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Space Security
and Strategic Stability

SPACE DOSSIER FILE 1

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About the author

Joseph Rodgers is a Visiting Researcher at the United Nations Institute for Disarmament Research (UNIDIR) and a Research Assistant at the Center for Nonproliferation Studies in Monterey, California. His current research project identifies fissile material flows in nuclear-armed States. He is a Nonproliferation and Terrorism Studies Master's Candidate at the Middlebury Institute of International Studies in Monterey, California.

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Acronyms and abbreviations

ASAT	Anti-Satellite Weapon
CD	Conference on Disarmament
COPUOS	Committee on the Peaceful Uses of Outer Space
GGE	Group of Governmental Experts
GPS	Global Positioning System
NASA	National Air and Space Administration
NPT	Non-Proliferation Treaty
OECD	Organisation of Economic Co-operation and Development
PAROS	Prevention of an Arms Race in Outer Space
PPWT	Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects
TCBMs	Transparency and Confidence-Building Measures
SSN	Space Surveillance Networks

Introduction

Since Germany's first rocket tests in 1942, States have recognized the strategic significance of space. The concept of "space superiority" is believed to have first been elaborated in the early 1950s by Wernher von Braun. A German engineer who invented the V2 rocket and later worked for the Government of the United States, in 1951 von Braun envisioned a space station that would give the United States "military omnipresence":[1]

> It appears to me that in the atomic age the nation which owns such a bomb-dropping space station might be in position virtually to control the earth. The political situation being what it is, with the earth divided into a western and an eastern camp, I am convinced that such a station will be the inevitable result of the present race of armaments.[2]

Almost 70 years later, the atomic bomb-dropping military space station von Braun imagined fortunately does not exist. Nevertheless, many modern technologies depend on space-based assets. For instance, militaries use remote sensing to plan operations, farmers use global positioning systems (GPS) to plough fields, and banks use communication satellites to transfer funds around the world. While the military and civilian uses of space are governed by international treaties, the world is more complex and interdependent than when States first recognized the strategic significance of space. Since then, geopolitical shifts, technological upheaval, the rise of a multipolar order, and new actors in space have altered the situation.

This paper examines how recent developments in the space environment may impact "strategic stability". It surveys changes in the space environment and existing political initiatives to govern space and constrain its militarization. It assesses some definitions and criticisms of strategic stability in the context of space and concludes by discussing the implications of reliance on strategic stability in space as a guiding principle in the contemporary and near future world.

The Space Environment in the Twenty-First Century

International Legal Regimes and Space

Space operations are no longer dominated by two or three State actors, such as the United States and the Russian Federation. It is estimated that there are 1,738 operational satellites in orbit, owned by roughly 441 private companies and governments in 93 countries.[3] There are 63 functioning national, regional, and international space agencies, nine of which have indigenously developed the ability to place satellites in space.[4] Today's space environment is more "contested, congested and competitive" than ever before.[5]

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[1] Neufeld, Michael, "*Space Superiority": Wernher von Braun's Campaign for a Nuclear-Armed Space Station, 1946–1956,* Smithsonian Institution, 2005. Available from https://repository.si.edu/bitstream/handle/10088/29811/Space%20Superiority.pdf?sequence=1&isAllowed=y.

[2] Braun, Wernher von, "*Giant Doughnut is Proposed as Space Station*", Popular Science, October 1951, pp. 120–121 quoted in ibid.

[3] These figures come from the Union of Concerned Scientists Satellite Database, which compiles data from the United States Space Surveillance Network and the United Nations Office for Outer Space Affairs National Space Object Registries. Union of Concerned Scientists, UCS Satellite Database, August 31, 2017. Available from http://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database#.WgmrL4WcHN9.

[4] To date, China, the Democratic People's Republic of Korea, France, India, Israel, Iran, Japan, the Russian Federation and the United States have developed their own orbital launch capabilities. In addition, several other States have acquired the necessary technology.

[5] United States, Department of Defense, *National Space Security Strategy Unclassified Summary*, January 2011. Available from http://archive.defense.gov/home/features/2011/0111_nsss/.

