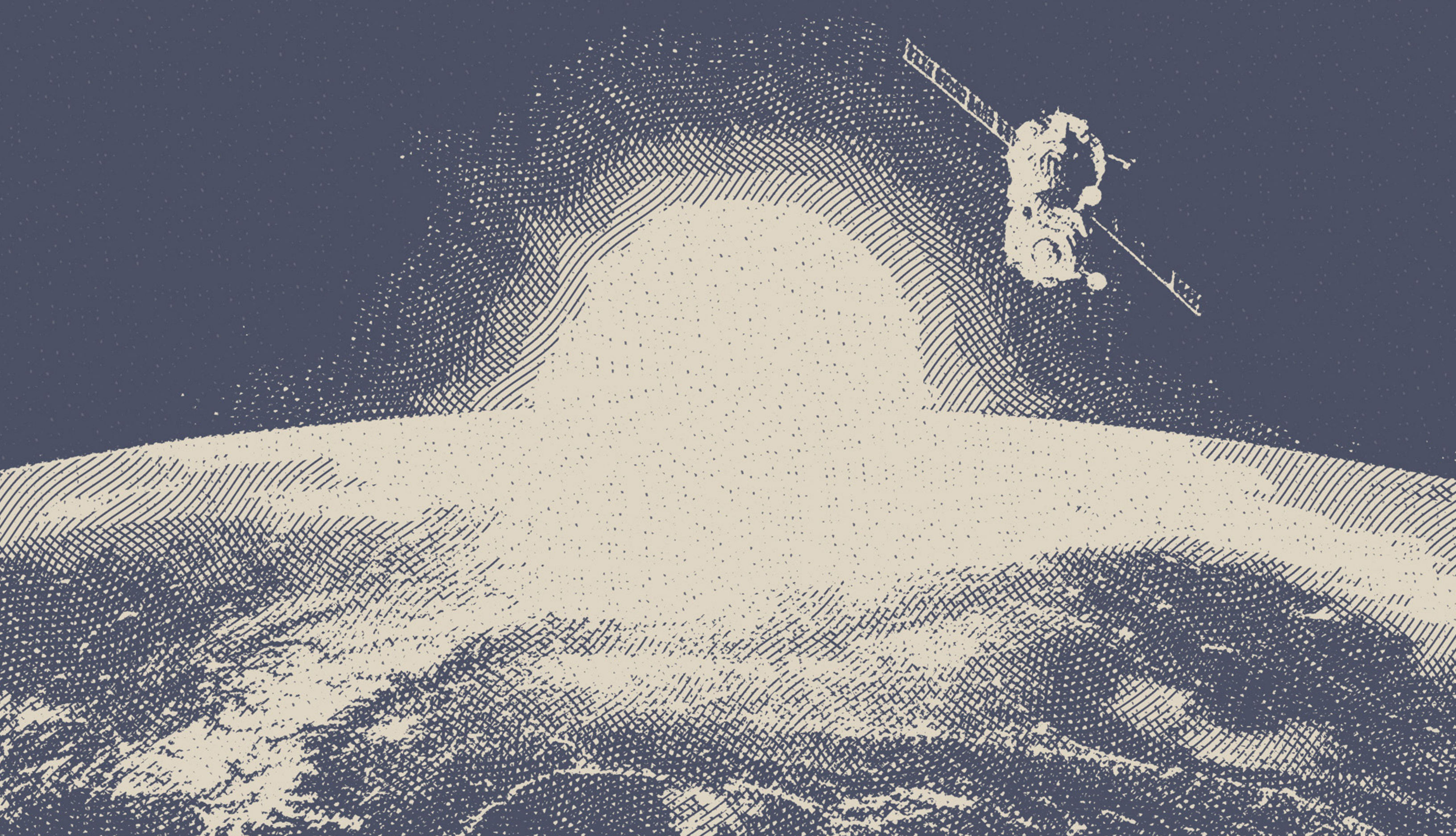
Ploughshares

SPECIAL REPORT

A Security Regime for Outer Space: Lessons from Arms Control

By Jessica West and Gilles Doucet

OCTOBER 2022



A Security Regime for Outer Space: Lessons from Arms Control

ISBN: 978-1-927802-31-1

First published: October 2022

Project Ploughshares
www.ploughshares.ca

ACKNOWLEDGEMENTS

This report is possible due to the following contributions:

Funding support from the Mobilizing Insights in Defence and Security (MINDS) program of the Canadian Department of National Defence

Research leadership and management by Dr. Jessica West of Project Ploughshares

Technical guidance and research by Gilles Doucet, Spectrum Space Security

Research by Research Assistant Grace Wright (University of Waterloo) and Project Ploughshares summer interns Lauren Vyse (Wilfrid Laurier University) and Emily Standfield (Balsillie School of International Affairs)

Participants at the global series of virtual workshops held on April 11-14, 2022

Workshop facilitators Cassandra Steer (ANU Institute of Space), Stacey Henderson (Flinders University), Chris Newman (Northumbria University), Tomas Hrozensky (European Space Policy Institute), Victoria Samson (Secure World Foundation), Daniel Porras (Secure World Foundation), Nancy Teeple (Defence Research and Development Canada), Branka Marijan (Project Ploughshares), Cesar Jaramillo (Project Ploughshares), and Kelsey Gallagher (Project Ploughshares)

Workshop rapporteurs Andrew Falle (University of British Columbia), Ewan Wright (University of British Columbia), Nermeen Zia' Islam (Balsillie School of International Affairs), Shaza Ahmed (Balsillie School of International Affairs), and André Doucet (Spectrum Space Security)

Editing by Ploughshares editor Wendy Stocker

Design and layout by Ploughshares Communications Officer Tasneem Jamal.

TABLE OF CONTENTS

List of Figures

Executive summary

Outer space is a fragile environment that is subjected to an array of interrelated hazards and threats to its safety, sustainability, and secure use. Hazards include deadly orbital debris and a growing risk of accidental collisions from the rapidly growing population of satellites. Threats are also increasing, from emerging technologies such as cyber-enabled attacks to new anti-satellite and other weapons capabilities that would support armed conflict in space. While there has been some progress in developing rules to mitigate some of these hazards, more than 40 years of efforts on arms control and conflict prevention at the United Nations have largely failed.

Updated approaches to arms control in outer space are needed. But we will not have to start from scratch. The premise of this report is that we can borrow insights from other experiences of arms control.

Building on recently completed research on space norms, partners Project Ploughshares and Spectrum Space Security examine potential pathways to arms control and other military restraints in outer space. Norms are at the core of this process. But norms are not a standalone tool to ensure strategic stability and collective well-being in a domain subjected to intense power rivalry and warfighting activities. In other domains of military activity, arms control and other restraints have successfully enhanced the security of all parties. Although space is a unique environment, the actors and the interests that are associated with this domain are the same as those related to other strategic security and disarmament domains. Responding to Canada's commitment in the Safe, Secure, Engaged defence policy to "provide leadership in shaping international norms for responsible behaviour in space," this report examines best practices and lessons learned from these other domains and experiences to inform the creation of additional frameworks for security in outer space.

The scope of our work is broad to capture the many obstacles to arms control in outer space. It includes content analysis of existing arms control agreements; qualitative research drawn from bilateral, multilateral, and humanitarian agreements; and insights from global experts from both the arms control and space communities. This material is synthesized into a series of lessons that are organized under five themes:

- Principles and objectives
- Scope
- Compliance, including implementation and verification
- Tools, mechanisms, and institutions
- Processes.

These lessons are presented in a comprehensive list on Page 7.

Because space is a unique environment, we recognize that no terrestrial solution will fully respond to the scope and challenges presented by arms control in this domain. We also recognize that arms control must be continuously adapted to respond to changing political and technical circumstances.

We approach arms control as a series of efforts to restrict the development, testing, produc-

> **Because space is a unique environment, we recognize that no terrestrial solution will fully respond to the scope and challenges presented by arms control in this domain. We also recognize that arms control must be continuously adapted to respond to changing political and technical circumstances.**

tion, stockpiling, and use of certain weapons, through mutual consent. The goal is to prevent or at least minimize conflict and to control or limit the use of the most egregious weapons that cause civilian and environmental harm.

Not a road map to arms control in outer space, the lessons are intended to inspire fruitful thinking on arms control efforts, facilitate new approaches, and identify opportunities for engagement and the pursuit of progress on mutual restraints at a time when the arms control agreements of past eras are under increasing strain.

The key takeaway from our research is that what is needed to make progress in arms control in outer space is a new perspective that sees arms control not as a discrete tool or agreement but as a broader regime of security governance comprised of principles and norms; restrictions and obligations; compliance and confidence-building measures; and tools, institutions, and mechanisms to facilitate ongoing political engagement, dialogue, and the implementation of measures that enhance collective security.

We conclude that arms control efforts for outer space should focus on finding opportunities to advance various elements of such a regime. What is required is an ongoing and iterative process to mitigate the risks that military competition and technology pose to the security and well-being of the space environment and its users.

Summary of lessons for outer space

PRINCIPLES AND OBJECTIVES

- It is important to start with clearly defined objectives.
- Norms provide a strong basis of principles and objectives for arms control.
- Humanitarian objectives must be included.

SCOPE

- Dual-use and dual-purpose capabilities can be managed within an arms control regime.
- Behavioural approaches to arms control can complement hardware approaches; both are needed.
- Clear definitions of scope also need attention.
- Accountability for the harmful effects of weapons and warfighting must be considered.

COMPLIANCE

- Verification is only one of many essential tools.
- Transparency and observability can help to build confidence in compliance.
- Compliance requires layers of measures and cooperation.
- Norms are an essential component of compliance.
- It is necessary to plan for non-compliance and disputes on the margins.
- Private sector and civil society actors provide key resources to support compliance.

TOOLS, MECHANISMS, AND INSTITUTIONS

- Means for communication and data exchange must be prioritized.

PROCESSES

- It is not necessary to start with trust.
- It is important to build on a common understanding of existing law and agreements.
- There are creative ways to think about material benefits.
- Leaders must act from a position of ongoing, inclusive engagement.
- Small, incremental changes can be valuable.

Introduction: A governance approach to arms control

When you look up at the night sky, you don't see the growing web of communications links and data flows that connect satellites in outer space with Earth and the lives of all its residents. But we all rely on that web for everything from banking to transportation to communication, weather forecasting, agriculture, mining, electricity grids, the Internet, and the movement of goods around the world, not to mention almost every single military and national security operation since the 1990s. We must also acknowledge that many of the satellites that populate outer space are military and dual-use systems, and thus potential targets of harmful interference or even armed violence.

But the continuous availability of these capabilities is far from guaranteed. Outer space is a fragile environment that is subjected to an array of interrelated hazards and threats to its safety, sustainability, and secure use. Hazards include deadly orbital debris and a growing risk of accidental collisions from the rapidly growing population of satellites. Threats are also increasing, from emerging technologies such as cyber-enabled attacks to new anti-satellite and other weapons capabilities that would support armed conflict in space. While there has been some progress in developing rules to mitigate safety and sustainability hazards, efforts on arms control and conflict prevention have largely failed.

Writing in 2006 on the need for cooperative threat reduction in space to mitigate heightening distrust and the resort to arms, Clay Moltz noted that, "fortunately, serious threats to security in space do not yet exist."[1] This is no longer the case. Forty years of stagnant discussions related to the prevention of an arms race in outer space (PAROS) at the United Nations (UN) have been punctuated by a growing number of kinetic anti-satellite (ASAT) demonstrations and a steep acceleration in the development of new technical capabilities that have the potential to inflict significant harm on space-based systems.[2]

Continued inaction increases the risks to the near- and long-term sustainability of the space environment and has a ripple effect on terrestrial activities, ranging from disruptions to critical infrastructure to conflict escalation and even possible nuclear confrontation. Importantly, a new multilateral effort to mitigate threats to space systems by advancing norms of responsible behaviour in outer space is currently proceeding under the mandate of the UN First Committee on Disarmament and International Security.[3] Such norms are an essential piece of the puzzle that has bedeviled space security proponents for decades.

Yet norms, while essential for safety and peacetime stability, are not sufficient to produce strategic stability and collective well-being in a domain subjected to intense power rivalry and warfighting activities. In other domains of military activity, arms control and other restraints have successfully enhanced the security of all parties. This study seeks to learn from these experiences.

---

1 James Clay Moltz, "Preventing Conflict in Space: Cooperative Engagement as a Possible U.S. Strategy," *Astropolitics* 4, no. 2 (August 2006): 121, https://doi.org/10.1080/14777620600910563.

2 Victoria Samson and Brian Weeden, eds., *Global Counterspace Capabilities* (Washington, D.C.: Secure World Foundation, 2022), https://swfound.org/counterspace.

3 For details and supporting documentation, visit "Open-ended working group on space threats," United Nations Office of Disarmament Affairs, https://meetings.unoda.org/meeting/oewg-space-2022.

REVISITING ARMS CONTROL

As prevailing international security arrangements – including key arms control agreements – crumble, a major study on how to advance new approaches to arms control for outer space may seem counterintuitive. But it is precisely at the most precarious moments that such approaches are most needed.

Long before the UN took up PAROS, space was a focus of strategic and bilateral arms control initiatives. Some succeeded. Following disastrous high-altitude tests of nuclear weapons that inflicted significant harm on the surrounding space environment and satellites, the Partial Test Ban Treaty (PTBT) banning nuclear explosions under water, in the atmosphere, and in outer space was ratified by the United States, Soviet Union, and United Kingdom in 1963. The value of arms control in space for strategic stability is clearly demonstrated by bilateral talks such as the Strategic Arms Limitation Talks (SALT), which produced both the Anti-Ballistic Missile (ABM) Treaty and the SALT I agreements, each of which prohibited interference with "national technical means of verification" (widely understood to mean military reconnaissance satellites), as well as strategic communications capabilities in outer space.[4] Additionally, the ABM Treaty limited the use of anti-ballistic missile systems to defending against ballistic missiles and restricted their placement in outer space.

However, key theorists on space power have been deeply resistant to arms control in principle – and not only for space. Pioneers in this field include Colin Gray, who famously viewed arms control as a paradox or "house of cards," concluding that it is "either impossible or unimportant."[5] But such skepticism confuses politics with strategy and reveals a fundamental misunderstanding of arms control itself.

Although it has become synonymous with the formal, legally binding weapons restrictions of the Cold War, arms control has a broader meaning and function. Thomas Schelling described it as "all the forms of military cooperation among potential enemies that may reduce the risk of war, its scope and violence if it occurs, or the costs of being prepared for it."[6] In Hedley Bull's classic and more specific definition, arms control involves "restraint internationally exercised upon armaments policy, whether in respect of the level of armaments, their character, deployment or use."[7] In essence, arms control is a tool for governing relations between potential enemies based on mutual accommodation and restraint.

Aimed at preventing and mitigating the consequences of violent conflict, some arms control measures take a hardware approach by controlling or restricting the development, production, and use of certain types of weapons. Others take a behavioural approach that seeks to enhance the transparency of military activities and so avoid miscommunication, misinterpretation, and the unintended escalation of conflict; or restrict certain activities and uses of weapons capabilities. Most agreements include both approaches.

4 David A. Koplow, "An Inference about Interference: A Surprising Application of Existing International Law to Inhibit Anti-Satellite Weapons," *Georgetown University Law Center* 35 (2014): 737–827.

5 Colin S. Gray, *House of Cards: Why Arms Control Must Fail*, Cornell Studies in Security Affairs (Ithaca: Cornell University Press, 1992), 16–19.

6 Thomas C. Schelling, "The Future of Arms Control," *Operations Research* 9, no. 5 (1961): 723.

7 Hedley Bull quoted in Daniel Frei, "International Humanitarian Law and Arms Control," *International Review of the Red Cross* 28, no. 267 (December 1988): 491–504, https://doi.org/10.1017/S0020860400071941.

Arms control objectives can also include disarmament, which involves eliminating or abolishing weapons. Many arms control agreements eliminate types or classes of weapons (the Chemical Weapons Convention [CWC]) or reduce stockpiles of certain weapons (the Strategic Arms Reduction Treaty [START I]). However, arms control can also include a range of efforts to enhance the predictability of, and limit, conflict escalation; clarify the intentions of states; and establish communication and transparency mechanisms that build confidence among states parties. As a tool of conflict prevention, arms control is described as "the only available means of eliminating unwarranted fears and misunderstandings."[8]

More recent multilateral arms control agreements have been guided by the concept of humanitarian disarmament. The Mine Ban Treaty, for example, prioritizes the protection of civilians by mitigating the impacts of conflict on humans and prohibiting certain weapons altogether. Shifting the focus from states to people, this approach emphasizes "ending human suffering" through a drive to disarm.[9]

We believe that all these objectives can benefit outer space. *Our own approach to arms control includes rules, practices, or restrictions related to the development, testing, production, stockpiling, or uses of certain capabilities, through mutual consent*. The goal is to prevent or at least minimize conflict and to control or limit the use of the most egregious weapons that cause civilian and environmental harm.

LEARNING FROM OTHER DOMAINS

Updated approaches to arms control in outer space are needed. But we will not have to start from scratch. The premise of this report is that we can borrow insights from other experiences of arms control.

Despite the unique physical environment of outer space, Colin Gray famously insisted that when it comes to strategy, there is nothing unique about space.[10] We agree. Moreover, we believe that what we can learn from other domains of military activity is not only the value of arms control, but how to achieve arms control in space and what an outer space arms control agreement might look like.

Part of this project involves a detailed study of the timeline of space arms control efforts and setbacks, which reveals a series of political and technical obstacles ranging from competing priorities and objectives to differences over approach, and includes definitional and verification quagmires.[11] However, these challenges are common to all arms control endeavours; a study of efforts that successfully overcame them can offer valuable insights for this case.

---

8 Richard Fieldhouse, "Naval Forces and Arms Control," in *Security at Sea: Naval Forces and Arms Control*, ed. Richard Fieldhouse (Oxford University Press, 1990).

9 Bonnie Docherty, "Ending Civilian Suffering: The Purpose, Provisions, and Promise of Humanitarian Disarmament Law," *Austrian Review of International and European Law Online* 15, no. 1 (2013): 7–44, https://doi.org/10.1163/15736512-90000064.

10 Rebecca Reesman and James R. Wilson, "The Physics of Space War: How Orbital Dynamics Constrain Space-to-Space Engagement" (Aerospace Corporation, 2020), https://aerospace.org/sites/default/files/2020-10/Reesman_PhysicsWarSpace_20201001.pdf; John J Klein, "Some Lessons on Spacepower from Colin Gray," *Naval War College Review* 74, no. 1 (2021): Article 7.

