth into a stronger power in the twenty-first century, China's maritime interests further expanded. Currently, China's maritime strategy also encompasses protection of its economic and political interests in the far seas—beyond the Indian Ocean.⁹⁶

Observation #6: A medium power needs to determine the appropriate reach of its seapower ambitions.

As demonstrated, every state that participates in the maritime domain has a unique context; there is no one-size-fits-all solution. Medium powers must consider their strategic environment and available resources to develop suitable ends for seapower. Only then will they be able to tailor appropriate strategies to secure their SLOCs.

Medium Powers in the Space Domain

There is no true space power that does not have its own unaffected access to space.

—Jean-Luc Lefebvre
Space Strategy

This section considers the observations derived from the maritime domain in the previous section and derives relevant applications for the space domain. The section begins with a definition of spacepower and thereafter addresses the strategic environment, ends, ways, means, and risks of spacepower for medium powers. Each subsection ends by summarizing the corresponding application for the space domain.

94. Robert Nield, *China's Foreign Places: The Foreign Presence in China in the Treaty Port Era, 1840–1943* (Hong Kong: Hong Kong University Press, 2015), 1–4, <https://doi.org/10.2307/j.ctt17w8gkt>.

95. Ryan D. Martinson, “Deciphering China’s ‘World-Class’ Naval Ambitions,” *Proceedings*, August 1, 2020, <https://www.usni.org/>.

96. Oriana Skylar Mastro, testimony before the House Foreign Affairs Committee Subcommittee on Asia, the Pacific, and Non-Proliferation, On Chinese Maritime Ambitions, 116th Cong., 2nd sess., June 30, 2020, 5, <https://docs.house.gov/>.

Understanding Spacepower

According to Observation #1, “seapower describes a state’s use of the sea—states can be classified according to their capabilities and areas of responsibility.” Several spacepower theorists define spacepower in a similar manner, by emphasizing how the state uses the domain. David Lupton defines spacepower as “the ability of a nation to exploit the space environment in pursuit of national goals and purposes, [including] the entire astronautical capabilities of the nation.”⁹⁷ More succinctly, Brent Ziarnick defines spacepower as “the ability to do something in space.”⁹⁸

The same conceptual challenges encountered in the measurement of seapower also surface in attempts at quantifying spacepower. Instead of counting the number of seafaring vessels, one website ranks states according to the number of satellites they have launched into space. By this classification, Russia is ranked above China, as it has launched almost five times the number of satellites launched by China.⁹⁹ However, China’s rapid growth in space capabilities has enabled it to overtake Russia. Today, Russia cannot match China’s space capabilities, such as its ability to launch its own space station and land on the dark side of the moon.¹⁰⁰ As in the maritime domain, the rudimentary indicator of numerical superiority is flawed; it does not adequately account for a state’s ability to use space.

Another categorization used by the *World Population Review* classifies states into seven levels of functional capability.¹⁰¹ Countries that are limited to ground-based space activities are at the first level. If they operate satellites, they are at the second level. If they can launch satellites, they are at the third level. Levels four to seven correspond to probe-sending capability, manned space operations, space station operating capability, and the ability to land humans on the moon, respectively. While this definition introduces a clear hierarchy of capability, a better classification would incorporate the state’s self-ascribed role in the domain, in the same way that brown-water, green-water, and blue-water navies specify a particular realm of functional responsibility. Under present circumstances, medium powers will never attain the seventh level of functional capability—landing humans on the moon—nor should they attempt to do so. In that regard, the *World Population Review*’s categorization is not very useful for medium powers, as it provides no insights on the reason-

97. Lupton, *On Space Power*, 4.

98. Ziarnick, *Developing National Power in Space*, 13.

99. Avery Koop, “Visualized: Which Countries Are Dominating Space?,” *Visual Capitalist*, July 8, 2022, <https://www.visualcapitalist.com/>.

100. Weichert, *Winning Space*, 82.

101. “Countries with Space Programs 2023,” *World Population Review*, 2023, <https://worldpopulationreview.com/>.

able level of spacepower that countries should aspire to develop. Identifying a state's interests and orientation in the domain—whether its focus is using space to enhance terrestrial activities, advance galactic ambitions, or a hybrid of the two—should accompany and explain a classification of states by space capability.

John Klein offers a slightly different framework for categorizing states according to functional capability. He identifies three broad categories of states: emerging, medium, and great space powers. According to Klein, emerging space powers are states “that can develop or control satellites but that are unable to launch them through indigenous means.”¹⁰² Medium space powers have a higher level of capability and can indigenously launch, develop, and control satellites. Finally, the great space powers have the highest level of capability and possess, in addition to medium space power capabilities, “the indigenous capability of human spaceflight.”¹⁰³ Klein does not distinguish between a state's capabilities and those of private companies operating within the state, perhaps because states monopolized the development of spacepower for much of the domain's early history.

While Klein's framework still does not address a state's intentions or realm of functional responsibility, one of its most significant contributions is its emphasis on *indigenous* capability as a fundamental criterion to differentiate between categories of states. Robert Harding similarly emphasizes the importance of indigenous capability in his analysis of space policy in developing countries. Harding lists three tiers of states with different spacepower capabilities: those who can autonomously produce and launch their own space technology, those who need to collaborate with others to produce space technology, and those who buy space technology from others.¹⁰⁴ The distinction is important: the indigenous capability to develop, launch, and operate space assets acquires greater importance in the space domain, because of the significant astrophysical hurdles that need to be overcome to get to space. Indigenous capability ensures that a state has complete control over developmental trajectories and can act in space without being beholden to another state. Incorporating this idea of freedom of action, this paper defines spacepower as the capability to access and exploit space, and the freedom to act *in* space and transmit and receive physical and non-physical artifacts *to* and *from* space.

102. John J. Klein, “Space Strategy Considerations for Medium Space Powers,” *Astropolitics* 10, no. 2 (May 2012), 111, <https://doi.org/10.1080/14777622.2012.698929>.

103. Klein, “Space Strategy Considerations for Medium Space Powers,” 111.

104. Robert C. Harding, *Space Policy in Developing Countries: The Search for Security and Development on the Final Frontier* (Abingdon, Oxon: Routledge, 2013), 78–79.

Application #1: Spacepower describes a state's ability to use space and its freedom to act in, to, and from space. The indigenous ability to develop and operate space assets is central to a state's freedom of action in space. Existing methods of categorizing spacepower are inadequate because they fail to consider what the state intends to accomplish through the domain.

The Strategic Environment for Medium Powers in the Space Domain

Observation #2 from the maritime domain states that “technological developments, legal changes, and realized threats characterized the maritime strategic environment for medium powers; non-engagement was not an option.” These same factors are considered in the context of space to determine if they are similarly influential.

The most influential legal agreement for the space domain is the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, also known as the Outer Space Treaty (OST). Dating further back than the 1982 Law of the Sea Convention, the OST is notable not for its specification of new boundaries—like a state's territorial sea and EEZ—but for its ambiguity. Article IV of the OST states that “the Moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes.”¹⁰⁵ States interpret “peaceful purposes” differently: while Russia understands this clause to mean that space should not be militarized, the United States suggests that military assets can be placed in space as long as they are not used aggressively.¹⁰⁶ France's 2019 Defense Space Strategy even goes so far as to assert that the OST “permits the militarisation and even weaponisation of Earth orbits, provided that weapons of mass destruction are not deployed there.”¹⁰⁷ The ambiguous language of the treaty is problematic for an undiscerning medium power, which may be lulled into a false sense of security.

The different perspectives of various states manifest in an enduringly inadequate global legal framework, with states unable to find consensus and unwilling to amend existing legal treaties. For instance, many states failed to ratify the 1979 Agreement Governing the Activities of States on the Moon

105. United Nations, “RES 2222 (XXI): Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies,” December 19, 1966, 14.

106. Han-Taek Kim, “Militarization and Weaponization of Outer Space in International Law,” *Korean Journal of Air & Space Law and Policy* 33, no. 1 (June 30, 2018), 266, <https://doi.org/10.31691/KASL33.1.9>; and Klein, *Understanding Space Strategy*, 50.