While the composition of the space environment has altered profoundly over the last several decades, the development of new space law in terms of international agreements has not kept pace. In the past, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) concluded five international treaties that govern space activities: (i) the 1967 Outer Space Treaty; (ii) the 1968 Rescue Agreement; (iii) the 1972 Liability Convention; (iv) the 1976 Registration Convention, and (v) the 1984 Moon Agreement.[6]

These treaties cover issues such as promoting the freedom of space exploration, establishing liability for damage caused by space objects, registering spacecraft and satellites in orbit, and rescuing astronauts that may return from space to land (or splash down) on foreign territories. Notably, the Outer Space Treaty prohibits the placement of nuclear weapons in outer space. It builds upon the 1963 Partial Test Ban Treaty, which bans nuclear weapons tests in space among its provisions.[7]

In the mid-1970s, the international community recognized that the development of anti-satellite weapons (ASATs) posed a threat to the maintenance of strategic stability between the United States and the Soviet Union by potentially compromising credible retaliatory second-strike nuclear capabilities. By 1977, the two superpowers entered into multi-year attempts to negotiate a ban on ASAT technology and testing. Throughout the discussions, the two sides encountered difficulty in achieving convergence with positions that were far apart.[8] Although neither side formally withdrew from the consultations, the negotiations collapsed, likely given a general deterioration of bilateral relations, which included the Soviet invasion of Afghanistan and the United States' refusal to ratify the SALT II Treaty. Nevertheless, multilateral efforts continue to this day to reach an agreement on arms control in outer space.

The Conference on Disarmament (CD), which currently has 65 States as members, has repeatedly attempted since the 1980s to commence negotiations on an agreement on "prevention of an arms race in outer space" (PAROS). The central goal of the PAROS negotiations is to create a legally binding instrument to prohibit the weaponization of space. However, the CD's inability to agree on a comprehensive programme of work has prevented progress toward this goal.

Nevertheless, China and the Russian Federation introduced two drafts of a proposed Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (PPWT) to the CD, in 2008 and 2014. This proposal met resistance from the United States. Responding to the 2014 draft, the United States said that the PPWT lacked a verification mechanism and did not prevent the development of ground-based ASAT weapons.[9]

There have also been a number of international working groups and group of governmental experts (GGE) meetings to enhance space security. In 2013, a United Nations GGE on transparency and confidence-building measures (TCBMs) in outer space activities agreed by consensus on a report proposing increased information exchanges on space policies, risk reduction notifications, and consultative mechanisms.[10]

As an alternative to legally binding arms control, the European Union has since 2008 promoted an international code of conduct for outer space activities. The code of conduct sought to set norms

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[6] There are also five declarations and legal principles that govern space. See *Space Law Treaties and Principles*, United Nations Office for Outer Space Affairs. Available from http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html.

[7] *Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water*, August 1963. Available from https://treaties.un.org/doc/Publication/UNTS/Volume%20480/volume-480-I-6964-English.pdf.

[8] "Memorandum from the Director of the Arms Control and Disarmament Agency (Warnke) to Secretary of State Vance", United States Office of the Historian, October 1997. Available from https://history.state.gov/historicaldocuments/frus1977-80v26/d13.

[9] Mission of the United States, "*Ambassador Robert Wood: Ensuring the Long-Term Sustainability and Security of the Space Environment*", September 2014. Available from https://geneva.usmission.gov/2014/09/09/ambassador-robert-wood-ensuring-the-long-term-sustainability-and-security-of-the-space-enviroment.

[10] United Nations General Assembly, "Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities", A/68/189, June 2013. Available from http://undocs.org/A/68/189.

and shape behaviour in outer space for the mutual benefit of all States. It was intended to enhance TCBMs among States by limiting debris-producing activities. Incorporating formalized arms control, building norms or taking simple TCBM steps could all enhance the security of outer space. In 2013 and 2014, there were multilateral open-ended consultations on the code of conduct and a multilateral meeting took place in 2015 to discuss the code of conduct.