11 Jessica West and Lauren Vyse, "Arms Control in Outer Space: Status, Timeline, and Analysis," Project Ploughshares, March 2022, https://ploughshares.ca/wp-content/uploads/2022/03/ArmsControlOuterSpace_Report.pdf.

> **The outcome of this analysis is captured in visual schematics linked to key themes throughout the report.**

The scope of our research is broad to encompass the many obstacles to arms control in outer space. Still, we recognize that no other domain is exactly like space, and no terrestrial solutions will fully respond to the scope and challenges presented by arms control in outer space.[12]

OUR APPROACH

Our search for insights began with content analysis of 56 existing bilateral and multilateral arms control agreements across various sectors, including weapons of mass destruction and conventional weaponry. The aim was to identify core features and the range of approaches to common technical challenges such as definitions, verification, and compliance. The outcome of this analysis is captured in visual schematics linked to key themes throughout the report.

Next, we conducted qualitative research on approaches to arms control, including strategic bilateral agreements, multilateral arms control and non-proliferation, and humanitarian disarmament.[13] We examined these different approaches because outer space is both a domain of strategic military competition for a few but growing number of states and a global domain of civilian and commercial space activities. Thus, there are both strategic and humanitarian imperatives to arms control in outer space.

From these approaches we have sought to gain a broad understanding of best practices. We look at a variety of examples, some more successful than others, related to nuclear, chemical, and biological weapons; we also examine ongoing multilateral discussions related to cyberspace and the persistent resistance to arms control on the high seas.

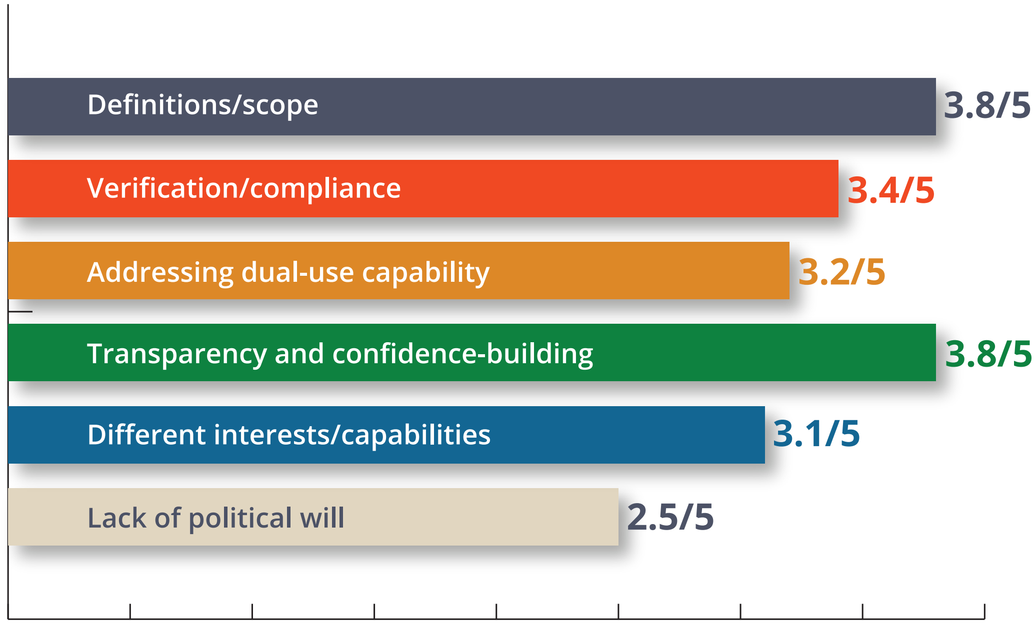
Finally, to refine our draft insights and lessons, we hosted a global series of workshops with experts from the arms control and outer space communities. Structured as multidisciplinary and interactive discussions, the workshops sought to use the rich personal insights of these individuals to foster dialogue that built bridges between the two groups.

---

12 A similar argument has been made for cyber arms control. See Andrew Futter, "What Does Cyber Arms Control Look Like? Four Principles for Managing Cyber Risk," Global Security Policy Brief (European Leadership Network, 2020).

13 Separate reports on lessons from humanitarian disarmament and the Chemical Weapons Convention are available: Jessica West, Branka Marijan, and Emily Standfield, "Regulating New Tools of Warfare: Insights from Humanitarian Arms Control and Disarmament Efforts," Project Ploughshares, March 2022, https://ploughshares.ca/wp-content/uploads/2022/03/Humanitarian-Arms-Control.pdf; Emily Standfield, "Lessons from the Chemical Weapons Convention," *The Ploughshares Monitor* (Fall 2021), https://ploughshares.ca/2021/09/lessons-from-the-chemical-weapons-convention.

Figure 1: Average rating by workshop participants on whether key obstacles to arms control in outer space can be overcome[14]



All this material has been pulled together in the following report on the space arms control conundrum, which is organized under five broad themes:

- Lack of agreement on core principles and objectives
- Technical challenges associated with scope and definitions
- Concerns related to compliance, including implementation and verification
- A persistent deficit of relevant institutions, tools, and mechanisms
- Political inertia.

Each section briefly presents background on the nature of the challenge, followed by a series of insights that reflect the best practices and lessons that we have derived from our analysis. Each insight includes an overview of relevant experiences and lessons learned. A comprehensive list of these insights is presented in the Executive Summary and provides a high-level overview.

Ultimately, however, the key takeaway from this process is that a broader view is needed, which sees arms control not as a discrete and singular tool or agreement but as a broader regime of security governance composed of principles and norms; restrictions and obligations; compliance and confidence-building measures; and tools, institutions, and mechanisms to facilitate ongoing political engagement, dialogue, and implementation of measures that enhance collective security in outer space.

We conclude that arms control efforts for outer space should focus on supplying various pieces of such a regime. What is required will be neither singular nor linear but an ongoing and iterative process to mitigate the risks posed by military competition and technology to the security and well-being of the space environment and its users.

14 Results from a poll of workshop participants conducted on April 12, 2022.

I. Principles and objectives

The ultimate purpose of arms control is to prevent or at least minimize conflict and to control or limit the use of the most egregious weapons. The intended results are peace and security, which include strategic stability, non-proliferation, and, more recently, the realization of humanitarian imperatives. However, as our review of existing arms control agreements shows, the path to reaching the destination is marked by advances on a broad range of narrower principles and objectives.

Multilateral arms control discussions on outer space fall under the mandate of PAROS and the principle of peaceful purposes that informs the Outer Space Treaty (OST). Debate on PAROS has been marked by competing concerns for the threats posed by ASAT weapons and by the potential placement of weapons in outer space. Yet this narrow focus on the "what" of arms control skirts a deeper question about the value and desirability of military restraint in space – the "why."

The objectives of outer space arms control are complex because the environmentally sensitive space domain is being used by humans in increasingly complex ways. Historically a domain of big power military competition, outer space has long been home to strategically sensitive capabilities such as nuclear command-and-control and missile detection, warning, and tracking. Today, space is also essential to critical infrastructure that underpins civilian life on Earth.

Figure 2: Principles and objectives identified in content coding of arms control agreements

Lessons for outer space

It is important to start with clearly defined objectives.

The PAROS mandate is subject to competing interpretations, interests, and priorities.[15] While some workshop participants pointed to the need to aim high, the lack of agreement on both problems and solutions presents a persistent obstacle to progress.

Cooperation is hard to achieve when there is no common understanding of the problem; it becomes even harder when states hold competing strategic interests and capabilities. For example, experts have identified the different strategic values and objectives of naval forces as a core contributor to the continued failure to incorporate naval capabilities into arms control agreements.[16] A similar challenge plagues a comprehensive approach to cyber arms control.[17]

Our research demonstrates that arms control can achieve different peace- and security-related objectives; polling of workshop participants indicates that arms control is valued for supporting a broad range of purposes. However, in practice, achieving multiple objectives in one agreement can be difficult, particularly if those objectives are not shared.

A key recommendation from the workshops is not to try to achieve all relevant objectives with a single agreement, but to approach arms control as an iterative and ongoing process that begins with, and builds on, narrow objectives that can include the establishment of principles and norms of behaviour that reduce the risk of misunderstandings and accidents, as in the Incidents at Sea Agreement between the United States and Soviet Union.

Such an iterative approach is evident in the 1972 SALT agreement, a bilateral strategic arms agreement between the United States and Soviet Union that laid the foundation for a series of ever more ambitious agreements over several decades. Despite Cold War animosity, the SALT agreement was possible, in part because both parties were interested in reducing the risk of a nuclear war that would have no winners. From a current perspective, the SALT agreement may seem modest, since it only froze the number of strategic missiles and bombers at the existing high level. However, we believe that it should be considered a breakthrough because it established a shared principle that limitations on strategic weapons benefit both parties and was the precursor to more restrictive agreements.

Current discussions related to cyberspace are focused on single-issue points of common concern and areas of potential cooperation, rather than a comprehensive agreement that would limit cyber technologies.[18]

---

15 Jessica West and Almudena Azcárate Ortega, *Norms for Outer Space: A Small Step or a Giant Leap for Policymaking?* (Geneva, Switzerland: UNIDIR, 2021), https://www.unidir.org/publication/space_dossier_7_norms_outer_space.

16 Richard Fieldhouse, "Naval Forces and Arms Control," in *Security at Sea: Naval Forces and Arms Control*, ed. Richard Fieldhouse (Oxford University Press, 1990).

17 Christopher A. Ford, "The Trouble with Cyber Arms Control," *The New Atlantis* (Fall 2010), https://www.thenewatlantis.com/publications/the-trouble-with-cyber-arms-control.

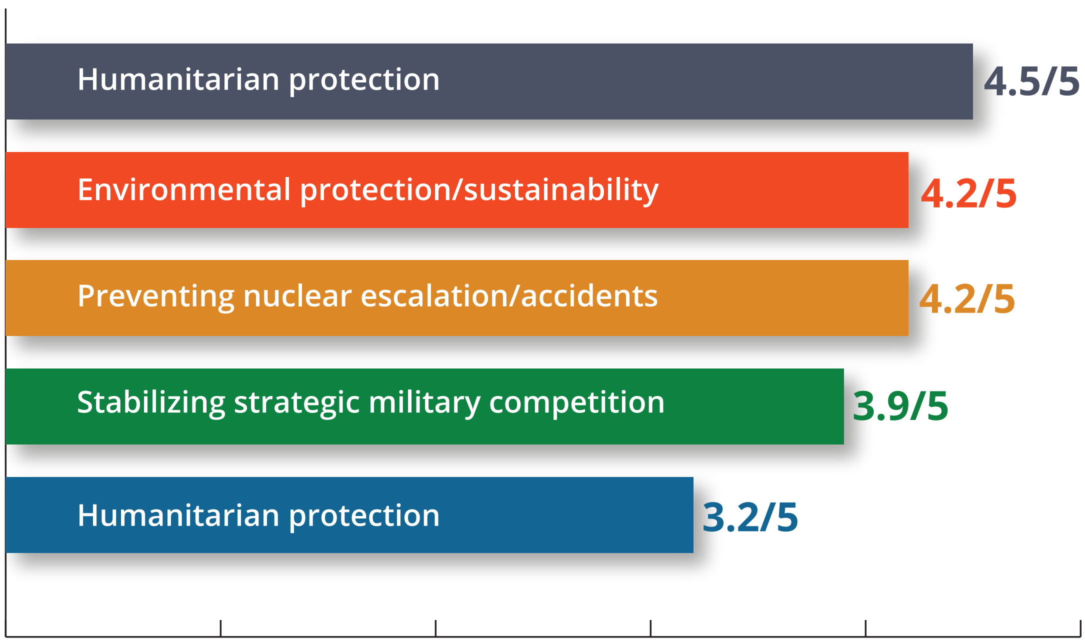
18 Andrew Futter, "What Does Cyber Arms Control Look Like? Four Principles for Managing Cyber Risk," Global Security Policy Brief (European Leadership Network, June 2020), https://www.europeanleadershipnetwork.org/wp-content/uploads/2020/06/Cyber-arms-control.pdf; Herbert Lin, "A Virtual Necessity: Some Modest Steps

Core arms control objectives that are relevant to space include:

- **Conflict prevention**, such as mitigating misperceptions and controlling confrontational weapons capabilities
- **Strategic stability**, such as protecting strategic nuclear command-and-control capabilities
- **Environmental sustainability**, such as restricting/banning intentional debris activities
- **Transparency and confidence**, such as addressing dual-use concerns of emerging technology
- **Humanitarian objectives**, such as protections for critical infrastructure and civilians.

Polling of workshop participants pointed to conflict prevention and preventing nuclear escalation as the most highly rated objectives, followed by environmental protection.

Figure 3: Average rating by workshop participants of the relevance of arms control objectives as they pertain to outer space[19]



Participants were neutral about the pursuit of humanitarian objectives in space arms control. Nonetheless, humanitarian objectives as well as broader transparency and confidence-building measures (TCBMs) related to the use of emerging technology in space intertwine with interests in preventing conflict and nuclear confrontation.

Progress on any of these objectives, however, must be built on, and informed by, solid norms.

---

toward Greater Cybersecurity," *Bulletin of the Atomic Scientists* 68, no. 5 (September 1, 2012): 75–87, https://doi.org/10.1177/0096340212459039.

19 These responses were collected as part of a follow-up survey to the global workshop series.

Norms provide a strong basis of principles and objectives for arms control.

At the heart of arms control agreements is a commitment to shared principles and associated norms of behaviour that relate to mutual military restraints. Such principles and norms inform and provide the impetus for legal agreements.[20] They can become the core source of restraint when formal control agreements are lapsing or collapsing.[21]

Workshop discussions reinforced the importance of norms for arms control; particularly important are taboos prohibiting possession or use of specific weapons. Taboos such as those that inform the non-use of both chemical and nuclear weapons are central to the strength of relevant arms control regimes.[22] Overall, there is a sense that stronger social and political norms support stronger arms control agreements. For example, the Biological Weapons Convention (BWC) and Chemical Weapons Convention are robust treaties with strong consensus, but they were also built on strong existing norms.

Moreover, the absence of strong norms can inhibit progress on arms control. For example, the lack of a taboo against the possession of nuclear weapons is cited as a reason why there wasn't a ban of such weapons prior to the adoption of the Treaty on the Prohibition of Nuclear Weapons (TPNW); developing and promoting such a norm is a key objective of that treaty.[23]

Because social and political norms and related principles involve a strong expectation of adherence,[24] workshop participants also emphasized their role in encouraging states parties to comply with arms control agreements.

Which norms/principles are key to arms control? As detailed in the outcome of our coding exercise (see Figure 1), there is no single principle or value that informs arms control; different approaches to arms control have operationalized different values.

- Principles of non-use are a powerful driver of bans on weapons of mass destruction.
- Humanitarian norms of civilian protection have informed restrictions on indiscriminate weapons such as landmines and cluster bombs.
- Principles of equality, stability, and non-interference influenced bilateral strategic arms control agreements.

Rather than seeing these values and approaches in competition, our visualization shows that they can be complementary and can even overlap. In many cases, arms control agree-

20 Dinah Shelton, "Soft Law," in *Routledge Handbook of International Law*, ed. J. D. Armstrong and Jutta Brunée, Routledge International Handbooks (London; New York: Routledge, 2009).

21 Nina Tannenwald, "Life beyond Arms Control: Moving toward a Global Regime of Nuclear Restraint & Responsibility," *Daedalus* 149, no. 2 (April 2020): 205–21, https://doi.org/10.1162/daed_a_01798.

22 Nina Tannenwald, "The Nuclear Taboo: The United States and the Normative Basis of Nuclear Non-Use," *International Organization* 53, no. 3 (1999): 433–68; Richard M. Price, *The Chemical Weapons Taboo* (Ithaca: Cornell University Press, 1997).

23 William Walker, "The Absence of a Taboo on the Possession of Nuclear Weapons," *Review of International Studies* 36, no. 04 (October 2010): 865–76, https://doi.org/10.1017/S0260210510001324.

24 Richard H. McAdams, "The Origin, Development, and Regulation of Norms," *Michigan Law Review* 96, no. 2 (November 1997): 338, https://doi.org/10.2307/1290070.

ments institutionalize more than one principle and objective.[25] For example, the Intermediate-Range Nuclear Forces Treaty (INF Treaty) cites as its core principles conflict prevention, strategic stability, and the need to avoid human devastation from the use of nuclear weapons. Nonetheless, our schematic reinforces the overall view of this report that arms control and military restraint are best pursued not with a single agreement or approach, but rather as a broad regime with many complementary parts.

But a problem remains in finding foundational norms and principles that relate to outer space peace, security, and arms control.

Figure 4: Values and activities embedded in space governance documents[26]

There is an urgent need to identify and clarify key principles and norms that inform arms control efforts related to outer space. The process should begin with a clear commitment to,

25 In her overview of humanitarian disarmament processes, Dr. Bonnie Docherty details what she describes as three approaches to arms control: security oriented, humanitarian oriented, and hybrid; see Bonnie Docherty, "Ending Civilian Suffering: The Purpose, Provisions, and Promise of Humanitarian Disarmament Law," *Austrian Review of International and European Law Online* 15, no. 1 (2013): 7–44, https://doi.org/10.1163/15736512-90000064.

26 Jessica West and Gilles Doucet, *From Safety to Security: Mapping the Normative Landscape in Outer Space*, Project Report and Recommendations, Project Ploughshares (March 2021), https://ploughshares.ca/wp-content/uploads/2021/03/SpaceNormsMapandRecommendations.pdf.

and common understanding of, the parameters of peaceful use. This is particularly important given the potential deployment of weapons or other offensive capabilities in space.

Although the OST principle of peaceful use is commonly agreed to mean non-aggressive use, the meaning of the term has been stretched over time.[27] Other concepts and principles embedded in the OST, such as due regard and avoiding harmful interference have no universally accepted definitions and remain poorly operationalized. While the continued absence of dedicated weapons systems in outer space might suggest the existence of an underlying taboo, international consensus is not certain[28] and it is difficult to reconcile an effective taboo with the rampant development and testing of weapons systems[29] and the growing operational focus on warfighting.[30] Meanwhile, norms that informed military restraint, such as the non-destructive testing of ASAT weapons, have clearly eroded, despite unilateral efforts by the United States and Canada to shore them up.[31]

In the context of PAROS, vagueness of what constitutes a weapon, let alone an arms race, contributes to a normative fog.[32]

When it comes to the placement or use of weapons in space, non-weaponization remains a key principle for many states.[33] "No weapons in space" was also viewed as the core principle of PAROS by workshop participants. But what a universal commitment to this principle means in practice remains unclear. Thus, at this stage, this principle is unlikely to inform a strong arms control regime for outer space.

