IAC-16-E3,4,12,x35460

SECURITY IN SPACE: CHALLENGES TO INTERNATIONAL COOPERATION AND OPTIONS FOR MOVING FORWARD

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Abstract

With outer space becoming increasingly congested, contested and competitive, greater attention is being placed on the long-term safety, security and sustainability of outer space activities. Promoting responsible behavior in outer space and building multilateral consensus on normative rules to ensure the sustainability of future space operations is of paramount importance not only for established space-faring nations, but also for newcomers. For many years, the European Union, individual states and organizations around the world have discussed how to conduct and communicate about space activities in order to enhance confidence and prevent mistrust. But progress has been intermittent, and further work is required.

Building on a study on space security by the European Union Institute for Security Studies (EUISS), the objective of this paper is three-fold. First, it examines the progress being made within multilateral *fora*, notably at the United Nations, with respect to space security. Particular attention is given to Russia and China's proposal for a Treaty on the Prevention of the Placement of Weapons in Outer Space, the Working Group on the Long-Term Sustainability of Outer Space Activities, the EU's diplomatic initiative on an International Code of Conduct for Outer Space Activities, and the UN Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities. Second, it analyses the main challenges to international cooperation for space security with particular regard to the aforementioned initiatives. Third, it offers a number of recommendations for moving forward to ensure that space will continue to be accessible and used for peaceful purposes and societal benefit.

This paper concludes that space-faring nations have been slow to adopt and implement voluntary guidelines, even those for which they have expressed support; that the primary challenges to international cooperation are diverging preferences on how to ensure sustainable space security, and concerns about potential limits on freedom of action in outer space; and that there has traditionally been a lack of shared values with respect to space security within the international community. In a more complex and connected world, no one state will be able to impose rules unilaterally or to act alone to ensure security in space. The pursuit of concrete initiatives for international cooperation, both multilaterally and bilaterally, can play a major role in reducing tensions, altering threat perceptions, facilitating shared activities, and preventing space from becoming a new area of conflict. Effective diplomacy can help create a community of stakeholders sharing common goals and interests with regard to the security and long-term sustainability of outer space.

Keywords: space security, long-term sustainability, international code of conduct, responsible behavior, TCBMs, arms control.

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1. Introduction

Space security involves the use of space for security purposes on earth (i.e. *security from space*) as well as the maintenance of outer space as a safe, sustainable, and stable environment (i.e. *security in space*). As the delivery of critical services from space assets requires the continuous availability of space assets themselves, security in space is increasingly important for security from space, as well as for a wide range of non-security applications. There is thus an alignment of interests between security communities and the wider public to pursue a space security discourse for preserving the stability and sustainability of the space environment, and ensuring freedom from threats to the effective access to, and use of, outer space.

With outer space becoming increasingly 'congested, competitive and contested'[1], preventing space from becoming a perilous minefield requires a wide range of tools. The international space community has been engaged in multiple activities to enhance international stability and ensure the security and sustainability of outer space activities. These have included the EU proposal for an International Code of Conduct for Outer Space Activities as well as initiatives at the United Nations to build multilateral consensus on norms of behavior, mechanisms for transparency and confidence-building, and guidelines for sustainable space activities. At the same time, space powers continue to develop the technical capabilities necessary to detect threats, attribute misconduct in space, and deter potential adversaries.

Against this background, this paper offers a description of the key features of today's changing space security environment, including a review of risks facing space systems. Then, it analyses the main multilateral activities to safeguard the use of outer space, and the major challenges to international cooperation for space security. Finally, it proposes a number of options for the international community to move forward in the area of security in space.

2. A changing space security environment

During much of the Cold War era, space security was primarily understood as relating to the military security of nation-states. As the two superpowers valued the secure and continued use of outer space for military purposes, they sought to regulate some aspects of space activities, prevent an arms race in space, and mitigate the risks associated with certain uses of outer space. This led to the development of international treaties to both regulate the use of outer space and increase international stability and security[ii].

Over the last 20 years, space activities have dramatically increased both in number and importance. Today, more than 1.400 operational satellites, owned or operated by some 60 countries and 20 organizations, provide a wealth of benefits for billions of people on Earth, to the extent that they are properly regarded as critical infrastructure. The traditional boundaries between the military and civilian space sectors have blurred. The armed forces are no longer the primary user of space applications. Commercial satellite operators provide a wide range of vital services, including to military users. New space actors offer low cost access to space, thereby changing the geostrategic space landscape and shaping international space policies.

However, this growing use of space comes with security concerns. The proliferation of space debris increases the likelihood of future collisions. Increased congestion of the most used orbits poses risks for the safety of space activities. Greater competition for limited resources such as orbital slots and radio frequency spectrum endanger space sustainability. All this has led to new conceptions of space security that not only focus on military matters, but also on how to reduce risks to all space assets and ensure that space operations can be safe, secure and sustainable in the long term [1]. While military space actors will continue to influence the space security discourse, for those actors without major military reliance on space, space security is primarily related to the absence of threats and hazards to space systems and the outer space environment.

3. Threats and hazards to space systems and services

With access to space providing significant strategic advantages and socio-economic benefits, outer space risks being exposed to additional competition and even conflict, with threats ranging from kinetic and energy anti-satellite weapons (ASAT), to hybrid warfare operations[iii].

