SPACE POLICY AND SUSTAINABILITY

ISSUE BRIEFING FOR THE BIDEN ADMINISTRATION

December 2020

PRESENTED BY

Secure World Foundation

Promoting Cooperative Solutions For Space Sustainability

Outer space activities are more important to the United States now than at almost any time in our history. Space technology and services provide critical national security capabilities, scientific knowledge, economic opportunities, and the tools to understand and respond to a changing climate. The rapid growth in new actors conducting space activities, an increasing number of active satellites and debris objects, and the growing potential for conflict create both opportunities and challenges that require timely policy responses from the incoming administration. As the Biden administration begins setting its policy agenda for the next four years, Secure World Foundation has developed an issue brief to provide background and recommendations on key issues to help the U.S. meet current and emerging challenges in outer space. This brief contains recommendations on issues ranging from fostering a vibrant commercial space sector to dealing with threats from counterspace capabilities.

ABOUT SWF

OUR MISSION

The mission of the Secure World Foundation (SWF) is to work with governments, industry, international organizations, and civil society to develop and promote ideas and actions to achieve the secure, sustainable, and peaceful uses of outer space benefiting Earth and all its peoples.

BACKGROUND

As the only organization devoted entirely to space sustainability, the Secure World Foundation strives to be a trusted and objective source of leadership and information on space security, sustainability, and the use of space for benefits on Earth. We use a global and pragmatic lens to study and evaluate proposed solutions to improve the governance of outer space. While recognizing the complexities of the international political environment, SWF works to encourage and build relationships with all willing stakeholders in space activities, including government, commercial, military, civil society, and academic actors. Central to this approach is increasing knowledge about the space environment and the need to maintain its stability, promoting international cooperation and dialogue, and helping all space actors realize the benefits that space technologies and capabilities can provide.

SWF ACTS AS A RESEARCH BODY, CONVENER AND FACILITATOR TO PROMOTE KEY SPACE SECURITY AND OTHER SPACE RELATED TOPICS AND TO EXAMINE THEIR INFLUENCE ON GOVERNANCE AND INTERNATIONAL DEVELOPMENT.

TABLE OF CONTENTS

LIST OF ACRONYMS

AFSPC	Air Force Space Command
ASAT	Anti-Satellite
CD	Conference on Disarmament
CME	Coronal mass ejections
COSPAR	Committee on Space Research
DART	Double Asteroid Redirection Test
DHS	Department of Homeland Security
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
FAA	Federal Aviation Administration
FAA/AST	FAA's Office of Commercial Space Transportation
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
GPS	Global Positioning System
IADC	Inter-Agency Orbital Debris Coordination Committee
IAWN	International Asteroid Warning Network
IOT	Internet of Things
IPO	Initial Public Offering
ISRU	In-Situ Resource Utilization
ITU	International Telecommunication Union
LEO	Low Earth orbit
NASC	National Aeronautics and Space Council
NED	Nuclear Explosive Device
NEI	Non-Earth Imaging
NEO	Near Earth Object
NEOSM	NEO Surveillance Mission
NOAA	National Oceanic and Atmospheric Administration
NSC	National Security Council
NSP	National Space Policy
NSpC	National Space Council
NSTC	National Science and Technology Council
ODMSP	Orbital Debris Mitigation Standard Practices
OSTP	Office of Science and Technology Policy
PAROS	Prevention of an Arms Race in Outer Space
PDCO	Planetary Defense Coordination Office
PNT	Position, Navigation, and Timing
ROI	Return On Investment
SMPAG	Space Mission Planning and Advisory Group
SPD	Space Policy Directive
SSA	Space Situational Awareness
STM	Space Traffic Management
SWORM	Space Weather Operations, Research, and Mitigation
UAG	Users Advisory Group
UN COPUOS	United Nations Committee on the Peaceful Uses of Outer Space
USSF	U.S. Space Force
USSPACECOM	U.S. Space Command

EXECUTIVE SUMMARY

Outer space activities are more important to the United States now than at almost any time in our history. Space technology and services provide critical national security capabilities, scientific knowledge, economic opportunities, and the tools to understand and respond to a changing climate. At the same time, the space domain is becoming increasingly complex and congested, and there is no guarantee that space will continue to be a secure, sustainable, and peaceful environment. Three major trends, the rapid growth in new actors conducting space activities, an increasing number of active satellites and debris objects, and the growing potential for conflict, create both opportunities and challenges that require timely policy responses. As the world's leading space power, the United States can remain at the forefront of most space activities, and is well-positioned to enable global coalitions that leverage the contributions of space activities for security, economic, and societal benefits.

Under the leadership of the recently reestablished National Space Council, solid progress was made on updating space-related policy for the changing space situation. While some of the Trump administration's space policy decisions and initiatives have generated criticism, that is more due to the political rhetoric accompanying them than the substance. Many of the Trump administration's space policy decisions built on work started under the Obama administration and continue long-standing principles and goals that have persisted across administrations, Republican and Democrat, because they reflect core American values and national interests. First and foremost among those interests is sustained U.S. international leadership in ensuring the long-term sustainability, safety, and security of the space domain and space activities. This is not done out of pure altruism, but to ensure that that we – the United States, our citizens, government, and companies – can continue to use space for benefits into the future.

We urge the Biden administration to place a high priority on supporting U.S. space activities by building on recent national space policy decisions that reflect long-standing U.S. principles while abandoning the divisive and antagonistic rhetoric that has accompanied those policy changes. Consistency across key national space efforts, such as retaining the National Space Council and building out the commercial space sector, the Space Force, and the Artemis Program and Accords, will help move the United States forward and demonstrate stability to international partners by avoiding the constant reset and lack of strategic direction that has happened in the past during presidential transitions. At the same time, there are significant challenges that remain unresolved and will need bold leadership, both at home and abroad, to be fully addressed.

AS THE WORLD'S LEADING SPACE POWER AND USER OF SPACE, IT IS IN THE INTERESTS OF THE UNITED STATES TO BE AT THE VANGUARD OF ESTABLISHING AND PROMOTING BEST PRACTICES FOR SAFE

The following are the compiled recommendations across all areas of U.S. space policy.

INTERAGENCY SPACE POLICY PROCESS

- Keep the National Space Council.
- Reform the Users Advisory Group.

ORBITAL DEBRIS

- Give NASA the authority to develop and execute a space environmental management plan.
- Centralize orbital debris mitigation requirements under one regulatory agency.
- Lead the creation of incentives for responsible behavior in space.

SPACE WEATHER

- Prioritize ensuring baseline observational capabilities.
- Work with international partners to augment observations and research.
- Support the development of commercial space weather services.

SPACE SITUATIONAL AWARENESS AND SPACE TRAFFIC MANAGEMENT

- Swiftly implement civil SSA and STM authority in a federal agency.
- Leverage commercial and international capabilities to the maximum extent while also supporting SSA as a public good.

NATIONAL SECURITY SPACE

- Redouble efforts to improve resilience.
- Establish norms of behavior for military space activities.
- Lay the foundation for focused space arms control.

SPACE DIPLOMACY

- Engage with and through multilateral fora to help shape international consensus on norms of behavior to enhance safety, stability, and sustainability in space.
- Implement the principles in the Artemis Accords to strengthen international space governance.
- Increase engagement with domestic commercial and other non-governmental stakeholders in support of U.S. international space diplomacy objectives.

U.S. SPACE FORCE

- Consolidate military space acquisitions authority under the USSF.
- Clarify the future missions for the USSF and its role in U.S. space activities.
- Develop a national consensus on space deterrence doctrine.

U.S. – CHINA ENGAGEMENT

- Modify the Wolf Amendment to allow for limited space engagement with China
- Increase understanding of the Chinese space sector.

EARTH OBSERVATION

- Support continuity of service for all Earth observing satellite capabilities and continue to champion free and open data sharing principles.
- Enable commercial sector value-added services and promote a thriving American commercial remote sensing industry.
- Recommit to contributing to global problems and promote the role of Earth observation in addressing these challenges.

REGULATION AND OVERSIGHT

- Provide predictability for commercial actors seeking regulatory approval.
- Clarify to commercial actors that they are required to abide by international legal principles.

COMMERCIAL SPACE

- Review, update, and implement the Commercial Space Guidelines in the National Space Policy.
- Establish an international dialogue on regulating commercial space.

MEGACONSTELLATIONS

- Ensure orbital debris mitigation requirements address the challenges posed by megaconstellations.
- Adapt existing licenses to include new findings and mitigation requirements as they emerge.
- Develop contingency measures for the possibility of megaconstellation operators ceasing business with spacecraft already in space.

CISLUNAR SPACE

- Sustain stable commitment to the Artemis Program.
- Continue work to implement Artemis Accords with the international community.
- Continue multilateral engagement on space resources governance.
- Implement the National Moon-Mars Development Strategy.

PLANETARY DEFENSE

- Give NASA the resources to complete the detection, cataloging, and characterization of all Near Earth Objects (NEOs) 140 meters and larger.
- Clarify the existing rules, rights, and responsibilities for a NEO deflection mission and the legality of using nuclear explosive devices.
- Implement a strategy to achieve the goals of interagency, federal, state, and local preparedness outlined in the 2018 Near-Earth Object Preparedness Strategy and Action Plan.

WHY SPACE (AND SPACE POLICY) IS IMPORTANT TO AMERICA

Space activities have garnered much broader public attention in recent years due to the massive changes and advances that are happening. Earlier this year, much of the world watched as a spacecraft designed and built by a private company launched humans into space for the first time. It was also the first time in nearly a decade that humans had been launched from U.S. soil, marking the return of a capability lost with the end of the Space Transportation System (Space Shuttle) program in 2011. Coupled with the launching of large constellations of satellites that could one day provide broadband internet access to millions, the public is interested in space.

Behind the scenes, space capabilities play an ever greater role in improving the lives of every American. GPS services have become ubiquitous to the point that many don't even realize it comes from a constellation of U.S. military satellites 12,000 miles above Earth. Other government and commercial satellites feed critical data into weather forecasts and climate models, helping scientists provide improved warnings of severe weather and its impact on communities. Still more commercial and government satellites serve as critical links in the global telecommunications network, particularly for serving remote and isolated communities and our military overseas.

The recent space successes and continuing benefits are the result of prescient space policy decisions. From the decision by the Clinton administration to provide full accuracy for civil GPS signals, to the Reagan administration's decision to open up space for commercial participation, to the Obama administration's decision to go ahead with NASA's Commercial Crew Program, space policy decisions can affect the daily lives of everyone and be visible like few other government policy decisions can.

Nearly every U.S. presidential administration since Eisenhower has issued national space policies. The Trump administration is no different and sought to bring renewed focus and public visibility to space policy. While some of the Trump administration's decisions and initiatives in the realm of space activities have occasioned criticism, that is more due to the political rhetoric accompanying them than the substance. Many of the Trump administration's space policy decisions continue long-standing principles and goals that have persisted across administrations, Republican and Democrat, because they reflect core American values and national interests. First and foremost among those interests is sustained U.S. international leadership in ensuring the long-term sustainability, safety, and security of the space domain and space activities. This is not done out of pure altruism, but to ensure that we – the United States, our citizens, government, and companies – can continue to use space for benefits into the future.

It is our sincere hope that the incoming administration places a high priority on space policy and reinforces the recent national space policy decisions that reflect long-standing U.S. principles while abandoning the divisive and antagonistic rhetoric. At the same time, there are challenges and problems that remain unresolved and will need to be addressed by the next administration. This briefing book serves as a quick, handy, and concise guide to identifying and understanding major space policy issues and guidance on how to meet their challenges.

THE CURRENT LANDSCAPE

Since the start of the space age with the launch of Sputnik in 1957, the space environment has become increasingly complex. More new actors, including governments and industry operators, are fielding space systems and developing more terrestrial applications and benefits that rely upon those space systems. This trend has accelerated in recent years as the space domain shifts from a government-driven domain to a multi-user domain (government, industry, academia). **Space is a key element of diplomatic and national security strategies and is an element of policies to advance scientific knowledge and societal benefit. Increasingly, space is also becoming an element of commercial and economic strategy and policy.** As the world's leading space power, the United States remains at the forefront of most space sector developments, although both allied and competitor nations are rapidly increasing their capabilities.

As of September 2020, over 3,000 functional satellites orbit Earth, providing tangible social, scientific, strategic, and economic benefits to billions of individuals throughout the globe. Roughly half of these satellites are operated by American agencies, companies, or organizations. U.S. commercial companies currently operate nearly three-quarters of U.S. satellites on orbit. As of August 2020, 84 countries operate satellites. Many of these commercial and governmental actors in space are new to the domain, and may be not fully aware of existing operational best practices for safe and sustainable space operations.