The current Open-Ended Working Group (OEWG) on reducing space threats can play a key role in identifying and defining core principles and norms related to peace and security in outer space. The Initial round of discussions identified many potentially foundational concepts, although some need clear definitions. Core values include peaceful use, non-weaponization, and humanitarian principles.[34] If these principles and the norms of behaviour associated with them are to become a basis for further arms control and other measures of restraint, it is essential that a common understanding of them and their applicability to space be developed.

27 Jessica West, "Outer Space: Cloaked by a Fog of Peace," *Ploughshares Monitor*, September 2021, https://ploughshares.ca/2021/09/outer-space-cloaked-by-a-fog-of-peace.

28 Todd Harrison, "International Perspectives on Space Weapons," Aerospace Security Project (Center for Strategic and International Studies, May 2020), https://aerospace.csis.org/wp-content/uploads/2020/05/Harrison_IntlPerspectivesSpaceWeapons-compressed.pdf.

29 Victoria Samson and Brian Weeden, eds., *Global Counterspace Capabilities* (Washington, D.C.: Secure World Foundation, 2022), https://swfound.org/counterspace.

30 Jessica West, "From Peaceful Uses to Warfighting: The Dangers of the New Military Era in Space," in *Military Space Ethics*, ed. Nikki Coleman (Howgate Publishing, 2022).

31 Theresa Hitchens, "US Pledges No Destructive ASAT Missile Tests, Urges International Norm," *Breaking Defense*, April 19, 2022, https://breakingdefense.sites.breakingmedia.com/2022/04/us-pledges-no-destructive-asat-missile-tests-urges-international-norm.

32 Benjamin Silverstein, Daniel Porras, and John Borrie, "Alternative Approaches and Indicators for the Prevention of an Arms Race in Outer Space," Space Dossier (UNIDIR, May 2020).

33 Jessica West, "Outer Space," *First Committee Monitor* 19, no. 5 (2021): 27–29.

34 An informal report from the Chair of the Working Group is forthcoming, but related documentation is available on the website of the UN Office of Disarmament Affairs, https://meetings.unoda.org/meeting/oewg-space-2022.

Humanitarian objectives must be included.

Humanitarian interests and protection for civilians have driven all recent major multilateral agreements that are epitomized by bans on arms such as landmines and cluster munitions. Humanitarian concerns are also shaping arms control discussions related to emerging domains and technology, including cyberspace and artificial intelligence (AI).[35] For example, cyber arms control efforts are increasingly focused on humanitarian concerns for the security of civilians, building on principles of international humanitarian law such as proportionality, necessity, and distinction.[36]

Critical infrastructure is another humanitarian focus. Even though cyber operations exist in a digital space, they affect many critical pieces of infrastructure that civilians rely on, including hospitals, banks, and transportation networks.[37] A focus on "human-centric" cyber security is thus emerging in response to the growing prevalence of cyber attacks on public health infrastructure, including hospitals.[38] This focus includes gender. Women are disproportionately affected by the disruption or loss of such infrastructure.[39] A focus on protecting civilians that includes critical infrastructure and gender is also driving the international effort to ban the use of explosive weapons in populated areas (EWIPA).[40] This emphasis is valid because of the disproportionate impact that EWIPA has on women.[41]

Environmental protection is yet another humanitarian focus and is at the heart of recent efforts to ban nuclear weapons.[42]

Although a distinctively humanitarian approach to arms control and disarmament has recent-

35 Jessica West, Branka Marijan, and Emily Standfield, *Regulating New Tools of Warfare: Insights from Humanitarian Disarmament and Arms Control Efforts* (Project Ploughshares, March 2022), https://ploughshares.ca/pl_publications/regulating-new-tools-of-warfare-insights-from-humanitarian-disarmament-and-arms-control-efforts. See, for example, Bernhards Blumberg, "A Pragmatic Perspective towards Minimizing the Civilian Harm of Offensive Cyberspace Operations," *Humanitarian Law and Policy* (October 21, 2021), https://blogs.icrc.org/law-and-policy/2021/10/21/pragmatic-perspective-minimizing-civilian-harm-cyberspace-operations.

36 Reaching Critical Will, "Cyber Peace and Security," Fact Sheet, https://reachingcriticalwill.org/resources/fact-sheets/critical-issues/14010-cyber-peace-and-security.

37 United Nations General Assembly, *Open-Ended Working Group on Developments in the Field of Information and Telecommunications in the Context of International Security*, Final Substantive Report A/AC.290/2021/CRP.2 (March 10, 2021), https://front.un-arm.org/wp-content/uploads/2021/03/Final-report-A-AC.290-2021-CRP.2.pdf.

38 Sheetal Kumar, "The Missing Piece in Human-Centric Approaches to Cybernorms Implementation: The Role of Civil Society," *Journal of Cyber Policy* 6, no. 3 (September 2, 2021): 375–93, https://doi.org/10.1080/23738871.2021.1909090.

39 G. Morgan et al., "Infrastructure for Gender Equality and the Empowerment of Women" (Copenhagen, Denmark: UNOPS, 2020), https://content.unops.org/publications/UNOPS-Infrastructure-for-Gender-Equality-and-the-Empowerment-of-women.pdf.

40 Cesar Jaramillo and Kelsey Gallagher, "Countering 5 Misconceptions about a Political Declaration on EWIPA," Ploughshares Spotlight, Project Ploughshares (November 2020) online: https://ploughshares.ca/wp-content/uploads/2020/01/EWIPASpotlight.pdf; Martin Butcher*, The Gendered Impact of Explosive Weapons Use in Populated Areas in Yemen* (Oxfam, November 26, 2019), https://doi.org/10.21201/2019.5327.

41 Martin Butcher*, The Gendered Impact of Explosive Weapons Use in Populated Areas in Yemen* (Oxfam, November 26, 2019), https://doi.org/10.21201/2019.5327.

42 Ray Acheson, *Banning the Bomb, Smashing the Patriarchy* (Lanham, Maryland: Rowman & Littlefield Publishing Group, 2021).

ly emerged,[43] a broad focus on civilian protection is neither new nor incompatible with approaches that prioritize national security and strategic stability. For example, early international agreements related to naval forces did not allow warships to sink or incapacitate merchant vessels without first making sure that all crew and passengers were safely removed.[44]

The BWC and CWC are examples of agreements that ban specific weapons of mass destruction. They both protect national security interests and reflect more than a century of humanitarian disarmament efforts to restrict the impact of inhumane weapons.[45] Even bilateral strategic stability agreements such as the 1979 Limitation of Strategic Offensive Arms (SALT II) agreement between the United States and Soviet Union acknowledge the devastation that nuclear war would have on humankind. The PTBT barred testing of nuclear weapons in space in response to the environmental damage that previous tests had inflicted.[46]

Commonly held humanitarian considerations can thus start a dialogue when strategic interests may not align. Additionally, the process of negotiating restrictions based on humanitarian principles can help to lower the perceived strategic value of certain weapons systems. Capabilities including landmines and cluster bombs, once considered indispensable, are now widely rejected by most militaries.[47]

Humanitarian principles and approaches, including gender perspectives, thus merit greater attention in space arms control discussions.

While the direct targets of warfighting in outer space are hardware and not human bodies, the human cost of warfare in space would be devastating because of the loss of essential services that use satellite connections, as well as widespread environmental contamination.[48]

Although workshop participants, when first polled, seemed to hold neutral views on the value of humanitarian protection in the pursuit of space-related arms control, specific humanitarian concerns such as protection of the environment and critical infrastructure featured prominently in all workshop discussions. A post-workshop poll listed a ban on debris-producing ASAT tests as the most important possible behavioural or operational restriction in space (see Figure 8).

---

43 Bonnie Docherty, "Ending Civilian Suffering: The Purpose, Provisions, and Promise of Humanitarian Disarmament Law," *Austrian Review of International and European Law Online* 15, no. 1 (2013): 7–44, https://doi.org/10.1163/15736512-90000064.

44 General Provisions Relating to the Limitation of Naval Armament (The Washington Treaty), 1922, Article 22.

45 Robert J. Matthews, "The Influence of Humanitarian Principles in the Negotiation of Arms Control Treaties," *international Review of the Red Cross*, No. 834, 1 (1999), https://www.icrc.org/en/doc/resources/documents/article/other/57jpty.htm.

46 James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests* (Stanford, Calif: Stanford Security Studies, 2008).

47 Adam Bower, "Norms Without the Great Powers: International Law, Nested Social Structures, and the Ban on Antipersonnel Mines," *International Studies Review* 17, no. 3 (September 1, 2015): 347-73, https://doi.org/10.1111/misr.12225.

48 International Committee of the Red Cross, "The Potential Human Cost of the Use of Weapons in Outer Space and the Protection Afforded by International Humanitarian Law," Position paper submitted by the International Committee of the Red Cross to the Secretary-General of the United Nations on the issues outlined in General Assembly Resolution 75/36, May 2021, https://front.un-arm.org/wp-content/uploads/2021/04/icrc-position-paper-unsg-on-resolution-A-75-36-final-eng.pdf.

II. Scope

Technical challenges are commonly cited as obstacles to progress on arms control in outer space. More specifically, there are difficulties in defining the scope of restrictions related to "space weapons."[49] Although the focus of PAROS is on preventing an arms race, it has been difficult to agree to a definition of weapons that applies across the entire domain of activity, which is characterized by different uses and users of common technical capabilities.

Discussions during the 2018-2019 meeting of the Group of Governmental Experts (GGE) on PAROS identified numerous possible ways to define the scope of an arms control agreement, including:

- an operational approach that includes restrictions on
    - use of force
    - attacks on, or destruction of, objects
    - deliberate actions that have specific harmful effects such as incapacitation, denial of service, degradation, damage, and destruction OR that cause long-lasting space debris
    - using an outer space object as a weapon
    - placement of any weapons in outer space
- restrictions on hardware or capabilities such as
    - developing, stockpiling, or deploying weapons;
    - dual-use technology controls.

Other challenges relate to the rapidly expanding technical capabilities of dual-purpose technology and the implications of such expansion.

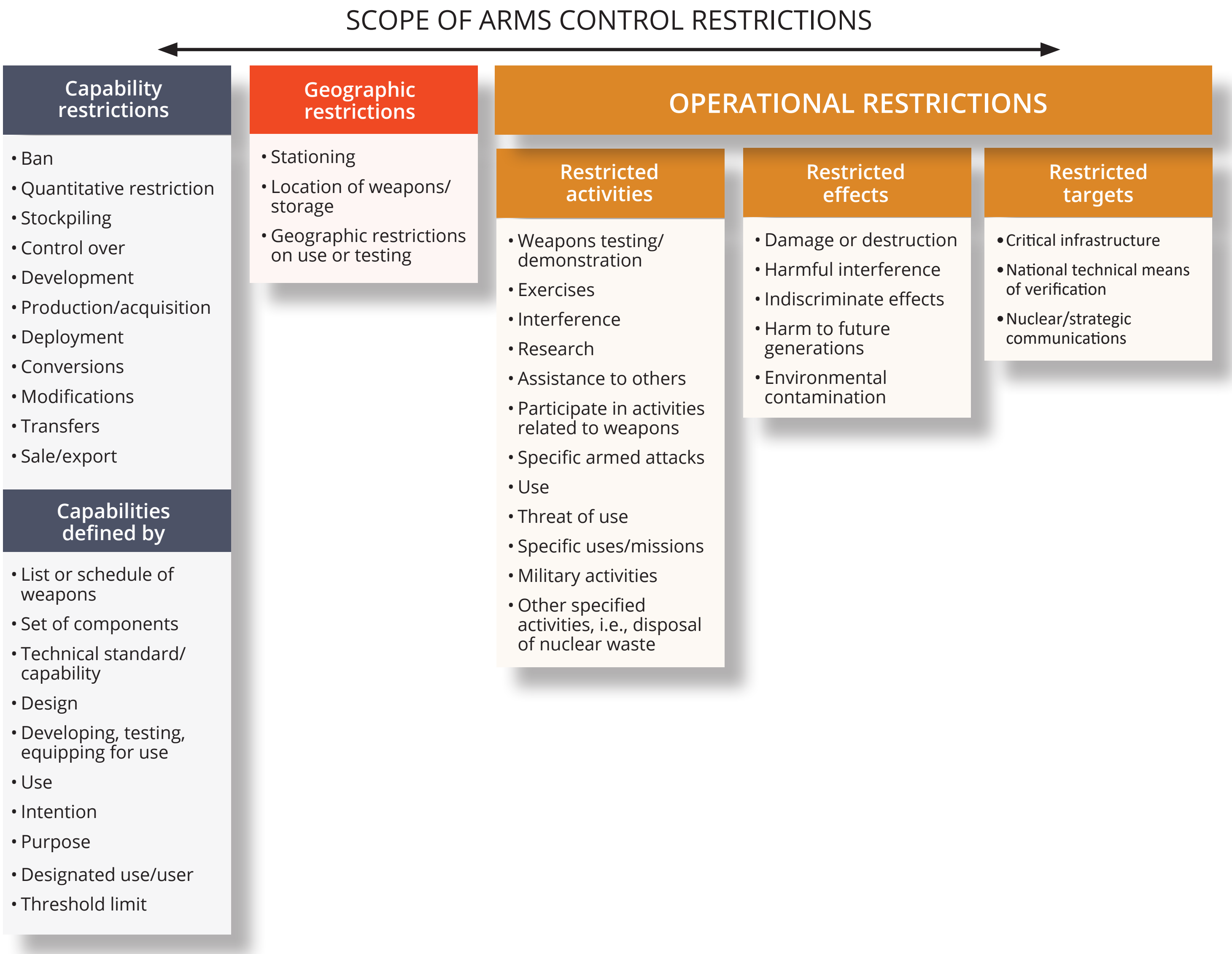
In combination, all these challenges have produced a deep divide between those states that prioritize a traditional arms control agreement that would restrict specific types of capabilities or weapons applications of technology and those states that want to focus on TCBMs and norms of behaviour to prevent conflict.[50]

But similar technical challenges hamper all arms control efforts. We can learn valuable lessons from them when pursuing arms control in space.

49 Christopher A. Ford, "Arms Control in Outer Space: History and Prospects," Arms Control and International Security Papers (Office of the Undersecretary of Arms Control and International Security, July 2020).

50 Jessica West and Almudena Azcárate Ortega, *Norms for Outer Space: A Small Step or a Giant Leap for Policymaking?* (Geneva, Switzerland: UNIDIR, 2021), https://www.unidir.org/publication/space_dossier_7_norms_outer_space.

Figure 5: Types of restrictions identified in content coding of arms control agreements



Lessons for outer space

Dual-use and dual-purpose capabilities can be managed within an arms control regime.

Technical capabilities that can be used by both civilian and military users (dual-use) and civilian technologies that are repurposed for military applications (dual-purpose) are commonly cited as key impediments to outer space arms control because users and uses are difficult to differentiate and "anything can be a weapon."[51] Such an assertion is false. It exaggerates the

51 See, for example, *Project Asteria 2019, Space Debris, Space Traffic Management and Space Sustainability*, Air , Power Development Centre, Canberra, Australia, 2019, p. 36, https://airpower.airforce.gov.au/sites/default/files/2021-03/AP43-Project-Asteria-2019-Space-Debris-Space-Traffic-Management-and-Space-Sustainability.pdf.

fungibility of technical capabilities and ignores a long track record of successful control and differentiation of technologies that are both dual-use and dual-purpose.

There are many precedents in which the existence of multiple applications of a technology has been presented as a reason for, rather than an obstacle to, arms control. The airplane is one relevant example. One of the most lethal weapons on Earth, the airplane developed civilian functions, which were differentiated and governed via the Chicago Convention. The result was a flourishing aviation industry.[52] Nuclear, chemical, and biological weapons have all been the subject of bans and other restrictions, while peaceful uses of related technologies have been promoted for their economic benefits.

There is a sense that the problem is becoming more complex with the emergence of new technologies, including space applications of capabilities such as AI, cyber, and robotics. Some experts at the workshops suggested that the concept of dual-use and even dual-purpose is outdated and of limited value. Many emerging technologies fall under the broader category of "general purpose." Capabilities and applications that continue to improve and evolve over time lead to many uses and spillover effects.[53] Such technologies, sometimes described as "omni-use," have a wide range of military, civilian, and private-sector applications.[54]

Of course, omni-use technology is not new. Consider the steam engine.[55] Multipurpose technology may be more prevalent today, but its existence does not make efforts to limit its application or uses either impossible or fruitless. Layering rules and restrictions to inform the development of capabilities and conduct of activities can help to distinguish civilian and military capabilities in outer space and differentiate among types of activities.

We will now describe some past efforts that indicate the importance of both hardware and behavioural/operational measures.

52 Details on this distinction were presented by Dr. Charles Stotler at the first meeting of the UN Open-Ended Working Group on Space Threats on May 12, 2022. The written presentation is available online: https://documents.unoda.org/wp-content/uploads/2022/06/OEWG-on-Norms-Rules-and-Principles-of-Responsible-Behaviour-in-Outer-Space-CStotler-Topic-4-12052022.pdf.

53 Nicholas Crafts, "Artificial Intelligence as a General-Purpose Technology: An Historical Perspective," *Oxford Review of Economic Policy* 37, no. 3 (September 23, 2021): 521–36, https://doi.org/10.1093/oxrep/grab012.

54 Michael T. Klare, "The Challenges of Emerging Technologies," *Arms Control Today* (December 2018), online: https://www.armscontrol.org/act/2018-12/features/challenges-emerging-technologies.

55 Nicholas Crafts, "Steam as a General Purpose Technology: A Growth Accounting Perspective," *The Economic Journal* 114, no. 495 (2004): 338–51.

Figure 6: Dual-purpose obligations identified in content coding of arms control agreements

DUAL-PURPOSE OBLIGATIONS

Differentiation

- Not mixing uses/hardware
- Distinguishing locations/sites of hardware/weapons
- Separate facilities
- Observable design differences

Rules for permitted/peaceful activities

- Declarations of permitted activities
- Notifications
- Testing and training rules
- Verification of peaceful use
- Safeguards
- Certification/licencing

- *Distinguishing uses and applications of technical capabilities*

Some agreements restrict specific types of hardware capabilities. START I limited deployment of strategic nuclear missile launch vehicles and included obligations to differentiate various types of weapons systems and capabilities. For example, parties to the agreement must not mix capabilities, must clearly indicate weapon locations and facilities, and must maintain functionally observable design differences. In other words, dual-purpose uses are avoided and such avoidance can be easily observed. Maintaining such distinctions in a variety of agreements has been critical not only to arms control efforts but to the peaceful development of technology. Examples include civilian and commercial air traffic[56] and nuclear energy.