Deliberate human threats to space systems are diverse. While the deployment of weapons in outer space may have not taken place yet (unless one considers a maneuverable satellite a space weapons *per se*), ground-based ASAT missiles have proven to be

[i] Statement of Lieutenant General John W. Raymond before US House Armed Services Subcommittee on Strategic Forces, 25 March 2015.

[ii] See, for example, the 1963 Partial Test-Ban Treaty; the 1967 Outer Space Treaty; the 1967 Astronauts Rescue Agreement; the 1974 Registration Convention; the 1972 Space Liability Convention; the 1972 Anti-Ballistic Missile Treaty; the 1979 Moon Treaty.

[iii] See Annex 1 for a taxonomy of threats and hazards to space systems and services, including their likelihoods, impacts, and mitigation strategies.

very effective. However, the resulting orbital debris "mines" the space environment, posing additional threats to the safety and sustainability of space operations. Increasingly, non-kinetic weapons such as lasers and electromagnetic pulses have become available to both state and non-state actors, and have been seen as less damaging to the space environment, potentially less traceable, and more tactically flexible, as they can be used to either temporarily blind sensors or completely destroy a satellite.

Irresponsible conduct in space operations also contributes to putting the long-term sustainability of the space environment at risk. Space assets (in space or on earth) and related services are also regularly confronted with signal jamming (often unintentional) and cyber attacks, with the potential for hostile takeover[iv]. These attacks can often be launched at little cost and require limited technical expertise, making them available to less technologically advanced actors such as terrorist groups and criminals, which are not receptive to the logic of classical deterrence.

Unintentional hazards, both natural and man-made, can also be a threat. They include space debris, unintentional collisions and electronic interference, and the impacts of space weather phenomena. Nearly one million of pieces of space debris larger than 1 centimeter are estimated to orbit the earth, with about 20.000 objects being tracked and catalogued. In a scenario in which the density of space objects becomes too high, one final collision may produce a self-sustaining cascade of collisions, rendering Low Earth Orbit (LEO) a dangerous minefield for space operations ('Kessler syndrome').

As the nature of these threats, and the available responses, are similar (although not entirely) for all space actors in space – whether civilian, commercial or military – common threat perceptions may influence how space actors choose to cooperate and readily serve as a basis for developing common responses.

4. Main approaches to space security

In recent years there has been an increasing interest in pursuing new space security multilateral initiatives to strengthen the existing outer space regime[v]. While there is no single venue for addressing all aspects of space security, multiple UN bodies have become essential multilateral fora for discussing these issues, each with their own specific mandate and rules. These include the UN General Assembly, particularly its First Committee and Fourth Committee, as well as the Conference on Disarmament (CD), the UN Committee on the Peaceful Uses of Outer Space (COPUOS), and the International Telecommunication Union (ITU). Today's discussions on space security take place in all of these venues and can be classified into two main categories: arms control and responsible behavior.

4.1 Arms control perspective

The consideration of space security from an arms control perspective has a long track record. Initiatives on the Prevention of an Arms Race in Outer Space (PAROS) have been discussed at the CD since 1981[vi]. From those first discussions until today, there has been a long-running clash between Russian-led efforts to ban the placement and deployment of any weapons in outer space, and the views of Western states that have consistently pointed to the emptiness of such initiatives without mechanisms for effective verification and compliance. Due to this longstanding rift between the Eastern and Western blocs, there has been limited progress at the CD on PAROS, largely due to the inability to agree on a work program.

Arms control efforts have been primarily focused on legally binding treaties to prevent weaponization of outer space, rather than on addressing the full spectrum of threats against space systems, whether space-borne or not. While this represents a limiting factor, if subscribed by enough space powers and equipped with proper enforcement mechanisms, well-crafted arms control proposals might still contribute to increasing international security and stability.

4.2 Responsible behavior perspective

With limited progress on PAROS, greater emphasis has been placed on principles of responsible behavior in outer space activities. They consist of both technical guidelines for how to safely conduct space operations as well as transparency and confidence-building measures (TCBMs) for how to communicate about space activities in a way to prevent mistrust amongst space actors. Commonly proposed conduct guidelines include those to prevent and minimize any form of damage to or harmful interference with space objects; TCBMs include notification sharing of space operations (e.g. launches, maneuvers, re-entries, collision risks) and information sharing of space activities (e.g. strategy, policy, expenditures).

Responsible behavior proposals to date have involved a set of voluntary, non-legally binding

[iv] See Pellegrino and Stang [1] for a more detailed analysis on cyber threats to space systems and services (pp. 26-27; 80-81).

[v] The outer space regime includes the five United Nations treaties on outer space; the five UNGA declarations and legal principles; and a number of other UNGA resolutions (See http://www.unoosa.org/oosa/en/ourwork/spacelaw/index.html)

[vi] See A/RES/36/97 (9 December 1981) for the resolution sponsored by the Western Europe and Others Group (WEOG), and A/RES/36/99 (9 December 1981) for the resolution sponsored by the Eastern European and other states.

measures that focus more on the degree of care with which space activities are conducted and communicated, than on what is actually deployed in outer space (i.e. whether they are weapons or not) or on what orbital systems are tasked with (i.e. civilian or military activities). Since such voluntary measures constitute instruments of soft law, they can be easier to be negotiated and adhered to, and can also develop into customary law. While this transition can be eventually seen as a stepping-stone toward legally binding treaties, responsible behavior proposals, rather than progressing further, might also end up being supported only with rhetoric or even ignored altogether. The potential that a voluntary pact may evolve into something more robust and constraining might also discourage states from joining should such a change be seen as a limit upon their freedom of action. Nonetheless, if readily comprehensible and easily applicable, well-designed voluntary measures can have measurable impacts in improving space security.