107. The French Ministry for the Armed Forces, “Space Defence Strategy: Report of the ‘Space’ Working Group” (DlCoD, November 2019), 16.

and Other Celestial Bodies, also known as the Moon Treaty.¹⁰⁸ More recently, opinion is divided on the China- and Russia-led Treaty on the Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects.¹⁰⁹ In response, some states resorted to bilateral agreements—such as the US-led Artemis Accords—and codes of conduct—like the European Union Draft Code of Conduct for Outer Space Activities—to influence interstate interaction in space, but it remains unclear whether such mechanisms will be effective if they cannot be enforced.¹¹⁰ There are disparate global governance bodies that oversee specific slices of space operations—for example, the International Telecommunications Union (ITU) governs spectrum management in geostationary orbit—but other aspects like space debris and space traffic management are essentially un-governed.¹¹¹ The lack of legal protection and resultant uncertainty creates a Wild West in space. While more powerful countries may be able to capitalize on the ambiguity to exploit their interests in space, less powerful countries would benefit from a clearer legal regime that establishes a fair and level playing field and prevents more powerful countries from doing whatever they want in the space domain.

Regarding technological developments, reusable space vehicles may open a new gateway to access the space domain in an unprecedented manner, just as the steamship enabled states to sail nearly everywhere regardless of the prevailing winds. The commercial space industry is a central actor in the development of space technology: reusable space vehicles are being popularized today because of commercial space companies like SpaceX and Blue Origin. While space technology development was traditionally the preserve of state militaries or state-run space agencies like the National Aeronautics and Space Administration, commercial space companies became more capable in the 1990s with the progressive proliferation of scientific and technological expertise. Today, commercial space technologies empower individual citizens to access space-based applications freely and ubiquitously; commercial products like Google Earth and Google Maps grant individuals access to satellite imagery and satellite-enabled navigation on their smartphones.¹¹²

108. Dolman, *Astropolitik*, 133.

109. Jinyuan Su, “The ‘Peaceful Purposes’ Principle in Outer Space and the Russia-China PPWT Proposal,” *Space Policy* 26, no. 2 (May 2010), 81, <https://doi.org/10.1016/j.spacepol.2010.02.008>.

110. Elya A Taichman, “The Artemis Accords: Employing Space Diplomacy to De-Escalate a National Security Threat and Promote Space Commercialization,” *American University National Security Law Brief* 11, no. 2 (2021), 114; and Klein, *Understanding Space Strategy*, 10.

111. Klein, *Understanding Space Strategy*, 13.

112. Harding, *Space Policy in Developing Countries*, 2–3.

The rise of the commercial space industry is a proverbial double-edged sword for medium powers.¹¹³ Where some medium powers may have lacked the indigenous capability to develop space technology, they can now purchase relatively advanced commercial space technologies. However, medium powers' rivals and adversaries can also gain access to commercial space technologies and use them in a threatening manner.

The threat of military conflict associated with the space domain has two main manifestations: (1) the use of space technology to enhance terrestrial warfare and (2) actual conflict *in* space. Only the former has been realized to date. For instance, the United States used satellite-guided precision munitions to great effect in the First Gulf War, swiftly repelling the invading Iraqi forces.¹¹⁴ The latter is a latent threat that seems most likely to be enacted by a desperate state with no other strategic options, such as Russia or North Korea.¹¹⁵ A medium power will need to prepare for both possibilities, even if it does not feel imminently threatened today.

Medium powers are compelled to engage in the space domain not only for security reasons, but also because of the fear of missing out on potential profits from the burgeoning space economy. US Department of Commerce estimates indicate that the space economy will be worth \$1 trillion by 2040.¹¹⁶ With the development of three-dimensional printing and advances in robotics, the prospect of space colonization and in-orbit manufacturing is increasingly realistic.¹¹⁷ Phillip Metzger and other authors argue that “if any nation initiates and controls [a robotic industry that exploits space resources,] it will have a perpetual lead in industrial power over any other nation that initiates the same capability second.”¹¹⁸ Yet there is a significant disparity in space capability between different groups of countries. There is a narrow band of states with a high level of space capabilities, such as the United States, China, and Russia, while the remaining countries have limited capability or even no capability at all.¹¹⁹ Medium powers are afraid that failure to participate in the space domain will compromise their autonomy in the long run and relegate them to be a weaker power—one that cannot independently safeguard its vital interests.

113. Klein, *Understanding Space Strategy*, 11.

114. Steven J. Bruger, “Not Ready for the First Space War: What about the Second?” *Naval War College Review* 48, no. 1 (1995), 77–78.

115. Timothy S. Rich, “Deciphering North Korea’s Nuclear Rhetoric: An Automated Content Analysis of KCNA News,” *Asian Affairs: An American Review* 39, no. 2 (April 2012), 73, <https://doi.org/10.1080/00927678.2012.678128>.

116. Goswami and Garretson, *Scramble for the Skies*, 12.

117. Philip T. Metzger et al., “Affordable, Rapid Bootstrapping of the Space Industry and Solar System Civilization,” *Journal of Aerospace Engineering* 26, no. 1 (January 2013), 18, <https://ascelibrary.org/doi/10.1061/%28ASCE%29AS.1943-5525.0000236>.

118. Metzger et al., “Affordable, Rapid Bootstrapping of the Space Industry,” 27.

119. Lefebvre, *Space Strategy*, 116.

Application #2: Legal ambiguity, inadequate governance, commercial space developments, security concerns, and a fear of missing out on the space economy characterize the strategic environment of space for medium powers.

Relating Spacepower and the Medium Power's Principal Ends

As previously argued in this paper, medium powers have the same grand strategic objectives and subsidiary political objectives, *regardless of the domain in concern*. They first identify as medium powers and are instinctively familiarized with the grand strategic objectives of surviving and thriving on their own terms. Thereafter, they decide on the appropriate amount of domain-specific capability to develop to support their subsidiary political objectives and in turn buttress their grand strategic objectives.

As with seapower in the maritime domain, medium powers use spacepower to support their subsidiary political objectives: to obtain security, political legitimacy, and economic sustainability. Harding writes that “space programs and their related technologies are now an integral part of the strategic and developmental policies of many relatively wealthy developing states that aspire to elevate their international status, security, and economic future.”¹²⁰ Stronger powers also use spacepower to accomplish a fourth objective: scientific advancement or self-actualization of human potential. However, medium powers have more basic needs to focus on and do not share this motivation.¹²¹ The following paragraphs explain how medium powers use spacepower to support their three subsidiary political objectives.

First, medium powers use spacepower to bolster their national security. In 1957, Major General Bernard Schriever, commander of the Ballistic Missile Division in the United States Air Force, presciently described the future importance of military spacepower when he stated that “our safety as a nation may depend upon our achieving space superiority [in the long haul].”¹²² In 1996, China, a rapidly rising medium power, experienced firsthand how a lack of spacepower could threaten a country’s national security. The Chinese wanted to dissuade the Taiwanese people from supporting the incumbent Taiwanese administration, which openly defied the one-China policy by expressing its pro-independence inclinations and making overtures to the US government for support. In a show of force, China fired three Global Positioning Satellite

120. Harding, *Space Policy in Developing Countries*, 2.

121. Klein, “Corbett in Orbit,” 60.

122. Bernard Schriever, “ICBM: A Step Toward Space Conquest,” (California, February 1957), quoted in Cox and Stoiko, *Spacepower: What It Means to You*, 121.

