INSTITUTE FOR HOMELAND SECURITY

A CROWDED SKY:

NEW THREATS AND OPPORTUNITIES FOR HOMELAND SECURITY IN THE CISLUNAR ECONOMY

Institute for Homeland Security

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Abstract

Homeland security has not traditionally been thought of as a mission area supporting space activities. Homeland security organizations, however, have been long time consumers of space data and services. Today, the space domain has opened for commercial activity and geopolitical competition alike. The security of the homeland is closely tied to the security of the space domain across multiple risk factors. The homeland security field faces an opportunity to pivot to be more involved in government and commercial space activities by bringing its unique capabilities and authorities to bear against challenges that did not exist a decade ago. This paper will study the evolution of the space economy and the role it now plays in the security of the homeland.

Introduction

Humans gazing at the night sky mostly see the same stars scattered across the blackness. Looking skyward is an essential part of being human so much that it is nearly biological. So is the wonder felt by pausing and staring skyward. As a young sailor deployed with the U.S. Navy, I can recall looking at the stars at various places in the world from the complete darkness of the ocean and being shocked by what I saw. No matter where you are in the world, the night sky puts on a show that has been enjoyed since time immemorial. However, the sky we see today is vastly different than the sky our ancestors saw, the one I marveled at from the Red Sea two decades ago, and even the one you may have looked up just two years ago. Today, when we look to the sky, we don't just see vastness or beauty but opportunity. Specifically, many of the humans looking that direction see economic opportunity. It may not be perceptible from the ground, but humanity has changed our skies more in the last three years than in all of human history.[1] That change does not simply mean that we may be able to see Starlink constellations from the ground on a clear night, which is possible. It also means that humanity is opening a new domain of operation and competition. This is not something that happens frequently but something that is happening now because of the rapid progress of emerging technologies and influx of investment. New domains and new economies create huge opportunities across multiple sectors, but they also create mission changes for those on Earth.

Space was once the exclusive domain of a small number of governments and a handful of government contractors. The prohibitive costs of building 20-story rockets to launch a space shuttle into orbit created barriers to entry that only the richest governments could overcome. The prohibitive launch costs limited what was put into orbit and in what quantities. Satellites that were launched were expected to have lifespans measured in decades. Little thought was given to issues like space traffic management and debris and the idea of space cybersecurity was an afterthought. Space was also seen as a demilitarized zone where scientific discovery and international partnership reigned. The predominant international treaty governing space, which is still in effect today, says as much as the 1967 Outer Space Treaty states:

[1] Statista Research Department; *Number of Active Satellites from 1957-2022*; March 2023; https://www.statista.com/statistics/897719/number-of-active-satellites-by-year/

> *The moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall also not be prohibited.*[2]

The creation of the commercial space industry fueled by emerging technology development created with it a new dynamic for how terrestrial operations consider and engage with space services. Between 2017 and 2021, the US reinvigorated the dormant National Space Council and turned out a flurry of policies and space policy directives that recognize and attempt to organize this dynamic. No long the exclusive domain of select governments with a prohibitive barrier to entry, our skies are getting more crowded. The implications of that crowding are broad and organizations across the homeland security enterprise are only beginning to realize how the new space domain impacts their mission. In this research, we will explore the changes that have taken place in the space domain over the past five years. We will examine the policy and international legal environment and show how even with a large body of space policy and legal scholarship, the development of the space sector is outpacing our attempts at normalization and organization. Finally, we will discuss how the commercial space industry creates new opportunities and potential threat vectors for homeland security. Whereas the homeland security enterprise has not traditionally been considered as a player in space activities, the commercial space industry changes that perception. This study will provide homeland security practitioners, managers, and educators with a perspective on how events occurring in what may feel like the farthest possible place from the homeland are growing in their capacity to directly impact homeland security equities. The denial or disruption of space assets and capabilities is already recognized as a threat to national security by the 2020 US National Space Policy but what is becoming increasingly clear is such a denial or disruption is even more of an impact to the homeland.[3] As a result, homeland security practitioners and educators must recognize the role space plays in activities in the homeland and how it is changing. The continued success of the homeland security mission space depends on how it can respond to and build resilience against issues originating in space.

The space domain has already changed but the impacts are just beginning. This creates the ideal conditions to build a cadre of space-aware homeland security professionals who can recognize the downstream impacts from a disruption or denial of a space-based service to critical infrastructure.