5. Russia and China's Proposal for a Treaty on the Prevention of the Placement of Weapons in Outer Space (PPWT)

On 12 February 2008, after six years of discussions, Russian Foreign Minister Sergey Lavrov, on behalf of Russia and China, formally submitted to the CD a draft "Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects" (PPWT)[vii]. Its primary (and declared) rationale is to strengthen existing provisions of international space law, notably Article IV of the 1967 Outer Space Treaty, which only bans the placement of Weapons of Mass Destruction (WMD) in outer space.

The PPWT requires that adhering states not place any type of weapons in outer space and that they should refrain from all types of force against space objects (see Table 1).

An updated draft of the treaty was introduced to the CD on 10 June 2014[viii]. While this revised version contains some important changes concerning definitions and procedural matters, it still suffers from the original flaws. First, the proposed PPWT focuses on space-based weapons only, ignoring threats to space systems from terrestrially-based weapons and debris-generating ASAT tests. Second, while the proposal prohibits the deployment of any weapons in outer space, it allows their development, production, possession, testing, use and storage. Third, it does not propose any verification regime for effectively monitoring compliance with the provision contained therein. Critics of the PPWT also point out that there are considerable definitional issues to be solved, notably with regard to the definition of a space weapon, which can be problematic considering the dual-use nature of many space capabilities. Doubts about the seriousness of the PPWT as a mechanism to genuinely contribute to space security may also be strengthened by the fact that, while advancing PAROS proposals, Russia and China are believed to develop and deploy counter-space capabilities. In its current form, the PPWT may thus be near useless as an arms control treaty.

The first draft treaty was heavily criticized by the US Administration of former President George W. Bush, as the proposal would limit their plans for the deployment of space-based missile defense systems. The Obama Administration has taken a more cautious approach. While the US has still an interest in defending its own freedom of action in outer space and continues to object to the PPWT, Washington has recently affirmed the need for multilateral international cooperative efforts for space security, and opened the door to 'proposals and concepts for arms control measures if they are equitable, effectively verifiable, and enhance the national security of the United States and its allies'[ix].

Though arms control in outer space is of primary importance to few states today (notably China, the Russian Federation, and the US), efforts to push the treaty have met with some success in the UN and buttressed anti-Western sentiment. In particular, Belarus, Iran, Kazakhstan, Republic of Korea and Turkey stated that the draft PPWT represents a good model for a future universal space treaty [2]. Brazil has also advocated the urgency for negotiating a legally binding instrument to prevent space weaponization, without limiting the right of states to develop legitimate and peaceful space programs [3]. These diplomatic differences are problematic and remain a factor in shaping the international discourse on space security, potentially impacting efforts to push forward and win support for more promising initiatives.

6. UN COPUOS Working Group on the Long-Term Sustainability of Outer Space Activities

In 2010, the Scientific and Technical Subcommittee (STSC) of the UN COPUOS established the 'Working Group on the Long-Term Sustainability of Outer Space Activities' to develop voluntary best-practice guidelines for all space actors that could help ensure the long-term

[vii] See CD/1679 (28 June 2002) for the first joint China/Russia working paper on the topic; CD/1769 (14 February 2006) and CD/1818 (14 March 2007) for the compilation of comments and suggestions to the joint working paper; CD/1839 (29 February 2008) for the draft PPWT.

[viii] See CD/1985 (12 June 2014).

[ix] National Space Policy of the United States of America (28 June 2010).

sustainable use of outer space. This issue had been raised in the COPUOS at least since 2004 and discussions gained momentum in 2007 following the Chinese ASAT test which created huge amounts of long-lived space debris. In 2008 and 2009, an ad hoc group of experts worked to develop the Brachet Code of Conduct, addressing a wide range of technical issues such as space debris, the safety of space operations, the radio-electric spectrum, and space weather. This led to the more formal inclusion of sustainability issues on the STSC agenda and the development of the official Working Group, whose terms of reference were finalized in 2011[x].

The activities of the Working Group are divided amongst four expert groups:

A. Sustainable space utilization supporting sustainable development on Earth;

B. Space debris, space operations and tools to support the sharing of space situational awareness;

C. Space weather;

D. Regulatory regimes and guidance for new space actors.

State delegations and permanent observers at UN COPUOS nominated nongovernmental experts to participate in the groups, while inputs were invited from other UN bodies, such as the CD and ITU, and non-UN bodies, such as the Inter-Agency Space Debris Coordination Committee (IADC) and the International Academy of Astronautics. NGO and private sector inputs were welcome if submitted through state delegations [4].