Human activities in space have also created an increasing density of debris in orbit. Orbital debris – dead satellites, spent rocket stages, and other fragments associated with humanity's activity in space – represents a growing threat to active satellites. The United States is currently tracking roughly 25,000 objects in Earth orbit, most of which are pieces of human-generated (anthropogenic) orbital debris larger than 10 centimeters (4 inches) in size, each of which could destroy an active satellite in a collision. Statistical modeling indicates there are as many as 900,000 pieces of orbital debris between 1 and 10 centimeters (0.4 to 4 inches) in size that are largely untracked, each of which could severely damage an active satellite in a collision. **Continued growth in orbital debris population, and failure to implement improved spacecraft operations practices, could lead to a sharp decrease in our ability to sustain the benefits that space systems provide to the entire world.**

The United States is currently the world leader in tracking and providing knowledge about the space environment and human activities in space, a capability set known as Space Situational Awareness (SSA). As the space environment becomes more complex, with more actors and increasing potential interactions among satellite operators, SSA capabilities are becoming increasingly critical to safety of operations. The United States provides certain SSA information to the global community as a matter of safety of spaceflight and has over 100 SSA sharing agreements signed with countries, companies, and intergovernmental organizations (IGOs) that allow for the sharing of more specific SSA data.

Space applications also provide a critical service in supporting human and environmental security functions on Earth. Space systems, including position, navigation and timing (PNT), Earth observation, and telecommunications satellites, provide significant benefits in supporting a wide variety of human and environmental concerns. American capabilities and systems are a key part of a global system of

space applications. The full utility of these important systems can be blunted by a variety of institutional, policy, educational, and social barriers. As a result, benefits from these systems do not always adequately reach decision makers or citizens when they need it most.

Space technologies also play an important role in both national and international security. The military use of space includes spacecraft designed to support terrestrial military and intelligence operations, such as global PNT systems, communications, intelligence, reconnaissance, and surveillance satellites. As more countries integrate space into their national military capabilities and rely on space-based information for national security, there is an increased chance that any interference (either actual or perceived) with satellites could spark or escalate tensions and conflict in space or on Earth. This is made more difficult by the challenge of determining the exact cause of a satellite malfunction. Several countries are developing or have developed a range of counterspace capabilities, including ground and space-based objects, that could be used to deceive, disrupt, deny, degrade, or destroy elements of space systems.

As space activities have grown, a multilateral governance and coordination system has evolved. The principal international fora for discussing questions related to space affairs are the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS), the International Telecommunication Union (ITU), and the Conference on Disarmament (CD). Of these fora, COPUOS is the leading multilateral body for discussing questions of international cooperation in space activities. It was responsible for crafting the 1967 Outer Space Treaty, which set out the foundations of international space law that were elaborated upon in later agreements. From its initial 24 founding members in 1959, the membership of COPUOS has increased to 95 states, and more states are applying for membership of this Committee each year, underscoring the growing number of space actors. The United States has historically been an active and leading participant in multilateral discussion of space governance, and has helped to shape a principles-based governance regime that has been largely supportive of space activities.

Domestically, many agencies have a role in space policy and regulation in the United States. These include the Departments of Defense, Commerce, Transportation, Energy, and State, as well as specialized agencies such as NASA and the Federal Communications Commission. Agencies may act in a regulatory role, a promotion role, a user role or a development role, or some combination of these. The Trump administration established the National Space Council as the main hub for interagency coordination on space policy and expanded its membership to include additional agencies. This reinstatement has served a useful purpose in improving whole-of-government consideration of space activities within the Executive Branch. Congress also has an active interest in space activities and regulation, with space-focused subcommittees in both chambers of Congress. Space has often been seen as a somewhat non-partisan issue in Congress, with differences between chambers or geographical constituencies often playing more of a role than party affiliation.

All told, space is undergoing significant changes. The rapid growth in the number of satellites, actors in space, and types of space activities is creating new economic opportunities and potential socioeconomic benefits, but is also generating potential challenges for continuing to use space in a sustainable manner.

WHAT IS SPACE SUSTAINABILITY, AND WHY IS IT IMPORTANT?

The more than 3,000 active satellites currently orbiting Earth provide tangible social, scientific, security, and economic benefits to billions of individuals all over the globe. Yet the ability to continue to provide these important benefits from outer space is now threatened by a number of challenges. Earth's orbital space environment constitutes a finite resource that is being used by an increasing number of space actors. The proliferation of space debris, the emergence of a large number of new space actors, the rapidly increasing number of operational satellites in orbit, and the increasing variety and complexity of space operations pose increased risks of collision and interference with the operation of space objects. In addition, the increasing use of space by militaries around the world creates the potential to spark or escalate conflict. As more countries integrate space into their national military capabilities and rely on space-based information for their national security, there is an increased chance that any interference with satellites could spark or escalate tensions and conflict in space or on Earth.

Taken together, all of these developments pose risks to the safety of space operations and raise concerns about the potential for severe degradation of the space environment, rendering it unusable for the space systems that form part of the critical infrastructure of many states, as well as the many other space systems that provide economically important space-derived information and services used by billions of people on a daily basis.

Space sustainability refers to addressing these challenges collectively to ensure that the space environment remains suitable for exploration and use by the current and future generations of all countries. Such is the growing international concern about space sustainability that in 2019, UN COPUOS adopted a set of 21 internationally agreed consensus guidelines for the long-term sustainability of outer space activities. In the preamble to these guidelines, space sustainability is defined as "the ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations."

As the world's leading space power and user of space, it is in the interests of the United States to be at the vanguard of establishing and promoting best practices for safe and sustainable conduct of space activities. This issue briefing examines the space landscape and developments in the space arena from a space sustainability perspective and suggests ways in which the United States is well placed to provide leadership to the international space community.

The following sections address specific areas of space policy that should be priorities for the Biden administration to work with Congress on addressing.

IMPROVING THE INTERAGENCY SPACE POLICY PROCESS

Creating national space policy needs to be a whole-of-government process that integrates perspectives, capabilities, and interests from across the federal government. Since the 1950s, every U.S. administration has had an interagency process for creating national space policy, although in many cases it was not a separate or unique process solely for outer space issues. In 2017, the Trump administration revived the National Space Council to formalize a separate space policy process and raise its visibility within the federal bureaucracy and the public.

BACKGROUND

Understanding how, and why, governments choose a course of action on an issue is one of the enduring problems in public policy and public administration. Policy decisions on dual-use technology (such as those involved in much of space activities) are particularly challenging as they require balancing the national security aspects with the potential societal and economic benefits. Over the last several decades, dual-use space technology has emerged as a critical enabler of both national security and broader societal and economic benefits. The U.S. military's Global Positioning System (GPS), for example, provides critical services to enable U.S. military operations but also supports global banking and transportation services and even the daily life of many Americans. Thus, there is a need for a process at the federal level that brings together multiple different agencies and departments to deliberate, debate, and resolve U.S. national policy on how space capabilities are developed and used.

The process used to create national space policy has changed and evolved over time. The first U.S. national space policy was issued by the Eisenhower administration in 1959 and developed using the same National Security Council (NSC) process as was used for many other national security decisions. The NSC was created by President Truman and was designed to be a discussion body with a permanent staff that helps formulate and debate policy issues that ultimately need a presidential decision. Under George H.W. Bush, the NSC process itself was formalized into a three-level model with the Policy Coordinating Committees, Deputies Committee, and Principals Committee to help ensure that only those specific debates which could not be resolved at the lower levels were elevated "up the chain," eventually to the president.

Later, the Eisenhower administration created the National Aeronautics and Space Council (NASC), which was eventually chaired by Vice President Nixon. The NASC and role of Vice President continued under the Kennedy administration. The Nixon administration dissolved the NASC, preferring instead to use separate task groups for non-national security space decisions, a process continued through the Reagan administration. The NASC was resurrected by Congress as the National Space Council (NSpC) during the transition to the George H.W. Bush administration. Subsequent administrations decided to not staff or use the NSpC, preferring instead to use the NSC or National Science and Technology Council (NSTC) run by the White House's Office of Science and Technology Policy (OSTP). The Trump administration revived the NSpC by staffing it, using it to coordinate a set of national space policy decisions, and holding periodic public meetings to discuss space policy issues.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

The revived NSpC has largely been successful in establishing an efficient process for discussing, debating, and finalizing national space policy. Over the last three years, the NSpC issued five major space policy decisions that reestablished the Moon as the near-term human spaceflight goal, directed an overhaul of the regulatory framework for oversight of U.S. commercial space activities, established the first ever U.S. national policy on space traffic management, laid the foundation for the establishment of the U.S. Space Force, and provided cybersecurity principles for protecting space systems.

The Trump administration has also used the NSpC to increase the political priority and public visibility of space policy. Vice President Pence has been actively engaged in space policy decisions as the Chair of the NSpC and has led several public meetings of the NSpC that included relatively high-level representatives from multiple federal agencies. In accordance with Public Law 101-611, the Trump administration also created a new Users Advisory Group (UAG) to serve as a Federal Advisory Committee to the NSpC for the purpose of bringing in perspectives from the private sector to give advice and recommendations to the NSpC. The UAG has held five public meetings and provided several formal recommendations to the NSpC.

Despite the successes, there have been several shortcomings of the Trump administration's approach to space policymaking. The first is that the high level political attention has increased the perceived partisanship of space policy decisions. Space was long seen as a nonpartisan topic, but President Trump has explicitly taken personal credit for many space policy decisions and tied them closely to his reelection, potentially resulting in a partisan backlash against those decisions. The second shortcoming has been in implementation of space policy decisions. While implementation is an issue in every administration, the highly publicized and politicized nature of the Trump administration's space policy decisions have made implementation harder in several areas. The third shortcoming is the growing perception that the public NSpC meetings are more staged events than serious discussions of space policy, prompting much of the previous public excitement to fade. Finally, the UAG contains several members whose only qualifications are their political connections and very few representatives of the actual end users of space applications, an important group that has often been underrepresented in space policymaking.

POLICY RECOMMENDATIONS

Keep the National Space Council. The Biden administration should continue to use the NSpC as the main body for developing national space policy. They must staff the NSpC with experts who both understand the interagency process and the importance of space.

Reform the Users Advisory Group. The UAG should be reformed to include more representatives from the key space user communities, including civil applications such as weather forecasting, economic development, and transportation, as well as increasing the participation from academia and civil society.

MANAGING THE RISK FROM ORBITAL DEBRIS

Orbital debris consists of the dead satellites, spent rocket stages, and other bits and pieces that have accumulated in orbit around the Earth over the last 60 years and presents a hazard to future space activities. Managing this risk is a collective action problem that will require stakeholders to adopt new practices and accept costs now to forestall large negative impacts to space activities in the future.

BACKGROUND

Orbital debris – dead satellites, spent rocket stages, and other fragments associated with humanity's six decades of activity in space – represents a growing threat to active satellites. The United States is currently tracking about 25,000 pieces of human-generated debris in Earth orbit larger than 10 centimeters (4 inches) in size, each of which could destroy an active satellite in a collision. Statistical modeling indicates there are an estimated 900,000 pieces of orbital debris between 1 and 10 centimeters (0.4 to 4 inches) in size that are largely untracked, each of which could severely damage an active satellite in a collision. This existing orbital debris is largely concentrated in the same altitudes that are heavily used by satellites, and in particular low Earth orbit between 600 and 900 kilometers and geostationary earth orbit at 36,000 kilometers.

The so-called "Kessler Syndrome" predicts that there would be a critical point where the density of orbital debris would lead to random collisions between orbital debris. These random collisions would in turn generate more debris at a rate faster than orbital debris is naturally removed from orbit by the Earth's atmosphere. Although this process takes place relatively slowly over decades or centuries, we are already seeing it impose a cost on space activities. Satellites operating in congested regions have to manage a growing number of close approach warnings and potentially expend fuel to avoid potential collisions. As the amount of both orbital debris and active satellites grows, this may make some space activities too risky or unprofitable to continue.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

Since the early 1990s, the main policy effort to deal with orbital debris has been to develop mitigation practices that reduce the creation of orbital debris through space activities. More than a dozen national space agencies participate in the Inter-Agency Orbital Debris Coordination Committee (IADC) to develop technical standards for orbital debris mitigation. While the IADC standards themselves are voluntary, a growing number of countries have put in place national policies and regulatory frameworks to implement these mitigation standards. A growing number of private sector efforts have also established their own best practices that often go beyond the IADC standards established by governments.

In the United States, NASA is the lead agency for developing the technical standards, which are encapsulated in the U.S. Government Orbital Debris Mitigation Standard Practices (ODMSP). Other federal agencies are expected to apply the ODMSP to their own space activities and implement them in their licensing of U.S. private sector space activities. However, there are differences in how each agency has implemented the ODMSP and concerns that the ODMSP have not gone far enough to address the emerging

challenges posed by small satellites and large constellations.

While mitigation reduces future growth in the orbital debris population, it does nothing to deal with the existing debris. Remediation, or active removal of orbital debris, is thus also necessary. There has been significant technical work done to develop remediation concepts, but a lack of government funding and commercial viability has hindered progress. Despite high-level policy direction to do so, the U.S. government has invested very little in research and development of remediation capabilities and currently lacks an overall development strategy and a federal agency with the authority to develop and execute such a strategy.

