50 years after the Outer Space Treaty: How secure is space?

Dr. Laura Grego is Senior Scientist, Global Security Program, with the Union of Concerned Scientists. Her work focuses on the technology and security implications of national missile defense and of space security. She has published many peer-reviewed papers on these and related topics. Dr. Grego has testified before the United States Congress and addressed the United Nations Conference on Disarmament. She has a PhD in experimental physics from the California Institute of Technology and did postdoctoral research at the Harvard-Smithsonian Center for Astrophysics.

> The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.

So stated the landmark Outer Space Treaty, which entered into force on 10 October 1967. With this treaty, scores of states, including all the spacefaring nations at the time, laid out the fundamental principles by which outer space is to be governed. Key among these principles: space is to be used for peaceful purposes; states parties must exercise due regard to the interests of others and avoid harmful contamination while using space; and no state can appropriate space or celestial bodies.

The OST's drafters could be forgiven for not anticipating the technological and geopolitical changes that have come about in the intervening decades. While the Treaty bans the placement of weapons of mass destruction in space, it provides less explicit guidance about other military uses of space. At the time, many national security activities in space, such as verification of arms control agreements and warning of ballistic missile launches, were essentially stabilizing. Today, military space capabilities are less clearly "peaceful" and are a yet greater source of contention. The Soviet Union wanted to ban nongovernmental activity in space, but the United States objected and, in the end, such activity was permitted, with states bearing responsibility for all nongovernmental activity. Today, commercial activity is poised to dwarf governmental activities.

Geopolitical trends

Space as just another warfighting regime

Space has for decades been "adjacent" to conflict, playing an important, but supporting role. Current trends put space at the center. For a small but increasing number of states, space services provide the capability to deploy military personnel globally and apply force more efficiently and effectively. Increasingly, these states view space as a sphere to be dominated and defended.

As Theresa Hitchens wrote in her 2015 SSI Global Assessment, "growing national security tensions among the major space actors threaten to negate the painstaking efforts toward multilateral governance," and thus space security is moving "one step forward, two steps back."[1]

In a significant shift in approach over the last couple of years, the Pentagon now assumes that operations in space will be challenged, and that plans should be laid to prevail in a contested environment. In 2017, this view was given clear expression when, within 24 hours of being sworn in, the Air Force Secretary declared that space is a warfighting regime, just like air, sea, and land. While it is prudent and may be stabilizing to devise plans to retain the use of space

in the face of threats, militaries tend to seek solutions in their own bailiwick—hardware, operations, technology. A commensurate amount of energy has not been invested in shaping the space environment into a more secure and peaceful one using negotiated constraints.

Space is not insulated from conflict on Earth, and it can unpredictably escalate crises on the ground or be the spark that starts one. As Jana Robinson noted in the 2016 SSI Global Assessment, a number of difficult problems are brewing, particularly in the South and East China Seas and in Ukraine, which have the potential to pull into conflict space powers (which are also nuclear powers), including the United States, Russia, and China.

China's arrival

While the decades after the Second World War were marked by the space race between the United States and the Soviet Union/Russia, China has decisively arrived as a leader in the exploration and use of space. Having invested heavily in launchers and on-orbit space capability, it is hitting its stride. In 2016, the United States and China were tied for the greatest number of space launch attempts (22), and China recently eclipsed Russia in the number of operating satellites. This year saw the successful maiden flights of China's heavy-lift Long March 5 and Long March 7, which will be the "workhorse" launcher for China. China now fields a complement of communications satellites; intelligence, surveillance, and reconnaissance satellites; and position, navigation, and timing satellites. It has announced ambitious plans for space exploration and has sought regional and international cooperative relationships for space activities.

How might this new reality affect space security? The United States and China do not have a well-functioning relationship on space matters, in contrast to the decades of interaction and cooperation between the United States and the Soviet Union/Russia.

China has not been invited to become involved with the International Space Station and, for years, the United States Congress has restricted the use of funds to support bilateral discussions or projects with China on space. Until recently, no reliable line of contact between the U.S. Space Command and China existed by which the United States could share information about possible satellite collisions. Fortunately, in this last year of the Obama administration, the United States and China were able to initiate bilateral discussions on civil and security space matters.

The People's Republic of China was not a member of the United Nations when the Outer Space Treaty was negotiated, but it did eventually become a signatory. It has frequently stated in international forums and in domestic declaratory policy that limits should be placed on space weapons. China cooperated with Russia to draft and promote the Treaty on the Prevention of the Placement of Weapons in Outer Space. The United States has repeatedly stated that it has no interest in that effort, but has not offered its own vision of acceptable limits on space weapons. The UN Conference on Disarmament has not been functioning for years, so there has been little opportunity to come to a sound understanding of what common ground on space security issues might exist.