Although the code of conduct attracted widespread support, some States were critical of the way that it was developed. After 2015, the European Union and its member States reassessed their objectives and approach, concluding that they will continue to work on principles for responsible space behaviour. Despite this commitment, the future of the code of conduct remains unclear.[11]

The Problem of Space Debris

As more actors assume roles in space and place physical assets there, there are growing concerns about the issue of space debris. Such debris poses a hazard to other space assets, and may remain in orbit for centuries. Today's space environment is so littered with debris that even if no future launches of space assets occurred, collisions between existing satellites and debris would increase the population of debris larger than 10cm faster than atmospheric drag would remove objects.[12] The United States Space Surveillance Network (SSN) tracks over 23,000 objects larger than 10cm orbiting the Earth.[13] The majority of these objects are potentially destructive space debris. Additionally, the SSN estimates that there are over 500,000 bits and pieces of debris between 1cm and 10cm, some of which could still damage satellites.[14]

Three recent events in space have highlighted the need for debris mitigating solutions:

- China's January 2007 ASAT test launched a kinetic kill vehicle (using the force of physical impact rather than an explosive warhead) against a Chinese weather satellite. The test produced more space debris than any other event to date. According to one source, the test produced at least 2,087 trackable pieces of debris larger than 10cm and around 35,000 debris particles down to 1cm in size.[15]
- In February 2009, a non-functioning Russian satellite collided with a functioning United States communication satellite. The SSN tracked over 1,800 pieces of new debris larger than 10cm produced by this collision. A larger quantity of debris smaller than 10 cm was also created.[16]
- The Russian BLITS satellite was struck by debris on 22 January 2013. The impact changed the satellites orbit and spin rate, eventually causing the satellite to stop functioning. This collision was likely caused by debris too small to be tracked by the SSN, highlighting the destructive potential of even small debris particles.[17]

Due to the scale of the space debris problem, several space agencies and private companies have begun researching debris removal options. For example, the United States' current national space policy instructs the National Air and Space Administration (NASA) and the Secretary of Defense to

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[11] For more information, see the UNIDIR Space Security Conference 2017 Report. Available from http://www.unidir.org/files/publications/pdfs/unidir-space-security-2017-en-685.pdf.
[12] NASA, "Orbital Debris Remediation", 2014. Available from https://www.orbitaldebris.jsc.nasa.gov/remediation.
[13] United States Airforce, "The Satellite Situation Report", *Project Spacetrack*. Available from https://www.space-track.org/documents/Recommendations_Optimal_Cubesat_Operations_V2.pdf.
[14] NASA, "Space Debris and Human Spacecraft", September 2013. Available from https://www.nasa.gov/mission_pages/station/news/orbital_debris.html.
[15] Kelso, T.S., "Analysis of the 2007 Chinese ASAT Test and the Impact of Its Debris on the Space Environment", Center for Space Standards and Innovation, 2007. Available from https://celestrak.com/publications/AMOS/2007/AMOS-2007.pdf.
[16] NASA, "The Collision of Iridium 22 and Cosmos 2251: The Shape of Things to Come", 60th International Astronautically Congress, October 2009. Available from https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20100002023.pdf.
[17] NASA, N. Parkhomenko et al., "Accident in Orbit", 2013. Available from https://cddis.nasa.gov/lw18/docs/papers/Posters/13-Po03-Natalia.pdf.

"[p]ursue research and development of technologies and techniques … to mitigate and remove on-orbit debris, reduce hazards, and increase understanding of the current and future debris environment".[18]

Proposed space debris remediation methods range from the use of lasers, tugs, nets, and magnets, to more exotic solutions. Yet, these technologies carry substantial risks for space security too. Most tools that can remove debris from space are potentially dual-use in nature and could be used for hostile purposes.

Space and Strategic Stability

Defining Strategic Stability

Policymakers and scholars have spent the entire nuclear age seeking to define strategic stability. The term has been used differently in a plethora of contexts. Some use the term to describe general peace within the global security environment. At other times, strategic stability appears to reference a lack of conflict in a specific bilateral or multilateral context. More precise definitions nestle strategic stability within the concepts and rhetoric of nuclear deterrence.