(GPS)–guided missiles at the Taiwan Strait, but two of them did not reach their targets because of suspected interference. Humiliated by the incident and with its dependencies exposed, China was prompted to develop its own Global Navigation Satellite System.¹²³ More recently, the 2013 French White Paper on Defense and National Security also acknowledged that “free access and use of space are [necessary] conditions [for] strategic autonomy.”¹²⁴ Spacepower is “an enabler and a primary provider of critical war-fighting capabilities” and a central component of many countries’ joint warfighting forces.¹²⁵

Second, medium powers use spacepower to obtain political prestige and legitimacy. Deganit Paikowsky suggests that “countries develop space programs . . . to maintain their power and international standing, or [because] they aspire to higher power and status for geo-political and/or domestic reasons.”¹²⁶ Joining the exclusive space club cements a medium power’s reputation as a country on the ascendancy.¹²⁷ The demonstration of space capabilities generates domestic support for incumbent administrations, improves a country’s international reputation, and increases its diplomatic influence in space policymaking forums like the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS).¹²⁸ Even just investing in the costly development of indigenous space capabilities signals a country’s commitment and intent on the global stage, and enhances its international standing.¹²⁹ Today, a space program is “almost obligatory” for recognition as a regional power.¹³⁰ To position itself as a regional space hub in the Middle East, the United Arab Emirates (UAE) widely publicized its Hope Probe as “the first Mars mission to be launched by a Muslim majority Arab nation.”¹³¹ Like the UAE, medium powers prefer to draw attention to their civil space capabilities, which are less threatening and more politically palatable than military space capabilities.¹³² While less technologically advanced states may not be able to accomplish complex space missions, they can strive for more achievable milestones, such as launching national satellites into space using commercial launch services or flying their citizens into space onboard another country’s spacecraft.¹³³

123. Bowen, *War in Space*, 203.

124. Lefebvre, *Space Strategy*, 78.

125. Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), 6.

126. Deganit Paikowsky, *The Power of the Space Club* (Cambridge: Cambridge University Press, 2017), 14, <https://doi.org/10.1017/9781108159883>.

127. Paikowsky, *The Power of the Space Club*, 8.

128. Klein, *Understanding Space Strategy*, 160; Johnson-Freese, *Space as a Strategic Asset*, 6.

129. Paikowsky, *The Power of the Space Club*, 85.

130. Harding, *Space Policy in Developing Countries*, 9.

131. Goswami and Garretson, *Scramble for the Skies*, 287.

132. Paikowsky, *The Power of the Space Club*, 14.

133. Klein, *Space Warfare*, 42–43; and Klein, *Understanding Space Strategy*, 160.

Third, medium powers use spacepower to strengthen their economies. As Ziarnick argues, “space power’s ultimate purpose is to generate wealth from space activities.”¹³⁴ Spacepower primarily enhances economic activities on Earth today, but there is future potential for a space-based economy worth many times more. From 1984 to 2017, GPS contributed \$1.4 trillion to the United States economy, by enabling innovations such as site-specific management of precision agriculture and spectrum sharing on wireless telecommunications networks.¹³⁵ The economies of medium powers also benefit from space technology, albeit on a smaller scale. For instance, Luxembourg generates almost 2 percent of its annual GDP from the space industry.¹³⁶ In the future, space resource exploitation has the potential to enable countries to grow their wealth exponentially. Space minerals from the asteroid belt between Mars and Jupiter are estimated to be worth \$700 quintillion, and space-based solar power extraction from geostationary orbit can produce more than 18 times the power human civilization consumes today.¹³⁷ These resources are already present and are simply waiting for the necessary exploitation technologies to mature. In the various ways thus described, medium powers use spacepower to support their security, political legitimacy, and economic sustainability goals.

Medium powers that do not prioritize the development of spacepower either have been misclassified as medium powers—when they really are weaker powers that do not share the same grand strategic objectives of survival and betterment—or have more effective and efficient methods of accomplishing their subsidiary political objectives apart from using spacepower. Seychelles is an example of the former. Apart from hosting a US Air Force space tracking station, Seychelles has not indicated much interest in developing its own space capabilities.¹³⁸ Oil-exporting Arab countries such as Kuwait, Oman, and Iraq are examples of the latter. Although they have some degree of space ambitions, they prioritize what they have always done best: securing oil resources and controlling oil supplies to benefit their domestic economies.¹³⁹

While most medium powers may share a common interest in the development of spacepower, their space policy emphases will vary because of differ-

134. Ziarnick, *Developing National Power in Space*, 25.

135. Alan C. O'Connor et al., *Economic Benefits of the Global Positioning System (GPS)* (Research Triangle Park, NC: RTI International, June 2019), ES-2, 5-1, 4-1.

136. “Business Sector: Space,” Luxembourg Trade and Invest, 2023, <https://www.tradeandinvest.lu/>; Goswami and Garretson, *Scramble for the Skies*, 282; and Michael Sheetz, “The Space Industry Is Now 2% of Luxembourg’s GDP, Deputy Prime Minister Etienne Schneider Says,” *CNBC*, November 13, 2017, <https://www.cnbc.com/>.

137. Goswami and Garretson, *Scramble for the Skies*, 12–13.

138. John Lablache, “Seychelles Station Tracks U.S. Satellites : Air Force Facility Marks 25th Anniversary of Indian Ocean Duty,” *Los Angeles Times*, November 6, 1988, <https://www.latimes.com/>.

139. International Monetary Fund, “Economic Diversification in Oil-Exporting Arab Countries,” *IMF Policy Papers* 2016, no. 28 (April 29, 2016), 7–9, <https://doi.org/10.5089/9781498345699.007>.

ences in their subsidiary political objectives. Medium powers are unique and heterogenous; they face different national security threats, have different political ambitions, and rely on different primary economic sectors. North Korea, with an existential threat to its political regime, emphasizes the security applications of spacepower.¹⁴⁰ Singapore, which derives its political legitimacy and global preeminence from its strong economy, emphasizes the economic applications of spacepower.¹⁴¹

Regardless of differences in space policy emphases, medium powers must secure their CLOCs to utilize spacepower to accomplish these subsidiary political objectives. This requirement is the logical implication of Observation #3, which states that “the medium power’s specific objective [within the maritime domain] is to secure its SLOCs.” Just as a state must be able to access and exploit its SLOCs to utilize the sea to support its subsidiary political objectives, it also must be able to access and exploit its CLOCs to utilize space for the same purpose.

Stronger, weaker, and medium powers have different approaches to utilizing space and securing CLOCs, primarily because of their differing perspectives and means. Stronger powers like the United States, China, and Russia act consistent with an offensive realist mentality and may seek to dominate CLOCs through the proliferation of indigenous space assets and the development of various offensive and defensive counterspace capabilities.¹⁴² Weaker powers like the Bahamas or Timor-Leste, constrained by their limited means and buffeted by the vagaries of international politics, may have no interest or ability to develop spacepower and consequently no need to secure their CLOCs.¹⁴³ Medium powers, represented by most countries in the world, are generally focused on preserving their own position—more consistent with defensive realism—in the international political arena and will aim to develop *some* degree of spacepower to serve their grand strategic objectives of survival and betterment, which must be matched by a corresponding ability to secure their CLOCs.¹⁴⁴

Since medium powers lack the means to proliferate space assets and field counterspace capabilities to the same degree as stronger powers, their domain-specific objective should be to secure their CLOCs by obtaining a *limited*—as opposed to complete—command of space. Several terms must be defined clearly here. Command of a domain entails the ability to control and

140. Defense Intelligence Agency, *2022 Challenges to Security in Space: Space Reliance in an Era of Competition and Expansion* (Washington, DC: Defense Intelligence Agency, March 2022), 31–32.

141. Office for Space Technology & Industry, “Singapore’s Space Ecosystem” (Economic Development Board, August 2022), 5.

142. Klein, *Understanding Space Strategy*, 106.

143. United Nations, “Member States,” United Nations, 2023, <https://www.un.org/>.

144. Goswami and Garretson, *Scramble for the Skies*, 293.

deny.¹⁴⁵ Control refers to the ability to use—access and exploit—a domain. Denial refers to the ability to deprive another party of control.¹⁴⁶ Complete command entails a pervasive and perpetual ability to control and deny, whereas limited command describes a localized and/or temporary ability to control and deny. A medium power with its limited means should strive to develop the latter: a localized and/or temporary ability to control and deny the domain of space specific to its unique application of spacepower in service of national interests.¹⁴⁷

For medium powers, denial should be prioritized over control. A medium power's highest priority is to prevent the enemy from accessing and exploiting space to harm its national interests, in accordance with its grand strategic objective of survival. There is a subtle nuance here: medium powers are more interested in preventing another party from inflicting harmful space effects on them than in denying another state's access to space so they can achieve their own objectives. For instance, Japan prioritizes hindering its opponents' use of space capabilities to conduct offensive military operations over counterspace capabilities that allow it to act aggressively against another country.¹⁴⁸ Dolman labels this negative, inhibitory aim as "contestation" and suggests that "if one cannot achieve or sustain control, then it is vital that one's potential adversary cannot achieve or sustain control."¹⁴⁹ Furthermore, denial is easier to accomplish than control, because denial can be achieved from outside the domain: space can be denied using terrestrial or cyber means, without reliance on space assets.