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[2] NASA: *The 1967 Outer Space Treaty*; January 1967; https://history.nasa.gov/1967treaty.html [3] White House; *2020 National Space Policy*; December 2020; https://trumpwhitehouse.archives.gov/wpcontent/uploads/2020/12/National-Space-Policy.pdf

Overview of the Space Economy

The existence of a space economy is a new concept anchored in a domain that was once only accessible by a small number of governments with deep pockets and the contractors that supported them. To some, this was a dynamic that was unlikely to change, and it all came down to one number: cost per kilogram. The reduction in the cost per kilogram to launch a payload into orbit was more than any other factor the innovation that made the space economy possible. Once the space domain became a place of economic opportunity, innovations and investment dollars flooded in and new products and services were available to the average person. Before getting into the impacts of this build up, we will first cover the trajectory of cost per kilogram as the defining factor in creating the space economy and how further innovations that bring this cost down further are likely to drive an economic expansion.

The space race in the 1960s led much less to innovation in the space domain than invention. Many of the capabilities that we take for granted today like low earth orbit satellites were fodder for science fiction. There really is nothing like a good geopolitical rivalry to drive innovation in dual military-civilian use technologies and the Cold War was a perfect example. The U.S. and Soviet Union were locked in the now infamous struggle between capitalism and communism and for alliances around the world. The nations chose to show their power through space launches, which were incidentally the same capabilities it would take to deliver a thermonuclear warhead to the other side of the planet. With laughable computing power and plenty of slide rules and sharp pencils, the U.S. and Soviet Union engineered the vehicles that would take people and material into space. Not every launch was a success, but such is the nature of rocket science.

In truth, the math required to launch any payload into space is not complex and has been well understood for some time. On a basic level, anything launched into space must achieve escape velocity, that is the speed at which a free object must travel to escape into space from a planet's gravitational pull.[3] Every celestial body has a different escape velocity based on its size, atmospheric density, gravity, and other factors. On Earth, that speed is 7 miles per second or over 25,000 miles per hour.[4] Achieving that speed takes an extraordinary amount of energy and the energy required increases with the weight. The lighter an object, the less energy it takes to accelerate it to a high speed. Heavier objects take considerably more energy, which can in turn increase the weight. This basic principle is based in physics making it simply a fact of launching from Earth. More weight equals more energy, and more energy equals more cost, therefore more weight equals more cost.

In the latter part of the 1960s the American Saturn V rocket had a cost per kilogram of just under $6,400. This cost increased substantially in the 1980s when the Space Shuttle program came in at a cost of over $51,000 per kilogram.[5] This was the peak of cost per kilogram in space launch, but it also set the tone for the perceived costs to do any activities in space. People around

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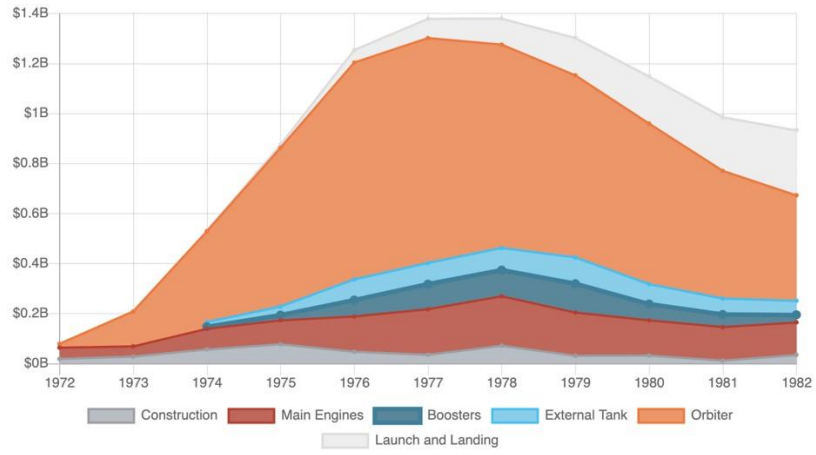
[3] Outer Space Properties of Earth; *What is Earth's Escape Velocity*; Earth How; May 11, 2022; https://earthhow.com/escape-velocity-earth-closed-system/

[4] Outer Space Properties of Earth; *What is Earth's Escape Velocity*; Earth How; May 11, 2022; https://earthhow.com/escape-velocity-earth-closed-system/

