OFFENSIVE DOMINANCE IN SPACE

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The US Space Force's competitive endurance framework may exacerbate offense-defense balance problems in space. Applying concepts of realism, the security dilemma, and offense-defense balance to the notion of competitive endurance supports a new theory of offense dominance in the space domain. Specifically, advances in military technology, space mobility and logistics, and space domain awareness provide an advantage to attackers and increase the probability of conflict in space. By prioritizing defense-focused technology development, defense-centric doctrine and tactics, and greater information-sharing, the Space Force can offset the factors driving increased advantage to the offense and decrease the likelihood of conflict.

Integrated deterrence, the centerpiece of US national security policy, operates on relatively straightforward logic: prevent conflict by making the cost of attack prohibitively high either by minimizing an attack's efficacy or punishing an attacker.[1] The 2022 *National Defense Strategy* defines the former as deterrence by denial and the latter as deterrence by direct cost imposition.[2] Escalation control is closely linked to deterrence: if deterrence succeeds, then competition will remain stable and conflicts will not escalate; if conditions destabilize or escalate, deterrence has failed.

To this end, the Space Force has begun developing strategies, concepts, doctrines, and policies for achieving deterrence and avoiding escalation in space. This process entails, in part, asking questions such as, In what ways does current US space strategy affect deterrence and escalation dynamics? What are the various factors that impact stability and security? What are the ways in which this occurs? A theory of offensive-dominance in space helps explain how Space Force policy, reflected in its competitive endurance framework, might impact deterrence and escalation to make conflict and

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1. Joseph R. Biden, Jr., *National Security Strategy* (Washington, DC: White House, October 2022), https://www.whitehouse.gov/.

2. Lloyd J. Austin III, *National Defense Strategy of the United States* (Washington, DC: Department of Defense [DoD], October 22, 2022), https://media.defense.gov/.

escalation in space more or less likely. This theory reveals how offense-defense balance problems—where the cost an offensive military force must pay is weighed against the defensive investment necessary to prevent an opponent's victory—incentivize conflict in the space domain.

The Importance of Theory

The social sciences, including international relations (IR) and military strategic studies, depend on theory to make scholarship applicable to policymakers.[3] Absent theory, unspoken, perhaps faulty, assumptions flourish and threaten policymakers with illusory solutions. For example, in US Space Force doctrine, space mobility and logistics is defined as the movement and support of military equipment and personnel to, from, and through the space domain.[4] One may assume that increasing the availability of space launches will improve the US Space Force's ability to reconstitute forces after an attack in space, thereby decreasing an attack's efficacy and increasing domain stability.

While it seems logical at first read, is this cause-and-effect relationship between launch capacity and domain stability correct? One's answer depends on their theoretical framework. The above assumption operates under the notion of deterrence theory: lowering the probability of an attack by signaling the ability to successfully degrade an adversary's space mission via rapid reconstitution should be stabilizing. Under a different theory, however, increased space mobility and logistics capabilities will destabilize a world where improved mobility favors offensive action, as detailed below. After all, what assurances do adversaries have that US investments in these capabilities will only be used to reconstitute satellite constellations and not rapidly deploy orbital weapons?

Ultimately, the perceptions of nations in the international system, shaped by their theoretical frameworks, will determine if increased space mobility and logistics capabilities will, in fact, improve or diminish space stability.[5] Theory is therefore important because it establishes an intellectual scaffolding for policy assessments.

Competitive Endurance

Competitive endurance, firmly nested in the framework of integrated deterrence of the *National Security Strategy* and *National Defense Strategy*, articulates the Space Force's "assumptions, logical conclusions, and guiding principles" for mission success.[6] The

3. John J. Mearsheimer and Stephen M. Walt, "Leaving Theory Behind: Why Simplistic Hypothesis Testing Is Bad for International Relations," *European Journal of International Relations* 19, no. 3 (September 1, 2013), https://doi.org/.

4. John W. Raymond, *Spacepower: Doctrine for Space Forces*, Space Capstone Publication (Washington, DC: US Space Force [USSF], June 2020).

5. Robert Jervis, *Perception and Misperception in International Politics*, new ed. (Princeton: Princeton University Press, 2017).

6. B. Chance Saltzman, CSO Note to Guardians (C-Note #15), Subject: Competitive Endurance, July 7, 2023, https://www.spaceforce.mil/.