The Working Group has spent the last five years looking into best practices, operating procedures, technical standards, and safety policies (see Table 1). The expert groups convened several times from 2011 through 2013 and draft reports were produced by 2014. However, the consolidation of these drafts into a consolidated set of guidelines has proven a difficult task, with new proposals and revisions being added even after the 2014 STSC meeting. At the 59th COPUOS plenary session in June 2016, the Committee agreed to a first set of guidelines, but full agreement could not be reached. Work continues on a preamble and a second set of guidelines with the goal of reaching consensus on a comprehensive final report to be referred to the General Assembly in 2018.

7. EU proposal for an International Code of Conduct for Outer Space Activities

The diplomatic impasse in the CD on PAROS encouraged the international community to find alternatives for moving forward on space security. In 2007, in response to UNGA resolution 61/75 and the UN Secretary General's call for concrete proposals on TCBMs, the EU initiated a process outside the framework of the UN to develop a comprehensive Code of Conduct for Outer Space Activities. After one year of consultations within Europe and with key space-faring nations (including China, Russia and the US), the Council of the European Union officially released an initial version of the Code of Conduct for Outer Space Activities in December 2008. The most recent version was released in March 2014 and is the result of periodical revisions (September 2010, June 2012, and September 2013) following bilateral and multilateral consultations that saw participation of approximately 100 states.

The Code was formally presented to the international community in Vienna on 5 June 2012, on the margins of the UN COPUOS plenary session. Its non-legally binding nature and primary focus on debris mitigation made it unsuited for the CD, while its overarching nature encompassing even military uses of outer space prevented it from formal introduction to the COPUOS. Ever since, it has been the subject of diplomatic discussions in multiple venues, notably in Kiev and Bangkok in 2013, Luxembourg in 2014, and at the UN Headquarters in New York in 2015.

The Code of Conduct is a non-legally binding international instrument, to which adhering states voluntarily commit themselves. It is intended to promote principles of responsible behavior in outer space to enhance the safety, security, and sustainability of space activities, so as to safeguard the continued access to, and use of, outer space.

Although the Code is intended for both military and civilian actors in outer space, provisions regulating the placement of weapons in outer space remain beyond its scope. Rather, the Code calls for signatory states to conduct their space operations with a high degree of care and to purse TCBMs (see Table 1).

Although there is widespread awareness of the benefits that a code of conduct would provide, the EU has encountered some resistance. First, reservations were raised concerning the process adopted by the EU to develop the Code. Many stakeholders felt that they were not properly consulted in shaping the document. In particular, countries such as China, India, Russia, and many Latin American states expressed concerns for the lack of transparency and disappointment over not having been sufficiently involved in the process.

Second, many states, including a joint African position, argued that such initiatives should be placed and developed under the UN umbrella, with discussions to be held with a UN mandate. This aspect proved controversial during the July 2015 meeting in New York, where the event was downgraded from a

[x] See Brachet [9] for a thorough review of the evolution of the topic of the 'long-term sustainability of outer space activities' within COPUOS.

negotiation to a consultation because the EU does not have member state standing at the UN and there was no legal ground for negotiating the text in that venue.

Third, some states are resistant to any potential limits that even a voluntary code could impose on their freedom of action in outer space. This includes both well-established space faring nations that are concerned about any limitation on the use of outer space for military and intelligence purposes and new entrants into space that perceive this initiative as an entry barrier to limit, or make more difficult, their engagement in space activities.

Other obstacles have slowed international acceptance of the Code. States such as Brazil, China, India and Russia believe that the Code has detracted attention from more promising legally binding instruments, such as the PPWT.

There have also been suspicions that, as the Code covers both civilian and military outer space activities and notes the importance of preventing an arms race in outer space, it is not only a means for space environment management but also arms control in disguise [xi] [5]. Brazil, China, Cuba, the Russian Federation, Ukraine and the non-aligned movement have indeed supported the idea of a code dealing with peaceful uses of outer space only and excluding military related issues, with negotiations taking place within the COPUOS [6]. The explicit reference to the right of 'self-defense', in particular, has become a further issue for disagreement. Deprived from this norm that seems to legitimize the use of anti-satellite weapons in wartime and negotiated in a purely civilian forum, the Code would leave the matter of space weaponisation still open so that its adoption could be facilitated.

The positioning of the EU with respect to the international space law has also been a limiting factor in how other countries view the Code[xii]. While in the Code of Conduct the EU calls on all signatories to accede to and abide by principles of international space law, the EU has not taken this step, perhaps slowing facilitation at the multilateral level.

Despite the numerous challenges, the Code has offered a new platform for discussing space security issues, allowing emerging space actors to participate. Following the 2015 New York meeting, the EU and its member states reassessed their approach, concluding that the EU should continue to support negotiations within the UN on a non-legally binding agreement for both military and civilian activities, with a small group of EU member states driving the process forward[xiii].

[xi] See Marta [6] for an additional interpretation on the issue of what the Code is and what it is not.

[xii] The EU is not a signatory to any of the five United Nations treaties on outer space.

[xiii] See remarks by Bruno Hanses (EEAS), 'Sustaining the Momentum: the Current Status of Space Security', at 2016 UNIDIR Outer Space Security Conference, Geneva, 28–29 April 2016.