STATISTICAL MODELING INDICATES THERE ARE AN ESTIMATED 900,000 PIECES OF ORBITAL DEBRIS BETWEEN 1 AND 10 CENTIMETERS (0.4 TO 4 INCHES) IN SIZE THAT ARE LARGELY UNTRACKED, EACH OF WHICH COULD SEVERELY DAMAGE AN ACTIVE SATELLITE IN A COLLISION.

POLICY RECOMMENDATIONS

Give NASA the authority to develop and execute a space environmental management plan. Congress, in coordination with the Executive Branch, should give NASA clear authority to develop a holistic strategy for space environmental management, including conducting basic research into understanding and modeling the problem, developing standards for orbital debris mitigation, and a remediation action plan, and the resources to work with other agencies and the private sector to carry out that strategy.

Centralize orbital debris mitigation requirements under one regulatory agency. Currently, orbital debris mitigation requirements are part of licenses issued by three different U.S. federal agencies (the Federal Aviation Administration, the National Oceanic and Atmospheric Administration, and the Federal Communications Commission). Instead, a single federal agency should be tasked with enforcing orbital debris mitigation requirements for all U.S. private sector space activities, ideally as part of a civil space situational awareness or space traffic management authority.

Lead the creation of incentives for responsible behavior in space. The U.S. government should lead the creation of positive and negative incentives to encourage responsible behavior in space by both government and private sector actors.

SPACE WEATHER

Space weather is a natural threat to objects in space and on Earth and affects the sustainable use of space. The Obama and Trump administrations sought to better organize and task the various space weather-related agencies to enhance preparedness, augment research and operational forecasting, and establish plans for response and recovery. In October 2020, President Trump signed authorizing legislation to codify this cooperation in law. The next administration's goals should be to execute this strategy, engage internationally to build global capacity, and ensure the reliability of solar-monitoring data from ground and space-based observatories, especially in light of the rising solar maximum of solar cycle 25.

BACKGROUND

During the Sun's roughly 11-year cycles, activity ebbs and flows as the solar magnetic field changes orientation from north to south, or vice versa. 2020 marks the beginning of a new cycle as the Sun comes out of a period of less activity, or a solar minimum, and builds over the next five years to a solar maximum. Minimum and maximum differ by activity and are measured in sunspots, or what appear to be dark regions on the surface of the visible Sun. Sunspots are areas of high magnetic activity where magnetic field lines become entangled and possibly lead to solar flares and coronal mass ejections (CMEs). Solar minimums have fewer sunspots, and therefore less activity, other than modulations in the solar wind. Solar maximums have more sunspots and therefore a greater potential for flares, CMEs, and other related phenomena, like radiation storms.

These phenomena interact with the Earth's magnetic field and can produce effects as benign as beautiful aurora, or as dangerous as satellite anomalies, increased radiation exposure for airline passengers, power grid failures, and radiocommunications blackouts on the side of Earth facing the Sun. Additionally, solar activity expands and contracts the Earth's atmosphere. The outer layers of the atmosphere interact with satellites to increase or decrease drag, shortening orbital lifetimes, but also throwing off orbital propagation models used for predicting the future location of objects, both of which affect space situational awareness.

Following roughly 20 years of on-again off-again collaboration, U.S. executive branch space weather activities were solidified in 2015 with the Obama administration's Space Weather Strategy and Action Plan. The Strategy and Action Plan laid out the structure and vision for the Space Weather Operations, Research, and Mitigation (SWORM) Task Force within the National Science and Technology Council. Including principals from multiple departments, agencies, and the Executive Office of the President, the SWORM laid out high level strategic goals and plans to achieve them. Without Congress formalizing this structure, it was unclear if the Trump administration would continue this effort. Thankfully, the new administration maintained relative continuity and updated the Strategy and Action Plan in March 2019.

On the legislative side, different versions of authorizing legislation related to government space weather activities have existed in the 115th and 116th Congresses. In mid-September of 2020, the House approved legislation that the Senate passed in July. The PROSWIFT Act was then signed into law on October 21, 2020 by President Trump. Largely, this legislation codifies the SWORM activities into authorizing legislation and suggests some additional specific appropriations. Paramount among these legislative mandates to the executive branch is sustaining and advancing critical space

weather observations. It also creates a Space Weather Advisory Group whose first task will be to conduct a user survey to identify needs for research, observation, and other capabilities that support space weather-related services and allows NOAA to establish a pilot program to offer contracts with entities in the commercial space weather sector for providing NOAA with space weather data that meets certain standards.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

The entities of the U.S. government that are focused on space weather are headed in the right direction. However, there is a danger these gains in collaboration could be shortlived; further, there are emerging areas that require additional action. For instance, space weather research is a key challenge to the government-led human space exploration agenda, as dangerous levels of radiation remain a challenge for long-duration space missions on the Moon, Mars, or en route to either. For instance, in between Apollo 16 and 17, a radiation storm struck the Earth-Moon system that would have killed any astronauts outside of the Earth's magnetic field. Today, private recreational spaceflight from companies like Virgin Galactic, Blue Origin, and SpaceX also faces the radiation challenge, but with the additional complication of being for paying and potentially litigious customers.

Outside of the directly human-related challenges, space situational awareness (SSA), the tracking and cataloging of space objects orbiting Earth, relies heavily on space weather models that work to make near-Earth orbits predictable. As the low Earth orbit satellite population balloons in the coming years, better SSA will require much more precise understanding and forecasting capabilities from the space weather community. Additionally, the large growth of the smaller satellite population in the last five years means that a large number of satellite operators are about to enter their first period of solar maximum with little or no understanding of how their satellites will fare in a significantly degraded environment.

POLICY RECOMMENDATIONS

Prioritize ensuring baseline observational capabilities. The solar observing satellites and other infrastructure are aging, and unexpected failures could lead to gaps in data collection. As solar cycle 25 begins, the erosion of capabilities across the solar-observation fleet will only increase. In order to maintain data collection to advance monitoring and forecasting of extreme space weather, a pipeline of new space- and ground-based observing systems must be initiated to ensure near real-time coronal mass ejection imagery, solar wind, solar imaging, coronal imagery, and other relevant observations.

Work with international partners to augment observations and research. The United States spends the largest amount of money on space-weather focused science across the world. Yet, regional monitoring and capacity are necessary to better understand and mitigate the effects of space weather on localities around the world. U.S. leadership in these efforts can build global capacity and can work to augment capabilities rather than duplicating efforts. In the short-term, work with European partners to revitalize and launch their L5 solar monitoring mission.

Support the development of commercial space weather services. Satellite companies, hardware manufacturers, researchers with operational concepts, and others are in the nascent stages of developing a commercial space weather enterprise. Radiation monitoring on commercial airplanes, paying commercial satellite operators for anomaly data that they're otherwise reluctant to share, and purchasing other data to enhance space situational awareness are some of the lowest hanging fruit that governments could utilize to spark further innovation.

SPACE SITUATIONAL AWARENESS AND SPACE TRAFFIC MANAGEMENT

Space situational awareness and space traffic management are critical for protecting satellites and ensuring the long-term sustainable use of space. The United States needs to develop a more holistic approach that expands the authorities of federal civil agencies, incorporates private sector capabilities, and increases international collaboration.

BACKGROUND

Space situational awareness (SSA, also known as space surveillance and/or space domain awareness) is knowledge about the space environment and human activities in space. The space environment consists of hundreds of thousands of pieces of human-generated and naturally-occurring orbital debris and space weather that is created by the complex interaction of energy and particle emissions from the Sun and the Earth's magnetic field and atmosphere. More than 3,000 satellites currently operate in this complex space environment around Earth. These satellites provide a wide range of social and private benefits, including enhanced national and international security, more efficient use and management of natural resources, improved disaster warning and response, and near-instantaneous global communications and navigation.

SSA has historically been done by the military for national security reasons, with secondary missions to protect important civil space missions such as human spaceflight. The United States military operates a network of ground and space-based optical telescopes and ground-based radars that provide the bulk of our current knowledge about the space environment and human activities there. The military tracking capabilities are augmented by space weather measurements from scientific and meteorological satellites operated by civil agencies as well as the military. Russia, China, and the European Union also have significant SSA capabilities and many other countries are developing their own more limited national capabilities. Over the last several years, the private sector has also developed significant SSA capabilities that in some cases meet or exceed those of governments.

Space traffic management (STM) is the planning, coordination, and on-orbit synchronization of activities to enhance the safety, stability, and sustainability of operations in the space environment. While there are some parallels to traffic management in the air or maritime domains, the physics of how objects move in space (ie, orbital mechanics) present unique challenges. A near-term focus of STM is detecting and avoiding collisions between active satellites and other space objects, but also includes a broader array of policy and regulatory tools to provide oversight and management of space activities. Although the legal authority for implementing and enforcing this oversight is at the national level, there is a need for international coordination and harmonization of the underlying norms of behavior, best practices, standards, and rules.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

The growth in commercial, civil, and international space activities and overall

number of satellites has stretched the current military-led SSA framework to the breaking point. In 2010, the Obama administration began an interagency policy discussion on STM that concluded the portion of the SSA mission related to safety of spaceflight activities should be transferred from the Department of Defense (DOD) to a civil federal agency and leaned towards giving it to the Department of Transportation (DOT). In 2018, the Trump administration issued Space Policy Directive (SPD)-3, the first national policy on space traffic management, which assigned the responsibility for civil SSA and a future STM regime should be with the Department of Commerce (DOC). However, Congress has not yet made the required changes in legal authorities and budget to implement this policy directive at either DOT or DOC. In August 2020, a Congressionally directed study by the National Academy of Public Administration (NAPA) recommended that DOC be immediately given the authorities and appropriations to implement a civil SSA/STM function.

A key issue is how the federal government interacts with the private sector on SSA. The DOD's reliance on traditional defense contractors for developing its SSA capabilities has shut out new commercial entrants that are innovating faster and could provide lower-cost services. At the same time, the current model of providing free SSA data and services to all satellite operators from taxpayer-funded sensors has hindered the ability of those same commercial providers to find private sector customers and investment. Shifting to a purely private sector model for providing SSA data and services risks shutting out academic, scientific, not-for-profit, and other users who cannot afford to pay for access.

Existing regulations also hinder development of future on-orbit commercial SSA capabilities. U.S. commercial entities that wish to use satellites to provide SSA must get a commercial remote sensing license from the DOC, which currently includes significant restrictions for non-Earth imaging (NEI, i.e. detecting, tracking, and imaging other human-created space objects). These restrictions do not generally apply for foreign competitors and place U.S. companies at a disadvantage in the international market. While DOC is currently pushing to lessen the restrictions on NEI, that push is being resisted by the national security community.

POLICY RECOMMENDATIONS

Swiftly implement civil SSA and STM authority in a federal agency. Avoid starting over with yet another debate on where this responsibility should land. The Biden administration should work with Congress to implement SPD-3 and give the necessary authorities and budget to DOC and staff it with leaders who embrace the STM mission.

Leverage commercial and international capabilities to the maximum extent while also supporting SSA as a public good. Both the DOD and whichever agency has civil SSA and STM responsibility should purchase commercial SSA data and services and pursue international data sharing agreements in lieu of building new government capabilities. The United States should also make as much of that data publicly and freely available as possible. The private sector should be incentivized to develop innovative analytical tools and advanced services based on the public data.

SPACE AND NATIONAL SECURITY

Space capabilities are a crucial enabler for U.S. national security. Growing reliance on space and proliferation of counterspace capabilities have increased concerns about how to protect and defend U.S. space capabilities in future conflicts. Current U.S. policy focuses on increasing the resilience of space capabilities to deter attacks while also more closely integrating them with commercial and allied capabilities. Questions remain on how effective current resilience and reorganization efforts will be, as well as the role for offensive counterspace capabilities, norms of behavior, and space arms control.

BACKGROUND

Space capabilities are a key part of U.S. national security. Space-based services such as satellite communications, positioning, navigation, and timing, and remote sensing are critical force enablers for the U.S. military. Space capabilities also provide nuclear command and control and strategic warning that are fundamental to strategic stability. Many of these same services have also been incorporated into the global and U.S. economy. As such, any significant interruption – or even the implication or concern about it – could have serious implications for national security and societal and economic ripple effects.

Threats to space capabilities have changed over time. During the Cold War, both the United States and the Soviet Union considered space to be a warfighting domain and developed both offensive and defensive capabilities, although the threat of nuclear war deterred outright conflict in space. After the fall of the Soviet Union, the United States saw space as a potential sanctuary free from serious hostile threats and optimized space capabilities for performance. Since 2010, the renewed development of offensive counterspace capabilities, particularly by Russia and China, has sparked new concerns about how to best protect U.S. space assets and deter attacks.