Space Force designates competitive endurance as the means of achieving "space superiority when necessary while also maintaining the safety, security, stability, and long-term sustainability of space." The concept is actualized through three core tenets: 1) avoiding operational surprise, 2) denying first-mover advantage, and 3) conducting responsible counterspace campaigning.[7]

Missing from the logic are the theoretical underpinnings that link the nature of the international system to the Space Force's desire for the stability achieved through the notion of competitive endurance. This article completes the formulation by analyzing the Space Force's competitive endurance framework using principles of offense-defense balance theory to illuminate the service's conceptual foundations. Offense-defense balance offers two analytical advantages. First, it provides a solid theoretical foundation with a wide explanatory range and prescriptive richness.[8] Second, principles of offense-defense balance underwrite the logic of some elements of Space Force policy, such as competitive endurance's emphasis on avoiding surprise.

Realism, the Security Dilemma, and Offense-Defense Balance

A comprehensive analysis of competitive endurance requires an overview of existing international relations theory germane to this notion, particularly realism, the security dilemma, and offense-defense balance.

Realism

For realists, in an anarchic world that lacks a superordinate authority to provide a security guarantee, nations engage in power-seeking behaviors to ensure stability and the promotion of national interests—such interests are the primary driver of state actions in global affairs.[9] As Ukraine experienced in the spring of 2022, there was no external guarantor of the nation's territorial sovereignty after the Russian invasion. Other states in the international system are extremely reluctant to challenge Russia and its nuclear arsenal directly.[10]

Inevitably, this system produces conflicts between nations and, occasionally, war. This condition, in turn, produces fear and suspicion in states because they can never be assured that danger, violence, and war are not soon coming. Threats to a state's existence are ever-present, and states can only be confident in their own efforts to

7. Saltzman, C-Note #15.

8. Stephen Van Evera, "Offense, Defense, and the Causes of War," *International Security* 22, no. 4 (1998), https://doi.org/.

9. Kenneth Neal Waltz, *Theory of International Politics* (Long Grove, IL: Waveland Press, 2010); and Waltz, *Man, the State and War: A Theoretical Analysis* (New York: Columbia University Press, 2001).

10. Bryan Frederick, Mark Cozad, and Alexandra Stark, *Understanding the Risk of Escalation in the War in Ukraine* (Santa Monica, CA: RAND Corporation, September 21, 2023), https://doi.org/.

minimize the risk of being dominated or destroyed by other states. The resulting power-seeking—as opposed to power-maximizing—behavior ensures security and survival.

Security Dilemma

As states compete for relative power, a dilemma emerges within the international system. This security dilemma exists because states can never be sure of other states' intentions as they pursue power—particularly military power. Rational states within an anarchic international system will seek to protect themselves from outside aggression, and military power provides effective means of defense. Yet given the uncertainty and fear inherent in the international system, states can never be confident that weapons acquired by a rival state will be used exclusively for self-protection and not for aggression or coercive threats.[11]

Therefore, one state's investment in defensive military power will incentivize a rival state to make its own investment in military power.[12] The rival nation's response and subsequent increase in military power intensifies the state's threat perception and encourages additional investment in military power, intensifying the spiral and producing an arms race between the two states. In turn, the armament spiral produced by the security dilemma will culminate when a dispute between the states eventually emerges that triggers war.[13]

Note that conflict need not be intended or desirable, as illustrated by the now infamous "false alarm" incident of November 1979, when a mistaken use of an exercise tape caused US missile warning systems at the Pentagon, Strategic Air Command, and North American Aerospace Defense Command to falsely indicate a Soviet ballistic missile attack on the United States.[14] Accidents, errors, or miscommunications are all that is needed to push preexisting tensions resulting from a security dilemma into active military conflict.

Offense-Defense Balance

This dreary outlook prompted noted political theorist Robert Jervis to ask a rhetorical question, "Why are we not all dead?"[15] In answer, he observes that the standard security model is insufficiently nuanced to explain the behavior of states in the real world and offers offense-defense balance theory as a remedy. The offense-defense balance reflects

11. Ken Booth and Nicholas J. Wheeler, *The Security Dilemma: Fear, Cooperation and Trust in World Politics* (Basingstoke, UK: Palgrave Macmillan, 2008); and Robert Jervis, *Cooperation under the Security Dilemma* (Los Angeles: Center for Arms Control and International Security, University of California, Los Angeles, 1977).

12. Jervis, *Perception*.

13. John A. Vasquez, *The War Puzzle Revisited*, Cambridge Studies in International Relations 110 (Cambridge, UK: Cambridge University Press, 2009).

14. "False Warnings of Soviet Missile Attacks Put U.S. Forces on Alert in 1979–1980," National Security Archives, March 16, 2020, https://nsarchive.gwu.edu/.