8. UNGA Group of Governmental Experts on Transparency and Confidence-Building Measures (TCBMs) in Outer Space Activities

Following discussions in the UN's First Committee, the UNGA passed a resolution (65/68) in 2010 calling for the creation of an expert group to study outer space TCBMs. The USA abstained from voting on this resolution because it noted the Chinese/Russian initiative on PPWT, but subsequently declared support for the process. The next year, Secretary General Ban Ki-moon established the Group of Governmental Experts (GGE) on Transparency and Confidence-Building Measures in Outer Space Activities to investigate ways to improve international cooperation and reduce the risks of misunderstanding, mistrust, and miscalculations in outer space activities [7].

Due to the deadlock within the CD and the dearth of other initiatives at the time, the GGE was viewed by many states as a pragmatic step forward for international space security. The work of the GGE may thus be seen as a model for how quickly and effectively it was able to produce a report, based on consensus, that measurably moved forward space security discussions at the international level.

The GGE was made up of 15 representatives, with five experts nominated by the permanent members of the UN Security Council (China, France, Russia, the United Kingdom, and the USA) and the remaining experts selected by the UN based on state applications and fair geographic representation (Brazil, Chile, Italy, Kazakhstan, Nigeria, Romania, South Africa, South Korea, Sri Lanka, and Ukraine were chosen). In its work, the GGE drew upon other space security and sustainability initiatives, including the work of a similar GGE convened between 1991 and 1993[xiv], reviewed existing international law regarding space, and took into account member state submissions. It also considered the proposed International Code of Conduct, the work of the UN COPUOS Working Group on the Long-term Sustainability of Outer Space Activities, and existing bilateral and multilateral TCBMs, and concluded that voluntary political measures can pave the way to legally binding obligations.

The consensus final report in July 2013 included recommendations for states to take action on a voluntary basis, through relevant national mechanisms, on key TCBMs. It called for improved information sharing (on goals, policies, programs, and military spending in space), activity notifications (of launches, maneuvers, re-entries, break-ups, and emergencies), visits to space facilities, mechanisms for continued dialogue, and wider

[xiv] See A/48/305 for the 1993 GGE study on the application of confidence-building measures in outer space.

cooperation and outreach, including with new and non-space powers (see Table 1). The report and its recommendations were universally welcomed by the international space community, and a major focus going forward will be to effectively pursue the implementation of the report's recommendations.

9. Major challenges to international cooperation for space security

Despite significant efforts and some progress, international cooperation for space security continues to face several obstacles [1].

First, there are incompatible perceptions of international security, which results in divergent national security goals and priorities. For example, while there is widespread and growing concern about space weaponization and arms control, this issue is of primary importance to few states only in the CD, with most of them focusing on nuclear disarmament. More importantly, states perceive multilateral efforts at improving international security very differently, with many seeing the development of certain international norms as coming at the cost of their national sovereignty. This is made even more complicated by the multiplication of governments involved in space activities - each with its own political and security agenda.

Second, there are differing visions for how to pursue space diplomacy, whether by means of legally binding treaties or instruments of soft law. There are also divergent views on the appropriate setting to address key challenges, whether within a particular body or with a specific mandate; different methodological preferences for decision making, whether to reach agreement by consensus or other rules; differences on which participants to include in the discussion and how and when to involve them, whether to start with a like-minded small group or to involve as many space actors as possible from the outset.

Third, existing differences in national capabilities impact on how states view the potential costs and constraints of any international cooperation initiatives. Emerging space nations may see the development of certain international norms or principles of responsible behavior as an attempt by the leading space powers to limit their access to and use of space. Space faring nations, for their part, while welcoming some additional mechanisms to regulate space activities, still oppose to those measures that they perceive as restricting their freedom of action in outer space or limiting options for enhancing their own national security.

Fourth, historical geopolitical differences, such as those between the Eastern and Western blocs or between developing and developed countries, limit trust amongst space actors. This contributes to the nurturing of biases and suspicions in pursuing space security initiatives, regardless of how effective they can be. For example, on the occasion of the 53rd session of the Scientific and Technical Sub-Committee of the UN COPUOS, the Russian delegation stated that some criticisms to their own proposals are based on prejudices.

Fifth, there are different approaches for how to use outer space. Military uses of space have historically shaped doctrines and policy options of the main space powers. Civilian uses of space and commercially driven space investments play a larger role in Europe and for most new space powers. Although threats to space systems are similar for all space actors, these differences impact how the two groups approach space security.

Sixth, there has traditionally been a lack of compliance with international agreements. Space-faring nations have been slow to adopt and implement voluntary guidelines and space security proposals, even those for which they had agreed on or expressed diplomatic support. A recent study by the CNES concluded that 40 percent of satellites and rocket bodies in LEO do not meet space debris mitigation practices [8]. Today, no space power has systematically implemented the recommendations of the GGE Report; and while 95% of satellites launched between 1957 and 2013 were registered, it often happens months or years later, after being detected, characterized, and tracked by others, and not always with correct data. Similarly, while tabling in the CD proposals to prevent space weaponization and any threats against space objects, China and Russia are simultaneously believed to develop counter-space capabilities. Compliance with principles of international law is equally important. For example, in the Code of Conduct, the EU calls on all signatories to comply with international space law. However, even though three of the five space treaties permit signature by international organizations, the EU has not declare acceptance, which has perhaps limited trust building.

Seventh, there has been limited coordination and communication amongst space powers outside of formal UN settings, which has not helped share common goals and interests with respect to the security of space.