Thomas Schelling coined one classic definition of strategic stability when he wrote in a 1958 RAND report that a "situation is stable when either side can destroy the other when it strikes first or second—that is, when neither in striking first can destroy the other's ability to strike back".[19] If used precisely, strategic stability is thus a term that describes a particular balance between nuclear-armed rivals that have credible retaliatory nuclear strike capabilities. To maintain this equilibrium, it is not sufficient for all sides to simply have nuclear weapons. Strategic stability demands "the maintenance of an effective second-strike capability".[20]

However, as with all types of deterrence, simply having the necessary technical capabilities is not sufficient to maintain strategic stability. Beyond mere capability, effective deterrence demands communication of will and demonstrated resolve. To achieve strategic stability, one must minimize an adversary's perceived incentives to use nuclear weapons first by informing them of clearly communicated redlines that are credible. In the words of William Kaufmann, adversaries must "be persuaded that [one has] the capability to act; that, in acting, [one] could inflict costs greater than the advantages to be won from attaining the objective; and that [one] really would act as specified in the stated contingency".[21]

Other theorists have sought more specific definitions of strategic stability. James Acton divided strategic stability into constituent parts by separately defining crisis stability and arms race stability. For Acton, crisis stability exists "if neither side has or perceives an incentive to use nuclear weapons first out of the fear that the other side is about to do so". Arms race stability is "the absence of perceived or actual incentives to augment a nuclear force—qualitatively or quantitatively—out of the fear that in a crisis an opponent would gain a meaningful advantage by using nuclear weapons first".[22] Thus, strategic stability incorporates the maintenance of predictable and non-escalatory measures between nuclear-armed rivals.

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[18] NASA, *National Space Policy of the United States of America*, 28 June 2010. Available from https://www.nasa.gov/sites/default/files/national_space_policy_6-28-10.pdf.

[19] Schelling, Thomas C., *Surprise Attack and Disarmament*, RAND, 10 December 1958.

[20] Harrington, Anne, "Power, Violence, and Nuclear Weapons", *Critical Studies on Security*, 2016, p. 92.

[21] Kaufmann, William, "The Requirements of Deterrence", in William W. Kaufmann, ed., *Military Policy and National Security*, 1956, p. 8.

[22] Acton, James, "Reclaiming Strategic Stability", in Elbridge Colby and Michael Gerson (eds.), *Strategic Stability: Contending Interpretations*, Strategic Studies Institute, 2013, p. 117.

Critics of Strategic Stability

While the term strategic stability became a widely used maxim for understanding Cold War security dynamics, critics of the concept have denounced its intellectual foundation and its political ramifications.

One of the most widely reiterated academic arguments against the pursuit of deterrence through strategic stability is the model's reliance on a rational actor approach. This criticism notes that decision makers and decision-making processes cannot and do not meet all of the demands of calculated assessments of risks and payoffs. There are "inherent constraints on the ability of both individuals and organizations to carry out all the steps in a procedural model of rationality".[23] There is too much room for bias, miscalculation and misunderstanding within the decision-making process. Moreover, strategic stability is not something objectively and independently defined, assessed and refereed. Even in the case of Schelling's definition of strategic stability, at least some elements of it may be in the eye of the beholder.

The implications of this criticism are far reaching. If strategic stability can fail at unpredictable times for illogical reasons, then reliance on strategic stability may lead policymakers towards reckless and provocative behaviour. The danger is that leaders may calculate that strategic stability ensures that political sabre-rattling will not result in warfare. However, an adversary may misinterpret and take action upon empty threats. This problem is further exacerbated if States pursue strategic stability postures without seeking avenues for risk reduction and cooperation.

Relying on strategic stability, which is predicated on the continued maintenance and threat of use of nuclear weapons, may also be politically problematic in light of States' avowed commitments to the goal of nuclear disarmament. For instance, it could be argued that a concept consolidating the indefinite salience of nuclear weapons in security doctrines is contrary to the obligation of the five Nuclear Non-Proliferation Treaty (NPT) nuclear-weapon States to "pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control" under article VI of the Treaty.[24]

Other critics of the concept of strategic stability note that it was conceptualized in an environment that was more binary and bipolar than today's strategic environment. The costs associated with pursuing strategic stability during the Cold War were enormous—both in terms of the resources and the level of concentration for the United States and the Soviet Union to track each other's capabilities and intentions. In today's multipolar world, with more strategic competitors, this may simply be unattainable.