Technological trends

Anti-satellite weapons develop and proliferate

For the foreseeable future, military tensions among the United States, China, and Russia are likely to remain high, as are those between China and India. It is imperative to track investments and strategies that could escalate a crisis or lead actors to consider approaching or crossing the nuclear threshold. Attacks on satellites can create or escalate terrestrial

crises in ways that are difficult to predict and which are particularly dangerous among nuclear powers.

While the OST prohibits nuclear weapons in space, it is less specific about other military activity, and states have different interpretations of "peaceful purposes." Thus, the drift is toward a space regime that includes increasingly sophisticated anti-satellite technology, with very little mutual understanding about how actions in space are perceived and what constraints, if any, global governance provides.

States—and, increasingly, sub-state actors—have been developing technologies that can be used to interfere with satellites. Not all such technologies are equally dangerous, and it may be possible to prioritize appropriate limits. Signals jamming, for example, is relatively low-tech, but is also limited temporally and spatially in its effects; identification of the perpetrator is relatively straightforward, even if remedies for the interference are less so. More concerning are technologies with a strategic-sized capability, or which are stealthy and hard to attribute, or which make intent difficult to discern; these technologies can provide new and unpredictable paths to crisis escalation. The inventories of such weapons are growing and relevant technology is proliferating.

Midcourse missile defense systems are of particular concern. Long-range ballistic missiles and satellites travel at similar speeds on similar trajectories, so the heart of these systems, the "kill" mechanism, can be used against either missiles or satellites. In fact, they're likely to be much more effective against satellites, which travel on repeated, predictable orbits.

The United States has an enormous advantage in missile defense capacity and sophistication. It has two missile defense systems that use hit-to-kill interceptors that could target satellites. The current fleet of Aegis missile defense interceptors can reach only satellites at the very lowest altitudes, at which satellites are very nearly de-orbiting. But the next generation of interceptors, the SM-3 IIA, should be able to reach any satellite in low Earth orbit.[2] The development of this interceptor, pursued jointly by Japan and the United States, saw some delays in 2016, but both countries are committed to it, and the accelerated pursuit of nuclear weapons and ballistic missiles by the Democratic People's Republic of Korea will reinforce support. These interceptors are likely to be deployed in much larger numbers, likely in the hundreds; in comparison, the currently deployed Ground-based Midcourse Defense system, which can in theory target all low-Earth-orbiting satellites, will soon comprise 44 interceptors. China and Russia each have in the order of 100 low-Earth-orbiting satellites. Thus, U.S. missile defenses potentially will have the capacity to hold a significant portion of an adversary's satellites at risk. This is essentially a strategic capability and has serious implications for stability and security in space.

While the Obama administration was not interested in space-based missile defenses (SBMD), certain members of the U.S. Congress have been pushing the idea for years. They had modest success in 2016, directing the Pentagon to come up with a space-based concept that could serve as a defense against ballistic missiles as they launched and/or against ground-launched anti-satellite weapons. The new president is likely to be more interested in SBMD, and has ordered a ballistic missile defense review.

While a full complement of hundreds or thousands of space-based interceptors would be prohibitively expensive to field (even with anticipated reductions in launch costs), it's quite possible that the Pentagon will be directed to build a testbed of a few interceptors. This is a concern for two reasons: 1) prototype interceptors in space would be viewed by adversaries and allies alike as putting the first dedicated space weapons in orbit, encouraging development of similar technologies by others; and 2) absent constraints, the development

of weapons explicitly aimed at an adversary's anti-satellite weapons can lead to a dangerous "use it or lose it" dynamic.

The United States is not alone in pursuing midcourse missile defenses. China has reportedly tested hit-to-kill interceptors a number of times, both against a satellite in 2007 and subsequently against ballistic missiles. China has also demonstrated a high-altitude rocket that could potentially bring those interceptors in reach of satellites in geosynchronous orbits. Little is known publicly about the state of its development program and the numbers and types of interceptors China plans to field.

While Russia has long had a modest missile defense system for Moscow, it has begun work on another ground-based system, "Nudol," which reportedly has an anti-satellite mission. Russia upped the tempo on this system, reportedly flight testing it three times in 2016. (It is not clear whether it was tested against a target.) Other countries continue research and development of missile defense systems; as ballistic missiles proliferate, more states may seek them.

Because hit-to-kill weapons produce large amounts of dangerous, persistent space debris, some inherent self-restraint against on-orbit testing or hostile use of these systems is expected. But this is a weak deterrent to using missile defenses against satellites in an actual crisis. And because missile defenses are politically sensitive, both internationally as well as in the United States, starting a conversation on useful limits is difficult.