While such a solution might not be possible for some space applications, whose technical capabilities are inherently dual- and even multi-purpose, it will not pose a problem for most systems, since only a few satellites have the technical potential to be repurposed into weapons. For example, to perform a kinetic intercept in orbit, a satellite must be designed specifically for that role, with technical characteristics that include a sensor that can detect and measure the relative position of the target satellite, from which the trajectory can be computed; control and guidance software that can use data from the sensor to compute

56 Details on this distinction were presented by Dr. Charles Stotler at the first meeting of the UN Open-Ended Working Group on Space Threats on May 12, 2022. The written presentation is available online: https://documents.unoda.org/wp-content/uploads/2022/06/OEWG-on-Norms-Rules-and-Principles-of-Responsible-Behaviour-in-Outer-Space-CStotler-Topic-4-12052022.pdf.

the required orbit adjustments; and much more precise thruster and attitude control than is found in a standard satellite. These attributes are not necessary for satellites intended for communications or remote sensing, for example.

Despite suggestions that civilian or commercial capabilities could be repurposed for counterspace uses,[57] in most cases, it is technically impossible.[58] Some advanced technical space capabilities, including robotics, manoeuvrability, close-proximity operations, and sensing, are essential to civilian and commercial applications such as orbital servicing and active debris removal. The small number of satellite missions with these capabilities could indeed be repurposed. The dangers in these cases could be mitigated by agreements on rules for peaceful use and transparency measures to aid verification of the civilian nature of operations (see below).

- *Developing rules for peaceful uses*

Arms control measures can be facilitated through the complementary development of rules and practices for peaceful use, which can help to distinguish peaceful capabilities from potential weapons and enhance access to and use of technology for civilian and commercial purposes. The right to access and use nuclear capabilities for peaceful purposes is the best known example. The CWC also mandates rules for commercial/private sector activities related to toxic and dangerous chemicals.

The development of rules for peaceful applications of technical capabilities in outer space should complement arms control efforts. Both help industry to flourish by building confidence in how technology is applied; both aid in creating distinctions between civil/commercial and military applications that facilitate verification of compliance with restrictions (see below).

- *Restricting purposes, uses, and effects*

Another approach is to develop rules related to the purposes, uses, and effects of capabilities.

The CWC focuses on use and intent, barring the use of any toxic chemicals for all non-peaceful purposes. Article II of the treaty loosely defines a toxic chemical as “any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals.” This definition and the restrictions and controls in the treaty continue to apply as new chemical capabilities are developed.

A focus on purposes, uses, and effects also facilitates strong linkages between behavioural and hardware approaches to arms control.

In the realm of space security, the focus on capabilities and activities that create space debris

57 Todd Harrison, Kaitlyn Johnson, and Makena Young, “Defense against the Dark Arts in Space: Protecting Space Systems from Counterspace Weapons,” Aerospace Security Project (Center for Strategic and International Studies, 2021).

58 For an overview of the physical requirements and limitations of counterspace capabilities, see Rebecca Reesman and James R. Wilson, “The Physics of Space War: How Orbital Dynamics Constrain Space-to-Space Engagement” (Aerospace Corporation, 2020), https://aerospace.org/sites/default/files/2020-10/Reesman_PhysicsWar-Space_20201001.pdf.

is intensifying. Another approach might restrict the use of capabilities that disable or physically damage satellite systems.

However, such broadly scoped restrictions face significant challenges with definition and compliance. For example, a longstanding agreement to limit "long-lived" or "harmful" space debris has not reined in destructive activities that produce such debris. The BWC has likewise faced ongoing compliance challenges related to interpretation of "hostile" uses, as discussed below.

Behavioural approaches to arms control can complement hardware approaches; both are needed.

Current international security and arms control discussions on emerging technology have tended to isolate approaches favouring traditional restrictions on weapons from those promoting rules on how technical capabilities should or should not be used.[59] The development of norms, rules, and principles for responsible state behaviour in the cyber domain is a case in point.[60] Insofar as it pertains to conduct, responsible behaviour is similar to operational arms control restrictions that focus on how capabilities are to be used, and is not legally binding. It can also include obligations for positive behaviours such as TCBMs (see Compliance). Both operational rules and restrictions, as well as obligations for responsible behaviour, provide alternatives to traditional restrictions on technical capabilities.

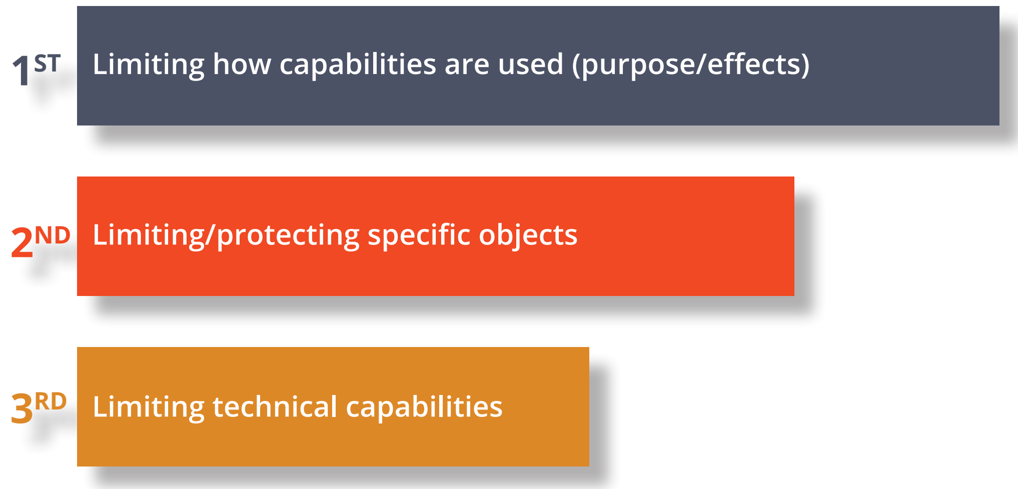
However, a clear message from the workshops is that hardware and behavioural approaches to arms control are complementary. Behavioural rules and restrictions flow from capabilities. Hardware restraints speak to underlying concerns about their effects and legitimate uses. As well, it should be noted that most successful security and arms control measures combine a behavioural approach with rules and restrictions related to hardware.

Nonetheless, because of the technical challenges associated with defining and identifying weapons capabilities in outer space, participants at all three workshops overwhelmingly prioritized a behavioural approach. Rules of responsible behaviour inform the conduct of activities more broadly, with fewer ties to specific restrictions. As well, unlike the classic restrictions on weapons hardware, operational restrictions limit specific uses of capabilities but not the capabilities themselves. Thus, prioritizing behaviour does not mean that hardware is ignored.

59 Jessica West and Almudena Azcárate Ortega, *Norms for Outer Space: A Small Step or a Giant Leap for Policymaking?* (Geneva, Switzerland: UNIDIR, 2021), https://www.unidir.org/publication/space_dossier_7_norms_outer_space.

60 United Nations General Assembly, "Group of Governmental Experts on Developments in the Field of Information and Telecommunications in the Context of International Security," A/70/174 (July 22, 2015), https://digitallibrary.un.org/record/799853?ln=en.

Figure 7: Ranking by workshop participants on the most appropriate approach to arms control restrictions in outer space[61]



Operational rules and norms of responsible behaviour can hinder the development of harmful capabilities and activities. The Comprehensive Nuclear-Test-Ban Treaty, for example, contains prohibitions on testing that make development more difficult and demonstrate to others a reliable weapons capability. The PTBT bans the testing of nuclear weapons under water, in the atmosphere, or in outer space.

Targets can also be restricted. Agreed-upon norms of responsible behaviour in cyber space do not attempt to define weapons but do forbid the targeting of critical infrastructure and emergency response teams.[62] Current international discussions on a political declaration to ban the use of EWIPA represent another effort to restrict the targets of a capability, not the capability itself.

Thus, we see that, although operational restrictions and rules of behaviour don't ban the development of potentially harmful capabilities, they can mitigate some key drivers of their use. For example, by creating clarity and predictability for operating in space, they help to quell misperception, misinterpretation, and conflict escalation. Such clarity and predictability also reduce the opportunities to use capabilities for harmful purposes.

Finally, such a behavioural approach has the added benefit of being better able to respond

61 Results of a poll of workshop participants conducted on April 13, 2022.

62 United Nations General Assembly, "Group of Governmental Experts on Developments in the Field of Information and Telecommunications in the Context of International Security," A/70/174 (July 22, 2015), https://digitallibrary.un.org/record/799853?ln=en.

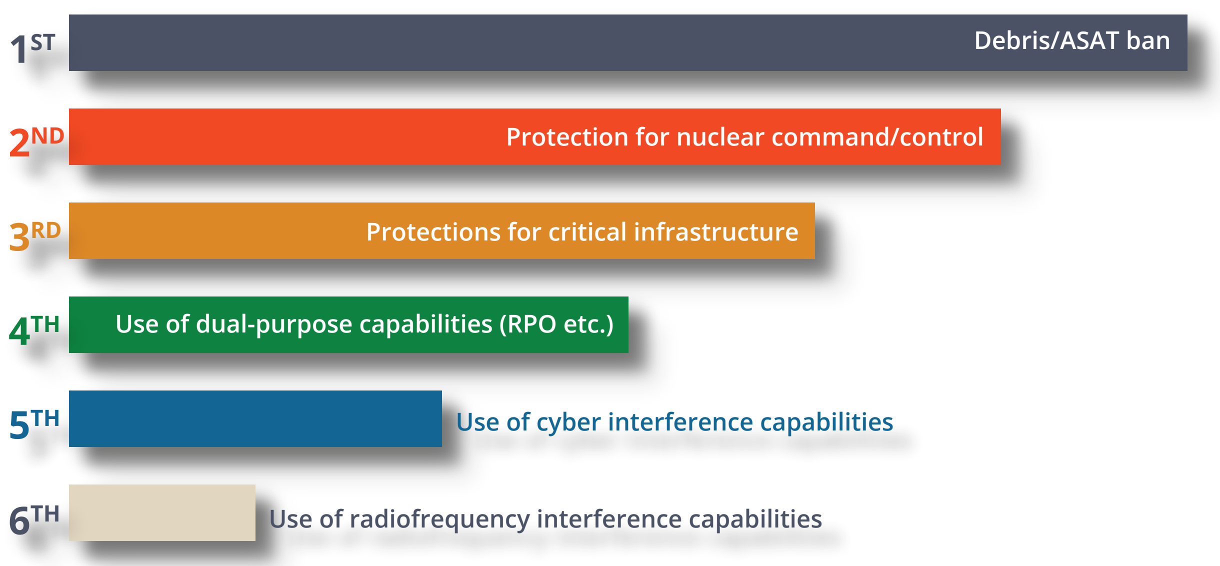
quickly to changing technology and its uses and can be pursued without intrusive verification measures. Rules of behaviour that promote transparency and confidence can help with the implementation of, and the verification of compliance with, any agreed-upon hardware restrictions (see Compliance below). Finally, as noted above, such rules also mitigate the risks of dual-purpose technologies.

To better link norms of behaviour to hardware capabilities, arms control discussions might include consideration of rules related to specific activities and their effects and targets.

Possible examples include:

- Restrictions on debris-creating activities and capabilities
- Bans or restrictions on technology demonstrations/tests
- Protections for specific targets, such as critical infrastructure and nuclear command-and-control capabilities
- Restrictions on activities or the use of capabilities that disable or damage space systems
- Rules to prevent harmful effects from non-cooperative close-proximity operations and inspections.

Figure 8: Priority ranking by workshop participants for potential operational/behavioural rules or restrictions in outer space[63]



Although a focus on behaviours is appealing because it seems to avoid the definitional challenges that have plagued hardware restrictions (see below), in practice, this approach is not

63 These responses were collected as part of a follow-up survey to the global workshop series.

immune to such challenges. As some workshop participants explained, the Incidents at Sea Agreement encountered turbulent waters when its crafters were trying to determine what should be considered “threatening” and “hostile” activities. Both the United States and the Soviet Union claimed that many activities conducted by the other were one or both. Thus, even a focus on behaviours requires precise language and a common understanding of each behaviour’s scope.

Discussions on responsible behaviour or other operational rules associated with space technology must be understood as only the beginning of a renewed and extended arms control process. Many bans on weapons (biological, chemical, landmines) have begun with a restriction on use that was later expanded to include production or possession.

Clear definitions of scope also need attention.

Despite the current focus on norms and rules of behaviour, the workshops sent a clear message: weapons still matter. Preventing the deployment of weapons in outer space remains a widely held objective of PAROS. A failure to do this, along with an unabated pursuit of weapons capabilities are viewed by some as the chief pitfall of an approach that over-emphasizes behaviour.

Many of the concerns that drive arms control and disarmament, including environmental and humanitarian devastation, require that attention be paid to hardware capabilities. International humanitarian law (IHL), for example, limits both the methods and means of warfare. Moreover, it demands a review of new weapons and keeps open the possibility that those that contravene its core tenets, such as the lack of discrimination, will be banned.[64] This attitude has driven some of the most recent weapon bans, including the Mine Ban Treaty, and informs ongoing discussions of restrictions on military applications of AI.

Maintaining suitable scope is key. Restrictions that are too broad or too narrow will cause problems. A blanket, domain-wide ban on weapons in space would be difficult, if not impossible, to implement, given the wide range of activities and technical capabilities in space, as well as interactions with capabilities in other domains. Such a ban would capture so many non-weapons applications that it would quickly become meaningless. If anything can, at least in theory, be a weapon, then nothing is a weapon. An overly broad ban would create loopholes and then political challenges over implementation and verification. The pitfalls of failing to clearly define and delineate weapons have been illustrated by the Biological Weapons Convention, which bans the development and acquisition of biological weapons and their delivery systems but fails to define either.[65]

Agreements from other domains also show us how the definition and control of weapons can be facilitated by focusing on specific categories or classes of weapons. Bilateral strategic agreements usually restrict clearly defined classes of nuclear weapons and delivery systems. However, if the scope is too narrow, the agreement risks excluding too many things that

64 International Committee of the Red Cross, “Review of New Weapons” (November 2011), https://www.icrc.org/en/document/review-new-weapons.

65 Samavi Srivastava and Rounak Doshi, “The Biological Weapons Convention: Loopholes and Suggestions,” Society of International Law and Policy, July 14, 2021, https://silpnujs.wordpress.com/2020/07/14/the-biological-weapons-convention-loopholes-and-suggestions.

are functionally related and could quickly be outpaced by new capabilities. For example, the 1922 Washington Naval Treaty that restricted the number and tonnage of key warships left some classes unrestricted, setting the naval arms race in a different direction but not tamping it down.[66]

Many potential weapons capabilities for use against space systems are under development. How can they be controlled? It might be possible to restrict specific types of weapons that share specific physical components or capabilities. The Outer Space Treaty already prohibits placing weapons of mass destruction in orbit around Earth or stationing them in outer space. Other possibilities could be weapons that could strike Earth, directed energy systems (lasers) above a certain power threshold, non-nuclear electromagnetic pulse systems, or objects released at a high velocity from satellites.

However, these complicated measures would still be subject to technological innovation and would leave numerous other means of attack unrestricted. As well, they are not free of definitional loopholes. The Mine Ban Treaty, for example, restricts the "primary" design and use of anti-personnel landmines. The Treaty to Ban Cluster Munitions restricts munitions that cause "unacceptable harm." The Arms Trade Treaty (ATT) restricts arms sales if there is an "overriding risk" of certain consequences. All suggest a certain facility in skirting restrictions.[67] Attempts at improving space sustainability are already hindered by the focus on "long-lived" debris.[68]

An operational focus on uses, purposes, and effects of capabilities may be a more feasible way to identify and restrain harmful capabilities and provide flexibility in developing rules for rapidly advancing space-based technology (see above). The draft Treaty on the Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force against Outer Space Objects (PPWT) adopts this approach. In this case, the challenges of scope and definition are even more significant.

Precedents include the CWC, which prohibits the use of any chemical as a weapon, and the BWC, which bans the use of biological toxins for "hostile purposes." The Environmental Modification Convention is focused on the effects of weapons, banning any use of capabilities that produce a widespread, long-lasting, or severe effect on the natural environment as a means of warfare.

But sometimes flexibility is gained at the expense of precision. The BWC (Article 1) bans the use of any biological toxin for "hostile purposes" and allows it for peaceful and protective purposes, but doesn't define either hostile or peaceful purposes. As a result, verification and attributing accountability are almost impossible.[69]

---

66 Thomas C. Hone, "The Effectiveness of the 'Washington Treaty' Navy," *Naval War College Review* 32, no. 6 (1979): 35–59.

67 Stuart Maslen and Peter Herby, "An International Ban on Anti-personnel Mines History and Negotiation of the "Ottawa Treaty," *International Review of the Red Cross* 38(325) (1988): 693-712, https://international-review.icrc.org/sites/default/files/S0020860400091579a.pdf.

68 Jessica West, "What Kinetic ASAT Testing Tells Us about Space Security Governance," Ploughshares Spotlight (February 2022), https://ploughshares.ca/pl_publications/what-kinetic-asat-testing-tells-us-about-space-security-governance.

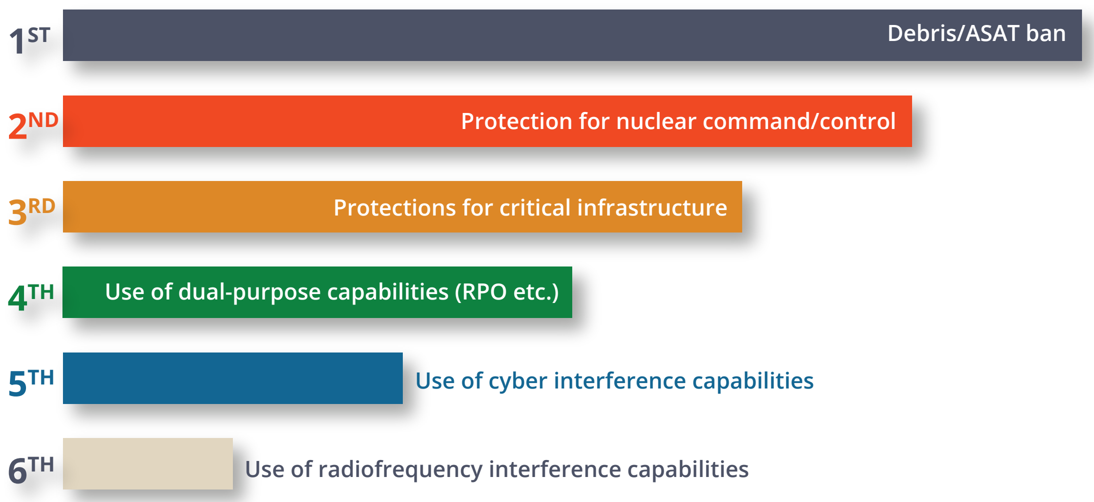
69 Samavi Srivastava and Rounak Doshi, "The Biological Weapons Convention: Loopholes and Suggestions," Soci-

In contrast, the CWC builds on well established norms and principles of non-use. It clearly defines chemical weapons (Article II), as well as a host of other concepts and categories such as "toxic chemicals." What some concepts, such as a "chemical weapons production facility," do not mean is also laid out. The Environmental Modification Convention includes an annex with clear definitions of "widespread," "long-lasting," and "severe."