15. Jervis, *Cooperation*, 170.

the amount of resources a state must invest in offense to offset a rival state's investment in defense.[16] This balance can be expressed as a ratio, where the cost an offensive military force must pay (X) is related to the defensive investment (Y) necessary to prevent victory. Therefore, if state A invests $3 million in military technology to overcome state B's defensive investment of $1 million, then the offense-defense balance can be expressed as 3:1.

Jervis offers two variables for offense-defense balance. First, he contends a measure of distinguishability exists between some offensive and defensive capabilities. For example, land mines are better understood as defensive weapons, while little defensive rationale exists for weapons such as aircraft carriers. Therefore, states can provide for their security while minimizing the security dilemma by investing in military technology, which is primarily defensive in nature and recognized as such by rivals. Second, Jervis contends the offense-defense balance influences the probability of conflict. Environments where it is easier for one state to destroy military forces and acquire territory than to defend their own are offense-dominant; defense dominance is the inverse.

High offense-defense ratios make conflict less likely. In contrast, low offense-defense ratios make conflict more likely because "when the offense has the advantage over the defense, attacking is the best route to protecting what you have . . . and it will be hard for any state to maintain its size and influence without trying to increase them."[17]

While offense-defense balance can be measured in terms of economic investment, a separate question exists regarding the causes of relative offensive and defensive dominance. What factors or conditions tilt an environment's balance in favor of the offense or defense? Extant literature has reached a consensus about two: military technology and geography.

Regarding military technology, IR scholars identify two major areas that incline an environment to offensive advantage.[18] First, improvements in mobility favor the offense because a force cannot attack if it cannot move, while defense can be accomplished while holding a position. As one study notes, "Nearly all historical advances in military mobility—chariots, horse cavalry, tanks, motor trucks, aircraft, mobile bridging equipment—are generally considered to have favored the offense, while major countermobility innovations—moats, barbed wire, tank traps, land mines—have favored defense."[19]

Second, improvements in firepower generally favoring the defense can be seen by inverting the logic—attackers are more susceptible to firepower since they must move and, therefore, expose themselves. Thus improvements in mobility favor the offense and render an environment more susceptible to conflict by decreasing the offense-defense

16. Sean M. Lynn-Jones, "Offense-Defense Theory and Its Critics," *Security Studies* 4, no. 4 (June 1, 1995), https://doi.org/.

17. Jervis, *Cooperation*, 211.

18. Charles L. Glaser and Chaim Kaufmann, "What Is the Offense-Defense Balance and Can We Measure It?," *International Security* 22, no. 4 (1998), https://doi.org/.

19. Glaser and Kaufmann, 63.

balance ratio. Conversely, improvements in countermobility and firepower increase the offense-defense balance ratio, making conflict less likely. Continuing the previous example, if state B adds a $1 million countermobility system that raises state A's cost to attack by $10 million, the new offense-defense balance can be expressed as 11:2, indicating a further advantage to the defense.

Geography influences the offense-defense balance through three causal mechanisms. First, rugged terrain slows movement, strains logistics, and strengthens defense more than easier terrain. Second, terrain that provides cover where defenders can hide strengthens the defensive balance. Third, greater distances favor the defense over shorter distances, given the logistical and economic difficulty of an inherently offensive requirement to project power.[20]

The Offense Dominance of the Space Domain

According to Stephen Van Evera, " 'offense dominant' means that conquest is fairly easy; 'defense dominant' means that conquest is very difficult." Like Van Evera, this article maintains defending is usually easier than conquering and uses " 'offense dominant' broadly, to denote that offense is easier than usual, although perhaps not actually easier than defense."[21]

As discussed above, offense-defense balance theory holds that conflict is more likely in offense-dominant systems. Applying offense dominance in space suggests that given anarchic international systems consistent with realism-rooted security dilemmas, the likelihood of conflict in space is increasing over time due to three causal factors.

First, advances in military technology have made negating a satellite or its mission far less expensive than constructing and fielding one. Second, military technology that enables increased mobility and maneuver in space is quickly developing. Third, a multinational emphasis on improved satellite identification and tracking has eroded the ability of space systems to leverage the opacity of the space domain as an effectual cover. In the following section, this article will outline a theory of offensive dominance in space, supported by present trends that indicate an increased degree of offensive dominance in the domain in the future.

This foundational theory thus enables strategists to bridge the gap between broader IR concepts and competitive endurance. While space as an arena for geopolitical conflict represents an evolution in warfighting domains, the central tenet of offense-defense balance and the implications of military technology and geography still apply.[22] In fact, an argument can be made that space is more sensitive to changes in the offense-defense balance, given that space systems are experiencing exponential growth in technological innovation.

20. Glaser and Kaufmann.

21. Van Evera, "Offense," fn 1, 5.

22. Brad Townsend, *Security and Stability in the New Space Age: The Orbital Security Dilemma*, Space Power and Politics (London: Routledge, 2020).