Two main strategies exist to deter attacks. One is deterrence by denying the benefits of attacks, which can be done by making space systems more resilient to attacks. The second is by deterrence by threat of force, which can be done by having offensive capabilities to retaliate against an adversary's capabilities, in space or elsewhere. Denial deterrence presents significant bureaucratic and technological challenges, while deterrence by threat needs to overcome America's much greater reliance on space than its adversaries do.

There is also a diplomatic component to space security. Since the 1960s, the United States has played an active role in shaping global governance structures to suit its national interests, including security, with the last major effort being the 1975 Registration Convention. While the 1967 Outer Space Treaty includes a ban on placement of weapons of mass destruction in outer space and the Moon, there are generally no specific restrictions on testing or deployment of space weapons. There are also no agreed-upon norms of behavior for conducting military activities in space. Since the 1980s, there have been repeated UN resolutions about the need to deal with prevention of an arms race in outer space (PAROS). Since 2008, Russia and China have proposed initiatives to ban placement of weapons in outer space, but they have not

gained wide international acceptance. The United States has opposed those proposals, but has not offered any alternatives of its own, despite support for arms control in space being a standard part of nearly every U.S. national space policy since the 1950s.

The United States has also had a long-running debate about how best to organize its national security space capabilities to meet potential threats. The debate focused on whether space should have a separate military service or combatant command or be integrated into existing organizations, and whether military and intelligence space acquisitions and operations should be integrated or separate.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

The current U.S. National Space Policy (NSP) is from June 2010 and generally outlines efforts to strengthen stability in space and increase the resilience of U.S. space capabilities. In 2011, the Department of Defense and Office of the Director of National Intelligence released a National Security Space Strategy that further expanded on denial deterrence as the cornerstone of U.S. space security. In 2018, the Trump administration released the National Space Strategy that outlined four pillars: transform to more resilient space architectures; strengthen deterrence and warfighting options; improve foundational capabilities, structures, and processes; and foster conducive domestic and international environments.

The Trump administration also continued and expanded reorganization efforts began during the Obama administration. In December 2018, President Trump signed a memo directing the Secretary of Defense to re-establish U.S. Space Command (USSPACECOM), which had been shut down in 2002 to allow for U.S. Northern Command to be stood up in response to the 9/11 attacks. USSPACECOM would take over as the combatant command for space from the U.S. Strategic Command and be in charge of day-to-day military space operations. Congress passed legislation re-establishing USSPACECOM in August 2018 as the 11th unified combat command. In February 2019, President Trump signed SPD-4 that called for the creation of a separate U.S. Space Force (USSF) within the Department of the Air Force to oversee the operate, train, and equip functions for military space activities. Congress enacted the USSF in December 2019.

Since the Eisenhower administration, U.S. national policy has largely supported space arms control discussions that were verifiable, equitable, and in the U.S. interest. The United States played a critical role in established arms control principles in the Outer Space Treaty and bilateral nuclear treaties during the Cold War. In recent decades, the United States has stepped back from support for legally binding initiatives, preferring to promote non-binding agreements instead. There has also been increased resistance from the national security space community to agree to any limitation on U.S. freedom of action in space. The DOD has talked about developing norms of behavior for space activities since 2010, but to date has made little progress in doing so. Major reasons include the classification and secrecy of national security space activities and concerns about placing limitations on future U.S. actions in space.

POLICY RECOMMENDATIONS

Redouble efforts to improve resilience. The United States needs to quickly enact a multi-pronged approach to ensuring the resiliency of its space assets that includes more responsive space launch, proliferated satellite architectures across multiple orbits and payloads, and more use of commercial and allied capabilities.

Establish norms of behavior for military space activities. During the Cold War, the United States and Soviet Union agreed on how ships and aircraft would interact to reduce tensions and mishaps. The United States should work with other countries to establish similar agreements for military space activities, and particularly those that could cause misperceptions or increase tensions such as rendezvous and proximity operations and anti-satellite (ASAT) testing.

Lay the foundation for focused space arms control. The United States should begin laying the foundation for space arms control agreements that target specific actions, such as destructive ASAT testing that creates orbital debris. The United States should take steps to improve space situational awareness that can help verify such actions, declare a unilateral moratorium on debris-creating ASAT tests, and work with like-minded countries to stigmatize such testing.

SINCE 2010, THE RENEWED DEVELOPMENT OF OFFENSIVE COUNTERSPACE CAPABILITIES, PARTICULARLY BY RUSSIA AND CHINA, HAS SPARKED NEW CONCERNS ABOUT HOW TO BEST PROTECT U.S. SPACE ASSETS AND DETER ATTACKS.

SPACE DIPLOMACY

Space diplomacy and international cooperation are essential foreign policy tools to maintain U.S. leadership in space exploration and to preserve the access to and use of outer space as a domain that the United States relies on for its prosperity and international security. As more nations become spacefaring, and as more foreign commercial entities become space actors, the United States needs to strengthen its space diplomacy and international cooperation initiatives to provide leadership in promoting wide international adoption of norms, standards, and best practices to enhance the safety, stability, and security of space activities.

BACKGROUND

Space diplomacy is an essential foreign policy tool. Historically, U.S. multilateral diplomatic efforts have played a major role in the formulation, promotion, and enforcement of the international laws and norms that guide space activities. The United States has also used bilateral diplomatic efforts to strengthen its relationship with key allies and partners, to mutual benefit. In both its multilateral and bilateral efforts, the United States has helped enshrine U.S. values in the current space governance regime and shape the regime to benefit U.S. interests, including national security. **The United States should continue to lead the world in creating the conditions for a safe, stable, and operationally sustainable space environment.**

Over the last decade, U.S. diplomatic efforts have faced new challenges. The international landscape for space has become more complicated, with a growing number of countries with diverse interests and capacities becoming involved in space activities and governance discussions. The domestic landscape has also changed, with stronger push for nationalism and increased skepticism in some quarters of the value of international agreements. At the same time, there is renewed competition from a rising China and resurgent Russia, each of whom is pushing their own initiatives and attempting to seize the diplomatic initiative to advance their own interests.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

U.S. policy on space diplomacy since the 1970s has largely been to urge countries to adopt and implement the four main international space treaties, while blocking attempts to create additional binding legal agreements. The United States has also insisted that several key areas of legal uncertainty, such as the delimitation between air and space and the definition of "space weapons," cannot be resolved. At the same time, the United States has supported international discussions on voluntary guidelines for addressing orbital debris and space sustainability, including the recent agreement at the United Nations on 21 guidelines for the long-term sustainability of space activities.

However, partly as a result of these U.S. policies, the existing space governance framework has not kept up with the changing space domain. While the core principles enshrined in the Outer Space Treaty of 1967 and other major space treaties remain relevant, there is a lack of international consensus in how they are interpreted and gaps in implementation, particularly for the new types of space activities that are now emerging. In particular, there are a lack of agreed-upon norms of behavior for how future commercial, civil, and national security activities in space should be conducted to ensure the continued safety, security, and sustainability of the space domain.

The United States has launched a diplomatic effort as part of the Artemis program to return to the Moon by 2024 to address some of these gaps. NASA, in conjunction with the State Department, is currently negotiating bilateral agreements with potential partners in the Artemis program called the Artemis Accords. The first part of the Accords is a set of general principles that reinforce the existing international space treaties and how they are interpreted. If widely adopted, the Artemis Accords could help establish norms of behavior across a wide range of space activities. However, if adoption is limited to just a small number of close U.S. allies, the Accords could lead to a fragmentation in interpretation of outer space law and conflicting norms.

The United States also needs to play a stronger role in improving the effectiveness of the fora for space diplomacy. The principal forum for multilateral civil space diplomacy, the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS), has made many valuable contributions to the governance of space activities during the past half century. With the rapidly evolving space landscape, UN COPUOS has focused on space sustainability with fruitful results, but it needs a clear direction in terms of agenda-setting for productive discussions on cooperative governance of new kinds of space activities. The Conference on Disarmament, the principal multilateral disarmament forum, has discussed practical measures to promote space security, such as transparency and confidence building measures for space activities, with some success. However, discussions on the prevention of an arms race in outer space are deadlocked. The United States is well placed to provide more prominent leadership in these forums to enhance the safety, security, and sustainability of space activities, as well as U.S. national interests.

POLICY RECOMMENDATIONS

Engage with and through multilateral fora to help shape international consensus on norms of behavior to enhance safety, stability, and sustainability in space. The United States should identify responsible commercial, civil, and national security space behaviors that enhance safety, stability, and sustainability in space and lead by example in adopting them in its own space activities while encouraging other countries to follow suit.

Implement the principles in the Artemis Accords to strengthen international space governance. The United States should leverage its leadership in space exploration to preserve the stability, safety and security of the space environment and to support multilateral efforts to improve cooperative space governance.

Increase engagement with domestic commercial and other non-governmental stakeholders in support of U.S. international space diplomacy objectives. The United States should increase engagement with industry, academia, and civil society as stakeholders on space issues to ensure their perspectives are included in the development and articulation of U.S. foreign policy positions. In addition, the United States should harness the expertise in the commercial, academic, and non-profit sector to support engagement in informal dialogues that help to build and sustain international connections, relationships, information sharing, and confidence-building.

FOCUS ISSUE: THE U.S. SPACE FORCE

In December 2019, the United States Space Force (USSF) was officially created as the sixth military service, capping off a multi-decade debate over how best to organize U.S. military space activities. Although the immediate changes were small, the creation of the Space Force could lead to major future changes in how the U.S. military views space activities, its organizational culture, and develops its professional cadre and doctrine.

BACKGROUND

The United States has debated how best to organize and structure its military space forces since the start of the Space Age. Originally, the Army, Navy, and Air Force each had their own space forces and capabilities, but over time they were largely consolidated within the Air Force under Air Force Space Command (AFSPC), which had overall responsibility for recruiting, training, and equipping space forces. In January 2001, the Rumsfeld Commission Report sparked a new debate about how best to prepare for growing challenges and threats in space, memorably warning against a "space Pearl Harbor," but progress was sidelined with the wars in Afghanistan and Iraq. Beginning around 2013, growing counterspace threats from Russia, China, and others renewed the debate, leading to a series of reorganization efforts from the Executive Branch and Congress aimed at accelerating the development of new military space capabilities, improving the resilience of its space systems, and public discussions of space as a warfighting domain where military assets might be threatened or attacked. In late 2016, Rep. Mike Rogers (R-Alabama) began a bipartisan legislative push for creating a Space Corps within the Department of the Air Force, but it did not gain traction in the Senate. Meanwhile, the Air Force insisted it could reform to handle the space mission better.

On June 18, 2018, while signing SPD-3 on space traffic management, President Trump publicly directed General Joseph Dunford, Chairman of the Joint Chiefs of Staff, to create a Space Force as the sixth military service. The direction was a surprise to nearly everyone, including the top U.S. military leadership. In February 2019, President Trump signed SPD-4, which directed the DOD to develop a plan for establishing a Space Force within the Department of the Air Force as a step towards a completely separate department in the future. Congress debated the issue through the rest of 2019 and formally agreed to create the USSF as part of annual authorization legislation passed in December 2019 with bipartisan support.

Initially, the USSF will not involve major changes in U.S. military space operations, but it may lead to changes in the future. The USSF is planned to eventually be composed of 15,000-16,000 personnel, many of whom will be direct transfers from AFSPC and other existing Air Force space, cyber, and intelligence career fields. Congress has blocked transfers from other services to the USSF for the time being. The missions the USSF carries out and the capabilities it operates today are essentially the same as those historically done by AFSPC – primarily providing space capabilities to support terrestrial military operations – but may change in the future. While the overall goal is for the USSF to change the U.S. military's culture and approach towards space, it will take years or decades for those changes to manifest through the recruiting and training pipeline and development of space doctrine.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

The creation of the USSF by itself does not address or fix any of the major underlying challenges that drove the original debate.

The biggest unresolved policy gap is how to "fix" the way the military acquires new space capabilities. There is general agreement that the current process is too slow and rigid to respond to emerging threats, in part due to the lack of central authority. A study done by the Government Accountability Office in 2017 found more than 60 agencies had some say in space acquisitions, and to date that number has only gone up with the creation of new agencies such as the Space Development Agency and the USSF. The USSF also does not include the space acquisitions of the intelligence community, which will remain separate.

The second major policy challenge is defining the future mission of the Space Force and how much it will focus on in-space activities versus supporting terrestrial military activities. Some USSF proponents believe the focus should change from supporting terrestrial operations to activities in space, such as attacking or defending satellites and providing security for commercial mining and other speculative space activities. There is also a debate over whether the Space Force should put more emphasis on new destructive offensive counterspace capabilities. The United States has had such capabilities in the past, but since the 1980s, has relied mainly on non-kinetic counterspace capabilities, such as jamming and cyber attacks, to deal with adversary space threats. How such capabilities will complement, and not undermine, the broader U.S. national security space strategy is unclear and an important question to answer before they are developed, as is their impact on future commercial space investment and development.