Eighth, there has been in recent years a multiplication of private actors involved in space activities. Not only have they contributed to degrading the outer space environment, but they will also shape the dynamics of future international relations.

Lastly, there has traditionally been a lack of shared values with respect to space security within the international community. For example, while the EU can be considered a community of values, the UN is not. This difference can impact how space actors value different space security and sustainability initiatives.

10. Options for moving forward

10.1Enhancing multilateral cooperation

In confronting space security challenges, there are multiple areas where the actions of individual states are likely to prove inadequate and where improved integration on an international level can be beneficial. While the complex context of the space security discourse – with different rationales, priorities, settings, mechanisms and participants – will not be easily rationalized into any common model soon, the work of the GGE, the IADC, and the Working Group on the Long-Term Sustainability of Outer Space Activities show that progress can still be made. Each of these has their own governance arrangements, memberships and rationale, highlighting the opportunities that can be created with innovative diplomacy. And for those issues, such as arms control, where talks remain deadlocked, it should be possible to use current discussions to develop ideas that will be applicable once the political conditions will have changed.

Overcoming national security concerns and reconciling divergent positions and priorities of sovereign states, however, require building confidence and trust amongst space actors. Work to overcome trust deficiencies and to develop innovative new mechanisms for progress can be facilitated through the creation of mechanisms for regular exchange on space security. More specifically, a way to improve multilateral cooperation outside the formal UN settings may be to create an International Space Diplomacy Network - an association of governments, NGOs, and private space actors.

This network can serve as an ongoing resource and communications forum for helping gather information and exchange views on an ever-wider range of space security issues, pursuing shared interests and building common values, and coordinating action plans for space diplomacy, which can be formally and likely more quickly developed and implemented in traditional fora. Such a network could also allow non-members of particular UN fora (e.g. CD) to get involved in relevant space security discussions. Importantly, this platform could be a stepping-stone towards the creation of a specialized 'Space Security Council' - a subsidiary or specialized organ of the UN Security Council with the aim of pursuing and promoting collective space security. Active engagement from all new and established space actors can help ensure that major space-faring nations, whose goals may differ from those of aspiring space nations, do not dominate the tone and content of the network.

10.2 Which diplomatic actors to involve?

Despite efforts to develop international norms and rules of the road for space security, not all parties are necessarily interested in the subject upfront. The 'all or none' approach can have its limits. In order to move off the starting line, a like-minded core group may sometimes be preferable to discuss the essence before making the debate larger. The work of the IADC on the space debris mitigation guidelines can serve as an example. Started by a narrow group of technical experts from the IADC agencies, the first complete set of guidelines formed then the basis for discussions within a wider audience at the STSC of the UN COPUOS. This initiative has received positive assessments by the international community and can provide a good model for how to make progress, as recommendations are supported and approved by all parties [9]. However, as the case of the International Code of Conduct shows, this method should be approached cautiously to ensure future buy-in from those outside the initiating group. This is especially the case in the field of space security, for which the outcomes will not have equal impacts on all participating states.

10.3 Improving bilateral cooperation

There will also be great value in bringing some space security issues into bilateral dialogues, complementing multilateral cooperation efforts within or outside the UN, especially if this can expand beyond purely technical considerations. Even the US and China, whose security agendas significantly differ, have included the long-term sustainability of outer space, space debris, satellite collision avoidance, and exchange on their respective space policies in the inaugural meeting of their civil space dialogue in September 2015. In shaping bilateral cooperation, it makes sense to build on existing space dialogues and prioritize initiatives with partners that have endorsed the principles of one's own initiatives. The EU and the US, for example, have indicated increased willingness to focus on diplomacy to improve security in space, though more work is needed [xv]. Understanding EU and US goals and approaches will also be essential to understand if and where potential synergies can be built. Dialogue cannot be limited to the Western countries, however. Russia and China may have very different views than the Western actors, but they are still essential for shaping the security of the outer space. The inclusion of space security concerns into existing dialogues could be a

[xv] See, for example, the new Global Strategy for the European Union's Foreign and Security Policy (page 42); remarks by US Deputy Assistant Secretary of State Mallory Stewart, 'Formulation, Coordination, and Implementation of Promoting Space Security and Sustainability,' at 2015 Space Resiliency Summit, Alexandria, VA, 9 December 2015; and remarks by US Assistant Secretary of State Frank A. Rose, 'The Role of Diplomacy in Keeping Outer Space Safe, Secure, and Sustainable', at 32nd Space Symposium, Colorado Springs, CO, 14 April 2016.

precursor for the establishment of dedicated bilateral space security dialogues, as the recent US-China dialogue on outer space safety has shown.

10.4 Ensuring compliance with international agreements

Effectiveness in pushing forward an international agenda on space security can be enhanced when governmental space actors unilaterally implement, to the greatest extent practicable and in a manner consistent with national interests, voluntary measures for space sustainability. A public and independent review of how principles and recommendations of major diplomatic proposals have been or are being applied can help ensure compliance and set the path for others to follow. This can be complemented with a review of how past treaties have been implemented. While pursuing full implementation of international agreements requires the development of adequate national legislation and additional administrative burden, in the long term this process will positively affect the security and sustainability of outer space.