Progress on controls or restrictions of specific technical capabilities or their applications in outer space is not impossible but will require a return to the basics of space governance: the core values and objectives of space security and arms control outlined in the section on Objectives in this report. It would also be necessary to identify the parameters of key principles, such as the peaceful use of outer space, and key concepts associated with the use of force or IHL and to establish how they are operationalized in outer space. Upcoming publications of the McGill and Woomera manuals will help with these tasks.[70]

However, prioritizing either hardware or behavioural controls also depends heavily on the ability and political will to monitor and verify. Successful weapons restrictions such as the CWC pair clear and extensive definitions with robust verification measures (see Compliance below).

Figure 9: Priority ranking by workshop participants for potential rules or restrictions on weapons capabilities in outer space[71]



ety of International Law and Policy, July 14, 2021, https://silpnujs.wordpress.com/2020/07/14/the-biological-weapons-convention-loopholes-and-suggestions; Lena Raxter, "A Dangerous Loophole: The Biological Weapons Convention's New Interpretation that Better Addresses Potentially Deadly Biological Research," *International Journal of Legal Information* 49(2) (2021): 102-29, https://doi.org/10.1017/jli.2021.13.

70 Ram Jahku and Steven Freeland, eds, *McGill Manual of International Law Applicable to Military Uses of Outer Space, Volume I – Rules,* McGill University (2022), https://www.mcgill.ca/iasl/files/iasl/mcgill_manual_volume_i_-_rules.pdf; *The Woomera Manual on the International Law of Military Space Activities and Operations,* Forthcoming, https://law.adelaide.edu.au/woomera.

71 These responses were collected as part of a follow-up survey to the global workshop series.

Accountability for the harmful effects of weapons and warfighting must be considered.

Influenced by IHL, advocates for humanitarian arms control and disarmament have shifted their focus from national security and strategic stability among states to preventing civilian suffering and assisting victims.[72] This shift affects scope.

Civilian protection and restitution now have greater importance and bring about remedial obligations, such as clearing unexploded landmines and providing direct assistance to victims, as required in the Mine Ban Treaty.[73] The Convention on Cluster Munitions (CCM) adopts a similar approach, focusing on preventing harm, removing harm, and assisting victims. The TPNW requires a range of assistance to victims of the use and testing of nuclear weapons. For example, states parties contaminated by use and testing must "take necessary and appropriate measures" to remediate the environment (Article 6[2]) and all states parties share in the responsibility to provide victim assistance and environmental remediation (Article 7).

Such measures reflect a move to greater accountability for the harmful effects of weapons and warfighting activities on people on Earth and the fragile outer space environment. We see acceptance of that responsibility in the adoption of the Long-term Sustainability Guidelines by the UN Committee on the Peaceful Uses of Outer Space (COPUOS)[74] and in the growing awareness that space systems are critical infrastructure that provide essential civilian services.[75] A focus on accountability also meshes with the principle of state responsibility in the Outer Space Treaty.

Accountability must also include an acknowledgement that gender has an impact on how weapons are used, who is targeted, and why someone is targeted. Weapons are used differently against victims, depending on their biological sex and the social norms associated with gender.[76] The 2008 CCM, the 2013 ATT, and the 2017 TPNW all include gender provisions. And the 2001 UN Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects recognizes the negative impact of these weapons on women (Preamble 6). Even treaties that do not include gender-based provisions have initiated efforts to incorporate them into ongoing implementation, such as the Oslo Action Plan for implementation of the Mine Ban Treaty.

72 Jessica West, Branka Marijan, and Emily Standfield, "Regulating New Tools of Warfare: Insights from Humanitarian Arms Control and Disarmament Efforts," Project Ploughshares, March 2022, https://ploughshares.ca/wp-content/uploads/2022/03/Humanitarian-Arms-Control.pdf.

73 Bonnie Docherty, "Ending Civilian Suffering: The Purpose, Provisions, and Promise of Humanitarian Disarmament Law," *Austrian Review of International and European Law Online* 15, no. 1 (2013): 7–44, https://doi.org/10.1163/15736512-90000064.

74 United Nations General Assembly, *Report of the Committee on the Peaceful Uses of Outer Space, Sixty-second session*, A/74/20 (12–21 June 2019), https://www.unoosa.org/res/oosadoc/data/documents/2019/a/a7420_0_html/V1906077.pdf.

75 President of the United States Joseph Biden, *United States Space Priority Framework,* The White House (December 2021), https://www.whitehouse.gov/wp-content/uploads/2021/12/United-States-Space-Priorities-Framework-_-December-1-2021.pdf.

76 Chantal de Jonge Oudraat and Jana Wattenberg, "A Gender Framework for Arms Control and Disarmament," Women in International Security, Policy Brief (May 2021), https://www.wiisglobal.org/wp-content/uploads/2021/05/Gender-Framework-for-ACD-May-2021.pdf.

> **Accountability must also include an acknowledgement that gender has an impact on how weapons are used, who is targeted, and why someone is targeted. Weapons are used differently against victims, depending on their biological sex and the social norms associated with gender.**

While gendered impacts of weapons and warfighting may seem irrelevant in the outer space domain, the impact that space hardware and technical systems have on critical civilian infrastructure provides a clear linkage. Because of entrenched gender roles and biases in the design of infrastructure, women tend to be disproportionately affected by disruption or loss of access. Determination of which services are deemed critical is also related to gender.[77]

77 G. Morgan, A. Bajpai, P. Ceppi, A. Al-Hinai, T. Christensen, S. Kumar, S. Crosskey, and N. O'Regan, *Infrastructure for Gender Equality and the Empowerment of Women,* United Nations Office for Project Services, Copenhagen, Denmark (2020), https://content.unops.org/publications/UNOPS-Infrastructure-for-Gender-Equality-and-the-Empowerment-of-women.pdf.

III. Compliance

Compliance, which is essential to the success of arms control agreements, refers broadly to a collection of processes, tools, and institutions that support and create confidence in the full and consistent enactment of the agreement. It includes adherence to all terms by parties to the agreement (implementation), the means to check that implementation processes are being followed (verification), and processes that are activated when implementation is not complete.[78]

Most concerns with compliance relate to verification of bilateral arms control treaties, but the concept of compliance in the context of arms control has now broadened to include "virtually any activity that contributes to the full implementation of a treaty."[79] We find it helpful to adopt this broader focus in our discussion of compliance.

Both implementation and verification require clearly expressed rules and restrictions that define scope and are devoid of vague language, subjective assessments, and qualitative restrictions.[80]

Verification remains a stumbling block in constructing weapons restrictions in outer space. Arms control proposals to date, including the draft PPWT, have not included provisions to verify implementation and adherence. Various regimes to monitor activities in outer space have been proposed. In 1979, Italy suggested an international satellite monitoring agency; in 1987, Canada suggested the PAXSAT program; in 1989, France advanced the idea of a UN international trajectography centre (UNITRACE).[81] Many other states have demanded such provisions since the UN General Assembly adopted the first PAROS resolution in 1981.[82] Beginning in 2010, U.S. national space policy has made the ability to verify adherence to an agreement a key criterion for consideration of any new space-related arms control agreement.[83]

Implementation and verification of arms control agreements are ongoing processes that require commitment by an international community that extends beyond states parties to the private sector and civil society.

78 Michael Moodie and Amy Sands, "Introduction," *The Nonproliferation Review* 8, no. 1 (March 2001): 1–9, https://doi.org/10.1080/10736700108436834.

79 Trevor Findlay, "Verification and the BWC: Last Gasp or Signs of Life?" Arms Control Association, September 2006, https://www.armscontrol.org/act/2006-09/features/verification-bwc-last-gasp-signs-life.

80 Trevor Findlay, "Verification of the Ottawa Convention: Workable Hybrid or Fatal Compromise?" *Disarmament Forum* 1999, no. 4: 45–55.

81 See examples in Jessica West and Lauren Vyse, "Arms Control in Outer Space: Status, Timeline, and Analysis," Project Ploughshares, March 2022, https://ploughshares.ca/wp-content/uploads/2022/03/ArmsControlOuterSpace_Report.pdf.

82 United Nations General Assembly, *Prevention of an Arms Race in Outer Space*, A/RES/36/97C (United Nations, 1981), https://www.unoosa.org/oosa/oosadoc/data/resolutions/1981/general_assembly_36th_session/res_3697c.html.

83 President of the United States, Barak Obama, *National Space Policy of the United States of America* (The White House, 2010), https://history.nasa.gov/national_space_policy_6-28-10.pdf.

Lessons for outer space

Verification is only one of many essential tools.

The ability to verify adherence to military rules and restrictions is a core building block of trust and confidence and a key element of any discussion on restrictions on arms or other military activities in outer space. Using technical capabilities to both detect violations and demonstrate one's own compliance,[84] verification gives states confidence that rules and restrictions are being implemented by all parties. Arms control proposals that do not address verification are unlikely to be tenable.

Verification is critical because in some circumstances a state's failure to adhere to an agreement may threaten the national security of other states. Formal, mandatory approaches to verification are linked to greater overall compliance.[85]

A poll revealed that workshop participants see verification and compliance more broadly as key to building confidence and trust in arms control.

Figure 10: What builds confidence in arms control agreements?[86]

Early arms control agreements such as the OST contain no verification provisions, while initial bilateral agreements between the United States and the Soviet Union (such as SALT) relied exclusively on each state's technical verification capabilities, such as reconnaissance satel-

84 Trevor Findlay, "Verification of the Ottawa Convention: Workable Hybrid or Fatal Compromise?" *Disarmament Forum* 1999, no. 4: 45–55.

85 Marie Isabelle Chevrier and Iris Hunger, "Confidence-building Measures for the BTWC: Performance and Potential," *The Nonproliferation Review* 7, no. 3 (September 2000): 24–42, https://doi.org/10.1080/10736700008436823.

86 Results from a poll of workshop participants conducted on April 12, 2022.

lites. When the BWC was drafted, compliance and verification were not significant concerns because biological weapons were not easy to control and so not widely used in combat.[87]

A laissez-faire approach to verification is no longer viable. Bilateral verification measures have become more formal and intrusive over time. As well, standardization of the formal means of verification is increasingly common in multilateral arms control and disarmament agreements. The BWC highlights the dangers of postponing verification efforts: advancements in science and technology have since made biological weapons more viable, while efforts to add verification requirements to the BWC have been unsuccessful.[88]

It is commonly believed that there are also technical challenges in verifying agreements that relate to outer space;[89] according to some, these challenges make such agreements "unverifiable."[90] However, the biggest obstacles to verification are often political.

Intrusive measures such as on-site inspection are not always politically palatable.[91] In some cases, verification is technically difficult and expensive, and might require actions by an external organization, which some states reject.[92] Verification also raises sensitive political questions about the standard of data, how data is collected and interpreted, and who has access to it.[93] And sometimes verification is used to obstruct an agreement altogether; a state might insist that verification is inherently impossible or require that other states submit to measures that they find politically unacceptable.[94]

Verification should never be used as a political tool to thwart the pursuit of arms control in space. It is important to recognize that no agreement will be fully verifiable[95] and that verification alone cannot ensure compliance with, or confidence in, arms control, both of which are ultimately based on political calculations by states.[96]

Instead, states should adopt a practical approach to arms control verification that is based

87 Jozef Goldblat, "The Biological Weapons Convention–An Overview," *International Review of the Red Cross,* 37(318) (1997), 251–65, https://www.icrc.org/en/doc/resources/documents/article/other/57jnpa.htm.

88 Filippa Lentzos, "Compliance and Enforcement in the Biological Weapons Regime," The United Nations Institute for Disarmament Research (December 5, 2019), https://doi.org/10.37559/WMD/19/WMDCE4.

89 Letter dated 19 August 2008 from the Permanent Representative of the United States of America Addressed to the Secretary-General of the Conference Transmitting Comments on the Draft Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects (PPWT) as Contained in Document CD/1839 of 29 February 2008, Conference on Disarmament, CD/1847, 28 August 2008.

90 Trevor Findlay, "Verification and the BWC: Last Gasp or Signs of Life?" Arms Control Association, September 2006, https://www.armscontrol.org/act/2006-09/features/verification-bwc-last-gasp-signs-life.

91 Naomi Egel and Jane Vaynman, "Reconsidering Arms Control Orthodoxy," War on the Rocks, March 26, 2021, https://warontherocks.com/2021/03/reconsidering-arms-control-orthodoxy.

92 Trevor Findlay, "Verification of the Ottawa Convention: Workable Hybrid or Fatal Compromise?" *Disarmament Forum* 1999, no. 4: 45–55.

93 Michael Moodie and Amy Sands, "Introduction," *The Nonproliferation Review* 8, no. 1 (March 2001): 1–9, https://doi.org/10.1080/10736700108436834.

94 Trevor Findlay, "Verification of the Ottawa Convention: Workable Hybrid or Fatal Compromise?" *Disarmament Forum* 1999, no. 4: 45–55.

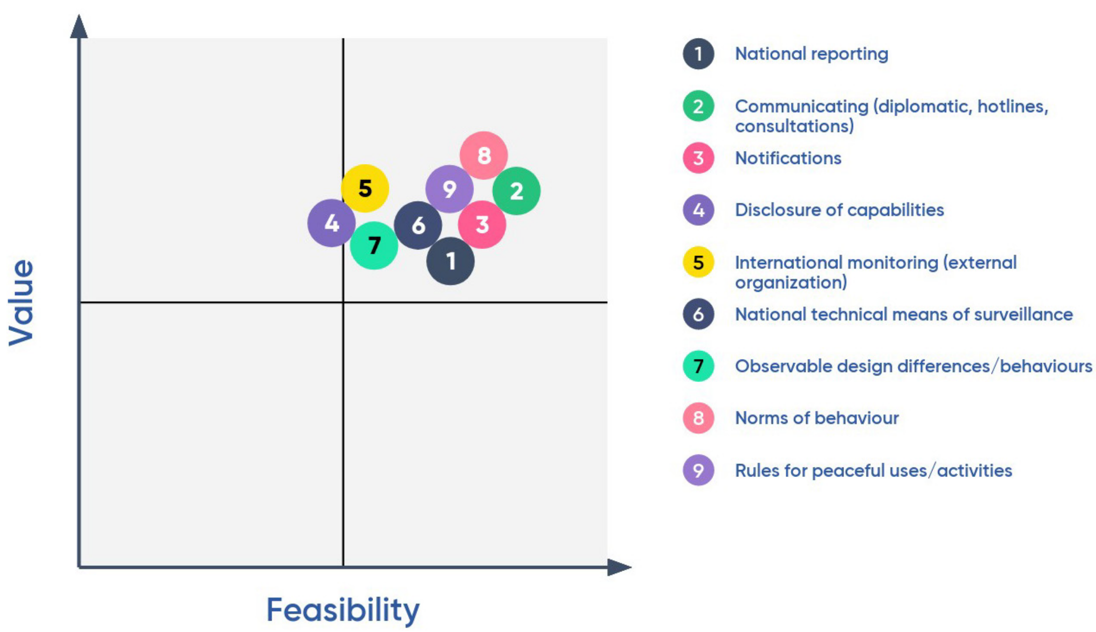
95 Ibid.

96 Michael Moodie and Amy Sands, "Introduction," *The Nonproliferation Review* 8, no. 1 (March 2001): 1–9, https://doi.org/10.1080/10736700108436834.

on what is feasible and adequate for the scope of restrictions. For example, in the case of bilateral, strategic agreements between the United States and Soviet Union/Russia, verification measures evolved over time to become stronger and more reliable and intrusive as restrictions became more robust. Initially the SALT and ABM Treaty ceded verification to the capabilities of the other party, while prohibiting interference with those means of verification. SALT II (never ratified) clarified verification measures and the non-interference principle. START's measures were significantly more intrusive than those in SALT, including the telemetric protocol not to encrypt data essential for verification by the other party and the required sharing of tapes of telemetric information needed to verify missile flight performance and capabilities. The parties also agreed to a regime of on-site inspections. Subsequent treaties included all these measures.

Other tools are necessary to facilitate implementation of, and compliance with, arms control measures, as we discuss below.

Figure 11: Evaluation of confidence-building measures by workshop participants[97]



Transparency and observability can help to build confidence in compliance.

Inspections are the gold standard of arms control verification. Among multilateral agreements, the CWC includes the most stringent provisions for compliance. States Parties must establish National Authorities that work in tandem with the Organization for the Prohibition

97 Results from a poll of workshop participants conducted on April 14, 2022.

of Chemical Weapons, the international body established to guarantee CWC implementation. The CWC Verification Annex provides a regime to verify chemical-related activities and monitor through routine on-site and 'challenge' inspections.[98]

However, our research documents many other technical approaches to verification: surveillance, detection, external monitoring. For example, START II included telemetry data to verify missile flight performance and capabilities. Implementation and verification of the Comprehensive Test Ban Treaty are facilitated by an International Monitoring System of 321 global monitoring stations and 16 laboratories that monitor Earth for any seismic, hydroacoustic, infrasound, or radionuclide indicators of a nuclear explosion (plus on-site inspections).[99] States Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) must agree to safeguards overseen by the International Atomic Energy Agency (IAEA); besides on-site inspections, there is accountability for nuclear material and the IAEA has access to surveillance equipment to detect possible diversion.[100]

Intrusive measures to verify treaty compliance for new types of weapons capabilities will be a hard sell because the weapons are difficult to define and/or use general-purpose technology. Beginning with a modest scope focused on observability could be helpful. Priority should be given to measures that can be independently observed and monitored by others, and to transparency measures that increase the observability of space activities.

Workshop participants repeatedly used as a model The Hague Code of Conduct against Ballistic Missile Proliferation, which adopts a declare-and-verify approach to transparency and confidence-building. This voluntary agreement includes commitments to annual declarations and pre-launch notifications, which can be assessed against observed practice. In theory, confidence gained through such an approach can create momentum for additional rules and restrictions.

Although outer space is remote, many behaviours and activities in this domain can be observed using existing procedures and technical capabilities such as space situational awareness (SSA). But there are limits. The physical capabilities of objects in space are more difficult to observe. So are many terrestrial weapons-related processes, including research and development, production, and even stockpiling.[101] Non-kinetic activities such as cyber intrusions and electronic warfare can be difficult to detect and attribute, and thus to monitor and verify.[102]

Space activities need to be more observable. This can be achieved by adopting TCBMs, such

98 Chemical Weapons Convention, Organization for the Prohibition of Chemical Weapons, https://www.opcw.org/chemical-weapons-convention.