Advances in Military Technology

Classification issues make quantitative comparisons of advancing military technology's impact on the offense-defense ratio challenging in unclassified settings; nevertheless, some generalizable examples are available. The venerable GPS provides a clear glimpse into how unbalanced the cost ratio of attack to defense has become.

According to the Government Accountability Office, the latest generation of GPS Block IIIF satellites are procured at approximately $497 million per unit.[23] Operationally, the GPS constellation requires a minimum of 24 operational satellites to maintain worldwide navigation services 95 percent of the time.[24] The cost of the GPS Block IIIF constellation is calculated to be approximately $11.9 billion by extrapolating the cost per satellite to the minimum necessary constellation. While GPS jamming is limited to a geographic region, offensive electronic warfare systems capable of negating the GPS mission can be procured relatively inexpensively.

For example, a recent experiment revealed that effective jamming techniques can negate a GPS-enabled unmanned aerial vehicle at close ranges with a $420 software-defined radio platform.[25] Extending to operationally relevant ranges requires only signal amplification, typically costing on the order of tens of thousands of dollars.

Another example of the strong offense-dominant nature of the space environment was the US Air Force's destruction of an earth observation satellite in 2008, worth "hundreds of millions," with a Standard Missile-3 at a total cost of between $40 and $60 million.[26] Even a conservative offense-defense calculation produces a ratio of 1:4—a figure extremely favorable to the offense.

The lesson of both examples is that very expensive satellites can be negated using very inexpensive counterspace weapons, producing an environment increasingly tilted toward offensive dominance as states develop kinetic and electronic warfare arsenals. Given the technical constraints that prohibit transitioning all Space Force missions to small, proliferated satellite constellations, one should expect this condition to persist for the foreseeable future.

The relative ease of destroying compared to defending space systems is also becoming more pronounced. According to open-source data, the number of satellites operated by the United States' main competitors, China and Russia, has increased by approximately 70 percent between 2019 and 2021.[27] This includes significant

23. "Weapon Systems Annual Assessment," Government Accountability Office, June 8, 2023, https://www.gao.gov/.

24. "GPS Space Segment," GPS.gov, accessed December 14, 2023, https://www.gps.gov/.

25. Renato Ferreira et al., "Effective GPS Jamming Techniques for UAVs Using Low-Cost SDR Platforms," *Wireless Personal Communications* 115, no. 4 (2020): 2705–727, https://link.springer.com/.

26. Jamie McIntyre, "Attempt to Shoot Down Spy Satellite to Cost up to $60 Million," CNN, February 15, 2008, https://www.cnn.com/; and Andrea Shalal-Esa, "Expensive New U.S. Spy Satellite Not Working: Sources," Reuters, August 9, 2007, https://www.reuters.com/.

27. *Challenges to Security in Space 2022: Space Reliance in an Era of Competition and Expansion* (Washington, DC: Defense Intelligence Agency, March 2022), https://www.dia.mil/.

investments in counterspace weapons research and development, deployment, and operations. Neutral and partner nations of the United States have reached the same conclusion and have increased spending on antisatellite (ASAT) weapons accordingly. Among the numerous examples are India's 2019 direct-ascent ASAT missile test and the United Kingdom's investment of $1.6 billion in military space capabilities.[28] Additionally, regional powers such as Iran and North Korea have recognized the offensive imbalance and have increased their development of ASATs in recent years.[29]

Cumulatively, recent increases in global ASAT development can be viewed as an international consensus on the space domain's offensive dominance. Were it easier to defend a satellite, states would be developing protective technologies in greater proportions. One can expect this space arms race to continue and accelerate in accordance with the predictions of the security dilemma and offense-defense balance theory.

Increased Space Access and Mobility

As mentioned earlier, attacking forces must be able to relocate while defenders can dig into fortified, static locations. Therefore, advances in mobility and maneuver favor the offense. US Joint doctrine defines the task of maneuver as military operations to "place the enemy in a disadvantageous position through the flexible application of combat power."[30] Military operations in space are no different. While the principles of mobility and maneuver have endured over the history of war, they assume a new character in the space domain.

In space, concepts of mobility and maneuver manifest as the "ability to resource, apply, and leverage spacepower in, from, and to the space domain."[31] Principles of maneuver are fundamentally applied in space through operations and technology to increase a state's ability to launch new satellites into space, reposition satellites once in orbit, and resupply operational satellites with fuel or technology updates. Spacefaring nations are increasingly investing significant resources into advancing all three of these applications, which, in turn, further shifts the balance in space to the offense.