A medium power's second priority, if it can prevent other states from inflicting harmful space effects on itself, is to develop localized and/temporary control of space for its own "betterment."¹⁵⁰ Klein submits that "by ensuring access to its own CLOCs, a state can help protect diplomatic, economic, informational, and military interests."¹⁵¹ In other words, it can use space to support its subsidiary political objectives of security, political legitimacy, and economic sustainability. Unlike denial, "control is possible only from within the domain," as a country cannot use space to create effects if it has no ability to access and operate in the space domain. While a medium power may not be able to obtain

145. Klein, *Space Warfare*, 60.

146. Everett Carl Dolman, "New Frontiers, Old Realities," *Strategic Studies Quarterly* 6, no. 1 (Spring 2012), 86–87.

147. Cable, "The Diffusion of Maritime Power," 2156.

148. Yasuhito Fukushima, "Japan Endeavors to Utilize Space for Defense Purposes," Stimson Center, February 23, 2023, <https://www.stimson.org/>; and Robert Farley, "Managing the Military Problem of Space: The Case of Japan," *The Diplomat*, April 23, 2021, <https://thediplomat.com/>.

149. Dolman, "New Frontiers, Old Realities," 85.

150. Hill, *Maritime Strategy for Medium Powers*, 13.

151. Klein, *Understanding Space Strategy*, 22.

pervasive and perpetual control of space, it should strive to develop the ability to access and exploit space at the desired place and time.¹⁵²

Application #3: Within the domain of space, the medium power's specific objective is to secure its CLOCs by obtaining limited command of space. A medium power should (1) prevent other parties from using space to harm its interests and (2) establish localized and temporary control of space for its own benefit.

How Should Medium Powers Secure Their CLOCs?

Three baskets of methods will address the two identified ends of preventing other parties from using space to harm the medium power's interests and establishing localized and temporary control of space for the medium power's benefit. The first basket of methods describes how to *prevent harmful space effects* by shaping the strategic environment, namely, by using the diplomatic, informational, and military instruments of power. The second basket of methods describes how to *establish limited control of space* by developing indigenous satellite engineering expertise and launch capability or by leveraging the expertise and capability provided by other parties. The third basket of methods describes how to *maintain limited control of space* by deterring and negating space denial activities, and rapidly reconstituting space access.

Shaping the Strategic Environment through the Diplomatic, Informational, and Military Instruments of Power

The first basket of methods describes how to prevent harmful space effects. As Observation #4 captures, "a state should use all its instruments of power to secure its SLOCs." In the same way, a medium power must optimally employ all its instruments of power to prevent harmful space effects.¹⁵³ Since medium or weaker powers may be deficient in military capability relative to their rivals, they may have to rely more heavily on non-military instruments of power.¹⁵⁴

One such instrument is the diplomatic instrument of power, which states can use to discourage space weaponization and promote the peaceful use of space. Unlike naval diplomacy, there is no need to sail into another country physically; space diplomacy is more about exerting influence in policy negotiations through active participation in the domain and at international fora.

152. Dolman, "New Frontiers, Old Realities," 86–87.

153. Klein, *Understanding Space Strategy*, 33; and Klein, *Space Warfare*, 60.

154. Klein, *Understanding Space Strategy*, 159.

Klein argues that “those with the most presence in outer space and the most space-based activities will have the greatest chance of shaping international laws, regulations, and norms of behavior.”¹⁵⁵ For example, Canada actively lobbies for its interests at the UN COPUOS, including “[the maintenance of] a safe, predictable, and sustainable outer space environment [and the implementation of] transparency and confidence-building measures in outer space activities.”¹⁵⁶

Other states may use the diplomatic instrument of power to influence policy discussions in alternative directions. Economically focused medium powers that fear the monopolization of the growing space economy by a few states could, for instance, emphasize the need for an equitable distribution of space resources. In 1977, nine equatorial states signed the Bogota Declaration, asserting national sovereignty over the airspace above their territories up to geostationary altitude.¹⁵⁷ While these countries’ claims were ultimately not recognized, their public solidarity instigated intense discussions at the World Administrative Radio Conference and forced the ITU to allocate geostationary orbit slots more equitably.¹⁵⁸ Luxembourg is another interesting example. As a member of the Hague Space Resources Working Group, Luxembourg actively shapes the global space resource governance regime to ensure it will be a central actor in the future space economy.¹⁵⁹ By participating in these international fora, medium powers can promote cooperation, discourage conflict, and prevent the passage of resolutions that run counter to their interests.¹⁶⁰

Apart from these diplomatic mechanisms, medium powers can also use the informational instrument of power to prevent harmful space effects. Medium powers should publicly emphasize their right to self-defense against an attack from space under Article 51 of the UN Charter.¹⁶¹ They should specify that their right to self-defense extends even to scenarios where satellites are targeted but no human lives are harmed. As medium powers may lack the ability to provide a co-orbital counterspace response to an attack from space, they should also explicitly assert their right to respond through retaliation in a different domain.¹⁶² The 2017 US National Security Strategy provides one example of how policy language can be worded, asserting the right to retaliate “at a time,

155. Klein, *Understanding Space Strategy*, 33.

156. Klein, *Understanding Space Strategy*, 159.

157. Dolman, *Astropolitik*, 64–65.

158. Ferdinand Onwe Agama, “Effects of the Bogota Declaration on the Legal Status of Geostationary Orbit in International Space Law,” *Nnamdi Azikiwe University Journal of International Law and Jurisprudence* 8, no. 1 (2017), 25.

159. Goswami and Garretson, *Scramble for the Skies*, 283.

160. Klein, “Space Strategy Considerations for Medium Space Powers,” 112–13.

161. Klein, “Space Strategy Considerations for Medium Space Powers,” 117.

162. Klein, *Understanding Space Strategy*, 76–77.

place, manner, and domain of our choosing.”¹⁶³ By making adversaries aware of the potential costs, such as the counterspace responses that are elaborated in the following paragraphs, medium powers will influence their decision calculus and hopefully deter them from conducting space attacks through the kinetic, electromagnetic, and cyber domains.

Threats are only credible insofar as relevant actions back them; thus, medium powers must develop credible military capabilities to counterspace attacks. For the space domain, the military instrument of power comprises co-orbital and terrestrial counterspace responses. The benefit of a co-orbital response is that it can be directed specifically at the initiator of the space attack and is unlikely to escalate the conflict. One potential co-orbital response requires the placement of dormant but weaponized microsattellites around the vicinity of an adversary’s strategic space assets.¹⁶⁴ If the adversary initiates an attack, these microsattellites can be triggered to jam, laze, or physically impact the attacking satellite.¹⁶⁵ Conceptually, this idea replicates a navy’s “fleet-in-being,” which acts as an amorphous and dispersed set of forces that can be activated when required.¹⁶⁶ The vastness of space also facilitates the staging of co-orbital strategic surprises, which a medium power can exploit to enhance its defensive capabilities. For example, states can design larger satellites to deploy pico- or nano-satellites while in orbit. These smaller satellites can then pre-position themselves for a retaliative function, while avoiding detection due to their size.¹⁶⁷

Medium powers lacking the resources or expertise to develop co-orbital counterspace capabilities should focus on terrestrial counterspace responses. If they cannot target the space segment performing the attack, they should target an associated ground segment or the linkage between the ground and space segments. For example, medium powers can conduct kinetic, electromagnetic, or cyberattacks on control facilities or uplink stations.¹⁶⁸ One benefit of this strategy is the imposition of asymmetric costs, since space-related infrastructure typically has a much higher value than conventional military forces.¹⁶⁹

Medium or weaker powers that cannot develop an adequate terrestrial counterspace response should ally with other stronger or medium powers. The weaker parties should seek access to shared capabilities or obtain contractual guarantees for collective defense.¹⁷⁰ For an agreement to be concluded, all par-

163. Klein, *Understanding Space Strategy*, 101.

164. Klein, *Space Warfare*, 122; and Klein, *Understanding Space Strategy*, 133.

165. Klein, *Understanding Space Strategy*, 26.

166. Klein, *Space Warfare*, 122.

167. Lefebvre, *Space Strategy*, 200.

168. Klein, *Understanding Space Strategy*, 165; and Klein, *Space Warfare*, 124.

169. Lefebvre, *Space Strategy*, 196–97.

170. Klein, *Understanding Space Strategy*, 130.

ties must derive some benefit from the arrangement. For example, 30 countries have Space Situational Awareness (SSA) sharing agreements with the United States, which benefits from a geographically dispersed network of sensors in return.¹⁷¹ As for mutual defense treaties, one relatively plausible idea is for the less powerful countries in the North Atlantic Treaty Organization to lobby for Article 5 to be amended to include attacks in and from the space domain specifically.¹⁷² However, as with negotiations for other mutual defense agreements, the more powerful parties are likely to have their reservations due to the potential for being entangled in undesired conflicts.