99 Comprehensive Nuclear Test-Ban Treaty Organization, "Overview of the Verification Regime," https://www.ctbto.org/verification-regime/background/overview-of-the-verification-regime.

100 International Atomic Energy Agency, "IAEA Safeguards Overview," https://www.iaea.org/publications/factsheets/iaea-safeguards-overview.

101 Trevor Findlay, "Verification of the Ottawa Convention: Workable Hybrid or Fatal Compromise?" *Disarmament Forum* 1999, no. 4: 45–55.

102 Rajeswari Pillai Rajagopalan, "Electronic and Cyber Warfare in Outer Space," Space Dossier (UNIDIR, 2019).

as pre-notifications, more ambitious registration practices, information exchanges, and national reporting. Many such measures were identified in the 2013 consensus report by the GGE on TCBMs for outer space.[103] Importantly, these recommendations include transparency of policies, priorities, and doctrines, which contextualize observed space activities.

Technical measures that directly aid in the observability of space activities can also be adopted. For example, satellites could forgo stealth materials and measures that make them more difficult to track and less safe to operate. Radiofrequency beacons and unencrypted telemetry would also contribute to observability and verification. Another approach would be to adopt different, observable designs for different satellite functions. While such measures could raise security alarms, they should be pursued in the context of efforts to demonstrate and verify peaceful uses of space.

Expanding the scope of verification beyond national technical capabilities through better data sharing would also enhance observability. While the creation of an independent monitoring capability for outer space might not be feasible in the short term, greater efforts should be made to both share and increase accessibility to orbital data that can be used to monitor activities in outer space. Although this is not low-hanging fruit – workshop participants emphasized the national, military nature of current space situational awareness data – expanded access and sharing will allow greater objectivity in assessing compliance.

It is not just orbital data that is relevant to compliance. Also important are space-related capabilities and activities that range from registration to notifications, as well as non-physical activities such as cyber and radiofrequency interference. Efforts to both share and provide greater accessibility to such data can make even non-physical space activities more observable.

A focus on transparency and observability indicates the need for cooperation and effective tools and mechanisms that facilitate the ability to share and access information.

Compliance requires layers of measures and cooperation.

Verification is often framed in an adversarial way, with a focus on detecting cheating.[104] But arms control also depends on cooperative measures that facilitate both the demonstration and verification of implementation. Verifying the peaceful use of capabilities[105] is particularly important with dual-purpose capabilities and activities. Also valuable are the means to cope with possible violations.[106] With respect to the BWC, Nicholas Sims has described an ideal

103 United Nations Secretary-General, "Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities: Note by the Secretary-General," A/68/189 (2013), https://digitallibrary.un.org/record/755155?ln=en.

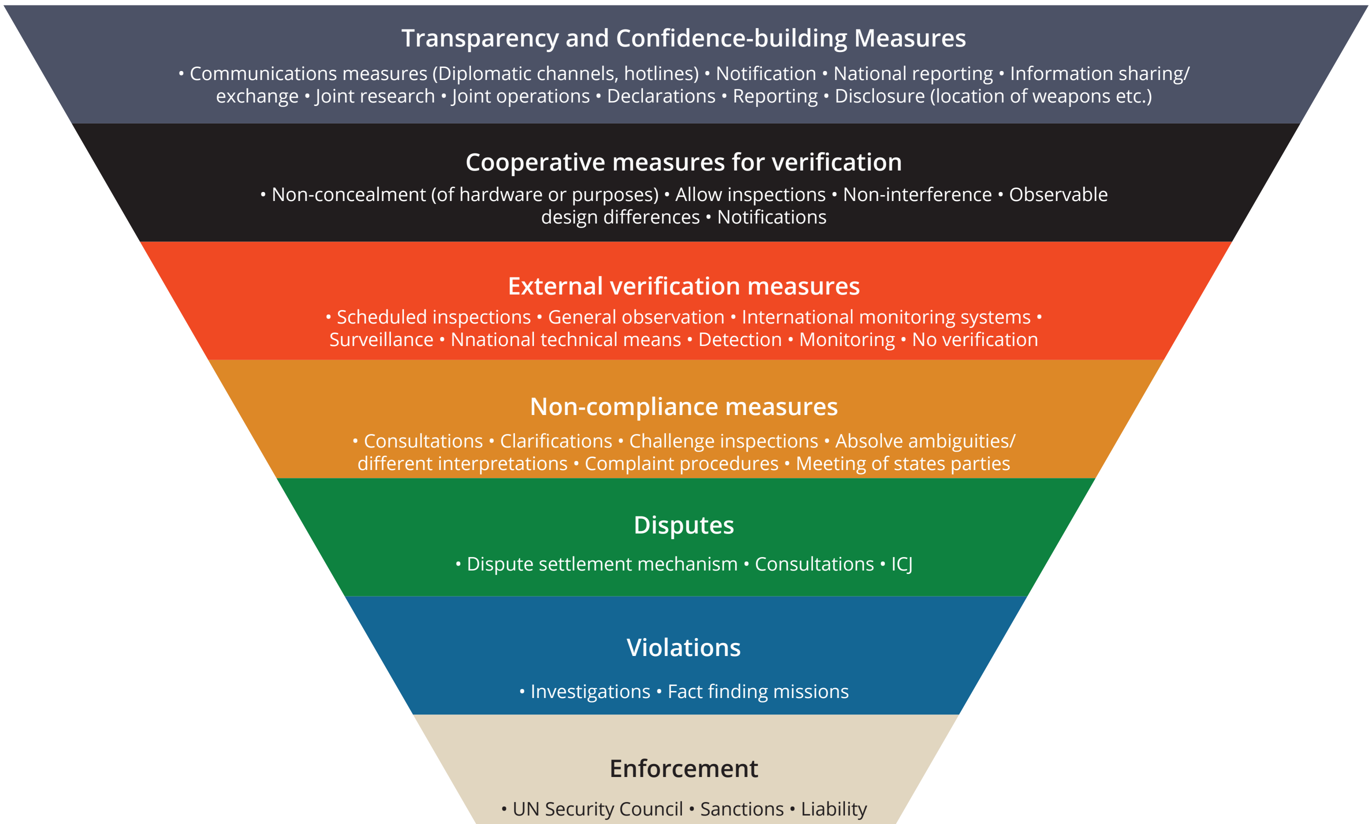
104 Brad Roberts, "Revisiting Fred Iklé's 1961 Question, 'After Detection – What?'" *The Nonproliferation Review* (2001): 15.

105 Lyne C. Klotz, "The Biological Weapons Convention Protocol should be Revisited," *Bulletin of Atomic Scientists* (November 15, 2019), https://thebulletin.org/2019/11/the-biological-weapons-convention-protocol-should-be-revisited.

106 Brad Roberts, "Revisiting Fred Iklé's 1961 Question, 'After Detection – What?'" *The Nonproliferation Review* (2001): 15.

approach to compliance as a series of "layers,"[107] which Phillip Lentzos sees as a combination of legally binding and voluntary measures.[108] Our own findings from the coding exercise of existing arms control agreements reinforce this emphasis on layers.

Figure 12: Approaches to compliance identified in content coding of arms control agreements



Placing verification in the broader context of compliance highlights the role of cooperation in efforts to facilitate technical approaches to verification and differentiation of dual-use capabilities. Some of the cooperative measures identified in our coding exercise are:

- Non-interference with national technical means of verification
- Not camouflaging or otherwise obstructing the ability of others to observe capabilities

107 Nicholas A. Sims, *The Evolution of Biological Disarmament*, SIPRI Chemical & Biological Warfare Studies 19 (Oxford, New York: Oxford University Press, 2001).

108 Filippa Lentzos, "Compliance and Enforcement in the Biological Weapons Regime," The United Nations Institute for Disarmament Research (December 5, 2019), https://doi.org/10.37559/WMD/19/WMDCE4.

- Using observable design differences to differentiate capabilities
- Using different storage facilities and launch vehicles to help distinguish capabilities
- Commitments to allow access to inspectors or fact-finding missions.

Cooperative measures that facilitate verification and compliance include, of course, the employment of TCBMs.[109] A state makes sure that other states understand its actions and intentions. Workshop participants noted that the Vienna Document developed by the Organization for Security and Co-operation in Europe (OSCE) is an example of non-binding security arrangements designed to facilitate military transparency in the context of arms restrictions.[110] Commitments include:

- Information exchange
- Notifications
- Acceptance of inspections
- Mutual observation
- Consultation.

Importantly, such cooperative measures can be performed prior to, or in the absence of, formal arms control verification. For example, in 1986, parties to the BWC agreed to measures that reduced the level of secrecy of biological facilities and activities, and demonstrated peacefulness through information sharing, publication of relevant research results, and promoting contacts among scientists. And, in the absence of formal arms control, TCBMs related to cyberspace are being pursed as a step toward more formalized arms control measures; measures such as establishing hotlines and transparent military actions are designed to indicate nonaggressiveness.[111]

However, TCBMs alone – particularly if they are voluntary – will not be enough to ensure compliance. For example, participation in the BWC and in measures to govern cyberspace has been poor, with few consequences in either case.[112] Layers of measures are needed to facilitate arms control compliance; they should include cooperation in implementation, disputes, and responding to non-compliance.

The Mine Ban Treaty exemplifies the cooperative approach that marks humanitarian agreements. With no formal verification mechanism, it encourages States Parties to work cooperatively to meet obligations, providing technical and other assistance when needed.[113]

109 Johan Jǿrgen Holst, "Confidence-building Measures a Conceptual Framework," *Survival* 25, no. 1 (January 1, 1983): 2–15, https://doi.org/10.1080/00396338308442072; Marie Isabelle Chevrier and Iris Hunger, "Confidence-building Measures for the BTWC: Performance and Potential," *The Nonproliferation Review* 7, no. 3 (September 2000): 24–42, https://doi.org/10.1080/10736700008436823.

110 Organization for Security and Co-operation in Europe, "Ensuring Military Transparency: The Vienna Document," https://www.osce.org/fsc/74528.

111 Erica D. Borghard and Shawn W. Lonergan, "Confidence Building Measures for the Cyber Domain," *Strategic Studies Quarterly* 12, no. 3 (2018): 10–49.

112 Marie Isabelle Chevrier and Iris Hunger, "Confidence-building Measures for the BTWC: Performance and Potential," *The Nonproliferation Review* 7, no. 3 (September 2000): 24–42, https://doi.org/10.1080/10736700008436823.

113 Bonnie Docherty, "Ending Civilian Suffering: The Purpose, Provisions, and Promise of Humanitarian Dis-

Fact-finding missions are allowed only when a majority of States Parties agree to them.[114]

While some form of technical verification is necessary to progress with arms control and other military restraints related to outer space activities, various layers of measures are also important to facilitate broader confidence in and capabilities for implementation and compliance.

Norms are an essential component of compliance.

Many of the measures outlined here are closely linked to the development and implementation of norms of behaviour, which are essential in establishing trust in verification and implementation.

Norms support transparency and communication, mitigate misperception, and stabilize strategic relationships and interactions; norms encourage efforts to make activities and capabilities more observable.[115]

The workshops revealed that norms of behaviour are essential because they establish regular, baseline behaviour and at least partially bridge the interpretation gap associated with technical means of verification. A common understanding of what constitutes a threat and what constitutes normal or reassuring behaviour provides an essential basis for interpreting specific activities or the use of specific types of capabilities.

It is necessary to plan for non-compliance and disputes on the margins.

It is not possible to design an agreement in a way that guarantees universal compliance.[116] There will be disputes and episodes of non-compliance. Therefore, it is important to consider in advance how non-compliance will be viewed and managed.

The best responses will feature cooperation and will not treat non-compliance as an automatic deal-breaker. In multilateral agreements, a violation by one party does not nullify the agreement, and responsibility for implementation and assessment of compliance is shared by all parties. Protocols will be established on how perceived violations are to be investigated or discussed, on possible repercussions of determined violations, and on how disputes over compliance are to be resolved.

A satisfactory resolution to an instance of noncompliance must be based on previously established and agreed-to definitions of compliance and non-compliance, as well as a universally accepted standard of evidence.[117] As well, any resolution must be seen to be impartial,

---

armament Law," *Austrian Review of International and European Law Online* 15, no. 1 (2013): 7–44, https://doi.org/10.1163/15736512-90000064.

114 Trevor Findlay, "Verification of the Ottawa Convention: Workable Hybrid or Fatal Compromise?" *Disarmament Forum* 1999, no. 4: 45–55.

115 Erica D. Borghard and Shawn W. Lonergan, "Confidence Building Measures for the Cyber Domain," *Strategic Studies Quarterly* 12, no. 3 (2018): 10–49.

116 Brad Roberts, "Revisiting Fred Iklé's 1961 Question, 'After Detection – What?'" *The Nonproliferation Review* (2001): 15.

117 Michael Moodie and Amy Sands, "Introduction," *The Nonproliferation Review* 8, no. 1 (March 2001): 1–9, https://doi.org/10.1080/10736700108436834.

as with the CWC forum.[118] Workshop participants emphasized the value of norms in establishing what counts as acceptable behaviour and what doesn't. Again, these norms provide common ground or context for interpreting the meaning and intent of both military activities and the use of specific technical capabilities.

Communication is key to managing disputes. Means and mechanisms for consultation and clarification are commonly used (see Institutionalization below). These can be both formal, as with the CWC, or informal. As noted during the workshops, annual meetings of the non-binding Incidents at Sea Agreement were held to discuss and compare notes on any activities that either party deemed threatening or hostile.

A clear process and mechanisms to respond to non-compliance can ensure a consistent response and mitigate some politically driven elements. For example, along with a rigorous verification mechanism, the CWC has a detailed process to address non-compliance. Although adherence to the treaty is not perfect, it remains very strong. The weakness lies in the absence of a means to hold violators accountable.[119]

Workshop participants wanted clear consequences for noncompliance, ranging from cooperative efforts that name and shame to robust international enforcement mechanisms that could involve arbitration.

Private sector and civil society actors provide key resources to support compliance.

The private sector develops and uses many new and advanced capabilities, some of which also have military and security-related applications. This sector must be involved in cooperative TCBMs as well as verification and compliance measures and the building of norms.[120] The CWC offers a model of how to do this.

Although industry is not a formal party to the CWC, the agreement expresses the desire of States Parties "to promote free trade in chemicals as well as international cooperation and exchange of scientific and technical information in the field of chemical activities for purposes not prohibited under this Convention in order to enhance the economic and technological development of all States Parties."[121] Moreover, in light of industry concerns about the cost of compliance, inspections, loss of confidential business information, and possible shutdowns, industry stakeholders were regularly consulted on the verification regime and inspection process. This care is reflected in key provisions for "managed access" and the "confidentiality annex" that limit inspections by the Organisation for the Prohibition of Chemical Weapons

118 A. Walter Dorn and Douglas S. Scott, "Compliance Mechanisms for Disarmament Treaties," *Verification Yearbook 2000*, Verification Research, Training and Information Centre (London, 2000): 229-247.

119 Organisation for the Prohibition of Chemical Weapons, "CWC Conference of the States Parties Adopts Decision Addressing the Threat from Chemical Weapons Use" (June 18, 2018), https://www.opcw.org/media-centre/news/2018/06/cwc-conference-states-parties-adopts-decision-addressing-threat-chemical; United Nations Security Council, "Impunity in Use of Chemical Weapons Must Not Be Tolerated, High Representative for Disarmament Affairs Underlines, Briefing Security Council on Syria," Press Release (February 3, 2021), https://www.un.org/press/en/2021/sc14429.doc.htm.

120 Erica D. Borghard and Shawn W. Lonergan, "Confidence Building Measures for the Cyber Domain," *Strategic Studies Quarterly* 12, no. 3 (2018): 10–49.

121 Chemical Weapons Convention, https://www.opcw.org/sites/default/files/documents/CWC/CWC_en.pdf.

(OPCW) and protect classified information.[122]

As the BWC continues to struggle to achieve a more robust verification and compliance regime, there is a growing recognition that the private sector, which includes significant pharmaceutical and research organizations, should be involved.[123]

Civil society is also necessary for the successful implementation of arms control agreements. This sector, experienced in dealing with national stakeholders and UN bodies, provides activities and resources that promote socialization, universalization, and capacity building, which all contribute to the cooperative implementation of obligations.[124]

As well, civil society provides resources and public information that are critical for monitoring compliance. One stellar example is the Landmine and Cluster Munitions Monitor, the research and monitoring arm of the International Campaign to Ban Landmines and the Cluster Munition Coalition. It provides information on, and assessments of, international activities on these munitions. Another example is the Arms Trade Treaty Monitor, which tracks implementation of, and compliance with, the ATT, using open-source intelligence, among other sources.[125] Although no longer active, the *Bioweapons Monitor,* a publication of the civil society network BioWeapons Prevention Project, monitored compliance with the international norm against the use of bioweapons and held governments accountable for their obligations to eliminate biological weapons permanently.[126] The Cyber Policy Portal of the UN Institute for Disarmament Research is yet another example of a non-state confidence-building tool to promote greater transparency and involvement in cyber governance.[127]

Although not focused on arms control compliance, civil society publications such as the Space Security Index annual volumes (no longer published) and continuing annual counterspace reports by the Secure World Foundation and the Center for Strategic and International Studies provide important open-source information on space activities and capabilities.

So, too, do the growing array of private-sector SSA services. All these actors can strengthen implementation of, and compliance with, agreed rules and restrictions in outer space – if they are provided with appropriate resources and support.

---

122 Emily Standfield, "Lessons from the Chemical Weapons Convention," *Ploughshares Monitor*, September 13, 2021, https://ploughshares.ca/2021/09/lessons-from-the-chemical-weapons-convention.

123 Henrietta Wilson, "Verification of the Biological Weapons Convention," *Trust & Verify* (February 2000), http://www.vertic.org/media/assets/TV/TV89.pdf.

124 United Nations Security Council, "Impunity in Use of Chemical Weapons Must Not Be Tolerated, High Representative for Disarmament Affairs Underlines, Briefing Security Council on Syria," Press release (February 3, 2021), https://press.un.org/en/2021/sc14429.doc.htm; Control Arms, "The Role of Civil Society in Supporting ATT Universalization" (February 5, 2020), https://controlarms.org/wp-content/uploads/2020/02/05-feb-2020-The-role-of-civil-society-in-supporting-ATT-universalization.pdf.