Deterrence in Outer Space

For some theorists, deterrence in the nuclear domain appears possible only because of the harsh consequences of failure (i.e. nuclear conflict). It is difficult to find an analogue in the space domain. The consequences of failure are devastating, but not in the same manner. Nuclear war could slaughter millions instantly. The impact is immediate. Failure in the space domain could have more long-term impacts. For example, by creating massive debris fields, the near-Earth environment could be rendered unusable for centuries. Nevertheless, it is important to note that the space domain does not exist in strategic isolation. Failure in space could entangle States into a spiral of escalation that might include conventional or nuclear consequences.

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[23] Knopf, Jeffrey, "Rationality, Culture and Deterrence", Naval Postgraduate School, 2013, p. 15.

[24] *Treaty on the Non-Proliferation of Nuclear Weapons*, 5 March 1970, article VI.

Military dependence on space technology to transmit data is rapidly increasing. For instance, remote piloting of modern military drones and the coordination required for some troop movements depend on space assets. Nuclear arsenals depend to some extent on remote sensing and communication from satellites to gather targeting information and transfer intelligence. The use of ASAT weapons against military communication satellites would complicate command and control and could undermine crisis management.

In the absence of successful international efforts for formalized arms control or norms building, there is evidence that some States have chosen to pursue deterrence policies. Michael Krepon defined deterrence in space as preventing "harmful actions by whatever means against national assets in space and assets that support space operations".[25] This broad, cross-domain conception of deterrence in space seems to be reflected in the strategy that the Obama administration set forth in the *2010 National Space Policy Review*. The United States Department of Defense's official *Strategy for Deterrence in Space* seeks to avoid conflict by supporting the development of international norms, building coalitions to enhance security capabilities, reducing dependence on and building redundancy in space architectures, and being prepared to respond to attacks against space systems proportionally, but not necessarily symmetrically nor in space.[26]

Yet the weaponization of outer space threatens many traditional conceptions of deterrence. Non-kinetic technologies such as lasers that disable satellites are particularly problematic because it can be difficult to attribute an attack. The ability to determine who is responsible if an attack is conducted is vital to establishing stable deterrence. Without proper technologies for space situational awareness, credibly threatening retaliation is impossible. It is also difficult to assess the spectrum of responses to attacks against space-based assets. Militaries might have strong incentives to regard any attack against their assets in the same manner, regardless of whether the attack permanently destroyed their assets or temporarily disabled them.

The implications for pursuing deterrence in space are unclear and have not been given much theoretical attention. Seeking deterrence in space may provide a source of stability or may be the basis of an arms race. The result will likely depend on the character of deterrence that is pursued. Deterrence involving a broadly accepted set of international norms for responsible behaviour could contribute greatly to the maintenance of international peace and stability. Policies that seek security through building up and testing weapons capabilities or directly weaponizing space instead risk escalation and arms race instability.

The roles of new actors in the space security environment is also under analysed. The rising number of governments active in space, particularly governments that are not militarily competitive but depend on space assets commercially, could play an important role in encouraging multilateral discussions on space sustainability.

In addition, private sector companies could play a part in reducing—or at least managing—military competition in space. The latest Organisation of Economic Co-operation and Development (OECD) report on the space economy in 2013 estimated that over 900,000 people were employed in the space sector, and that total revenues generated by the space economy exceeded USD 256.2 billion.[27] Enterprises prefer stability when it comes to investing. Yet the influence that private actors can exert on national defence postures is unclear. Key questions that remain to be answered include: How does private investment affect how deterrence is conceived? Will economic

[25] Krepon, Michael et al., "Anti-Satellite Weapons, Deterrence and Sino-American Space Relations", Stimson Center, 2015, p. 15. Available from https://calhoun.nps.edu/bitstream/handle/10945/36842/Antisatellite_Weapons.pdf?sequence=1.