One final use of the military instrument of power is to foul, or achieve large-scale and general denial of, the space domain. This effect can be achieved by employing multiple direct-ascent antisatellite (ASAT) weapons to create a massive debris field or by detonating a nuclear electromagnetic pulse in space.¹⁷³ While some medium powers may be able to foul the space domain, they should not pursue this course of action. Fouling the space domain will likely provoke an overwhelming military response and relegate the responsible party to a pariah state.¹⁷⁴ North Korea is probably the only medium power with the capability and appetite to consider the fouling of space a viable strategy, since most states that benefit from operating in space would be hesitant to compromise their own interests.¹⁷⁵

Developing Indigenous Satellite Engineering Expertise and Launch Capability, and Leveraging Other Parties

The second basket of methods describes how a medium power can establish limited control of space after it achieves its foundational aim of preventing harmful space effects. To access and exploit the medium of space, a country must possess the expertise to build hardware that can operate in space, as well as the capability to launch space equipment into orbit. A medium power should first strive to develop this satellite engineering expertise and launch capability indigenously, to maximize its autonomy and independence of action. If this approach does not fully meet its needs, a medium power can consider utilizing

171. James H. Dickinson, “Fiscal Year 2023 Priorities and Posture of United States Space Command” (Presentation to the Senate Armed Services Committee, US Senate, March 1, 2022), 18, <https://www.armed-services.senate.gov/>; and Klein, *Understanding Space Strategy*, 73.

172. Klein, *Understanding Space Strategy*, 74.

173. Lefebvre, *Space Strategy*, 146–47, 152–53; and Weichert, *Winning Space*, 144–45.

174. Lefebvre, *Space Strategy*, 147.

175. Weichert, *Winning Space*, 146–47; Namrata Goswami, “Space Engagement and Cooperation with the Democratic People’s Republic of Korea (DPRK),” *NAPSNet Special Reports*, October 25, 2021, 8, <https://nautilus.org/>.

the expertise and launch capabilities of other parties to address any gaps in its capabilities.

The first component of an indigenous capability strategy is to develop the scientific expertise to build hardware that can operate in space. Education begins from a young age: school curricula and national media must encourage young children to cultivate an interest in space and develop an intellectual curiosity for scientific advancements. As they grow, higher-level educational institutions must equip them with relevant theoretical knowledge—like orbital physics—and practical skill sets—such as aerospace engineering.¹⁷⁶ If a medium power lacks the necessary scientific expertise, it should establish joint partnerships with more developed space powers or entice international space companies to set up shop in-country. This approach can facilitate the gradual diffusion of relevant knowledge and expertise into the local population.¹⁷⁷ For instance, the Bahrain National Space Science Agency signed an agreement with the UAE Space Agency, with the latter committing to train the former in satellite technology design, construction, and launch.¹⁷⁸ Luxembourg is another example, as it established a \$227 million fund to attract asteroid mining companies and successfully lured companies such as Planetary Resources and iSpace to establish local branches.¹⁷⁹ However, sustained long-term investment is necessary to develop the scientific base; there is no shortcut to equipping a country with the indigenous scientific expertise to build space technology overnight.¹⁸⁰

The second component of an indigenous capability development strategy is to develop the capability to launch space equipment into orbit. While some medium powers like France and Japan may have suitable sites for ground-based launches, others like Luxembourg and Singapore may not.¹⁸¹ This latter group of countries can consider developing sea- or air-based launch platforms. China and Russia have demonstrated the viability of sea-based launch platforms, which vaguely resemble mobile sea barges. These sea platforms successfully launched Long March 11 and Zenit-3SL rockets into space.¹⁸² Northrop Grumman's Stargazer, based on the Lockheed L-1011 Tristar aircraft, is an example of an air-based launch platform. The Stargazer successfully launched Pegasus

176. Lefebvre, *Space Strategy*, 180–84.

177. Goswami and Garretson, *Scramble for the Skies*, 280.

178. Goswami and Garretson, *Scramble for the Skies*, 291.

179. Goswami and Garretson, *Scramble for the Skies*, 282.

180. Lefebvre, *Space Strategy*, 185.

181. Thomas G. Roberts, "Spaceports of the World," CSIS Aerospace Security Project (Washington DC: Center for Strategic & International Studies, March 2019), 21, 25, 30, <http://rgdoi.net/>.

182. Goswami and Garretson, *Scramble for the Skies*, 192; Zhengyu Song et al., "Prospects of Sea Launches for Chinese Cryogenic Liquid-Fueled Medium-Lift Launch Vehicles," *Chinese Journal of Aeronautics* 34, no. 1 (January 2021), 424–25, <https://doi.org/10.1016/j.cja.2020.06.018>; and Adrian Beil, "China Launches Advanced Space-Borne Solar Observatory," *NASASpaceFlight.com*, October 9, 2022, <https://www.nasaspacespaceflight.com/>.

XL rockets into space.¹⁸³ While still not widely adopted today, sea- and air-based launches have their advantages. For instance, sea launches enable flexible launch azimuths and reduce the risks associated with launch failures, while air launches may be more cost-effective for specific payloads if the high-altitude release substantially reduces the rocket propulsion fuel needed for orbital insertion.¹⁸⁴

Where a medium power cannot develop the indigenous capability to build and launch its own space assets, it should seek to mitigate its shortfalls by purchasing space assets or services from the commercial industry or more developed space powers. From commercial space companies, medium powers can purchase a variety of space services, ranging from remote sensing to launch capability.¹⁸⁵ For example, Virgin Orbit offers an air-based launch service from a modified Boeing 747 aircraft nicknamed the “Cosmic Girl.”¹⁸⁶ Commercial companies like Arianespace and SpaceX, and national space agencies like the Indian Space Research Organisation, also offer ground-based launch capability as a purchasable service.¹⁸⁷ Medium powers can avoid the lengthy research and development timelines associated with indigenous capability development by purchasing space assets and services from a third party. However, the downside is that these countries will be beholden to the profit incentives of commercial space corporations and the political motivations of other national space agencies, which may not always coincide with their national interests.¹⁸⁸ For instance, the United States relied on Russian Soyuz spacecraft to launch its astronauts into space from 2011 to 2020, after the retirement of the space shuttle.¹⁸⁹ Had the United States still been dependent on Russia for manned spaceflight capability when Russia invaded Ukraine in 2022, Russia would probably have sought to limit the United States’ strategic options by threatening to withhold access to this capability—in the same way that it coerced Western European states reliant upon it for natural gas to moderate their public support for Ukraine.¹⁹⁰ As Jean-Luc Lefebvre contends, nationally-owned space capabil-

183. Tyler Rogoway and Joseph Trevithick, “Is The Stargazer Air-Launch Mothership About To Test A Secretive Air Force Payload?” *The Drive*, August 13, 2020, <https://www.thedrive.com/>.

184. Song et al., “Prospects of Sea Launches,” 424–25; and Collin Krum, “Why Motherships Are Making A Big Comeback For Sending Things Into Space,” *Jalopnik*, October 6, 2015, <https://jalopnik.com/>.

185. Klein, *Understanding Space Strategy*, 132.

186. Andrew Griffin, “Virgin Orbit Launch: What Happened? A Timeline of the Failure and What Might Come Next,” *Independent*, January 10, 2023, <https://www.independent.co.uk/>.