Advancements in spacelift technology have rapidly increased the rate at which states can launch satellites. According to data compiled by the Center for Strategic and International Studies, the number of global space launches have steadily risen from 50 in 2000 to 182 in 2022.[32] This rise corresponds to the decreasing economic cost of launching satellites. For example, the cost of a heavy launch to low-Earth orbit in 2004

28. Brandon Weeden and Victoria Samson, *Global Counterspace Capabilities: An Open Source Assessment* (Broomfield, CO: Secure World Foundation, April 2023).

29. Kiseok Kang, "Extended Space Deterrence: Providing Security Assurance in Space," *Journal of Strategic Security* 16 (July 1, 2023), https://doi.org/.

30. *Joint Campaigns and Operations*, Joint Publication (JP) 3-0 (Washington, DC: Chairman of the Joint Chiefs of Staff, June 18, 2022), III-37.

31. Raymond, *Spacepower*.

32. "Space Environment: Total Launches by Country," Aerospace Security, Center for Strategic and International Studies (CSIS), July 24, 2023, https://aerospace.csis.org/.

was $11,600 per kilogram in the United States. By 2018, that price had fallen to $1,500 per kilogram, with future projections anticipating additional price decreases.[33] Advancements in China and India have produced similar results.[34] Increasing the launch capacity of a state produces a corresponding increase in the amount of military spacecraft, including orbital ASAT systems, that can be deployed to the space domain in a given time.

For historical context, this situation is analogous to the problems of US power projection in World War I. In 1917, the US Army faced a daunting problem transporting a force of 500,000 men to Europe, which required a significant increase in logistical capacity to mobilize quickly and efficiently. The US Army solved its mobilization problem during the war by reappropriating civil and commercial ships.[35] In 2023, military space forces face similar bottlenecks to mobilizing technology and deploying satellites from Earth to space. Therefore, spacefaring nations are increasing the number of transports to orbit, now through technological advancement instead of the asset reappropriation of 1917. The result is identical in both cases: more combat power in a theater of operations increases the offensive capability of a deployed force.

This relationship between space mobility and offensive capacity can be demonstrated historically. The military space community underwent a significant paradigm shift in January 2007 when China tested a direct-ascent kinetic ASAT missile on one of its own malfunctioning weather satellites.[36] Before 2007, the United States and Russia were the only major states involved in militarizing space. China's ASAT test was the first instance of a US competitor's ability to apply principles of mobility to project combat power into space directly from the Earth. China's direct-ascent ASAT missile ended US policymakers' view of space as an uncompetitive and uncontested environment.[37]

Since 2007, an additional 10 nations have developed military space programs as part of their national security strategies.[38] Furthermore, according to the Central Intelligence Agency, the number of nations with active space programs has grown from 2 in 1957 to 94 in 2023.[39] Space was prohibitively distant for most nations in the twentieth century,

33. Thomas G. Roberts, "Space Launch to Low Earth Orbit: How Much Does It Cost?," Aerospace Security, September 1, 2022, https://aerospace.csis.org/.

34. "China's Long March Rocket Launch Opportunity Opens Auctions for 1st Time," *Global Times*, July 9, 2023, https://www.globaltimes.cn/; and Nivedita Bhattacharjee, "India's First Private Rocket Company Looks to Slash Satellite Costs," Reuters, November 26, 2022, https://www.reuters.com/.

35. "The American Expeditionary Forces - A World at War," Library of Congress, accessed December 18, 2023, https://www.loc.gov/.

36. Shirley Kan, *China's Anti-satellite Weapon Test*, RS22652 (Washington, DC: Congressional Research Service, April 23, 2007).

37. Todd Harrison et al., "The Evolution of Space as a Contested Domain," in *Escalation and Deterrence: In the Second Space Age*, ed. Todd Harrison et al. (Washington, DC: CSIS, 2017), http://www.jstor.org/.

38. Kari Bingen, Kaitlyn Johnson, and Makena Young, *Space Threat Assessment 2023* (Washington, DC: CSIS, April 2023), https://csis-website-prod.s3.amazonaws.com/.

39. Central Intelligence Agency, "Reference - Space Programs," *World Factbook*, accessed December 18, 2023, https://www.cia.gov/.

both literally and technologically. Today, nearly any global economy may have realistic aspirations of accessing space.