The domestic political rhetoric surrounding the USSF has also created significant international concern and potential diplomatic challenges for the United States. Although other countries such as China and Russia had previously done their own military space reorganizations, President Trump's involvement in the USSF created much more media attention and controversy than similar Russian and Chinese efforts. In particular, the White House's insistence on American "space dominance," which does not appear in the official policy documents, and linking the USSF to human space exploration has created consternation, confusion, and apprehension internationally about the intended goals of the USSF. This undermines the ability of the United States to achieve other diplomatic goals, such as developing norms of behavior for space activities and marshalling international pressure on irresponsible actors.

POLICY RECOMMENDATIONS

Consolidate military space acquisitions authority under the USSF. Establish a coherent, efficient, and agile military space acquisitions enterprise that can meet the growing threat posed by great power actors. To the greatest extent possible, military space acquisition authority should be consolidated under the USSF. USSF should also establish clear links with the intelligence community to harmonize development of space capabilities, enhance resilience, and avoid duplication of effort.

Clarify the future missions for the USSF and its role in U.S. space activities. There are still considerable misperceptions among politicians and the public about the future role of the USSF and the distinction between its responsibilities and those of other agencies such as NASA. The next administration should make a clear policy statement about the future role of the USSF and the delineation between civil and military space activities in Earth orbit and beyond. The United States should also clarify the restrictions international law places on military space activities beyond Earth orbit.

Develop a national consensus on space deterrence doctrine. How best to deter attacks against space assets, and the role of space in deterring attacks on Earth remains a long-standing debate with significant political, legal, and commercial implications. The next administration should work to develop a consensus, whole-of-government approach to space deterrence that is made publicly available.

U.S. – CHINA ENGAGEMENT IN SPACE

For the last several decades, the United States has been unsettled by China's space programs and plans, which often reflects the larger United States-China relationship. In an attempt to constrain China's space program, the United States has put in place laws and policies that more often than not end up harming the United States while doing little to impede China's progress in space. While recognizing that China is a competitor, the United States can still benefit from finding ways in which to engage with one of the few other major space superpowers.

BACKGROUND

China's space program in many ways originated as a result of U.S. national security fears. The program was started by Qian Xuesen, who worked on the Manhattan Project and was one of the early scientists working on U.S. space projects at CalTech's Jet Propulsion Lab, until (unfounded) worries about him passing classified information to communists led to his security clearance being taken away in 1950 and five years of partial house arrest. He subsequently emigrated to China and helped to found their nuclear weapons and space programs. This set the tone for much of the way the United States has viewed China's space program: with great suspicion and responses that often exaggerated the threat while simultaneously creating the exact circumstances they were trying to prevent.

U.S. concerns about China's space program re-emerged in the late 1990s. After two launch failures of U.S. commercial satellites on Chinese rockets, U.S. companies provided technical information during the accident investigation that ended up improving the reliability of Chinese rockets for both space launch and ballistic missiles. In response, Congress imposed strict export controls on everything related to space. While these restrictions did not impede China's space program, they did harm the U.S. space industry, which lost significant global market share due to the rise of international competitors who were not hampered by similar export restrictions. Export controls on space technologies were loosened somewhat in 2014 but the damage had already been done.

Today, China is engaged in a long-running effort to develop the full breadth of space capabilities for scientific research and exploration, human spaceflight, and national security uses. It has robust human spaceflight capabilities and plans on assembling a space station in low Earth orbit in the early 2020s, two decades after being excluded from the International Space Station program, with human Moon landings at some point in the 2030s. China is developing its own space-based intelligence and reconnaissance capabilities, its own version of the Global Positioning System called BeiDou that has military applications, and is developing a suite of offensive counterspace capabilities aimed at deterring and negating U.S. capabilities in a future conflict. There has also been recent government and private sector funding towards developing a nascent commercial space sector in China.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

In 2011, Congress passed the Wolf amendment, named after Rep. Frank Wolf (R-Virginia), who was concerned about China's treatment of religious minorities. While it does not officially preclude U.S.-China bilateral cooperation in space, it requires the White House's Office

of Science Technology Policy or NASA to get certification by the FBI that no information will be shared with China and that none of the entities involved have human rights violations in order to engage with China bilaterally.

The Obama administration started two sets of bilateral exchanges with China, one on space safety and one on security. Space was also included in recent iterations of the bilateral Economic and Security Dialogue. The Trump administration has largely continued these dialogues, although without much public fanfare. China hawks have stoked concerns about China's lunar plans, often to the detriment of redirecting attention away from more pressing threats. Much of the reporting on China's planned Moon missions focus on its potential to threaten the United States and almost exclusively on this explanation as to why China is interested in these efforts. By isolating China from bilateral existing multilateral cooperative efforts in space, the United States has pushed China to launch its own space capabilities. Furthermore, this forced separation has allowed China to use its space program to create its own relationships with countries the United States has long ignored, particularly in Latin America and Africa. This has resulted in soft power advantages for China that have shown benefits in trade and diplomatic discussions.

POLICY RECOMMENDATIONS

Modify the Wolf Amendment to allow for limited space engagement with China. Congress should modify the Wolf Amendment to allow NASA to engage in space activities with China that support U.S. national interests. Priority areas for engagement include basic space science and research, robotic space exploration, and increased data sharing on space weather and orbital debris.

Increase understanding of the Chinese space sector. Congress should work with the administration to fund and carry out studies that systematically document and understand the structure and nature of the Chinese space ecosystem, how the industry is structured, the true relationships between the central government, the state-owned enterprises, and the private companies, the role of the provincial governments, how private capital operates in the Chinese space sector and how all of this relates to the space program priorities of the Chinese government.

THE UNITED STATES HAS PUT IN PLACE LAWS AND POLICIES THAT MORE OFTEN THAN NOT END UP HARMING THE UNITED STATES WHILE DOING LITTLE TO IMPEDE CHINA'S PROGRESS IN SPACE.

EARTH OBSERVATION

Monitoring the Earth and its environment from space contributes to scientific, social, economic, and political activities on Earth. Earth observation data and derived information and applications allow us to monitor and forecast weather conditions, measure land-use change such as deforestation, and monitor and respond to natural disasters. The United States needs to ensure continuity of service via developing both national and commercial capabilities, continue to improve the commercial licensing processes, champion open and free data sharing principles, and support Earth observation data's contributions to global initiatives.

BACKGROUND

In the more than 50 years since the first satellite was launched, space-based remote sensing, defined as the scanning of Earth by satellites in order to obtain information about it, has transformed from a small set of military-driven satellites producing low resolution images to thousands of government, commercial, and academic satellites producing a huge variety of datasets for civil, research, and military purposes. This technology and associated applications improve life on Earth in innumerable ways. For instance, Earth observation satellites allow us to assess the impacts of natural disasters, monitor land use, make weather predictions, measure ocean temperature, and create nautical charts.

For decades, the United States has been the clear leader in designing, manufacturing, and operating remote sensing satellite systems. One example has been the Geostationary Operational Environmental Satellite (GOES) series of satellites. A joint effort of NASA and NOAA beginning in 1975, the GOES series of spacecraft helps meteorologists observe and predict local weather events, including thunderstorms, tornadoes, fog, hurricanes, flash floods, and other severe weather. Also in the 1970s, NASA and USGS launched the Landsat program, which provides the longest continuous space-based record of Earth's land in existence and contributes to a better understanding of agriculture management, assessing regeneration of tropical forests, tracking forest fire damage, and other changes to land cover and use. These are just two examples of the cutting-edge and critical Earth observation technology supported by NASA, NOAA, USGS, NGA, and the DOD. Many other countries have also developed their own capabilities. Fueled by a changing regulatory landscape, improved launch capabilities, and innovations in manufacturing, recent years have also seen an explosion of commercial Earth observation capabilities including a growing array of optical, radar, hyperspectral and video imagery and data.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

Recognizing the importance of maintaining critical public services, enabling new discoveries, and advancing knowledge, the United States has sustained strong political support to ensure continuity of service for meteorological-related

satellites. Land-observing systems, equally important for the nation, have received less consistent study, funding, and coordination. Recent administrations have made good strides to address this instability, such as support for the Sustainable Land Imaging Technology Program, but better coordination across the many relevant agencies efforts is still needed. The United States Group on Earth Observations, a subcommittee under the National Science and Technology Council, is made up of a number of relevant Federal agencies and serves as the forum for coordinating, planning, and assessing government Earth observation activities and for finding ways to improve Earth system data management and interoperability throughout the government. While this group released the 2019 National Plan for Civil Earth Observations, the rapidly changing data needs across many government agencies and the incorporation of commercial data are highlighting the need for stronger coordination efforts from the White House. In the last four years, the United States government has signaled its unwillingness to fully support efforts to address global problems such as climate change, poverty, and disaster risk. Since Earth observation data is a key component to understanding and addressing these issues, the abdication of U.S. leadership is concerning.

Under multiple recent administrations, the United States has maintained as a core principle that Earth observation data are public goods, paid for by the American people, and that free, full, and open access to these data significantly enhances their value. As more commercial data sources are becoming available and purchased by the government to augment public data, the government needs to ensure that federal programs do not compete with commercial markets/products, while also maintaining critical public good datasets as free and open. Commercial activities serve to complement government satellites and offer new analytic capabilities for aggregate or service providers to generate new information for better decision-making. Currently, government agencies are more academic and research focused: the U.S. government builds and funds big, exquisite satellites and allows anyone to access the data. To date, there are many unexplored possible partnerships with technology and other firms for hosting, interpreting, and using data that represent opportunities for Americans to receive even more value from the satellites they are funding.

Additionally, the government has taken recently strong action to support the development of a competitive American remote sensing industry. Rule changes, such as those to Licensing of Private Remote Sensing Space Systems, have streamlined and updated regulations in order to allow American businesses to compete in the global arena. The current focus is now on implementation of these rules changes and on assessing the need for supportive legislation that would update the Land Remote Sensing Policy Act of 1992, which is the most recent piece of legislative guidance on this issue.

POLICY RECOMMENDATIONS

Support continuity of service for all Earth observing satellite capabilities and continue to champion free and open data sharing principles. The U.S. government should remain committed through policy and funding to having an appropriate pipeline of essential meteorological satellites and should extend the same commitment to continuity of coverage for land observing systems. The National Science and Technology Council must provide stronger direction across all federal agencies by developing a formal framework and process for coordinating data and addressing continuity challenges. Further, the next administration should continue to hew to the core principle of free and open by supporting technology and best practices designed to improve data discoverability and usability.

Enable commercial sector value-added services and promote a thriving American commercial remote sensing industry. The U.S. government should include expanding public-private partnerships to increase the use and value of Earth observation data that is already being produced. The government should also continue to improve the regulatory environment for U.S. companies by ensuring that implementation of recent rules changes is carried out swiftly and with clear guidance. A further update of older legislation, such as The Land Remote Sensing Policy Act of 1992, may also be required to accomplish this.

Recommit to contributing to global problems and promote the role of Earth observation in addressing these challenges. The United States government should re-engage as a world leader in using Earth observation data to address efforts to improve life on Earth, including supporting the Sustainable Development Goals, the Paris Climate Agreement, and the Sendai Framework for Disaster Risk Reduction.

COMMERCIAL ACTIVITIES SERVE TO COMPLEMENT GOVERNMENT SATELLITES AND OFFER NEW ANALYTIC CAPABILITIES FOR AGGREGATE OR SERVICE PROVIDERS TO GENERATE NEW INFORMATION FOR BETTER DECISION-MAKING.

MODERNIZED SPACE REGULATION AND OVERSIGHT

Governmental authorization and supervision of commercial space activities is not just required by international law, it is fundamental for a robust and vibrant space economy. And while the U.S. commercial space sector is already the largest national space economy in the world, the government can do even more to assist the commercial space sector while promoting other national interests.

BACKGROUND

The United States government provides oversight of private sector space activities to meet national obligations and interests. Oversight of private sector space activities allows the federal government to implement national policy objectives, such as export controls and protecting national security, and fulfill international obligations. Article VI of the 1967 Outer Space Treaty requires the United States to authorize and continually supervise commercial space activities. Part of this obligation to regulate is an incentive: we regulate to ensure that commercial actors do not violate international law because the United States itself is internationally responsible for any such violations.

The United States implements its oversight of private sector space activities through a series of licensing authorities. The FAA's Office of Commercial Space Transportation (FAA/AST) licenses all commercial space flight launch and reentry operations and conducts reviews for payloads on those launches. If a spacecraft is capable of taking pictures of the Earth, a remote sensing license is also required from NOAA (National Oceanic and Atmospheric Administration). The Federal Communications Commission (FCC) licenses all commercial use of radio frequencies, an essential capability in all space communications. Other agencies such as the State Department and Department of Defense also play a role in administering or advising on export controls and national security restrictions.