[5] Venditti, Bruno; *The Cost of Space Flight Before and After SpaceX*; Visual Capitalist; January 2022; https://www.visualcapitalist.com/the-cost-of-space-flight/

the world looked at the Space Shuttle strapped to the back of an enormous fuel tank and two rocket boosters measured in stories on the flanks and that became the symbol of cutting-edge space flight. We will return to the Space Shuttle, but it is important to first note that the costs did begin coming down as technology improved. The American Delta Heavy brought the cost down to under $13,000 per kilogram while the Chinese Long March 3b brought costs down farther to Saturn V levels between the late 1990s and mid-2000s.[6] The true change came when SpaceX brought the Falcon 9 to market and dropped the price below $1,600 per kilogram. The Falcon 1 almost a decade before the Falcon 9 was on par with the Delta Heavy near $13,000 but a drop to $1,600 represents the opening of the space economy. As costs dropped, space began to open for private firms who no longer had to surmount a launch cost of over $51,000 per kilogram.

The Space Shuttle program today is viewed as an extremely high cost and perhaps somewhat wasteful program. According to the Planetary Society, NASA spent $49 billion between the program's approval in 1972 and its successful deployment in 1982, adjusted to 2020 dollars.[7] See the graph below for a full financial breakdown of the Shuttle's costs per year.



NASA's obligations for Space Transportation System development, per year.

While the Space Shuttle program was costly and may have a mixed reputation among the space community, it was trying to solve for the exact problem that SpaceX was able to champion reusability.

Another factor driving cost per kilogram was the fact that every space vehicle was single use. Single use equipment was wasteful and cost prohibitive for most. SpaceX was famously able to land its spent boosters on a barge at sea enabling it to reuse the boosters and pass significant cost savings on to public and private sector customers While the Space Shuttle itself was reusable, it was also the costliest according to the graphic above. Knowledge of the problem has been present for decades but technology has now caught up to the point that it can enable growth of a brand-new economy.

With cost per kilogram projected to fall to as low as around $200 with the SpaceX Starship, economic opportunity in space is now real. In 2021, private sector funding alone was

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[7] The Planetary Society; *How Much Did it Cost to Create the Space Shuttle*; 2023; https://www.planetary.org/spacepolicy/sts-program-development-cost

more than $10 billion representing a tenfold increase in a single decade.[8] That investment was concentrated in low earth orbit, or the orbital space where most satellites reside. That is likely due to the potential for space-based services to be offered to terrestrial customers and the revenue streams associated with a demand for space services and the accessibility of technology to receive those services for a large terrestrial demographic. Commercial space services were on fully display as Russia invaded Ukraine and an army of internet sleuths began to use open-source geospatial resources to detect military movements and possible evidence of war crimes.[9] The other famous example is the proliferation of position, navigation, and timing services or PNT. The American Global Positioning System (GPS) is an example of a PNT system and more and more terrestrial services rely on space based PNT. Those are two mainstream examples of space services, but many more exist.

With the cost per kilogram down to a manageable level and the spread of connected devices able to access space services, the space economy is growing and attracting significant investment. While this growth is exciting, and the innovation is awe-inspiring, new threats and vulnerabilities are developing that impact the U.S. homeland in a way that has not been true throughout the history of human space flight to this point. In the next section, we will explore areas that are impacting the security of both the space domain and the homeland.

Impact Areas

Understanding the factors that led to the formation of the space economy is an important first step because it also provides a glimpse into how innovations may drive further growth. With billions of dollars in investment, a slowdown is not likely so those on Earth charged with protecting the security of terrestrial assets must be able to recognize potential problem areas and mitigate risks before they create real disruption. Below is an examination of impact areas to drive risk and resilience planning across the public and private sectors. This list is not exhaustive and may evolve as technology develops. At a minimum, homeland security officials should be familiar with and have plans to address issues emanating from these areas.