187. Lefebvre, *Space Strategy*, 191; and Weichert, *Winning Space*, 199.

188. Klein, “Space Strategy Considerations for Medium Space Powers,” 115.

189. Emilee Speck, “Russia Has Lost Its Power Over NASA and in the Space Business: Experts,” *New York Post*, March 5, 2022, <https://nypost.com/>; and Robert D. Dittmore, “A Gap in Capability,” *SpaceNews*, June 29, 2004, <https://spacenews.com/>.

190. Becky Sullivan and Jackie Northam, “How Europe’s Reliance on Russia’s Gas Plays Into the War in Ukraine,” *NPR*, February 24, 2022, <https://www.npr.org/>.

ity is the only guarantee of autonomous access to space: “there is no true space power that does not have its own unaffected access to space.”¹⁹¹

Diversification is the best alternative for a medium power with limited indigenous ability to access and exploit space. By purchasing space assets and services from a variety of different sources, a medium power generates multiple access routes into space, facilitating redundancy and systemic resilience. Diversification applies to the entire supply chain; the goal is to avoid sole-source dependencies at every point in the supply chain. For example, the US space industry was significantly affected by a Chinese restriction on rare-earth exports in 2010.¹⁹² By diversifying access to raw materials, space services, launch capabilities, and other aspects of space capability development and operations, a medium power can minimize disruptions to its use of space.

Deterring and Negating Space Denial Activities, and Rapidly Reconstituting Space Access

The third basket of methods describes how a medium power can maintain its limited control of space after obtaining the ability to access and exploit the domain. To maintain control of space, a medium power must deter its adversaries from conducting space denial attacks. If the adversary persists with the space denial attacks anyway, a medium power must be able to negate those attacks and rapidly restore its space access.

A rational opponent is deterred when the expected costs of an action outweigh the expected benefits. Two main methods alter the opponent's cost-benefit calculus: deterrence by denial—which decreases the expected benefits—and deterrence by punishment or cost imposition—which increases the expected costs.¹⁹³

Deterrence by denial can be facilitated by hardening satellite systems and improving cybersecurity safeguards. A satellite is hardened by adding a protective shield around its core components. For instance, encasing a satellite in electromagnetic shielding makes it less susceptible to jamming.¹⁹⁴ While hardening renders satellites less susceptible to kinetic or electromagnetic attacks, a cybersecurity safeguard reduces the probability of a successful cyberattack. Gold copies are one example of a cybersecurity safeguard.¹⁹⁵ The gold copy

191. Lefebvre, *Space Strategy*, 193.

192. Clementine G. Starling et al., *The Future of Security in Space: A Thirty-Year US Strategy*, Atlantic Council Strategy Papers (Washington DC: Scowcroft Center for Strategy and Security, April 2021), 44.

193. Forrest E. Morgan, *Deterrence and First-Strike Stability in Space: A Preliminary Assessment*, RAND Corporation Monograph Series (Santa Monica, CA: RAND, 2010), 24–26.

194. Jacob G. Oakley, *Cybersecurity for Space: Protecting the Final Frontier* (Berkeley, CA: Apress, 2020), 21, <https://doi.org/10.1007/978-1-4842-5732-6>.

195. Oakley, *Cybersecurity for Space*, 70.

enables the satellite to revert to its original operating system and default settings if a cyberattack corrupts its software. Collectively, hardening and cybersecurity safeguards enable individual satellites to be more impervious to interference, reducing the expected benefits of a space attack.

Aside from improving the resilience of individual satellites, another way to support deterrence by denial is by creating systemic resilience through distributed and disaggregated mesh networks.¹⁹⁶ Distributed networks involve multiple nodes contributing to the same mission, whereas disaggregated networks comprise multiple nodes performing distinct functions, which combine to provide a broader composite capability. Since a network of satellites does not rely on a single satellite, it can better withstand momentary disruptions. A successful takedown of an individual satellite only results in partial and “graceful degradation.”¹⁹⁷ Israel is one example of a medium power using CubeSats to pursue a disaggregation strategy.¹⁹⁸

While methods that support deterrence by denial increase the difficulty of disrupting a country’s access to space, deterrence by punishment or cost-imposition relies on a credible and capable threat.¹⁹⁹ To impose costs on the appropriate party, a medium power first needs to acquire adequate SSA.²⁰⁰ An adversary will only be concerned if it can be positively identified as the perpetrator of a counterspace attack. Since counterspace attacks originate from the kinetic, electromagnetic, and cyber domains, a medium power should endeavor to obtain an observational capability in all three domains. Many medium powers are unlikely to have such a comprehensive sensing ability on their own and should rely on a diversified combination of commercially available services and joint partnerships with other countries to leverage a broader network of sensors.²⁰¹

Besides being able to attribute hostile acts, a medium power must also specify a threat that is severe enough to discourage attempts at space denial, and it must be willing to follow through on its threat if deterrence fails. At a minimum, a medium power’s response should negate the space denial attempt and dissuade the adversary from continuing its attacks. As previously described, a medium power can choose to retaliate by executing a co-orbital or terrestrial counterspace response. In addition, it can inflict reputational damage by de-

196. Klein, *Understanding Space Strategy*, 82.

197. Titos Saridakis, “Design Patterns for Graceful Degradation,” in *Transactions on Pattern Languages of Programming I*, ed. James Noble and Ralph Johnson, vol. 5770, Lecture Notes in Computer Science (Berlin, Heidelberg: Springer Berlin Heidelberg, 2009), 67, https://doi.org/10.1007/978-3-642-10832-7_3.

198. Weichert, *Winning Space*, 189.

199. Morgan, *Deterrence and First-Strike Stability in Space*, 26.

200. Lefebvre, *Space Strategy*, 148.

201. Klein, *Understanding Space Strategy*, 73.

nouncing the adversary's aggression and providing evidence of the harm caused. For example, the United States publicly humiliated China in 2007 after China's ASAT test generated thousands of pieces of debris.²⁰² Since then, China's ASAT tests have not been debris-generating.²⁰³ Another possible response is to withhold strategic resources upon which the adversary is critically dependent. For instance, Taiwan produces more than 60 percent of China's semiconductor chips.²⁰⁴ While tensions between China and Taiwan have been rising, Taiwan's ability to cut chip supplies will factor into China's calculus of when and whether to aggressively reunify what it considers as a renegade province. In this manner, a medium power possessing strategic resources but lacking military capability can divert the contest into a domain where it has leverage.²⁰⁵

If an adversary successfully disrupts a medium power's ability to access and use space, the medium power must be able to restore its space capabilities rapidly. Ideally, it will have pre-positioned dormant satellites in orbit, so that these can be swiftly activated to restore lost functionality.²⁰⁶ If a medium power does not have any spare satellites in orbit, it should develop or acquire an on-demand launch capability—prior to anticipated conflict—to quickly repopulate damaged or destroyed satellites.²⁰⁷ In the interim, before its new satellites deploy, a medium power can bridge capability gaps by launching high-altitude pseudo-satellites.²⁰⁸ It can also have prearranged contracts with commercial space companies to access commercial space services during contingencies.

In summary, a medium power should pursue three baskets of methods to secure its CLOCs. First, it should use the diplomatic, informational, and military instruments of power to prevent an adversary from inflicting harmful space effects on itself. Second, it should strive to develop indigenous satellite engineering expertise and launch capability to establish its ability to control and use space. A medium power should only leverage third party capabilities to meet indigenous capability shortfalls as a last resort. Finally, to maintain its

202. Moltz, *The Politics of Space Security*, 53.

203. Mike Gruss, "U.S. Official: China Turned to Debris-Free ASAT Tests Following 2007 Outcry," *SpaceNews*, January 11, 2016, <http://spacenews.com/u-s-official-china-turned-to-debris-free-asat-tests-following-2007-outcry/>.

204. Richard Cronin, "Semiconductors and Taiwan's 'Silicon Shield,'" Stimson Center, August 16, 2022, <https://www.stimson.org/>.

205. Lefebvre, *Space Strategy*, 111.

206. Klein, "Space Strategy Considerations for Medium Space Powers," 121.

207. Lefebvre, *Space Strategy*, 149.

208. The French Ministry for the Armed Forces, "Space Defence Strategy: Report of the 'Space' Working Group," 45.

ability to use space, it should deter and negate space denial activities, and be able to reconstitute disrupted space access rapidly.