The Executive Branch of the United States government is in the process of updating and reviewing the framework by which it provides authorization and oversight of private sector space activities. The process began during the Obama administration and was accelerated under the Trump administration with the release of Space Policy Directive 2 in May 2018, which directed the Secretary of Commerce and Secretary of Transportation to review and update existing licensing processes for commercial space launch and remote sensing.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

The current U.S. commercial space regulatory regime is relatively comprehensive in regulating launch, communication, and remote sensing. However, certain nontraditional commercial space activities are not directly addressed in the current regulatory landscape. The regulatory landscape is also a patchwork of overlapping agencies and mandates which have developed over time as new commercial activities develop.

While regulators overlap in some areas, there is a clear absence of authority in other areas. One such area is on-orbit authority over commercial space actors. The FCC has authority over the use of frequencies in orbit and requires operators to submit space debris mitigation plans, but they do not regulate stationkeeping, maneuvers, and

collision-avoidance tasks. Neither the FAA nor the Department of Commerce currently has authority to regulate on orbit activities. This gap prevents commercial actors from knowing which regulator to approach for permission to undertake advanced, pioneering activities on orbit or on a celestial body. Without regulatory certainty, investors may be hesitant to back such commercial ventures.

Another issue is the lack of certainty regarding the uniform application of rules over both governmental and commercial space activities. NASA and other governmental space activities adhere to a standard set of government-wide rules for space activities, usually including best practices as coordinated amongst space agencies around the world. These include the IADC space debris mitigation guidelines and the Committee on Space Research (COSPAR) planetary protection guidelines. However, commercial actors may be uncertain as to whether these government-developed rules apply to their commercial actions.

The regulatory gaps and lack of authority have increased the chances of commercial entities launching without a license, violating international principles, or creating costs for other operators. U.S operator Swarm Technology's Spacebees constellation of satellites launched from India without the appropriate FCC license and the Arch Mission Foundation secretly placed tardigrades onto the Israeli SpaceIL lunar lander in violation of their planetary protection disclosure requirements. The lack of on-orbit authority and agreed-upon space traffic rules also increases the chances of an on-orbit collision or accident that could create long-lived orbital debris and risks for all space operators.

Additionally, as commercial space activities increase in number and complexity, the ability of regulatory agencies to keep pace with the increasing number of applications is being challenged. Budgets, staffing, and capacity of regulatory authorities have not kept pace with the amount of activity. In order for regulators to operate effectively and efficiently, appropriate resourcing must be provided.

POLICY RECOMMENDATIONS

Provide predictability for commercial actors seeking regulatory approval. The U.S. government should establish clear regulatory authority for oversight of new and innovative on-orbit space activities, including space resources utilization. This approach might take the form of a mission authorization process first proposed by the Obama administration. Congress must act to give the authority and budget to allow effective and efficient implementation of any new regulatory process. Establishing this clear, effective, and predictable regulatory regime is essential to further development of American commercial space activities.

Clarify to commercial actors that they are required to abide by international legal principles. The U.S. government should continue developing a regulatory framework for space activities that ensures its private sector actors are complying with international legal principles, including those found in the Outer Space Treaty. The United States should encourage other countries to follow suit to ensure that all private sector space activities are held to a similar standard.

FOSTERING COMMERCIAL SPACE

Largely driven by American companies and organizations, commercial space activity is in the midst of a worldwide expansion, including new actors, new application areas, and new business models. The United States needs a space policy approach that sustains this growth, orients it for economic and societal benefit, and considers both effective regulation and the government's role as a customer in concert.

BACKGROUND

The global space economy has grown to an estimated value of more than $420B in 2019. Approximately one-fifth of that is government space program budgets, while the value of commercial space products, services, infrastructure, and supporting industry services is estimated at approximately $336B. Traditionally, commercial space activities have largely been confined to satellite telecommunications services, a limited amount of commercial remote sensing activities, and a relatively small amount of commercial space launch services. Outside of those activities, most other space industry revenue is associated with government space programs as contractors or service providers. Many commercial space firms remain closely dependent on government programs.

However, driven by the rapid commoditization of the underlying technology, easier access to capital, and the spread of a disruptive innovation spirit, private sector space actors are introducing a range of new applications, services, and approaches to space activities. These applications include new direct to consumer and business-to-business services in remote sensing and communications; new in-space activities such as on-orbit satellite life extension and servicing and space-based manufacturing; novel approaches to space launch (such as rocket reusability and dedicated small-size launch vehicles); and interest in space tourism, space resources utilization, and lunar commercialization.

In the past decade, these new business models and applications have attracted an increasing amount of venture and private capital. Analysts estimated that in 2019 space start-ups attracted $5.7 billion in investment capital, up from $3.5 billion in 2018. Much of this activity is centered upon the United States – more than 80% of the investment in the 2017-2019 period went into American companies. The United States also represents the largest base of investment sources: in the 2018-2019 period, 47% of investors in space related start-ups were based in the United States. China is the next most significant source of both capital and individual investors.

Yet this investment interest is potentially fragile. Approximately 68% percent of the investment total in 2019 was invested into just three companies: SpaceX, OneWeb, and Virgin Galactic, and it should be noted that OneWeb filed for bankruptcy in early 2020, and has reemerged with new investors. Despite some trends towards lower costs and more rapidly deployed technology, space activities remain a technically risky area and have longer return on investment (ROI) timelines than many other areas of venture interest. There have also been

few successful initial public offerings (IPOs) or other investment exits. At the same time, economic disruption related to the ongoing coronavirus crisis threatens to impede further commercial space investment in the United States and globally.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

The United States government must balance both industry promotion functions and regulatory functions. Several agencies have both a regulatory role and an industry promotion role (e.g. the FAA's office of Commercial Space Transportation, the Department of Commerce); others have an independent role that must consider both space and terrestrial industry needs (the Federal Communications Commission); while still other agencies play an important role as both a customer of the space industry and a developer of space technology (e.g. NASA and the Department of Defense). Agencies including the Department of Commerce and the Department of State also administer export control requirements that affect commercial space activities. The overall structure for commercial space related policy implementation and regulation in the United States is fragmented.

However, the United States does have a long-standing policy goal of "encouraging and facilitating the growth of a U.S. commercial space sector." The current (as of September 2020) U.S. National Space Policy, which was issued by the Obama administration in 2010 and left largely unaltered by Trump administration policies, contains a set of Commercial Space Guidelines aimed at directing how the U.S. government should engage with the commercial space industry through procurement strategy, avoiding government-industry competition, trade policy, and regulatory approaches. These Guidelines have not been consistently implemented. In particular, commercial space-related procurement strategies used across the government are inconsistent and unevenly applied. In many cases, criteria used for decisions about purchasing commercial capabilities versus pursuing traditional development approaches are opaque at best. Furthermore, the government can play a critical role in advancing early space-related technology to commercially relevant levels of maturity; yet the early-stage technology programs within the government's space-related agencies are often ineffective and in particular lack strategies to advance beyond the proof of concept stage to the validation and demonstration-stages (where a commercial transition is more likely to occur).

As the U.S. government seeks to both grow and leverage the commercial space sector, there is a need to better understand the potential economic size and return of the space sector in the United States, in order to help set realistic policy goals. The space industry is not systematically tracked as an economic sector (in terms of employment and contribution to overall economic output) and efforts initiated under the Trump administration DOC to do so (as well as previous efforts under the Obama administration) have not yet resulted in sustained outcomes. This will become more important in the post-COVID recovery period.

The United States is not alone in efforts to develop a domestic commercial space sector. Countries around the globe have similarly initiated policy efforts focused on commercial space strategy, including in China, Europe, Japan and elsewhere. Commercial space will be both an area of economic cooperation and trade and an area of competition. Diplomatic efforts related to the space sector must increasingly consider commercial space activities as part of the overall approach to space-related foreign policy.

POLICY RECOMMENDATIONS

Review, update, and implement the Commercial Space Guidelines in the National Space Policy. An update of these Guidelines, conducted through the National Space Council, and in consultation with industry, would be an important step towards implementing a more coordinated commercial space strategy across the government. Subsequent implementation guidance would then inform procurement approaches, technology development strategies, regulatory reform, and other related matters.

Establish an international dialogue on regulating commercial space. In order to improve the linkages between commercial space and foreign and trade policy, the U.S. government should pursue an active strategy of diplomatic and civil-society dialogue on international approaches to commercial space sector policy, including with competitor nations. Such an approach will help to identify and share regulatory best practices, reduce risk of regulatory fragmentation and forum shopping, and potentially help to identify trade opportunities for U.S. companies.

AS THE U.S. GOVERNMENT SEEKS TO BOTH GROW AND LEVERAGE THE COMMERCIAL SPACE SECTOR, THERE IS A NEED TO BETTER UNDERSTAND THE POTENTIAL ECONOMIC SIZE AND RETURN OF THE SPACE SECTOR IN THE UNITED STATES, IN ORDER TO HELP SET REALISTIC POLICY GOALS.

FOCUS ISSUE: MEGACONSTELLATIONS

Megaconstellations (also called "global constellations") are large numbers of small satellites flying in formation to provide global coverage for a variety of governmental and commercial uses, including both communications and Earth observation. Many megaconstellation developers are planning to offer communications services, including broadband internet services. However, the deployment of thousands of satellites into already populated orbits raises concerns about space debris and collision with other spacecraft, as well as challenges to STM and risk of radiofrequency interference amongst all these spacecraft. Additionally, governments face challenges in regulating megaconstellations, and other users of the space domain have concerns about megaconstellations affecting their activities.

BACKGROUND

The past few years have seen the rise of global constellations of fleets of small satellites flying in formation and operated by a single user. The satellites in these constellations are often largely identical, small in size, and can be developed, built, and launched more quickly than large, unique satellites. They are meant to be cheap and more rapidly replaced compared to larger satellites. These attributes, along with increased investment capital availability and growing predicted demand for broadband Internet connectivity, have contributed to a wave of new companies aiming to field their own constellations for a variety of commercial purposes.

More than a dozen companies from multiple countries have announced plans for or are currently operating constellations of more than 100 satellites each. Within the commercial remote sensing sector, Planet operates over 150 satellites, Spire has launched more than 100 satellites, and at least a few other companies are planning similarly sized constellations. Within the communications sector, SpaceX's Starlink constellation has already placed more than 700 satellites in orbit with Phase-1 plans for over 4,400 satellites in five separate orbital shells ranging from 550 km to 1,325 km. SpaceX has filed FCC applications for frequency licenses to operate a total of 42,000 satellites. OneWeb launched 68 satellites out of a planned 900 before declaring bankruptcy, but has emerged from bankruptcy with a licence filing for nearly 48,000 satellites. Amazon's Project Kuiper has announced plans for a constellation of 3,236 satellites between 590 km and 630 km. Telesat, a Canadian operator of geostationary telecommunications satellites, aims to field a LEO constellation of around 300 satellites. Another Canadian company, Kepler Communications, aims to field 140 shoebox-sized satellites at 575km altitude for Internet of Things (IOT) connectivity. Entities in China, Japan, and India have also announced intentions to field large constellations, with the Chinese plans being the most advanced.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

One key issue with megaconstellations is their potential to contribute to the increasing creation of space debris. Megaconstellation operations pose a number of unique risks and challenges to the safety of the orbital operation environment. These include the reliability and failure rate of the satellites, commitment to and procedures for deorbiting and passivization at end of life, and capabilities and intra-operator coordination practices to avoid collisions with other spacecraft. Regulators might ask whether megaconstellations are a risky threat to the space domain, especially in already crowded and polluted orbits. Governments should also consider the risk posed by large constellations and how to mitigate it. Currently, responsible operators seem willing to abide by the modest 25 year rule promulgated by the Inter-Agency Space Debris Coordination Committee (IADC), and many operators have called for a commitment to deorbit within five years of end of life. However current adherence (by all satellite operators, not just megaconstellations) to post-mission disposal within 25 years is low. This, along with the projected on-orbit spacecraft failure rate for megaconstellations, leads to concern for the actual sustainability of many orbits in the space domain.

The authorization and oversight of megaconstellations places a significant burden on government regulators. This burden is at the frequency allocations stage, the launch stage, and for operations on orbit. All commercial U.S. satellite operators must apply for spectrum access through the FCC. For communications satellite operators, the competition for frequency in service bands can be intense. Operators go through multiple coordination rounds and comments periods, in which operational details of planned constellations are disclosed and updated. Remote sensing operators do not participate in the same coordination rounds. There is continual unease at the way access to commercial communication frequency bands are assigned by the FCC, with competition amongst commercial operators vying for licenses. Ambitious launch schedules demand multiple launches per month to get a fleet deployed and operational, and each launch is another administrative burden on the government. Megaconstellation tracking and space traffic management is another technical and administrative burden for the government. It is uncertain if the government has the resources to perform all of these tasks. Just as troubling is the real possibility of satellite constellation operators going bankrupt, and the ensuing consequences.

POLICY RECOMMENDATIONS

Ensure orbital debris mitigation requirements address the challenges posed by megaconstellations. The United States should prioritize identification of responsibility for and funding of scientific studies on the most effective ways to mitigate the impact of megaconstellations on the space environment and implement those mitigation measures in regulation. Those requirements should apply to both operators domiciled in the United States and foreign operators seeking U.S. market access. Additionally, the United States should encourage other countries to adopt similar mitigation measures.