Yet, a nation's increased access to space is indistinguishable from its increased ability to deploy space forces to the operational environment. In offense-defense balance, maneuver is the ability to "move, supply, and concentrate forces for battle."[40] US Joint doctrine further defines maneuver as "deploying forces into an operational area" and the ability to "deploy, shift, regroup, or move joint and/or component force formations within the operational area by any means or mode."[41] Taken together, these definitions reveal that increasing spacelift capacity can be properly understood as simultaneously increasing space maneuver and mobility, a condition favoring the offense as evidenced by the Space Force's tactically responsive space concept.[42]

Space mobility and maneuver are also being increased by government-sponsored advances in in-space servicing, assembly, and manufacturing (ISAM) technologies.[43] While ISAM has a wide array of technical applications, the role of satellite refueling in orbital mobility and maneuver is germane to this discussion. Currently, satellites are limited in their ability to maneuver by fuel constraints. While all modern mobilization equipment—including ships, aircraft, and trucks—requires fuel, satellites are uniquely hindered by an inability to be refueled. Therefore, military space planners must be extremely judicious about when and how to maneuver an orbital weapon system. Yet future ISAM advancements that permit on-orbit satellite refueling remove the incentives for operationally constraining mobility and maneuver.

In addition to maneuver implications, the dual-use nature of on-orbit servicing technology presents additional security dilemma problems. States can never be sure whether another state's repair satellite will be weaponized against their space forces.[44] As one spacepower theorist explained, "If I can tighten a screw on my satellite, I can loosen a screw on yours."[45] Taken together, increased global space launch capacity and ISAM technology maturation increase orbital mobility and maneuver capabilities and, consequently, the space domain's offensive dominance.

Space Domain Awareness

Under offense-defense balance theory, environments that provide defenders places to hide favor the defense. Historically, space has been a highly opaque setting, giving

40. Glaser and Kaufmann, "Offense-Defense Balance," 62.

41. JP 3-0, III-37.

42. See Aaron Blore, "Responsiveness Is Not Operational: Aligning Strategy in the Newest Service," *Æther: A Journal of Strategic Airpower & Spacepower* 2, Special Edition (Winter 2023), https://www.airuniversity.af.edu/.

43. In-Space Servicing, Assembly, and Manufacturing [ISAM] Interagency Working Group, National Science & Technology Council, *ISAM National Strategy* (Washington, DC: White House, April 2022), https://www.whitehouse.gov/.

44. Amir Lupovici, "The Dual-Use Security Dilemma and the Social Construction of Insecurity," *Contemporary Security Policy* 42, no. 3 (July 3, 2021), https://doi.org/.

45. Nathaniel Lee, conversation with the author, June 9, 2019.

space systems ample opportunity to hide among gaps in sensor coverage. The domain's impenetrability made the military tasks of finding, fixing, and tracking satellites technically difficult. Calculating satellite locations and velocity vectors is prone to mathematical errors, which increase position uncertainty and thus severely hinder ASAT weapons targeting.[46] The opacity of space is also unsettling for policymakers since they can never be sure that an unknown threat does not lurk in obfuscated terrain.

Accordingly, the Space Force has increased its emphasis on improving space domain awareness (SDA) capabilities, resulting in the first tenet of competitive endurance—avoiding operational surprise. According to the Space Force's chief of space operations, avoiding operational surprise means "space forces must be able to detect and preempt any shifts in the operational environment that could compromise the ability of the joint force to achieve space superiority," and this "requires an enhanced level of space domain awareness."[47]

The SDA enhancements have driven significant investment in global terrestrial sensor coverage and the development of several satellites designed to find and track objects in space. In 2015, the US military announced initial operational capability of the Geosynchronous Space Situational Awareness Program. In 2020, the US military established a space surveillance radar system in the Pacific Ocean, and in 2022, the US Space Force and the Australian Department of Defence finalized the deployment of an optical satellite tracking telescope in Australia.[48] US leadership has also produced a multinational, multisector SDA data-sharing agreement where satellite-tracking data is shared among 117 government, civil, and commercial entities.[49]

While improving space domain awareness capability is a clear imperative for the Space Force, space strategists should think carefully before assuming that increased SDA capabilities will automatically produce a more stable space domain. One cumulative effect of improved SDA is reducing the available locations for unknown defensive systems that constrain attacks. Said differently, increases in SDA capability reduce the uncertainty which acts as a restraining force on leaders' decisions to attack. Additionally, improvements in SDA increase a military's ability to target on-orbit space systems, effectively lowering the cost of attack by increasing the probability of kill. Both factors favor offense over defense.

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46. Aubrey Poore, Jeffrey Aristoff, and Joshua Horwood, eds. *Covariance and Uncertainty Realism in Space Surveillance and Tracking* (Washington, DC: Air Force Space Command Astrodynamics Innovation Committee, June 17, 2016), https://apps.dtic.mil/.

47. B. Chance Saltzman, "Guardians in the Fight," keynote address, Air & Space Forces Association (AFA) Warfare Syposium, Aurora, CO, March 7, 2023, https://www.airandspaceforces.com/.