Application #4: A medium power must use all its instruments of power to secure its CLOCs. Where inherently deficient, it should rely on commercial actors and developed space powers to mitigate capability gaps.

Conditions for the Generation of Spacepower and the Medium Power's Means

Mahan writes extensively on the concept of seapower and its importance to national security. He also identifies various fundamental conditions that nations need to fulfill to develop seapower. Several spacepower theorists adopt a similar approach to identify conditions that states must develop to generate and leverage spacepower.

Donald Cox and Michael Stoiko, writing in 1958, list several “criteria to gauge a nation’s missile potential,” which can be regarded as a proxy of its space launch potential. Key factors they identify include the quality of political leadership, capability of educational institutions, number of scientists, availability of natural resources, and quality of basic research and test facilities.²⁰⁹ Ziarnick’s description of the principal enablers of spacepower is fairly similar. In his analysis are factors like “educational infrastructure, human capital, number and character of population, natural resources, industrial base capacity, level of scientific understanding and knowledge . . . economy . . . and geography.”²¹⁰ Separately, Dolman offers six policy considerations for astropolitics: society and culture, political environment, physical environment, military and technology, economic base, and theory and doctrine.²¹¹

Four general conditions affecting the development of spacepower can be distilled from these analyses. The first factor is geographical suitability for space launch and operations. A state must be sufficiently large to provision for a safety zone around a launch site, due to the possibility of launch mishaps and falling rockets. A state also needs a wide expanse of land so that it can disperse its ground control stations to facilitate continuous access to satellites. If a state does not have a sufficiently large landmass, satellite-to-satellite relays to a single ground station are possible, but access will probably be intermittent. Finally, a state that is closer to the equator will achieve better orbital efficiency

209. Cox and Stoiko, *Spacepower: What It Means to You*, 53–54.

210. Ziarnick, *Developing National Power in Space*, 19.

211. Dolman, *Astropolitik*, 145–47.

during launch, reducing the propulsion requirements—and therefore the launch costs—to put a satellite into orbit.²¹²

The second factor is natural resources, specifically, whether a state naturally possesses the raw materials required to manufacture satellite vehicles. For instance, satellite bodies are commonly made out of aluminum, titanium, and stainless-steel composites; solar cells are made out of silicon; and spacecraft windows use quartz, silica, and sapphire.²¹³ A state that does not naturally possess the requisite raw materials will have to purchase them from another state, which may introduce undesirable dependencies.

The third factor is population size and “space-mindedness.” A state must have enough people to support a space industrial base, and its population must have a desire “to harness the latent power of space in the continuing pursuit of national power.”²¹⁴ A state’s educational institutions must be capable of educating and equipping successive generations with the relevant aeronautical expertise to develop space technologies and make scientific discoveries in space-related fields and disciplines.

The final factor is political will and financial commitment. Joan Johnson-Freese has suggested that the actual cost of developing space technology is usually double the upper limit of the initial estimate.²¹⁵ A state’s political authorities must be willing and able to invest substantial amounts of money in the long-term development of space capability.²¹⁶ How much spacepower is generated and how quickly that is accomplished depends on whether space is prioritized above other competing demands for the budget, such as health care and defense.²¹⁷

As Observation #5 indicates, “a state’s means of generating seapower include its inherent characteristics and other more pliable factors.” Of the general conditions affecting the development of spacepower, some factors are more controllable than others. While a state’s geographical disposition, population size, and financial strength are unlikely to change rapidly, it can improve its access to raw materials and foster an attitude of space-mindedness among its population. Yet even the less controllable factors can be mitigated: sea- or air-based launch sites can overcome terrestrial launch limitations, commercial space industry can augment a small domestic industrial base, and financial strength can be cultivated by prudent policy over time. Therefore, states can

212. Dolman, *Astropolitik*, 67–70.

213. Miria M. Finckenor, “Materials for Spacecraft,” in *Aerospace Materials and Applications*, ed. Biliyar N. Bhat (Reston, VA: American Institute of Aeronautics and Astronautics, Inc., 2018), 411, 422–23, <https://doi.org/10.2514/4.104893>.

214. Ryan Sanford, “Space-Mindedness: The Application of Space Power,” *Air Power Strategy*, March 18, 2017, <https://www.airpowerstrategy.com/>.

215. Johnson-Freese, *Space as a Strategic Asset*, 59.

216. Dolman, *Astropolitik*, 146.

217. Johnson-Freese, *Space as a Strategic Asset*, 52.

still largely influence the factors required to develop spacepower; if they truly wish to develop spacepower, most will be able to, at least to a degree.

Most medium and weaker powers will probably not be favorably disposed in regard to all of the conditions for the development of spacepower. However, they should harness their strengths to mitigate their weaknesses. For example, a poor country located along the equator, like Somalia, should consider monetizing its geographical advantages. If it is willing to allow another country to construct a spaceport on its premises, it may be able to obtain financial resources and scientific expertise in return. Conversely, a rich country with limited astronomical expertise can use its financial resources to incentivize research and development in space capabilities. For instance, Singapore introduced a \$112 million Space Technology Development Program “to support domains such as aviation, maritime and sustainability [and] improve the country’s space industry’s competitiveness.”²¹⁸

Application #5: The four general conditions affecting the development of spacepower are geographical suitability, natural resources, population size and space-mindedness, and political will and financial commitment. Medium powers should focus their spacepower generation efforts on the factors within their control. In particular, they should harness their strengths to mitigate their weaknesses.

The Primary Risk: Developing Too Much or Too Little Spacepower

According to Observation #6, “a medium power needs to determine the appropriate reach of its seapower ambitions.” The same is true for medium powers aspiring to develop spacepower. To ascertain how much spacepower to develop, they must consider “chances of success, costs of failure, [the] value of the objective, alternate strategic options, and [the] acceptability of the consequences of not [developing spacepower].”²¹⁹ Risk is introduced when medium powers fail to make the right assessments.

If a medium power develops too little spacepower and mis-assesses the consequences of doing so, it risks having its national sovereignty compromised by a country with stronger spacepower. For example, when Iraq invaded Kuwait in 1990, it did not anticipate how effectively spacepower could be applied to support military campaigns.²²⁰ Iraq had the fourth-largest army in the world

218. Office for Space Technology & Industry, “Singapore’s Space Ecosystem,” 7.

219. Richard K. Betts, “Is Strategy an Illusion?” *International Security* 25, no. 2 (October 2000), 14, <https://doi.org/10.1162/016228800560444>.

220. Halliday, “The Gulf War 1990–1991 and the Study of International Relations,” 114.

and combat-experienced soldiers fresh from its war with Iran.²²¹ When the United States–led coalition forces employed spaceborne assets to liberate Kuwait in 1991, Iraq had no effective way to respond. The coalition forces utilized intratheater satellite communications to facilitate decisions across the chain of command, accessed satellite weather data for weapon planning, employed GPS-guided missiles, and used Defense Support Program satellites to detect Iraqi Scud missile launches and provide early warning of imminent strikes.²²² In just over a month, Iraqi forces were driven out of Kuwait. Much of their rapid capitulation can be attributed to their inability to contest the space domain, because they had insufficient spacepower.

But if a country develops too much spacepower, it can compromise other aspects of national development. Prior to 2022, Russia had ambitious plans for its space program, with substantial funding committed to research and development, manufacturing, and cosmodrome development.²²³ When Russia invaded Ukraine in 2022, it must have anticipated a swift and unopposed campaign, similar to its rapid annexation of Crimea in 2014.²²⁴ However, the Ukrainian resistance continues to hold its ground. With the war dragging on, Russia's military spending has swelled to 5 percent of its GDP, and Russia has cut its budget for space activities by almost 20 percent as it redirects funds for the war effort.²²⁵ Furthermore, the United States stopped buying manned spaceflight seats from Russia in 2020, depriving Russia of a considerable revenue stream.²²⁶ From 2011 to 2019, Russia sold \$3.9 billion worth of spaceflight seats to the United States, at an average cost of \$55 million per seat.²²⁷ Given Russia's precarious budgetary position, it may not be able to sustain its existing space capabilities. For instance, more than half of its Global Navigation Satellite System satellites have already exceeded their expected lifespans, but Roscosmos does not have enough funding to produce more than one or two replacement

221. Hisham H. Ahmed, "Iraq's Conduct of the Gulf Crisis: A Critical Assessment," *Arab Studies Quarterly* 13, no. 1/2 (1991), 25; and James W. Pardew, "The Iraqi Army's Defeat In Kuwait," *Parameters* 21, no. 1 (July 4, 1991): 17, <https://doi.org/10.55540/0031-1723.1605>.