Adapt existing licenses to include new findings and mitigation requirements as they emerge. Existing licenses for megaconstellations should be updated to incorporate new orbital debris mitigation guidelines and standards as they are developed. Such guidelines and standards should reflect the current scientific understanding of the risks posed by large constellations and other space activities and be designed to mitigate those risks with the least amount of burden and cost to satellite operators.

Develop contingency measures for the possibility of megaconstellation operators ceasing business with spacecraft already in space. It is likely that at least some megaconstellation operators will not survive and may go out of business with at least some of their constellations deployed. Regulators should put in place mechanisms to ensure such constellations are not entirely abandoned and still undergo proper post mission disposal. Contingency measures could include requiring indemnification, insurance, bonds, and/or active debris removal capabilities as part of the licensing process to insure that the deployed satellites do not represent a long-term hazard to other satellite operators.

HOWEVER, THE DEPLOYMENT OF THOUSANDS OF SATELLITES INTO ALREADY POPULATED ORBITS RAISES CONCERNS ABOUT SPACE DEBRIS AND COLLISION WITH OTHER SPACECRAFT, AS WELL AS CHALLENGES TO STM AND RISK OF RADIOFREQUENCY INTERFERENCE AMONGST ALL THESE SPACECRAFT.

EXPANDING INTO CISLUNAR SPACE

Cislunar space is the volume of space lying between Earth and the Moon or the Moon's orbit. The term is used to describe activities occurring anywhere from above geostationary orbit, through lunar orbit, to the surface of the Moon. Governmental and commercial space activities are expanding into cislunar space, which raises national security, economic, legal, and policy questions, particularly about developing norms of behavior and interpreting international legal principles.

BACKGROUND

Since the end of the Apollo program in 1972, the United States has sent only sporadic uncrewed missions to the Moon. Lunar exploration by other countries has likewise been limited to small robotic orbiters and scientific rovers. In recent years, international government and commercial interest in lunar presence, exploration, and utilization has increased. Several robotic commercial missions from the United States and elsewhere – for resource exploration and other purposes – are planned to begin to fly to the Moon as soon as 2021 (following failed Israeli and Indian landings in 2019). In addition to the United States, several other governments (including India, China, and Russia) are planning further lunar activities.

There is now significant interest in the United States and other countries for a sustained return to the lunar surface both with robotic spacecraft and crewed missions. The Trump administration has directed NASA to develop and execute the Artemis Program, which seeks to land an American crew on the Moon, including the first woman on the Moon, by the end of 2024. The initial landing would be followed by a sustained human lunar presence through subsequent missions to both lunar bases and an orbiting gateway. NASA has begun procuring commercial and industry contributions to Artemis, including human landing system and assorted robotic precursor missions. Although led by the United States, Artemis would be executed in cooperation with a range of international partners, similar in some ways to the International Space Station program. The Trump administration and NASA also views Artemis as a step towards eventual crewed missions to Mars.

Sustained human presence on the Moon will require the use of lunar resources to support crew life and function. This capability – known scientifically as In-Situ Resource Utilization (ISRU) – is a key enabler for long-term human presence on the Moon or other celestial bodies. Scientific exploration of the Moon has established the precedence of significant amounts of water, likely in the form of ice in the upper portions of the lunar surface (regolith) and concentrated in the polar regions. This water potentially may be useful to both support crew life in lunar operations and to manufacture rocket fuel to support and enable further in-space operations. A major focus of near-term lunar exploration will be to verify the extent and usability of this resource. Lunar regolith itself may prove to be useful for building lunar structures and habitats. Other lunar resources may have scientific, exploration, and commercial utility.

Long-term human presence in space will be operationally dependent on space resources, and achieving this use will require policy and governance frameworks to address possible overlapping and competing interests and to provide legal certainty to private operators. However, considerable uncertainty exists around the legal framework that would enable rational and sustainable space resources activities.

Under the Outer Space Treaty, national sovereignty over celestial bodies (and parts thereof) is prohibited. The Treaty also states that all celestial bodies are free for exploration and use by all. This creates a tension around whether the utilization of space resources is a permitted activity or not. Multilateral discussions on the topic since 2016 have trended towards the position that space resources utilization is permitted, but have raised a number of questions over how that activity should be regulated, coordinated, and executed.

An increased tempo of activity on and around the Moon raises a number of governance and policy challenges. The Moon has both cultural and historic significance, and measures must be developed to protect that while enabling future activities and use. The lunar environment poses unique operations challenges (such as lunar dust) which must be mitigated. The creation of lunar bases, including commercial and scientific operations sites, may require safety zones, which need to be developed in a manner that does not establish territorial control. Interoperability between systems of different operators and countries may be important to support safety, in particular for crewed activities. As more operators function on the surface and in lunar orbit, there is an emerging need to develop space situational awareness and space traffic management capabilities specifically for cislunar space. Orbital debris mitigation practices must be developed as lunar orbits see more utilization.

There are also national security concerns about cislunar activities. National space security strategists in both the United States and China have referred to the lunar environment as the "ultimate high ground." While this terminology is often oversold, it does convey a philosophical belief that the Moon has strategic value in military activities in space. The Outer Space Treaty limits the use of the Moon exclusively to peaceful purposes and expressly prohibits their use for establishing military bases, installation, or fortifications; testing weapons of any kind; or conducting military maneuvers. However, some in the United States question whether China will comply with the Outer Space Treaty, given their territorial claims in the South China Sea.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

The United States lacks a consolidated strategy or coordination function for lunar activities. Traditionally the Moon has been viewed by United States policymakers as a domain of exploration, addressed under NASA projects and programs. Commercial activities on the Moon do not have a clear regulatory structure and fall into the same gap in authorities and ad-hoc processing as many other non-traditional commercial space activities. Cislunar domain awareness is only just beginning to emerge as a serious element of national security space strategy.

Space resources activities raise a number of legal and regulatory challenges that are not adequately addressed through current policy and law. There is no mechanism for assignment and international recognition of priority or access rights to resources; nor is there means for deconfliction potential competition for access to specific resources sites on the Moon or asteroids. However, there remains considerable uncertainty around the technical and business approaches to space resources utilization, so efforts to develop regulatory specificity should proceed in an adaptive incremental manner. Addressing these issues will require both domestic and international discussion.

The United States has consistently stated that it does not believe that the Moon Agreement is a practical path forward for lunar governance activities, and that where international coordination is needed on lunar governance the United States will not consider the Moon Agreement as relevant. As an alternative under the Artemis program, the Trump administration has commenced an initiative known as the Artemis Accords. Through the Accords, the

United States seeks to secure commitment from international partners participating in Artemis to follow a number of legal principles related to lunar (and other space) activities and interpret them in a specific way. These principles cover a range of topics, including space resources utilization, safety zones, heritage site protection, and interoperability. As of November 2020, eight countries have signed up to the Artemis Accords and several more are in active negotiations to join.

THERE IS NOW SIGNIFICANT INTEREST IN THE UNITED STATES AND OTHER COUNTRIES FOR A SUSTAINED RETURN TO THE LUNAR SURFACE BOTH WITH ROBOTIC SPACECRAFT AND CREWED MISSIONS.

POLICY RECOMMENDATIONS

Sustain stable commitment to the Artemis Program. The administration should reaffirm its commitment to the Artemis Program and a return of U.S. astronauts and international partners to the Moon on an achievable timeline that leverages commercial capabilities. The administration should work with Congress to establish bipartisan support for a sustained presence on the Moon and in cislunar space that serves as the cornerstone of further space exploration and development to Mars and beyond.

Continue work to implement Artemis Accords with the international community. The principles of the Artemis Accords represent a practical approach forward to addressing a number of cislunar governance issues. Efforts should be made to continue to work towards adoption of these Accords, including engagement with possible competitor nations.

Continue multilateral engagement on space resources governance. The United States should continue to positively engage in discussions at COPUOS and other multilateral fora to develop consensus principles to enable space resources activities. These principles can complement bilateral approaches like Artemis Accords and serve a coordinating function.

Implement the National Moon-Mars Development Strategy. The administration should work with Congress, industry, and international partners to refine and implement the National Moon – Mars Development Strategy established by the National Space Council. This includes supporting the commercialization of low Earth orbit, sustaining a human presence on the Moon, extending a human presence to Mars, bolstering deep space science, and reinvigorating STEM education and development of a space-capable workforce.

PLANETARY DEFENSE

The threat of a devastating asteroid or comet strike somewhere on Earth's surface is perhaps the ultimate "low probability, high impact" event. Large asteroid strikes are rare over shorter time spans, but in the long-term they are inevitable. As the potential for damage and devastation is large, a sustained expenditure of resources towards asteroid strike detection, forecasting, and mitigation and response efforts is warranted. Finding all of the threatening near Earth objects (NEOs) is still an outstanding task, and the United States should continue to lead cooperative global efforts in planetary defense preparation.

BACKGROUND

NEOs are defined as any natural space object coming within 30 million miles of the surface of Earth. NEOs are mostly asteroids from the main asteroid belt located between the orbits of Mars and Jupiter, but can also be comets originating in the outer solar system and which head towards the Sun. Out of an estimated 10,000 NEOs detected so far, it is the potentially hazardous NEOs (a subset of the entire NEO population) that warrant concern and potential action. Potentially hazardous NEOs are any objects larger than 30 meters in size with orbits predicted to bring them to within 5 million miles of the Earth.

In 1998, Congress directed NASA to find and characterize, within 10 years, at least 90% of all NEOs 1 kilometer in size or larger. These largest NEOs would cause the most catastrophic destruction if they were to hit the Earth. NASA completed this task by 2013, and no "planet killer" asteroid strikes have been predicted. In 2005, Congress then directed NASA to find and characterize, by 2020, 90% of all NEOs 140 meters in size or larger. Impacts from NEOs this size still threaten regional or national destruction. As of 2020, NASA is less than 40% with this task and estimates that it will take until 2050 to finish. The impact of a 1,000 meter asteroid would cause global effects and many millions dead. Currently we have detected approximately 95% of an estimated 940 of these NEOs. The impact of a 300-500 meter asteroid would cause destruction on a continental scale, and currently we have detected approximately 68% of an estimated 3,500 to 7,200 of these near-Earth objects. The impact of a 140 meter asteroid would cause destruction on a regional to national scale, and currently we have detected approximately 38% of an estimated 24,000 of these NEOs. Lastly, the impact of a 50 meter asteroid would cause local damage equivalent to the largest thermonuclear weapon on Earth and we have currently detected approximately 5% of an estimated 230,000 of these NEOs. The challenge in completing this task is mainly due to limited funding, and the technological limits of Earth-based telescopes. According to an independent assessment by NASA's Space Portal office, finding the remaining 60%+ of these remaining NEOs, as mandated by Congress, is contingent upon space-based telescopes like the NEO Surveillance Mission (NEOSM).

In addition to cataloging the NEO population, scientists have begun developing concepts for mitigating an asteroid impact. Mitigation involves attempting to deflect or change the

trajectory of the NEO such that it misses the Earth. The most promising NEO deflection techniques include striking it with a series of kinetic impactors, or using massive spacecraft as gravity tractors to slowly pull it off course, and (as a last ditch effort) detonating nuclear explosive devices near the surface. Mitigation also includes terrestrial disaster responses and civil defense measures. In the mid-2000s, the United Nations began discussions on three specific aspects of international cooperation in defending the Earth from NEO impacts. These are information gathering, analysis, and warning of potential impacts; planning and operations of a deflection mission; and the authorization and oversight of both deflection and disaster responses.

CURRENT POLICY AND GAPS OR SHORTCOMINGS

Domestically, planetary defense enjoys broad bipartisan support and is rated a top priority by the American public. NEO threat detection and response is addressed by the National Science and Technology Council (NSTC)'s 2018 Near-Earth Object Preparedness Strategy and Action Plan, which summarized NEO detection accomplishments, deflection techniques and capabilities, and necessary domestic NEO strike response plans. Responses on Earth may include the evacuation of large areas where an asteroid strike is predicted, but this is a massive undertaking that requires national, regional, state, and local governments with a predetermined plan of action and allocated responsibilities. The 2018 Plan, meant to organize and coordinate NEO-related efforts within the U.S. government, also stressed remaining tasks and coordination gaps. One of its recommendations was to strengthen and routinely exercise NEO impact emergency procedures and action protocols.

Finding NEOs is an ongoing task. In 2016, NASA created a Planetary Defense Coordination Office (PDCO) to coordinate NASA's NEO threat detection, cataloging, and characterization activities and preparedness and coordination tasks with agencies such as the DOD, DOE, and DHS. Additionally, NASA's current Double Asteroid Redirection Test (DART) is scheduled to launch in July 2021 and will rendezvous with the asteroid Didymos, a binary object, in September 2022 to determine if it is possible to perturb its trajectory, a capability which may prove critical should a real NEO threat arise. The NASA PDCO is also taking a lead in coordinating the NEO Surveillance Mission (NEOSM).