More complex, but just as concerning, are technologies that can be used both for peaceful and aggressive purposes. This ambiguity may lead to on-orbit behavior that is difficult to interpret. A prime example is satellites that are nimble on orbit and can closely approach another satellite without that satellite's cooperation. These "proximity operations" can be peaceful—inspecting or repairing a satellite, or salvaging or bringing a failed satellite safely out of orbit. But they can also facilitate interference with a satellite, since damaging a satellite is easier at close ranges and low relative speeds.

A number of states and commercial actors are pursuing such cutting-edge technology. In 2016, the U.S. military bolstered its Geosynchronous Space Situational Awareness Program by adding two new satellites to the two already in orbit. The United States has been transparent about the existence of this and its Automated Navigation and Guidance Experiment for Local Space program.

While China and Russia are testing these technologies as well, they provide little public detail. In spring 2017, one of Russia's satellites reportedly demonstrated the ability to cease maneuvers for a period of time, then return to maneuvering, a capability which might increase the satellite's stealth. Stealth is likely to be perceived as a valuable technology, particularly since the United States has a large advantage in capability to surveil space.

There's been little appetite on a state level to discuss constraints on proximity-operations technology or norms for behavior. For example, how close may another satellite get without notification or prior permission? At present, individual states must deal with the possible collision or signals interference and with trying to interpret the intent of another state's actions. Such a situation increases the risks for miscalculation and misinterpretation.

Small satellites

The miniaturization of relevant technologies has led to the possibility of using smaller, lighter, and cheaper satellites to provide useful capability. The Obama administration began funding this "Small Satellite Revolution"[3] to harness its potential for innovation. This "revolution"

has been somewhat limited by the capacity to get the small satellites to orbit; often they are launched using surplus mass capacity in the launch of large satellites, essentially hitching a ride. But, increasingly, small satellites are taking up significant parts of the payload of large launches; in February 2017, India launched 103 small satellites along with a larger payload. Launchers dedicated to launching multiple small satellites are being developed. Small satellites are likely to play an increasing role in any number of space endeavors.

With space becoming cheaper and more accessible, more states own their own satellites and non-state actors such as universities and space startups can also reach space. Every year, a few more countries see the launch of their first satellite; more than 60 have now done so.

This trend could increase stability in space by increasing the number of stakeholders, or it could challenge the sustainability of space. Smaller satellites are generally not equipped to maneuver, and so cannot move out of the way of a potential collision; the sheer number of satellites could make avoiding collisions more difficult. Additionally, smaller satellites may be stealthier, and their behavior less transparent and observable.

Commercial space innovations

Investors with sweeping visions and deep pockets are transforming space launch and space services. A number of constellations of huge numbers of satellites are being planned, primarily to provide broadband internet globally, some to collect Earth observation data. In 2016, commercial companies filed for U.S. Federal Communications Commission licenses for 8,731 non-geostationary communications satellites, including 4,425 for SpaceX, nearly 3,000 for Boeing, and 720 for OneWeb. (The total number of operating satellites today is about 1,500.) Done well, these constellations can transform life on Earth for the better—generating new capacities to help underdeveloped regions and transforming industries. Done poorly, they can pose a serious challenge to space traffic management and the health of the space environment and concentrate control of resources and what may amount to a global utility in the hands of those who are not accountable to the global populace.

Other transformative satellite-based capabilities that now are beginning to be provided by private companies include the publicly available, constant imaging of Earth, timely weather forecasting, and better maritime tracking. Planet Labs Inc. aims to provide high-resolution imagery of the entire Earth, every day. Planet has secured launches for its "Dove" satellites at a steady tempo; in early 2017, 88 Doves were onboard India's record-breaking launch. A number of new companies are developing commercial synthetic aperture radar capabilities, which can provide high-resolution Earth imagery at night or during cloud cover. Commercial SAR outfits currently operate from Germany, Italy, and Canada, among others; four new companies (one each from Canada and Finland, two from the United States) recently announced that they planned to pursue their own commercial SAR constellations.

Constant surveillance could be stabilizing and beneficial, especially if it provides accountability; Planet Labs' explicit aim is to foster solutions to ecological, social, and humanitarian problems and commercial data can provide unclassified, shareable, objective data to help resolve disputes. Constant Earth imaging can also, of course, be used for ill, for example, to target political enemies or those who are vulnerable.

Global governance under stress

Concurrent with these changes, and perhaps because of them, global space governance is under stress. Governance is becoming less global and is fracturing into smaller domains as

actors respond to their perceived needs. Declaratory policy is being made on a state level, and states are establishing norms of behavior unilaterally. For example, some states, such as the United States, Luxembourg, and the United Arab Emirates, seek to create a favorable legal and regulatory environment for private companies to pursue resource extraction on celestial bodies, although it is not at all clear that other states see such regimes as consistent with OST principles. As this publication states, proliferating legal and regulatory regimes could encourage companies to adopt "flags of convenience" by which to do their business.