222. Bruger, "Not Ready for the First Space War," 74–78.

223. Eric Berger, "Putin Slashes Russia's Space Budget and Says He Expects Better Results," *Ars Technica*, October 8, 2021, <https://arstechnica.com/>.

224. Paul Kirby, "Why Did Russia Invade Ukraine and Has Putin's War Failed?," *BBC News*, April 12, 2021, <https://www.bbc.com/>.

225. Boris Grozovski, "Putin's War Costs: Shifting the Burden to the Population," *Wilson Center* (blog), January 18, 2023, <https://www.wilsoncenter.org/>; and Berger, "Putin Slashes Russia's Space Budget and Says He Expects Better Results."

226. Jeff Foust, "Soyuz Launch Marks End of an Era for NASA," *SpaceNews*, October 14, 2020, <https://spacenews.com/>.

227. "US Pays Russia \$3.9 Billion for Ferrying Astronauts to ISS," *TASS*, November 15, 2019, <https://tass.com/>.

satellites every year.²²⁸ Russia's overly ambitious space program not only hampered the war effort against Ukraine, but also led to the unsustainability of Russia's existing space capabilities.

Another risk of developing too much spacepower is that a country can become overly reliant on the domain, and overreliance can create an asymmetric vulnerability that others can exploit. It is a paradox of spacepower that strength begets vulnerability.²²⁹ Today, as the country that is most dependent on space, the United States "has the most to lose from space weaponization."²³⁰ Its economy, which is reliant on CLOCs, will be ravaged by the loss of access to space.²³¹ Similarly, its military, which is reliant on space-enabled capabilities, will be crippled by space denial.²³² One way to mitigate overreliance on the space domain is to practice living without satellites.²³³ A society that can continue to function without space access can freely reap the benefits of space without fear of being threatened.

All countries, especially medium powers with their limited means, must determine for themselves what it means to develop just enough spacepower—not too little and not too much. The appreciation of opportunity costs is a central component of domain-specific strategies; the opportunity costs of developing spacepower—or not—must also be weighed against the opportunity costs of developing capabilities in other domains. An accurate assessment of opportunity costs is fundamental to risk minimization.

Application #6: A medium power needs to determine the appropriate amount of spacepower to develop.

This section has distilled six applications for medium powers specific to the space domain. Application #1 suggests that states must possess the ability to develop and operate space technologies indigenously to have freedom of action in, to, and from space. In addition, medium powers should identify the nature and extent of their space interests—whether terrestrially-focused, galactically-oriented, or both—to inform their spacepower development strategy. Application #2 posits that medium powers will have to overcome the challenges of legal ambiguity and security threats but can benefit from the

228. Pavel Luzin, "Russian Space Spending for 2023," Jamestown Foundation, February 10, 2023, <https://jamestown.org/>.

229. Lefebvre, *Space Strategy*, 94.

230. Mueller, "Totem and Taboo," 12.

231. Bowen, *War in Space*, 25.

232. Lefebvre, *Space Strategy*, 77.

233. Lefebvre, *Space Strategy*, 208.

opportunities presented by commercial space industry and the burgeoning space economy. Application #3 argues that medium powers must secure their CLOCs by firstly preventing others from inflicting harmful space effects on themselves. Subsequently, they should establish their own ability to access and exploit space. However, if they can only achieve either, medium powers should prioritize denial over control. Application #4 reiterates that medium powers should use all their instruments of power—diplomacy, information, the military, and economics—to secure their CLOCs. Medium powers should utilize commercial actors or seek the assistance of developed space powers if they are unable to secure their CLOCs by themselves. Application #5 suggests that medium powers identify how their strengths can mitigate their inadequacies to facilitate the development of spacepower. Application #6 urges medium powers to consider the opportunity cost of developing spacepower vis-à-vis power in other domains and cautions medium powers against developing too much or too little spacepower.

Conclusion

This paper adapted six observations from the maritime domain for the space domain. The maritime observations and space applications are collated in Table 1. The applications should be viewed as general considerations and not specific prescriptions.

As Bleddyn Bowen writes, “responsible analogies begin with knowing their limits.”²³⁴ Conducting a detailed analysis of medium powers in the maritime and space domains reveals some similarities but also, perhaps more usefully, notable differences. In both domains, domain-specific power entails the ability to access and exploit the domain, and states must determine the appropriate amount of power to develop. In both domains, a state’s central objective is to protect its lines of communications, and all instruments of power must be utilized toward this end. Both domains are also influenced by common factors like technological developments and legal agreements.

However, both domains have a different natural environment, which affects how states interact with and use the domain. For instance, the relative inhospitality of space, as compared to the maritime domain, means that space is predominantly occupied by machines that communicate information, whereas the sea is mainly used by sailors to trade goods.²³⁵ Environmental differences also favor different states according to their natural endowments: coastal states are better suited to the development of seapower, while equatorial states are

234. Bowen, *War in Space*, 46.

235. Mueller, “Totem and Taboo,” 18.

better placed for the development of spacepower. The higher barrier to accessing the space domain increases the importance of indigenous capability, which is necessary to ensure freedom of action in space. This higher barrier to access also produces a more prominent role for commercial actors and interstate partnerships, since many states cannot develop and launch space vehicles indigenously.

Even though the two domains have their differences, medium powers can employ a similar strategic approach to achieve their ends. Crucially, while the natural environment cannot be changed, medium powers can influence their strategic contexts to work around existing challenges. For example, although a state that wants to launch ships cannot eradicate the trade winds, it can build steamships to sail against the wind. Similarly, even though a state that wants to launch satellites cannot escape orbital mechanics, it can procure access to commercial launch facilities even if it cannot develop an indigenous launch facility by itself. Medium powers should not forget that they have the agency to produce change. This paper identifies six applications to bring attention to the medium power's role in the space domain and provoke further intellectual debate. In doing so, it is hoped that the medium power will no longer be the forgotten middle child in the space domain.

Table 1. Observations from the maritime domain and applications for the space domain

Category	Observation from the Maritime Domain	Application for the Space Domain
Concepts	Observation #1	Application #1
	Seapower describes a state’s use of the sea—states can be classified according to their capabilities and areas of responsibility.	Spacepower describes a state’s ability to use space and its freedom to act in, to, and from space. The indigenous ability to develop and operate space assets is central to a state’s freedom of action in space. Existing methods of categorizing spacepower are inadequate because they fail to consider what the state intends to accomplish through the domain.
Strategic Environment	Observation #2	Application #2
	Technological developments, legal changes, and realized threats characterized the maritime strategic environment for medium powers; non-engagement was not an option.	Legal ambiguity, inadequate governance, commercial space developments, security concerns, and a fear of missing out on the space economy characterize the strategic environment of space for medium powers.
Ends	Observation #3	Application #3
	Within the maritime domain, the medium power’s specific objective is to secure its SLOCs.	Within the domain of space, the medium power’s specific objective is to secure its CLOCs by obtaining limited command of space. A medium power should (1) prevent other parties from using space to harm its interests and (2) establish localized and temporary control of space for its own benefit.
Ways	Observation #4	Application #4
	A state should use all its instruments of power to secure its SLOCs.	A medium power must use all its instruments of power to secure its CLOCs. Where inherently deficient, it should rely on commercial actors and developed space powers to mitigate capability gaps.
Means	Observation #5	Application #5
	A state’s means of generating seapower include its inherent characteristics and other more pliable factors.	The four general conditions affecting the development of spacepower are geographical suitability, natural resources, population size and space-mindedness, and political will and financial commitment. Medium powers should focus their spacepower generation efforts on the factors within their control. In particular, they should harness their strengths to mitigate their weaknesses.
Risks	Observation #6	Application
	A medium power needs to determine the appropriate reach of its seapower ambitions.	A medium power needs to determine the appropriate amount of spacepower to develop.

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