48. SpOC [Space Operations Command] Staff Writer, "U.S. Space Surveillance Telescope in Australia Achieves Initial Operational Capability," Space War: Your World at War, September 30, 2022, https://www.spacewar.com/; "Swinging for the Space Fence," USSF, April 7, 2020, https://www.spaceforce.mil/; and "Geosynchronous Space Situational Awareness Program," USSF, accessed December 18, 2023, https://www.spaceforce.mil/.

49. USSPACECOM Public Affairs, "USSPACECOM Adds Portugal – a Strategic NATO Ally – to SSA Data Sharing Cadre," USSPACECOM, July 15, 2020, https://www.spacecom.mil/.

A reading of Clausewitz might support the notion that increases in SDA capability remove the advantages of surprise typically perceived as critical to the offense.[50] Removing the offensive advantage of surprise means increases in SDA capability actually favor the defense. Yet these objections are misplaced for two reasons.

First, there is little justification for the presumption that a force's ability to find, track, and target adversary satellites eliminates the adversary's potential for strategic surprise. Unknown payloads on known satellites provide an effective means of achieving surprise. For example, Russia's deployment of a suspected nuclear satellite has ignited fear and insecurity worldwide. The possibility of a devastating unwarned attack from a satellite with a possible nuclear payload was sufficient enough for congressional leadership to characterize the situation as a "grave national security threat."[51] Here, awareness of the subject satellite's location is insufficient to ameliorate fear of strategic surprise. Surface-to-space antisatellite missiles, hypersonic weapons, fractional orbital bombardment systems, and cyber weapons all provide additional examples of technologies adversaries can utilize to generate surprise despite advancements in SDA capability.

Second, the advantage of surprise is more relevant at the tactical level of war and less effective at the strategic and structural levels of analyses. "History did not show cunning to be a significant trait," argues Clausewitzean scholar Antulio Echevarria. "Nor did it show surprise to be strategically significant, as a rule."[52] Clausewitz himself observed this in *On War*: "Basically, surprise is a tactical device, simply because in tactics time and space are limited in scale. Therefore in strategy surprise becomes more feasible the closer it occurs to the tactical realm."[53]

Taken together, these two factors can lead one to reasonably conclude SDA advancements will not significantly impact a state's ability to generate strategic surprise, and even if they did, such impacts would not significantly impact the strategic and structural conditions that are the topic of this article. Therefore, increases in SDA capability will not restrain offensive forces but will inhibit defenders, as argued above.

Competitive Endurance in an Offensive Dominant System

The Space Force's theory of success, competitive endurance, has two primary objectives: space superiority and the stability of the space domain. Given the security dilemma and space's offensive dominance, the service will likely discover that competitive endurance's two objectives are in opposition to each other. Developing the capability necessary to achieve space superiority will destabilize the space domain because US rivals can never be sure of America's benign intent.

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50. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton: Princeton University Press, 1989).

51. Christian Davenport et al., "U.S. Officials Say Russia Has Deployed a Nuclear Weapon in Space," *Washington Post*, February 15, 2024, https://www.washingtonpost.com/.

52. Antulio J. Echevarria II, "7 Principles of Strategy," in *Clausewitz and Contemporary War*, ed. Antulio J. Echevarria II (Oxford, UK: Oxford University Press, 2007), 165, https://doi.org/.

53. Clausewitz, *On War*, 198.

Consider the US reaction to China's testing of a satellite grappling capability. In 2021, China's SJ-21 satellite attached to a defunct Chinese navigation satellite and towed it to a disposal orbit. As argued earlier, this capability is a clear example of dual-use technology. The SJ-21 could be used as benign space debris cleanup or to attack a US satellite. Viewed through the lens of realism and compounded by uncertainty with regard to China's intentions, the United States had little choice but to interpret the SJ-21 as a threat. As General James H. Dickinson, former US Space Command commander observed, "Whether it's directed energy, whether it's direct ascent . . . or SJ-21s, those kinds of capabilities provide, or can provide, a layer of capabilities that we need to be concerned about."[54] Unsurprisingly, the United States' rivals have expressed nearly identical concerns about the X-37, the US-developed space plane.[55]

Conversely, actions the Space Force might take to maintain the space domain's stability will likely undermine the service's ability to achieve space superiority. One of the few ways a state can reassure a rival is by using costly signals, such as disarmament, because costless signals are easily dismissed. Yet, such signals in an offense-dominant system are dangerous because of the environmental incentives to attack.[56] In the space domain, such costly signals will preclude the Space Force from operationalizing the capability needed to ensure the Joint Force has access to space-enabled weapons, if needed. Additionally, costly signals are strongly disincentivized because the United States cannot trust rival powers to reciprocate.