125 Kelsey L. Hartigan and Corey Hinderstein, "The Opportunities and Limits of Societal Verification," Nuclear Threat Initiative (July 2013), https://media.nti.org/pdfs/The_Opportunities_and_Limits_of_Societal_Verification.pdf; Melissa Hanham, "Using Open-Source Intelligence to Verify a Future Agreement With North Korea," Carnegie Endowment for International Peace (July 27, 2021), https://carnegieendowment.org/2021/07/27/using-open-source-intelligence-to-verify-future-agreement-with-north-korea-pub-85006.

126 BioWeapons Prevention Project, *BioWeapons Monitor* (2011), http://www.bwpp.org/documents/BWM%202011%20WEB.pdf.

127 UNIDIR, "Cyber Policy Portal," https://cyberpolicyportal.org/about.

IV. Tools, mechanisms, and institutions

Arms control agreements are political, but they involve technical objectives and obligations that in turn must be supported by an array of tools, mechanisms, and institutions.

The lack of institutionalization is a key challenge in implementing the Outer Space Treaty. Although the treaty calls for consultations and processes for due regard, it does not establish any mechanism to trigger meetings of states parties and few means to arrange and conduct them. To date, states have been reluctant to put some of the key principles of the OST into practice or to develop and implement norms.[128]

Lessons for outer space

Mechanisms for communication and data exchange must be prioritized.

Competent and impartial institutions are necessary to support implementation of arms control efforts.[129] Such institutions help to regularize and depoliticize implementation and monitoring of compliance and can assert authoritative judgement.[130]

The most robust international arms control agreements include significant organizational structures to facilitate and monitor implementation and respond to alleged instances of non-compliance. For example, the IAEA facilitates peaceful cooperation of states in the use of "safe, secure and peaceful nuclear technologies."[131] The CWC has more than one body involved in implementation; the OPCW is specifically mandated to implement the provisions of the CWC, while the Executive Council also deals with issues of compliance/non-compliance and the Technical Secretariat is responsible for on-site verification of CWC implementation. In contrast, the Mine Ban Treaty is seen to lack any organ such as a secretariat that "would give the treaty an institutional voice and create a multilateral vested interest in its effective verification"; processes such as requests for fact-finding are left up to member states.[132]

However, institutional measures can be expensive and burdensome. Member states must foot the bill for organizational structures and staffing, and some might find paying their share a serious challenge.[133] And, as the BWC illustrates, participation in mechanisms for re-

---

128 Jessica West and Gilles Doucet, *From Safety to Security: Mapping the Normative Landscape in Outer Space*, Project Report and Recommendations, Project Ploughshares (March 2021), https://ploughshares.ca/wp-content/uploads/2021/03/SpaceNormsMapandRecommendations.pdf.

129 United Nations Secretary-General, "Confidence-Building Measures Supporting Arms Control Extremely Critical, Secretary-General Tells Security Council Meeting on Non-proliferation," Press Release (January 18, 2018), https://www.un.org/press/en/2018/sgsm18858.doc.htm.

130 Walter Dorn and Douglas S. Scott, "Compliance Mechanisms for Disarmament Treaties," *Verification Yearbook 2000*, Verification Research, Training and Information Centre (London, 2000): 229-247.

131 International Atomic Energy Agency, "History," https://www.iaea.org/about/overview/history.

132 Trevor Findlay, "Verification of the Ottawa Convention: Workable Hybrid or Fatal Compromise?" *Disarmament Forum* 1999, no. 4: 45–55.

133 Paul Holtom and Mark Bromley, "Implementing an Arms Trade Treaty: Lessons on Reporting and Monitoring from Existing Mechanisms," SIPRI, Policy Paper 28 (July 2011), https://www.sipri.org/publications/2011/sipri-policy-papers/implementing-arms-trade-treaty-lessons-reporting-and-monitoring-existing-mechanisms.

porting and information exchange can be poor unless legally required.[134] Finally, some states still resist ceding assessments on their compliance to international bodies.[135]

But even with all these shortcomings – or perhaps because of them – tools and mechanisms that facilitate cooperation for arms control are essential. For example, the ATT provides a mechanism for regular reporting.[136] The Hague Code of Conduct requires members to exchange data, including pre-launch notifications of ballistic missile flights and space launches and annual declarations of policies on ballistic missiles and space launch vehicles, as well as annual meetings. Prominent bilateral arms control processes between the United States and the Soviet Union/Russia have included mechanisms to facilitate communication, such as the Washington-Moscow hotline established in 1963 at the height of the Cold War and the sharing of telemetric data from missile test flights.

Figure 13: Tools, mechanisms, and institutions identified in content coding of arms control agreements

Data	Communication	Institutional support	National mechanisms	International cooperation
• Data standardization • Data bank • Electronic database • Records • Registry • Data/report repository • Public data	• Points of contact • Hotlines • Meetings • Consultation mechanisms	• Assistance from non-state body • Secretariat • Meeting of states parties • External org to facilitate: » Notifications » Verification » Consultations » Data sharing/ exchange • Dispute resolution	• National regulation • State oversight • Licensing • National control system • Export controls • Reporting	• Cooperation in use/ development of tech • Technical assistance • Financial assistance • Capacity building

There is little institutional infrastructure to facilitate cooperative governance in outer space. Lacking are mechanisms that support the development, implementation, and monitoring of arms control agreements, including core tools and processes to support dialogue with others, exchange information, consult, and communicate at political and operational levels.

134 Marie Isabelle Chevrier and Iris Hunger, "Confidence-building Measures for the BTWC: Performance and Potential," *The Nonproliferation Review* 7, no. 3 (September 2000): 24–42, https://doi.org/10.1080/10736700008436823.

135 Walter Dorn and Douglas S. Scott, "Compliance Mechanisms for Disarmament Treaties," *Verification Yearbook 2000*, Verification Research, Training and Information Centre (London, 2000): 229-247.

136 Mark Bromley and José Francisco Alvarado Cóbar, *Reporting on Conventional Arms Transfers and Transfer Controls: Improving Coordination and Increasing Engagement*, SIPRI (August 2020), https://www.sipri.org/sites/default/files/2020-08/2007_reporting_on_conventional_arms.pdf.

> **The lack of institutionalization is a key challenge in implementing the Outer Space Treaty. Although the treaty calls for consultations and processes for due regard, it does not establish any mechanism to trigger meetings of states parties and few means to arrange and conduct them.**

There is both a need to make better use of existing mechanisms, such as the Registration Convention, and to create new mechanisms that prioritize communication, cooperation, and transparency practices. Many of these mechanisms could also support the development and implementation of norms and other governance measures.

Communication is necessary for both cooperation and coordination.[137] Both the workshop discussions and the concluding poll frequently cited the need for means and mechanisms to support engagement among states, such as ongoing dialogue, as well as the need for enhanced modes of private communication and consultation among states.

Also critical are the sharing and exchange of data, which help to build mutual confidence in the activities and behaviours of others. As well as facilitating monitoring, such mechanisms support a greater breadth of engagement and inclusion in arms control and other security-related processes. And, as demonstrated by the successful series of Cold War bilateral agreements, such cooperation and information can help to build momentum toward greater trust and more ambitious measures.

137 Elinor Ostrom, "Collective Action and the Evolution of Social Norms," *The Journal of Economic Perspectives* 14, no. 3 (2000): 137–58.

V. Processes

Procedural and political challenges have stalled substantive multilateral arms control discussions related to outer space for the last four decades. These challenges include:

- A lack of political will
- A lack of trust
- Competing preferences for a legally binding treaty or voluntary rules
- Asymmetric interests driven by competing strategic priorities
- Integration of space systems with weapons systems on Earth, including nuclear weapons systems and ballistic missile defence
- The growing diversity of stakeholders and interests.

Workshop discussions and the final poll overwhelmingly pointed to the first two as the biggest obstacles.

Figure 14: Workshop participants' ideas to overcome obstacles to arms control in space[138]

Ultimately, arms control is a political process that requires a political commitment by states. How do we get there?

138 Results from a poll of workshop participants conducted on April 12, 2022.

Lessons for outer space

It is not necessary to start with trust.

Lack of trust is frequently cited as a reason to prioritize TCBMs over arms control restrictions.[139] Yet the commonly held belief that arms control must flow from trust or good relations is incorrect. As workshop participants noted, we don't sign arms control agreements with allies.

Instead, successful arms control measures can build trust. Early arms control agreements between the United States and Soviet Union were struck in what was arguably a low-trust environment. SALT began with limited objectives and measures that were independently verified by each side. Early compliance helped to develop a greater level of trust and led to the more ambitious START, which required more intrusive verification measures, such as on-site inspections and exchange of telemetric data.

The process of arms control can also develop and build confidence in shared principles and goals/objectives (see above). During the Cold War, these goals included strategic stability and avoidance of armed conflict.[140]

Absolute distrust or disagreement about basic facts is, however, a clear impediment to reaching any arms control agreement[141] and is a growing challenge in our current environment of disinformation and competing narratives. Thus, it is important to begin any process of arms control or other military restraints by developing common understandings of basic facts, core concepts and principles, and material interests. While the following lessons can help, it is important to acknowledge the ongoing, iterative, and non-linear nature of these efforts, as well as the need for a robust and layered approach to verification and compliance.

It is important to build on a common understanding of existing law and agreements.

A consistent message from the workshops is that the best place to find the shared principles, norms, and interests that will inform arms control initiatives is existing governance frameworks that are currently inadequately used. Examples include the OST, which contains key principles such as peaceful purposes and due regard, concepts such as harmful interference, and mechanisms such as international consultation. Legal requirements under IHL that apply to armed conflict are also relevant.

Identifying and clarifying these principles and tools is a key goal of the UN OEWG on space threats.[142] Reports on the applicability of international law including the McGill Manual and

---

139 Jessica West and Almudena Azcárate Ortega, *Norms for Outer Space: A Small Step or a Giant Leap for Policy-making?* (Geneva, Switzerland: UNIDIR, 2021), https://www.unidir.org/publication/space_dossier_7_norms_outer_space.

140 Jon Brook Wolfsthal, "Why Arms Control?" *Daedalus* 149, no. 2 (April 2020): 101–15, https://doi.org/10.1162/daed_a_01792.

141 Sarah Jacobs Gamberini, "(Dis)Trust and Verify?: Arms Control in Today's (Dis)Information Environment Part I," Center for the Study of Weapons of Mass Destruction, May 11, 2021, https://wmdcenter.ndu.edu/Publications/Publication-View/Article/2603426/distrust-and-verify-arms-control-in-todays-disinformation-environment-part-i.

142 Open-Ended Working Group on Reducing Space Threats, United Nations Office of Disarmament Affairs,

the Woomera Manual will also help in this task.[143]

Momentum for enhanced security measures in outer space can also build on existing safety and sustainability initiatives, including the long-term sustainability guidelines and debris mitigation guidelines, as well as on emerging operational safety protocols when servicing commercial satellites and removing debris (see an earlier study of security-related norms for outer space[144]).

It is also possible to build on the interests and tenets of non-security agreements, as demonstrated by a moratorium on the testing of direct-ascent kinetic anti-satellite weapons led by the Untied States and since joined by Canada, which applies existing debris mitigation imperatives to a security context.[145] These less controversial arrangements, which benefit all parties, can open the door to arms control.

There are creative ways to think about material benefits.

Research indicates that people support arms control because they believe that all sides experience material benefits.[146] But what should be done when there are several camps with seemingly opposed priorities? One camp wants a ban on weapons capabilities in outer space. Another wants to focus on ground-based and other threats to space systems. Then there are states that currently have few space-based capabilities but want to ensure that when they are ready to expand their use of space for peaceful purposes, access will still be possible. A new approach is needed to bring all these groups together. Workshop discussions emphasized incentives to participate in arms control. Agreements in other domains offer insights into what these might be.

A key driver of arms control is the belief that the material benefits of an agreement outweigh its costs and trade-offs.[147] And while it is true that all parties will benefit from a successful agreement, it is not true that all must share equally. Agreements can be structured to meet various interests. For example, the 1972 SALT I agreement exchanged limits on strategic missiles for limits on missile defence systems (the preceding ABM Treaty), while the 1991 START I agreement included reductions in heavy missiles along with limits on air-

---

https://meetings.unoda.org/meeting/oewg-space-2022.

143 Ram Jahku and Steven Freeland, eds, *McGill Manual of International Law Applicable to Military Uses of Outer Space, Volume I – Rules,* McGill University (2022), https://www.mcgill.ca/iasl/files/iasl/mcgill_manual_volume_i_-_rules.pdf; *The Woomera Manual on the International Law of Military Space Activities and Operations,* Forthcoming, https://law.adelaide.edu.au/woomera.

144 Jessica West and Gilles Doucet, *From Safety to Security: Mapping the Normative Landscape in Outer Space*, Project Report and Recommendations, Project Ploughshares (March 2021), https://ploughshares.ca/wp-content/uploads/2021/03/SpaceNormsMapandRecommendations.pdf.

145 Theresa Hitchens, "US Pledges No Destructive ASAT Missile Tests, Urges International Norm," *Breaking Defense* (blog), April 19, 2022, https://breakingdefense.sites.breakingmedia.com/2022/04/us-pledges-no-destructive-asat-missile-tests-urges-international-norm.

146 Sarah Jacobs Gamberini, "(Dis)Trust and Verify?: Arms Control in Today's (Dis)Information Environment Part I," Center for the Study of Weapons of Mass Destruction, May 11, 2021, https://wmdcenter.ndu.edu/Publications/Publication-View/Article/2603426/distrust-and-verify-arms-control-in-todays-disinformation-environment-part-i; Allan S. Krass, "Verification and Trust in Arms Control," *Journal of Peace Research* 22, no. 4 (1985): 285–88.

147 Naomi Egel and Jane Vaynman, "Reconsidering Arms Control Orthodoxy," War on the Rocks, March 26, 2021, https://warontherocks.com/2021/03/reconsidering-arms-control-orthodoxy.

Lack of trust is frequently cited as a reason to prioritize TCBMs over arms control restrictions. Yet the commonly held belief that arms control must flow from trust or good relations is incorrect. As workshop participants noted, we don't sign arms control agreements with allies.

and-sea-launched cruise missiles.

Multilateral agreements introduce a greater range of possible obligations and benefits.[148] Material incentives can include locking in existing conditions – for example, through non-proliferation – and reducing the impact of war and weapons on civilians. For example, the NPT provides access to technology in exchange for a commitment to peaceful use. Other possible benefits are an information exchange on capabilities or policies, data sharing, and transparency mechanisms associated with implementation. For example, OSCE member states adopted the Vienna Document 2011 on Confidence-and Security-Building Measures (VD11), which provides for annual exchanges of military information.

Asymmetric interests are common in outer space, where capabilities are often closely connected with anti-ballistic missile defence, nuclear deterrence, and cyber operations. Such interests could be met by establishing obligations that cover capabilities from more than one domain. This admittedly rare option was examined during INF negotiations; a Soviet proposal to include unilateral cuts to conventional weapons in exchange for nuclear reductions was ultimately abandoned. Such an approach could be effective now in limiting the harmful effects of emerging technologies, which frequently operate in multiple domains.[149]

It is sometimes possible to find a common interest in restrictions or bans by identifying unacceptable dangers, such as interference with nuclear command-and-control capabilities

148 Ibid.

149 Heather Williams, "Asymmetric Arms Control and Strategic Stability: Scenarios for Limiting Hypersonic Glide Vehicles," *Journal of Strategic Studies* 42, no. 6 (September 19, 2019): 789–813, https://doi.org/10.1080/01402390.2019.1627521; Jack Snyder, "Limiting Offensive Conventional Forces: Soviet Proposals and Western Options," *International Security* 12, no. 4 (1988): 48–77, https://doi.org/10.2307/2538994.

or critical civilian infrastructure. Another approach is to identify the costs associated with specific weapons systems or by establishing that such systems offer no material benefits to any party.[150] Biological weapons and blinding lasers have been banned, in part because they were viewed at the time of the ban as unusable for military purposes.[151] Using nuclear weapons in space would harm all parties with space assets, while providing no strategic benefit; on these grounds, the use of such weapons has long been banned in outer space. The use of kinetic anti-satellite weapons, which create long-lasting clouds of debris that could damage all space assets, might be restricted using this approach.

This focus on behaviour rather than hardware can both lower the cost of arms control and mitigate some of the perceived national security risks associated with military restrictions. Rules of behaviour can incorporate cross-domain elements and create greater stability, transparency, trust, and confidence, which can nurture more ambitious future agreements. It remains true, however, that broad technical and political engagement to build consensus are essential.

Leaders must act from a position of ongoing, inclusive engagement.

Workshop participants rated the lack of political will as the single most important obstacle to arms control in outer space. States must step up and provide political leadership and commit to inclusion and engagement, so that arms control processes are open to all interested stakeholders.

The will to pursue arms control is often encouraged by international crises or campaigns. The reality of imminent disaster, as with the Cuban missile crisis, spurred on bilateral arms control agreements during the Cold War.[152] In recent times, humanitarian arms control has been largely driven by campaigns sponsored by international civil society, even in the face of opposition from major powers.[153]

But strong political leadership from state champions, particularly middle powers, is still a critical factor in moving from an international campaign to a formal political process. This truth is revealed in the Mine Ban Treaty, the Convention on Cluster Munitions, the Arms Trade Treaty, and, most recently, the Treaty on the Prohibition of Nuclear Weapons. The International Network on Explosive Weapons (INEW) is partnering with Ireland to restrict

150 Rebecca Crootof, "Why the Prohibition on Permanently Blinding Lasers Is Poor Precedent for a Ban on Autonomous Weapon Systems," Lawfare, November 24, 2015, https://www.lawfareblog.com/why-prohibition-permanently-blinding-lasers-poor-precedent-ban-autonomous-weapon-systems.

151 Elvira Rosert and Frank Sauer, "How (Not) to Stop the Killer Robots: A Comparative Analysis of Humanitarian Disarmament Campaign Strategies," *Contemporary Security Policy* 42, no. 1 (January 2, 2021): 4–29, https://doi.org/10.1080/13523260.2020.1771508.

152 C. Lalengkima, "The Role of Crises in the Arms Control Process: A Lesson for India and Pakistan," *World Affairs: The Journal of International Issues* 17, no. 1 (2013): 108–23.