Militaries, which use space as an instrument of state power, have begun to declare that conflict in space is "inevitable." Civil society has been ineffective in calling for the robust exploration of diplomatic solutions and constraints to produce a less militarized space in the future. Commercial interests are moving to shape the regulatory regime to their preferences. These actions are likely to set the playing field for decades to come if global governance does not provide a strong cohesive counter-vision.

Should trends continue, the traditional balance of civilian-governmental-military uses of space will be shifted heavily toward commercial space, with militaries a significant part of the customer base. A number of the new commercial investors in space are from the internet-startup culture, which prefers few regulations. Current regulations provide little guidance on some commercial ventures, such as building big satellite constellations, extracting resources from celestial bodies, and transforming space launch and human spaceflight into affordable quotidian tasks. But companies are unlikely to wait for slow-moving bureaucratic processes to catch up and will exert pressure to shape the legal regime to their preferences. However, states must have a say in this, as the Outer Space Treaty clearly assigns responsibility for national space activities to states, even those performed by nongovernmental entities.

Few resources are being devoted to developing shared notions among states on issues such as how the principles of "peaceful purposes" and "due regard" interact with national security needs.

The venue where space security and arms control initiatives are to be discussed, the UN Conference on Disarmament, has been moribund for two decades, and little serious effort has been made to bridge the divides. The United States has rejected the Russia-China PPWT proposal, but offers no alternatives. Efforts to negotiate and sign an International Code of Conduct for Space have derailed, despite the successful assembling of relevant parties in New York in 2015 for the negotiation of the Code's language. While a UN Group of Governmental Experts completed their work in 2015 on a draft set of transparency and confidence-building measures for space, little has been done to implement them.

Without a renewed commitment by state actors, global governance will not be up to the task of shaping trends to ensure that space remains sustainable and secure, with its benefits equitably enjoyed. Judging from the slow progress of recent years, the going will be tough. However, some bright spots are evident, and there are reasons to think that robust engagement from the civil sector will play an important role.

Positive signs

The UN Committee on the Peaceful Uses of Outer Space (COPUOS) has been steadily making progress on a number of issues. In 2016, COPUOS had a banner year; it concluded negotiations on a set of 12 draft Long Term Sustainability Guidelines, and was poised to agree on more. COPUOS shepherded 84 states to agreement on seven themes for a formal marking of UNISPACE+50 in 2018. COPUOS identified clearly how important a

secure and sustainable space environment is by connecting it to the UN 2030 Sustainable Development Goals, creating an important shared vision that resonates deeply with the original principle of the Outer Space Treaty, that space activities should be "to the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development."

The initiation of a number of high-level bilateral and multilateral dialogues on civil and security aspects of space should be noted, as should the accession of India to the Missile Technology Control Regime and The Hague ballistic missile code of conduct.

On some issues where states may find difficult terrain, civil society is stepping in. For example, 2016 saw the inception of an effort to clarify what existing international law, including the Law of Armed Conflict and International Humanitarian Law, says about military uses of outer space. The McGill Centre for Research in Air and Space Law and The University of Adelaide Research Unit on Military Law and Ethics have spearheaded a project to draft the Manual on the International Law Applicable to the Military Use of Outer Space,[4] in the vein of the Tallinn Manual on Cyber Operations.[5] The Secure World Foundation published a Handbook for New Actors in Space to assist new actors in conducting their space activities in a safe and sustainable manner.

Looking forward

Still, these efforts are no substitute for a comprehensive, forward-looking system of global space governance. Space is clearly at an inflection point. The global governance regime is being stressed by rapid technological innovation and geopolitical realities. The Outer Space Treaty presents an important framework, but the structure must be filled in, lest disparate interests carve out their own fragmented areas of influence. Should that happen, the risks of conflict escalation would grow; space actors would waste resources to build fortress-like protection around their space investments; and the pollution of the space environment would accumulate, perhaps spoiling its use for future generations. In this world, the most advanced and richest could reserve the benefits of space for themselves and leave the rest behind. But a different future is possible.

The golden anniversary of the Outer Space Treaty is a prime opportunity for the three depository states (United States, United Kingdom, Russia) to provide leadership and to convene a meeting, such as a review conference, to provide clarifying discussions about how different states view the balancing of freedom to use space for peaceful purposes, due regard to other actors, and the use of space to benefit all humankind. Or perhaps a new generation of space states or civil society will take the lead. The sense that space is fundamentally for peaceful purposes and that its use must be for the benefit of all humankind needs to be reaffirmed by practice and rhetoric, and the Treaty's basic principles must be elaborated to govern new challenges.