10.5 New space actors and the private sector

To systematically improve cooperation in international discussions, paying careful attention to the needs of aspiring space nations will be important. Emerging space nations are approaching space security and sustainability as developing countries do with respect to climate changes – they are eager to develop and progress, and are often suspicious of proposals aimed at mitigating those problems (degradation of the space environment vs. global warming) created by others (often the proponents themselves). This mistrust can be overcome if new space actors are properly consulted and included in the elaboration of space security proposals and in the development of those conventions that formalize the resulting obligations. Helping new space actors prepare and implement plans for managing space security risks will also contribute to trust and relationship building. This inclusive approach can also prove very useful for earning their support in diverse multilateral diplomatic initiatives.

Equipping newcomers into space with the necessary technical, political and legal expertise to integrate space security thinking into their strategic planning can also be an avenue for maximizing benefits while limiting potential negative consequences. The efforts of the Secure World Foundation (SWF) in developing a handbook that introduces principles of international laws, norms and best practices for secure, safe and sustainable activities in space for any new actors is a very promising initiatives in this field. Space business incubators may also play a catalyst role in spreading such initiatives, embedding the space security principles contained therein into their day-to-day activities in support of start-up companies.

As the number of private space actors continues to expand, the development of a framework that incentivizes security conscious behavior for the exploitation of space by the private sector could provide great value. For examples, abiding by space debris mitigation guidelines would be financially prudent if companies were liable for any damages produced by the satellites they launch, and this cost was included in the insurance premium. Being compliant with best practices and other rules of the road could become a priority if this results in lower costs and easier access to funds.

10.6 International Code of Conduct

There is widespread support for the main ideas of the International Code of Conduct. Lessons learned from the consultation process relating to the Code, and about the disagreements over some of its provisions, can help the EU inform future diplomatic actions. For example, consultations could move from an 'EU holding the pen' approach towards one that has greater involvement and cooperation with non-EU countries from the outset. A few EU states, with the support of relevant EU institutions and bodies, can provide impetus to the process, bringing other actors on board to revitalize discussions in a more open manner. While opening up the process may lead to new problems, this approach might help draft a document defining, *inter alia*, widely agreed principles of responsible behavior in outer space. To increase possibility of re-energizing discussions over any updated Code and its ideas, flexibility may be required about working within or outside UN channels (or both simultaneously). For work within the UN, a UNGA resolution on principles of responsible behavior in outer space and efforts towards the development of a consensus report on the implementation of the 2013 GGE Report might help expedite the process, and facilitate negotiations and a future adoption of the Code. Throughout the whole process, the EU could also take important action to clarify and review its positioning with respect to the international space law and main UN fora.

In the long term, the ideas in the Code could even evolve towards a more comprehensive space traffic management regime; it would thus be important if the EU and its member states could start looking into the matter as soon as possible, as discussions at intergovernmental level have already started at the UN COPUOS.

10.7 Capabilities matter in space diplomacy

Space diplomacy can best be pursued when supported by the technical capabilities necessary to detect threats and hazards to space systems. The viability of any future international instrument to

regulate space activities, for example, will require SSA information to verify violations and attribute irresponsible behavior in outer space. This is another area where better international cooperation is envisaged. The sharing of SSA information, however, is a sensitive security issue for space actors. While it would provide useful information and a common space picture to help space actors act safely, efficiently and responsibly, a well-crafted mechanism for data sharing will require dedicated efforts to ensure that all data is protected and used in a responsible manner. Importantly, the international community urgently needs to take any pre-emptive measures to improve the resilience of space infrastructure, both in space and on earth. This entails protecting space systems against physical and cyber attacks, building redundancy into satellite constellations, or sharing capabilities with third parties to ensure backup service provision.

11. Conclusions

No single body or law governs the use of space, and efforts to improve space governance are complicated by the clashing priorities of major space powers. Concrete initiatives for international cooperation can play a systematic role in reducing tensions, altering threat perceptions, and facilitating shared activities to prevent space from becoming a perilous battleground. While it might not be possible for space actors to share common values with regard to the security of space, building on shared interests could form a basis for future consensus.

Acronyms/Abbreviations

ASAT	Anti-satellite
CD	Conference on Disarmament
COPUOS	United Nations Committee on the Peaceful Uses of Outer Space
GGE	Group of Governmental Experts
IADC	Inter-Agency Space Debris Coordination Committee
ITU	International Telecommunication Union
PAROS	Prevention of an Arms Race in Outer Space
TCBMs	Transparency and Confidence-Building Measures
WMDs	Weapons of Mass Destruction

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Table 1. Comparison of major international cooperation efforts on space security (Source: Pellegrino and Stang [1])