153 Elvira Rosert and Frank Sauer, "How (Not) to Stop the Killer Robots: A Comparative Analysis of Humanitarian Disarmament Campaign Strategies," *Contemporary Security Policy* 42, no. 1 (January 2, 2021): 4–29, https://doi.org/10.1080/13523260.2020.1771508; Adam Bower, "Norms Without the Great Powers: International Law, Nested Social Structures, and the Ban on Antipersonnel Mines," *International Studies Review* 17, no. 3 (September 1, 2015): 347–73, https://doi.org/10.1111/misr.12225; Richard Price, "Reversing the Gun Sights: Transnational Civil Society Targets Land Mines," *International Organization* 52, no. 3 (1998): 613–44, https://doi.org/10.1162/002081898550671.

the use of explosive weapons in populated areas. In cooperation with the Stop Killer Robots coalition, states from the Global South are currently championing a treaty on lethal autonomous weapons, emphasizing the negative consequences of these weapons on developing countries and countries already suffering from armed violence.[154]

Unilateral state action can also provoke multilateral agreements. For example, prior to the negotiation of the BWC in 1971, the United States formally renounced the development, production, and stockpiling of biological weapons independently of a successful future treaty.[155] The U.S. unilateral moratorium on the destructive tests of direct-ascent ASAT weapons is another relevant example. Such unilateral declarations inspired many bilateral efforts at arms reductions between the United States and Soviet Union; not all were immediately successful, but they kept the idea of progress alive.[156]

However, while such efforts can create much needed political windows, they are not sufficient to develop broad support as well as the processes, tools, and mechanisms for implementation, all of which require engagement. Such engagement might begin with likeminded states but must at some point include opponents.

Arms control is essentially a cooperative approach to managing security relations among potential competitors and adversaries, based on mutual interests and benefits. Workshop participants consistently emphasized the need to develop common understandings of the security-related problems to be solved in outer space as well as solutions based on mutual benefits and interests. One way to do this, the participants prescribed, is to maintain ongoing dialogue in as many fora as possible, including unofficial, track-2, and track-1.5 discussions among civil society and academic experts.

This approach requires engagement and inclusion. Or rather, it requires engaged inclusion. Among other factors, inclusion means more women need to actively participate in arms control in outer space. UN Security Council Resolution 1325 urges states to "ensure increased representation of women" in all decision-making processes related to peace and conflict.[157] The inclusion of women and gender considerations in arms control agreements makes these agreements more legitimate, effective, and sustainable.[158]

Participation by civil society organizations is also critical, for both negotiations and implementation.[159] Finally, industry must not be overlooked. Much dual-purpose technology is de-

---

154 Ingvild Bode, "Norm-making and the Global South: Attempts to Regulate Lethal Autonomous Weapons Systems," *Global Policy* 10, no. 3 (September 2019): 359–64, https://doi.org/10.1111/1758-5899.12684.

155 Jozef Goldblat, "The Biological Weapons Convention–An Overview," *International Review of the Red Cross,* 37(318) (1997), 251–65, https://www.icrc.org/en/doc/resources/documents/article/other/57jnpa.htm.

156 William M. Rose, "Single-Shot, Conditional Unilateral Arms Control Initiatives: Lessons from Six Cases," *The Fletcher Forum of World Affairs* 16, no. 1 (1992): 99–113.

157 United Nations Security Council, Resolution 1325 (2000), http://unscr.com/en/resolutions/doc/1325.

158 International Gender Champions Disarmament Impact Group, "Gender and Disarmament Resource Pack for Multilateral Practitioners," UNIDIR (May 2022), https://unidir.org/publication/gender-disarmament-resource-pack.

159 Robert Perkins, "Civil Society Remains Vital to Success of Arms Control Processes," United Nations Association UK, https://una.org.uk/7-civil-society-remains-vital-success-arms-control-processes; J. Arthur Boutellis, "The Changing Role of Conventional Arms Control in Preventing and Managing Violent Conflicts," UNIDIR (2018), https://unidir.org/files/publications/pdfs/-en-725.pdf.

veloped by the private sector,[160] which must be engaged and on board to implement useful rules and restraints.

Small, incremental changes can be valuable.

Workshop participants believed that current outer space arms control discussions are too broad and would benefit from a narrow focus on one or two initiatives, which could begin with the political support of a small group of actors. This approach, which fits into the history of incremental arms control, makes it more feasible to develop common interests and can help to provide a sufficiently specific scope as well as the means and mechanisms for implementation and verification.

Landmark treaties, such as those banning landmines and chemical and biological weapons, might seem dramatic but are often preceded by a long process of incremental change. Both the Biological Weapons Convention and the Chemical Weapons Convention are outcomes of earlier attempts to ban the use of such weapons under the 1925 Geneva Protocol. The CWC process took 25 years to reach a successful conclusion. Banning landmines also took decades, beginning with a series of rules related to mine clearing in the Geneva Conventions.

Progress doesn't have to be linear. Efforts to support both hardware and operational restrictions can be supported by developing mechanisms for enhanced transparency and data sharing or channels of communication, for example. The current effort to develop norms of behaviour at the UN OEWG on space threats can evolve into numerous additional initiatives that lay out both implementation measures and more stringent restrictions.

160 Kara Frederick, "The Civilian Private Sector: Part of a New Arms Control Regime?" ORF, November 6, 2019, https://www.orfonline.org/expert-speak/the-civilian-private-sector-part-of-a-new-arms-control-regime-57345.

Conclusion: a governance approach to arms control

While there are many lessons from previous arms control experiences that can be applied to the current context in outer space, they must be adapted to new challenges: we must both learn and reinvent.

One of the biggest adaptations required is rethinking our approach to arms control.

Going forward, ***arms control for outer space must be about function not form.*** The most significant takeaway from this study is an understanding that arms control is not any one approach or agreement. Instead, it consists of a constellation of norms, rules, and restrictions, as well as a range of both formal and informal agreements, mechanisms for implementation and compliance, means for communication and consultation to nurture common understandings, and even external organizations. In other words, arms control involves a regime of moving parts, or what Peter van Ham calls a security ecosystem.[161]

No single tool can provide adequate security. What is needed is a broad, multilayered governance process that may include treaties, but could also rely on non-legally binding instruments, as well as innovative mechanisms and processes for implementation.

Norms are at the heart of this approach. Although our initial intention with this study was to identify pathways that began with norms but ended with more formal arms control agreements, we came to understand that norms and arms control go hand in hand. Norms and principles provide a basis for mutual restraint through shared values and objectives. Rather than moving beyond norms, the pursuit of more robust arms control is better conceptualized as an effort to clarify, deepen, and institutionalize the values, behaviours, processes, and mutual obligations that maintain peace and keep space free of weapons and warfighting.

Specifically, by creating a shared understanding of appropriate, routine behaviours, norms

- provide an essential link between hardware restrictions and operational approaches to arms control
- mitigate perceived risks posed by restrictions on dual-use and multi-purpose technical capabilities
- facilitate confidence in compliance by mitigating miscommunication, misinterpretation, and misperception
- aid in assessment and judgement of compliance.

And, at the current moment, norms present a critical point of much needed political engagement.

The current arms control regime has many gaps that must be filled by layers of rules, restraints, and confidence-building tools and institutions. This process must be one that is iterative and dynamic. The key to progress is taking the opportunities to fill gaps whenever possible, as part of an ongoing, positive momentum toward long-term peace and security in outer space.

161 Peter van Ham, "Arms Control and Regimes," *Strategic Monitor* (2018-2019), https://www.clingendael.org/pub/2018/strategic-monitor-2018-2019/arms-control-and-regimes.

Progress requires action across multiple tracks of engagement. There is no single end goal; the goal is not perfection but improvement. According to Martha Finnemore and Duncan Hollis, who have written about international cyber norms, the process is the product.[162] Arms control includes a host of interactive processes and mechanisms that range from political engagement, dialogue, and negotiation to implementation measures such as communication, consultation, and forums to review and discuss compliance. These processes – not just the agreements – give ongoing value to arms control. In a world in which formal arms control agreements are in decline, political engagement is more important than ever.[163]

GET STARTED

Ultimately, arms control is a process, and the diplomatic engagement that it entails, albeit slow and often frustrating for advocates, plays an important role in protecting civilians and reducing risk to global stability. Failed efforts and first steps should not be lamented but valued as steppingstones to the next advance. Many actors must take many steps to reach the goal: a broad and effective governance regime.

A persistent refrain from experts is the need to get started. Governments, civil society, academia, and the private sector must all prioritize and pursue engagement in arms control in outer space. Although the international community has long emphasized the need to prevent an arms race in outer space, the opportunity to maintain outer space as a peaceful domain is quickly slipping away as inaction reigns. We must grasp all opportunities to show that the world remains committed to the peaceful use of space, and find ways to halt and reverse the growing encroachment of warfighting and weapons in this shared and essential domain of human activity.

162 Martha Finnemore and Duncan B. Hollis, "Constructing Norms for Global Cybersecurity," *The American Journal of International Law* 110, no. 3 (2016): 425–79.

163 Nina Tannenwald, "Life beyond Arms Control: Moving toward a Global Regime of Nuclear Restraint & Responsibility," *Daedalus* 149, no. 2 (April 2020): 205–21, https://doi.org/10.1162/daed_a_01798.

Acronyms and abbreviations

ABM	Anti-Ballistic Missile
AI	Artificial Intelligence
ASAT	Anti-satellite
ATT	Arms Trade Treaty
BWC	Biological Weapons Convention
CCM	Convention on Cluster Munitions
COPUOS	Committee on the Peaceful Uses of Outer Space
CWC	Chemical Weapons Convention
EWIPA	Explosive weapons in populated areas
GGE	Group of Governmental Experts
IAEA	International Atomic Energy Agency
IHL	International humanitarian law
INEW	International Network on Explosive Weapons
INF	Intermediate-Range Nuclear Forces
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
OEWG	Open-Ended Working Group
OPCW	Organisation for the Prohibition of Chemical Weapons
OSCE	Organization for Security and Co-operation in Europe
OST	Outer Space Treaty
PAROS	Prevention of an arms race in outer space
PPWT	Treaty on the of Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force against Outer Space Objects
PTBT	Partial Test Ban Treaty
SALT	Strategic Arms Limitation Talks
SSA	Space situational awareness
START I	Strategic Arms Reduction Treaty
TCBM	Transparency and confidence-building measure
TPNW	Treaty on the Prohibition of Nuclear Weapons
UN	United Nations
UNITRACE	UN International Trajectography Centre

Annex: Arms control agreements examined for this report

(*=opened for signature/signed/adopted; †=entered into force)

African Nuclear Weapon Free Zone Treaty (Treaty of Pelindaba) 1996*, 2009†, https://treaties.unoda.org/t/pelindaba

Agreement between India and Pakistan on the Prohibition of Attack against Nuclear Installations and Facilities (India-Pakistan Non-Attack Agreement), 1998*, 2001†, https://www.nti.org/education-center/treaties-and-regimes/india-pakistan-non-attack-agreement

Agreement Between the Government of The United States of America and the Government of The Union of Soviet Socialist Republics on the Prevention of Incidents On and Over the High Seas (Incidents at Sea Agreement), 1972*†, https://2009-2017.state.gov/t/isn/4791.htm

Antarctic Treaty, 1959*, 1961†, https://www.ats.aq/index_e.html

Arms Trade Treaty (ATT), 2013*, 2014†, https://thearmstradetreaty.org/#

Central African Convention for the Control of Small Arms and Light Weapons, their Ammunition and all Parts and Components that can be used for their Manufacture, Repair and Assembly (Kinshasa Convention), 2010*, 2017†, https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXVI-7&chapter=26&clang=_en

Comprehensive Nuclear-Test-Ban Treaty (CTBT), 1996*, https://www.ctbto.org/our-mission/the-treaty

Convention on Cluster Munitions (CCM), 2008*, 2010†, https://www.clusterconvention.org

Convention on Nuclear Safety (CNS), 1994*, 1996†, https://www.iaea.org/topics/nuclear-safety-conventions/convention-nuclear-safety

Convention on Registration of Objects Launched into Outer Space (Launch Registration Convention), 1975*, 1976†, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introregistration-convention.html

Convention on the Physical Protection of Nuclear Material (CPPNM), 1979*, 1987†, https://www.iaea.org/publications/documents/conventions/convention-physical-protection-nuclear-material-and-its-amendment

Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (EMMOD), 1976*, 1978†, https://www.un.org/disarmament/enmod

Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction (Biological Weapons Convention [BWC] / conBiological and Toxin Weapons Convention [BTWC]), 1972*, 1975†, https://www.un.org/disarmament/biological-weapons

Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (Chemical Weapons Convention [CWC]), 1993*, 1997†, https://www.opcw.org/chemical-weapons-convention

Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction (Mine Ban Treaty / Ottawa Convention), 1997*, 1999†, https://www.apminebanconvention.org/en/the-convention

India-Pakistan Agreement on Chemical Weapons, 1992*, https://www.nti.org/education-center/treaties-and-regimes/india-pakistan-agreement-on-chemical-weapons

Inter-American Convention against the Illicit Manufacturing of and Trafficking in Firearms, Ammunition, Explosives, and Other Related Materials (CIFTA), 1997*, 1998†, https://www.oas.org/en/sla/dil/inter_american_treaties_A-63_illicit_manufacturing_trafficking_firearms_ammunition_explosives.asp

Inter-American Convention on Transparency in Conventional Weapons Acquisitions (CITAAC), 1999*, 2002†, https://www.oas.org/en/sla/dil/inter_american_treaties_A-64_transparency_conventional_weapons_adquisitions.asp

Interim Agreement Between the United States of America and the Union of Soviet Socialist Republics on Certain Measures with Respect to the Limitation of Strategic Offensive Arms (SALT I), 1972*†, https://nuke.fas.org/control/salt1/index.html

International Code of Conduct Against Ballistic Missile Proliferation (ICOC) / The Hague Code of Conduct (HCOC), 2002*, https://www.hcoc.at

International Convention for the Suppression of Acts of Nuclear Terrorism, 2005*, 2007†, https://treaties.un.org/pages/ViewDetailsIII.aspx?src=TREATY&mtdsg_no=XVIII-15&chapter=18&Temp=mtdsg3&clang=_en

Joint Comprehensive Plan of Action (Iran Nuclear Deal), 2015*, 2016†, https://www.consilium.europa.eu/en/policies/sanctions/iran/jcpoa-restrictive-measures

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, 1997*, 2001†, https://www.iaea.org/topics/nuclear-safety-conventions/joint-convention-safety-spent-fuel-management-and-safety-radioactive-waste

Joint Declaration of South and North Korea on The Denuclearization of The Korean Peninsula, 1992*, https://media.nti.org/documents/korea_denuclearization.pdf

Lahore Declaration, 1999*, https://peacemaker.un.org/sites/peacemaker.un.org/files/IN%20PK_990221_The%20Lahore%20Declaration.pdf

Law of Mongolia on its Nuclear-Weapon-Free Status, 1992*. 2000†, https://www.nti.org/wp-content/uploads/2021/09/law_of_mongolia.pdf

Mendoza Agreement, 1991*, https://www.nti.org/education-center/treaties-and-regimes/mendoza-agreement

Missile Technology Control Regime (MTCR), 1987*, https://mtcr.info

Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects (POA), 2001*†, https://www.un.org/disarmament/convarms/salw/programme-of-action

Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare (Geneva Protocol), 1925*, 1928†, https://www.un.org/disarmament/wmd/bio/1925-geneva-protocol

Six-Party Talks on North Korea's Nuclear Program, https://www.cfr.org/backgrounder/six-party-talks-north-koreas-nuclear-program

South Pacific Nuclear Free Zone Treaty (Treaty of Rarotonga), 1985*, 1986†, https://treaties.unoda.org/t/rarotonga

Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water (Partial Test Ban Treaty), 1963*†, https://treaties.un.org/pages/showDetails.aspx?objid=08000002801313d9

Treaty between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START Treaty), 2010*, 2011†, https://www.state.gov/new-start

Treaty Between the United States of America and the Russian Federation On Strategic Offensive Reductions (SORT / Treaty of Moscow), 2002*, 2003†, https://www.acq.osd.mil/asda/ssipm/sdc/tc/sort/index.html

Treaty Between The United States of America and The Union of Soviet Socialist Republics on Further Reduction and Limitation of Strategic Offensive Arms (START I), 1991*, 1994†, https://www.armscontrol.org/node/2493

Treaty Between The United States of America and The Union of Soviet Socialist Republics on the Elimination of their Intermediate-Range and Shorter-Range Missiles (INF Treaty), 1987*, 1988†, https://2009-2017.state.gov/t/avc/trty/102360.htm#text

Treaty Between The United States of America and The Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems (ABM Treaty), 1972*†, https://2009-2017.state.gov/t/avc/trty/101888.htm

Treaty Between The United States of America and The Union of Soviet Socialist Republics on the Limitation of Strategic Offensive Arms (SALT II), 1979*, https://2009-2017.state.gov/t/isn/5195.htm#treaty

Treaty Between The United States of America and The Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests (and Protocol Thereto) (TTBT), 1974*, 1990†, https://2009-2017.state.gov/t/isn/5204.htm

Treaty Between The United States of America and The Union of Soviet Socialist Republics on Underground Nuclear Explosions for Peaceful Purposes (and Protocol Thereto) (PNE Treaty), 1976*, 1990†, https://2009-2017.state.gov/t/isn/5182.htm

Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (Treaty of Tlatelolco), 1967*, https://treaties.unoda.org/t/tlatelolco

Treaty on a Nuclear-Weapon-Free Zone in Central Asia (CANWFZ), 2006*, 2009†, https://www.un.org/nwfz/content/treaty-nuclear-weapon-free-zone-central-asia

Treaty on Conventional Armed Forces in Europe (CFE), 1990*, 1992†, https://www.nti.org/education-center/treaties-and-regimes/treaty-conventional-armed-forces-europe-cfe

Treaty on Open Skies, 1992*, 2002†, https://www.osce.org/files/f/documents/1/5/14127.pdf

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (Outer Space Treaty), 1967*†, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html

Treaty on the Cessation of Production of Fissile Material for Use in Nuclear Weapons or Other Nuclear Explosive Devices (FMCT) (Proposed), https://www.armscontrol.org/factsheets/fmct

Treaty on the Non-Proliferation of Nuclear Weapons (NPT), 1968*, 1970†, https://www.un.org/disarmament/wmd/nuclear/npt

Treaty on the Prohibition of Nuclear Weapons (TPNW), 2017*, 2021†, https://www.un.org/disarmament/wmd/nuclear/tpnw

Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subsoil Thereof (Seabed Treaty), 1971*, 1972†, https://2009-2017.state.gov/t/isn/5187.htm

Treaty on the Southeast Asia Nuclear-Weapon-Free Zone (Bangkok Treaty), 1995*, 1997†, https://treaties.unoda.org/t/bangkok

Vienna Document 2011 on Confidence- and Security-Building Measures, https://www.osce.org/files/f/documents/a/4/86597.pdf

Ploughshares

Project Ploughshares is a Canadian peace research institute with a focus on disarmament efforts and international security, specifically related to the arms trade, emerging military and security technologies, nuclear weapons, and outer space.

For more information please visit: www.ploughshares.ca.