[26] United States, Department of Defense, *Strategy for Deterrence in Space*, 2010. Available from http://archive.defense.gov/home/features/2011/0111_nsss/docs/DoD%20Strategy%20for%20Deterrence%20in%20Space.pdf.

[27] OECD, *The Space Economy at a Glance*, 2014, p. 9. Available from http://www.keepeek.com/Digital-Asset-Management/oecd/economics/the-space-economy-at-a-glance-2014_9789264217294-en#.WhfrIIWcFLg#page11.

incentives lessen the likelihood of confrontation? How will the outsourcing of military activities to private space companies affect this balance? And can deterrence work at all given the presence of so many private actors complicating situational awareness?

The Space Beyond Strategic Stability

Counter-space capabilities challenge many traditional elements of nuclear deterrence and strategic stability. The use of force in space could undermine key military assets, complicate command and control infrastructures, and make crisis management even more problematic.[28] In many cases, the use of counter-space capabilities provides challengers with asymmetric advantages. The dominant powers are currently the most reliant on space-based technology and infrastructure—and thus potentially the most vulnerable to its destruction or disruption.

One way forward is to move beyond strategic stability as a maxim for understanding global security. Rather than confronting all of the challenges associated with cross-domain deterrence, meaningful progress could be made through the creation of norms and arms control-related mechanisms and confidence-building measures.

In the past, States have agreed to limits on some dangerous military technologies as they perceived such measures enhanced their security. Given the strategic challenges, high costs, and technological barriers associated with counter-space technologies, it may be possible to negotiate limits on the militarization and weaponization of space, but this is likely to require States to take a view of security interests broader than reductionist Cold War-era notions of strategic stability. A starting point could be a prohibition or limitation on the use of kinetic debris-producing ASAT tests since the dangers posed by debris are indiscriminate and long lasting. Furthermore, verification of this type of agreement is already possible through national technical means.

Ensuring the continued peaceful uses of space will likely require greater inducement and cooperation. Continuing to rely on deterrence alone while States research and develop counter-space capabilities is a recipe for an arms race that could escalate into direct conflict.

Concluding Remarks

Controlling the dangerous technologies applicable to space warfare presents novel challenges for the arms control community. Some verification and dual-use challenges have been overcome in the nuclear domain, but only after decades of substantial negotiations and technical work. Problems with dual-use technologies, space situational awareness, and attribution will present substantial barriers for formalized arms control in space.

The demonstrated danger of kinetic ASAT tests and the associated risks posed by space debris could be an important starting point for meaningful negotiations. In the nuclear domain, States recognized the environmental threats posed by nuclear weapons testing. The danger posed by debris producing ASATs is in some ways comparable.

In broader terms, the continued reliance on Cold War notions of strategic stability in a multipolar environment is increasingly problematic. Actors of strategic relevance in space and the technologies they may use have evolved drastically since strategic stability was initially conceived in the early Cold War period. Moreover, attempting indefinitely to ensure stability through the maintenance of

[28] For instance, see Livingstone, D. and Lewis, P., *Space, the Final Frontier for Cybersecurity?* Chatham House, September 2016.

second-strike nuclear capabilities runs contrary to avowed political commitments to nuclear disarmament.

Overall, deterrence and strategic stability face real limits as a basis for ensuring peace in space. These frameworks may be insufficient to respond to the full spectrum of challenges facing the security of outer space, including debris mitigation, command and control safety, and rising commercial interests. Substantial enhancements of the military space architecture carry risks of an exorbitantly costly arms race.

Persuasion and cooperation will have to play a larger role in space security. While formalized arms control faces a plethora of diplomatic and technical issues that will demand substantial time and thought, there are other options. TCBMs and the creation of norms against weapons testing can be a more immediate and politically feasible route forward.

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The space environment and existing political initiatives to govern space and constrain its militarization are changing. This paper surveys those changes and examines how recent developments in the space environment may impact “strategic stability”. It assesses definitions and criticisms of strategic stability in the context of space and discusses the implications of reliance on strategic stability in space as a guiding principle in the contemporary and near future world.

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