	PPWT	International Code of Conduct	GGE Report on TCBMs	LTS Working Group (Draft Guidelines)
Proposing Entity	**Russia & China**	**EU**	**UNGA**	**UN COPUOS**
Legal status	Legally-binding treaty	Voluntary agreement	Voluntary guidelines	Voluntary guidelines
Conduct Guidelines	· No weapons in outer space; · No threat or use of force against space objects; · Will not engage in activities inconsistent with the treaty, or incite others to do so.	· Do not damage or destroy space objects; · Minimize risk of collisions; · Minimize debris creation; · Implement IADC debris mitigation guidelines.	· Implement other guidelines, including those developed through COPUOS.	· Conduct only activities of a peaceful nature; · No cyber disruption; · No deliberate alterations of space environment; · Respect ITU regulations on spectrum protection & ensure equitable access to geostationary orbit.
TCBMs	· The Executive Organization of the Treaty shall collect and distribute any information provided by parties (the information to be provided is not specified).	· Notification of launches, maneuvers, re-entries, malfunctions and collision risks; · Information sharing on policy, strategy, research programs and SSA info; · Site visits & demonstrations.	· Information sharing on policy, goals, space military expenditures, registrations and orbital parameters of space objects; · Notification of launches, maneuvers, re-entries, malfunctions and emergencies; · Site visits and demonstrations.	· Information sharing: develop a mechanism or procedures for information exchange on space activities, debris and space weather; · Enhance space object registration; · Notification of launches is encouraged; · Investigate shared rules for active removal and/or intentional destruction of space objects.
Resolving grievances	States concerned over possible violations may request clarifications, then consultations. The Executive Organization may convene review meetings and refer matter to UNGA or UNSC.	States affected by activities contrary to Code may request consultations to find mutually acceptable solutions.		
Outreach and support		Is supported, especially toward developing countries.	Is recommended, notably within UN system.	· Raise public awareness of of space sustainability; · Support scientific, technical and legal capacity-building.
Verification	None	None	None	None
Coordination	The Executive Organization shall hold meetings on amendments, develop procedures for collective data sharing and conduct consultations into alleged violations.	· Regular meetings and Code reviews by subscribing states; · Coordination points of contact established; · Electronic database for sharing data.	· Coordination focal points established; · Consultations are encouraged, notably using existing mechanisms.	· Provide contact details for information exchange bodies; · Develop appropriate mechanism or procedures for information exchange on space activities.

Appendix A – Threats and hazards to space systems and services

Table 2. Space segment (Source: Pellegrino and Stang [1])

Intentional Threats			
Type of Threat	**Effect**	**Mitigation**	**Priority**
Kinetic Energy Weapons (KEW) - Hit-to-Kill ASAT - Exploding ASAT - Passive ASAT	Satellite partially or totally destroyed	International law, export control, rules of the road, TCBMs, deterrence, SST	Very low
High-altitude Nuclear Weapons (EMP)	Satellite destroyed; excitation of Van Allen belts	International law, export control, rules of the road, TCBMs, deterrence, SST	Low
Directed Energy Weapons (DEW)	From signal disturbance to mechanical destruction effects	Depends on the specific threat (see below)	Medium
Laser-based ASAT	Sensors damaged/destroyed and mechanical damage	Classified	High
High-power microwave ASAT	Sensors temporary or permanently blind; receivers and electrical components degraded	Self-protection devices	Medium
Electronic Warfare (EW)	Ranges from signal disturbance to loss of satellite control	Depends on the specific threat (see below)	Very high
Jammers	Radar satellites and communications transponders temporarily or permanently incapacitated	Specific waveforms, nulling antennas, beamforming, jammer location neutralisation	Very high
Cyber attacks	Hijacking of transponders, degradation of a satellite and its components, loss of information, spoofing	Cryptography, secured software, process standardisation	Very high

Non-intentional/Natural			
Type of Threat	**Effect**	**Mitigation**	**Priority**
Space debris	Physical damage to a satellite, space debris pollution	TCBMs, SST, shielding	High
Space weather (e.g. solar flares radiation)	Bugs, component damage, mission duration decrease	SSA, Space weather monitoring and forecast, specific components, specific software	High
Unknown space phenomena	Component failure	Redundancy, hardening, resilience, R&D	Medium

Table 3. Uplink and Downlink Communication Channels (Source: Pellegrino and Stang [1])

Intentional Threats			
Type of Threat	**Effect**	**Mitigation**	**Priority**
Jamming	Denial of service of communications and/or radar systems	Radio-frequency coordination at national and international levels, nulling antennas, specific waveforms, jammer neutralisation	High
Spoofing	Wrong information provided	Cryptographic authentication procedure, integrity checks	Medium
Cyberattacks	Denial of service	Cryptography, secured software	Very high
Interception	Information compromised	Cryptography, specific waveforms	High

Non-intentional/Natural			
Type of Threat	**Effect**	**Mitigation**	**Priority**
Interference	Denial of service of communications and/or radar systems	Radio-frequency coordination at national and international levels, nulling antennas, specific waveforms	Medium

Table 4. Ground segment (Source: Pellegrino and Stang [1])

Intentional Threats			
Type of Threat	**Effect**	**Mitigation**	**Priority**
Physical attacks	Loss of communication with satellites, temporary or permanent disruption of the ground segment	Redundancy, specific hardening measures, increased physical security procedures	Medium
Sabotage	Loss of communication with satellites, ground segment breach	Hardening	Medium
Cyberattacks	Denial of service, information stolen/compromised	Cryptography, authentication procedures, secured software, integrity checks	Very high
Back doors	Information compromised	Cryptographic authentication procedures, integrity checks	High

Non-intentional/Natural			
Type of Threat	**Effect**	**Mitigation**	**Priority**
Natural disaster (e.g. floods, fires, earthquakes)	Loss of communication with satellites, temporary or permanent disruption of the ground segment	Redundancy, specific hardening measures, increased physical security procedures	Medium