Internationally, the Fourth Committee of the UN General Assembly adopted a draft resolution by consensus in 2013 that established two major international coordinating associations to help prepare for a potential NEO strike. The first is the International Asteroid Warning Network (IAWN), which acts as a clearing house for NEO detection activities – including those done by NASA, its international partners, and a global community of amatuer observers coordinated by the Minor Planet Center in Cambridge, Massachusetts. The second association created by the UN in 2013 is the Space Mission Planning Advisory Group (SMPAG), a voluntary coordinating body for various national actors developing deflection capabilities. One finding by a SMPAG working group on legal issues was that significant legal questions remain regarding any NEO redirect activities, including those of duties to warn and liability risks. They also found that in the case of large asteroids predicted to strike imminently, where there is insufficient time to mount a redirect missions and where the option of using a nuclear explosive device (NED) is therefore the only viable option, the legality of such a use has yet to be internationally agreed upon.

POLICY RECOMMENDATIONS

Give NASA the resources to complete the detection, cataloging, and characterization of all NEOs 140 meters and larger. Finding these remaining NEOs mandated by Congress is more difficult than those already found, and space-based telescopes appear to be the best or only path forward.

Clarify the existing rules, rights, and responsibilities for a NEO deflection mission and the legality of using nuclear explosive devices. More clarification is needed on how the existing body of international law applies to attempts to deflect a threatening NEO, particularly the liability considerations for a full or partial mission failure. Current international law also forbids the placement of weapons of mass destruction in orbit or on celestial bodies, which hinders the ability to test or deploy nuclear explosive devices to deflect a threatening NEO. These issues need to be addressed to help clear the path for developing an effective international NEO deflection capability.

Implement a strategy to achieve the goals of interagency, federal, state, and local preparedness outlined in the 2018 Near-Earth Object Preparedness Strategy and Action Plan. These include strengthening and routinely exercising the communication of threats, and response and recovery efforts by agencies such as FEMA and DHS.

DOMESTICALLY, PLANETARY DEFENSE ENJOYS BROAD BIPARTISAN SUPPORT AND IS RATED A TOP PRIORITY BY THE AMERICAN PUBLIC.

CONTRIBUTORS

PETER MARTINEZ

Dr. Peter Martinez is the Executive Director of the Secure World Foundation. He has extensive experience in multilateral space diplomacy, space policy formulation, and space regulation. He also has extensive experience in capacity building in space science and technology and in workforce development.

Prior to joining SWF, from 2011 - 2018, he chaired the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) Working Group on the Long-Term Sustainability of Outer Space Activities that negotiated a set of international consensus guidelines to promote the safety and sustainability of space operations. In 2012 and 2013, he was South Africa's representative on the United Nations Group of Government Experts on transparency and confidence-building measures for space activities. From 2010 – 2015, he was the Chairman of the South African Council for Space Affairs, the national regulatory authority for space activities in South Africa. From 2014 - 2018, he was Professor of Space Studies at the University of Cape Town. Before this, he acquired fifteen years of executive level management experience and associated general management skills gained in the research and development environment of the South African Astronomical Observatory, a National Facility under the South African National Research Foundation.

Dr. Martinez is a member of the International Academy of Astronautics, the International Institute of Space Law, a Fellow of the Royal Astronomical Society, and an Honorary Professor at the University of Cape Town. He has authored or co-authored over 200 publications on topics in space policy, space sustainability, astronomy, space research, space law, and space policy.

KRYSTAL AZELTON

Krystal Azelton is the Director of Space Applications Programs at Secure World Foundation and has over 10 years of international and domestic space, public policy, and management experience. She focuses on the Human and Environmental Security initiative, which promotes improved governance and cooperation in the delivery and use of information derived from space systems. In this role, she represents herself and the organization at the United Nations, the Group on Earth Observation, and at topical conferences, events and workshops around the world.

Prior to joining SWF, Ms. Azelton was a consultant at Access Partnership, where she worked with international satellite service providers and other leading technology companies on policy issues related to spectrum management, emergency communications, telecommunications standards, orbital debris, and multilateral processes including representing industry at the Inter-American Telecommunication Commission. She has also served as a project manager at the Tauri Group, a leading aerospace analytics firm, providing research, analysis, strategic planning, and regulatory assessment to government and commercial clients. She led and supported production of NASA's strategic plans, audits, performance plans, budgets, and annual reports. Her work exposed her to the full range of NASA's Earth observation, human exploration, and aviation programs. In that role, she was also recognized as a key member of a data management team that received the NASA Group Achievement Award.

Previously, Ms. Azelton was in the field of international development as a Monitoring and Evaluation Manager at Development Alternatives, Inc in Afghanistan working on U.S. military and local government initiatives and as Senior Program Assistant at the National Democratic Institute in Africa and Washington, DC working on sustainable governance projects. In those roles, she worked closely with the United Nations, the World Bank, the Department of State, the Department of Defense, U.S. and international nonprofits, and others.

IAN CHRISTENSEN

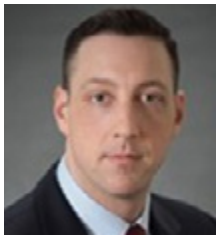
Ian Christensen is Director of Private Sector Programs at Secure World Foundation. He is responsible for leading SWF's engagement activities with the commercial space industry, where his activities focus on policy and governance topics in support of the development of private sector space capabilities, including topics such as: space debris mitigation, norms of behavior for responsible space operations, and space resources policy. In this role, Mr. Christensen was a member of the Hague International Space Resources Governance Working Group, where he chaired the Group's Socioeconomic Panel. He is also a member of the Secretariat for the Consortium for Execution of Rendezvous and Servicing Operations (CONFERS), an industry group developing best practices and standards for commercial satellite servicing.

Prior to joining SWF, Mr. Christensen worked at leading space-sector consulting firms Futron Corporation and Avascent. In these positions, he managed or served in lead analysis roles on market, business planning, and forecasting studies for numerous commercial space sector clients in the United States, Israel, and Europe. For government clients, Mr. Christensen has provided space-related strategic and analytic services for NASA, the Federal Aviation Administration (FAA), the United States Trade and Development Agency (USTDA), the Japan Aerospace Exploration Agency (JAXA), and the Government of Australia. Mr. Christensen has supported consulting engagements with clients in Australia, Israel, the Isle of Man, Japan, and South Korea; and led in-country work in Brazil, Burkina Faso, Europe, and Japan.

While at Futron, Mr. Christensen led a multi-year project for NASA's Office of Safety and Mission Assurance, and served for one and a half years on a NASA team tasked with managing the retirement of the Space Shuttle. On behalf of USTDA, Mr. Christensen organized several reverse trade missions and workshops aimed at U.S. export promotion. Mr. Christensen also led an industry research team in support of the annual Space Report, a comprehensive guide to the global space industry published by the Space Foundation.

Prior to Futron, Mr. Christensen was a research assistant at the Space Policy Institute at George Washington University, a Policy Fellow at the National Academies of Science Committee on Science, Engineering and Public Policy, and a research assistant at the University of Nebraska Public Policy Center.

CHRIS JOHNSON

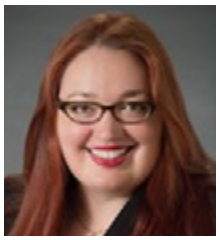


Chris Johnson is the Space Law Advisor for Secure World Foundation and has nine years of professional experience in international space law and policy. He has authored and co-authored publications on international space law, national space legislation, international cooperation in space, human-robotic cooperative space exploration, and on the societal benefits of space technology for regions such as Africa.

Prior to joining SWF, Mr. Johnson worked as an attorney in New York City and entered the space field in 2010 as an intern at the United Nations Office for Outer Space Affairs (OOSA) in Vienna, Austria during the 53rd Committee on the Peaceful Uses of Outer Space. He has also served as an intern in the Office of International and Interagency Relations (OIIR) at NASA Headquarters in Washington, DC, and as a legal stagiaire in the International Law and EU Legal Affairs division at the European Space Agency's Legal Department at ESA Headquarters in Paris, France. As a member of the Space Generation Advisory Council (SGAC), Mr. Johnson co-founded the Space Law and Policy Project Group in 2012.

Mr. Johnson serves as a Professor of Law (Adjunct) at the Georgetown University Law Center in Washington, D.C., where he co-teaches the spring Space Law Seminar. He is also Adjunct Faculty at the International Space University (ISU) in Strasbourg, France, and a Core Expert and Rule Drafter in the Manual on International Law Applicable to Military Activities in Outer Space (MILAMOS) project.

VICTORIA SAMSON



Victoria Samson is the Washington Office Director for Secure World Foundation and has over twenty years of experience in military space and security issues. Ms. Samson focuses on the security and stability aspects of space policy and development, including discussions on SSA, counterspace capabilities globally, and geopolitical implications of activities on orbit. She also strives to clarify U.S. capabilities and intentions to international audiences, and explain international capacities and interests to U.S. policy-makers.

Before joining SWF, Ms. Samson served as a Senior Analyst for the Center for Defense Information (CDI), where she leveraged her expertise in missile defense, nuclear reductions, and space security issues to conduct in-depth analysis and media commentary. Prior to her time at CDI, Ms. Samson was the Senior Policy Associate at the Coalition to Reduce Nuclear Dangers, a consortium of arms control groups in the Washington, D.C. area, where she worked with Congressional staffers, members of the media, embassy officials, citizens, and think-tanks on issues surrounding dealing with national missile defense and nuclear weapons reductions. Before that, she was a researcher at Riverside Research Institute, where she worked on war-gaming scenarios for the Missile Defense Agency's Directorate of Intelligence.

Known throughout the space and security arena as a thought leader on policy and budgetary issues, Ms. Samson is often interviewed by multinational media outlets, including The New York Times, Space News, and National Public Radio. She is also a prolific author of numerous op-eds, analytical pieces, journal articles, and updates on missile defense and space security matters.

BRIAN WEEDEN

Dr. Brian Weeden is the Director of Program Planning for Secure World Foundation and has nearly two decades of professional experience in space operations and policy.

Dr. Weeden directs strategic planning for future-year projects to meet the Foundation's goals and objectives, and conducts research on space debris, global space situational awareness, space traffic management, protection of space assets, and space governance. Dr. Weeden also organizes national and international workshops to increase awareness of and facilitate dialogue on space security, stability, and sustainability topics. He is a member and former Chair of the World Economic Forum's Global Future Council on Space Technologies, a member of the Advisory Committee on Commercial Remote Sensing (ACCRES) to the National Oceanic and Atmospheric Administration (NOAA), and the Executive Director of the Consortium for Execution of Rendezvous and Servicing Operations (CONFERS).

Prior to joining SWF, Dr. Weeden served nine years on active duty as an officer in the United States Air Force working in space and intercontinental ballistic missile (ICBM) operations. As part of U.S. Strategic Command's Joint Space Operations Center (JSpOC), Dr. Weeden directed the orbital analyst training program and developed tactics, techniques, and procedures for improving space situational awareness.

Respected and recognized as an international expert, Dr. Weeden's research and analysis have been featured in The New York Times, The Washington Post, National Public Radio, USA Today, The BBC, Fox News, China Radio International, The Economist, The World Economic Forum's Annual Meeting in Davos, academic journals, presentations to the United Nations, and testimony before the U.S. Congress.

JOSH WOLNY

Josh Wolny was a Project Manager at Secure World Foundation. In that role, Mr. Wolny supported all of the issue-areas that SWF is engaged in, through research, event planning, and independent publications. His specific focus areas were space-weather policy, space situational awareness, security issues, and federal space policy processes. Prior to moving to D.C. for graduate education in 2016, Mr. Wolny was an eighth-grade science teacher in Cleveland, Ohio.

Mr. Wolny has since left Secure World Foundation for work elsewhere in the space policy community.

SECURE WORLD FOUNDATION

PROMOTING COOPERATIVE SOLUTIONS
FOR SPACE SUSTAINABILITY

Space technology and services provide critical national security capabilities, scientific knowledge, economic opportunities, and the tools to understand and respond to a changing climate.

The rapid growth in new actors conducting space activities, an increasing number of active satellites and debris objects, and the growing potential for conflict create both opportunities and challenges that require timely policy responses from the incoming administration.

As the Biden administration begins setting its policy agenda for the next four years, Secure World Foundation has developed an issue brief to provide background and recommendations on key issues to help the U.S. meet current and emerging challenges in outer space. This brief contains recommendations on issues ranging from fostering a vibrant commercial space sector to dealing with threats from counterspace capabilities.

525 Zang Street, Broomfield, Colorado 80021
+1 303-554-1560

1779 Massachusetts Avenue NW, Washington, DC 20036
+1 202-568-6212

info@swfound.org *www.swfound.org* *@SWFoundation*