Although these aims seem ultimately unreconcilable as discussed, there is a way forward for Space Force decisionmakers. The Space Force should consider three paradigmatic courses in pursuing competitive endurance to minimize instability while retaining the ability to achieve space superiority.

Invest in Technologies Favoring Defense

Central to ideas of offense-defense balance is the principle of distinguishability between offensive and defensive weapons in some cases.[57] While current Space Force thinking can be interpreted as doubtful of such distinguishability, the service should consider how future acquisitions impact the offense-defense ratio through the mechanisms of mobility and firepower. According to offense-defense balance theory, high lethality/low maneuverability weapons with limited range are better understood as defensive systems that disincentivize attack by increasing the cost attackers must pay while decreasing the attacker's probability of success. Examples from other domains

54. Cambrie Eckert, "JUST IN: SPACECOM Prepared to Defend U.S. Assets," *National Defense*, July 19, 2023, https://www.nationaldefensemagazine.org/.

55. Brent M. Eastwood, "908 Days in Space: Why China and Russia Fear the X-37B Space Plane," MSN, May 12, 2023, https://www.msn.com/.

56. Evan Braden Montgomery, "Breaking Out of the Security Dilemma: Realism, Reassurance, and the Problem of Uncertainty," *International Security* 31, no. 2 (October 1, 2006), https://doi.org/.

57. Jack S. Levy, "The Offensive/Defensive Balance of Military Technology: A Theoretical and Historical Analysis," *International Studies Quarterly* 28, no. 2 (1984), https://doi.org/.

that can be applied to space, albeit with limitations, include concepts of point fortification and defense identification zones with appropriate enforcement capabilities.

Develop Defense-centric Doctrines and Tactics

The companion of the inherent capabilities of weapons is the doctrine and tactics that govern their operation. As a historical example, Napoleon's conceptions of maneuver warfare and rapid mobility were not predetermined by the technology of the age—he was working with the same arsenals other states possessed. Napoleon's development of offensive doctrine and tactics that could then be applied to available weapons made him distinct. As one scholar notes, "The offensive or defensive character of a weapons system must be defined by both its intrinsic characteristics and the tactical doctrine which determines its use."[58]

As the Space Force develops and codifies its operational doctrine and tactics, this article recommends the service develop and publish doctrine at the operational level (3-10X) specific to protection as a defined Joint function. Operational doctrine should call out defensive approaches to space superiority. The Joint function of "protection" is an obvious place for the service to start. Operational doctrine will signal both internally and externally the value the Space Force places on defense and stability and will also inform the downstream tactical doctrine used by space operators.

Provide Transparency in Counterspace Strategy and General Capabilities

Minimizing uncertainty in rival states is a third critical element of addressing the tension between the two objectives in competitive endurance. Unfortunately, one of the unintended consequences of the Space Force's development of highly classified space systems is increasing uncertainty and fear among the United States' strategic competitors, thereby exacerbating the existing space security dilemma. While calls for reforming the classification architecture are not new, and while significant barriers to declassification justifiably exist, the Space Force should seek to increase transparency when possible. As General John Hyten, former vice chairman of the Joint Chiefs of Staff noted, "You can't deter people if everything you have is in the black [classified]."[59]

Ultimately, nations who better understand each other will be less susceptible to the misperceptions that drive security spirals and instability.[60] The Space Force can contribute to this dynamic by reinvigorating discussions about selective declassification, especially of defensive weapons, and ensuring continued open-source access to service doctrine.

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58. Levy, 226.

59. Robert Fahs, "Gen. Hyten Finds Over-Classification of Space Information Undermines National Security, Promises Reform," *Transforming Classification* (blog), National Archives of the United States, December 1, 2020, https://transforming-classification.blogs.archives.gov/.

60. Charles L. Glaser, "The Security Dilemma Revisited," *World Politics* 50, no. 1 (1997), https://doi.org/.

Conclusion

The Space Force's competitive endurance strategy, aimed at achieving space superiority while maintaining stability, faces inherent paradoxes as actions to enhance space superiority may instead destabilize the domain. As technology advances and space becomes more accessible, the space domain's offensive dominance grows, amplifying the security dilemma. The Space Force's commitment to competitive endurance should be guided by these considerations to ensure a secure and stable space environment for the benefit of all spacefaring nations. Addressing the challenges posed by the offensive dominance of space necessitates a reasoned approach grounded in established international relations theory. Failure to connect military strategy to theoretical foundations threatens the ability of policymakers and planners to execute the goals of competitive endurance. **Æ**