Cybersecurity Issue

On September 4, 2020, and to limited acclaim, the Trump Administration released Space Policy Directive-5, *Cybersecurity Principles for Space Systems*. SPD-5 provided a set of six principles that defined a framework for cybersecurity measures that should be taken by commercial satellite owners and operators.[10] When the policy was made public, there was a combination of pushback and apathy toward the principles-based approach that it took. For

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[8] Brukardt, Ryan; Klempner, Jesse; Stokes, Brooke; *Space: Investment Shifts from GEO to LEO and Beyond*; McKinsey; January 2022; https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/spaceinvestment-shifts-from-geo-to-leo-and-now-beyond

[9] Albon, Courtney; *How Commercial Space Systems are Changing the Conflict in Ukraine*; C4ISRNET; April 2022; https://www.c4isrnet.com/intel-geoint/2022/04/25/how-commercial-space-systems-are-changing-the-conflict-inukraine/

[10] White House, *Space Policy Directive-5*; September 4, 2020; https://trumpwhitehouse.archives.gov/presidentialactions/memorandum-space-policy-directive-5-cybersecurity-principles-space-systems/

example, the policy has no enforcement mechanism nor language that compels anyone to actually implement the principles. Further, it has no implementation plan or set of steps that the commercial space industry should take. It was seen by many as a toothless government document that sought to address a minor issue.

On February 24, 2022, Russia launched an invasion of Ukraine both on the ground and in cyberspace. One hour before its invasion in an attempt to break critical communications lines, Russia hacked and disrupted a U.S.-based satellite communications company called Viasat.[11] The hack and subsequent disruption of Viasat over both Ukraine and other geographic areas highlighted the space cybersecurity issue to a broader audience and legitimized it to many previous doubters. Whereas space cybersecurity was once viewed an esoteric, perhaps even academic, issue, it was now revealed as a legitimate threat from advanced cyber actors. With the threat recognized and the space economy expanding, the awareness of cybersecurity in space grew, but the industry still lacked concrete actions to put into practice.

Reenter the principles of SPD-5. While the criticisms of the policy were factually true (lack of enforcement, lack of compelling language) what was also true is that the federal government did not want to go down a path toward regulation in an infant economic domain. Rather than regulate space activities, the federal government provided a framework from which industry could build security practices that made sense for its sustainable growth. Policies like SPD-5 are meant to create momentum behind a topic, not to regulate it, which is a different approach entirely. In retrospect, SPD-5 was actually two years ahead of its time and advanced the space cybersecurity conversation. However, it still stands alone in speaking on the cybersecurity for space topic outside of minor language in the 2020 National Space Policy and DHS's Space Policy from 2022.

While the issue had some temporary momentum, more work is needed because of the growth of the commercial space industry and the services it is providing to terrestrial consumers. Because of the growth induced by the reduction in cost per kilogram, the number of active satellites shows a sharp jump in the last 20 years. For example, in 2002, there were a total of 806 active satellites in orbit. That's the sum total of all satellites launched from 1957-2002, that's 45 years of launch activity. By 2022, there were 6,905.[12] In 20 years, humanity launched over 6,000 satellites and most of those satellites were meant to create economic value. That economic value came from providing services to Earthlings who paid with their Earthling money. Users of spacebased services are around the world and those services do a variety of things, but that means that a disruption to space services impacts more people. More on this in the Homeland Security Mission Evolution section. Cyberattacks are the cheapest and least-attributable way to disrupt a satellite in contrast to shooting it out of the sky.

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[11] Howell O'Neill, Patrick; *Russia Hacked an American Satellite Company One Hour Before the Ukraine Invasion*; MIT Technology Review; May 2022; https://www.technologyreview.com/2022/05/10/1051973/russia-hack-viasatsatellite-ukraine-invasion/

[12] Statista Research Department; *Number of Active Satellites from 1957-2022*; March 2023; https://www.statista.com/statistics/897719/number-of-active-satellites-by-year/

Space Debris Issue

Another issue that may feel like one that has no impact on life on solid ground is that of space debris. On January 11, 2007, the Chinese military shot a missile from Earth that shattered the defunct Fengyun-1C weather satellite and created a massive debris field in the sky.[13] When something breaks apart in space, its fragments do not "fall" to the ground in the way that they would if an airplane was shot down on Earth. Instead, the fragments continue to orbit the Earth potentially for hundreds of years. Some may burn up in the atmosphere, but the majority stay in orbit. This creates a dangerous cloud of small and large metal fragments traveling at over 17,000 miles per hour and occupying the same orbital space as vital satellites, the international space station, and humans in transit. Space debris is not limited to fragments from missile strikes but also includes satellites that pass their service life, spent rocket bodies, and other items no longer in use. Debris in space is an issue without an easy answer because clearing it is technically challenging and possibly cost prohibitive. Adding to the 6,905 active satellites in orbit, space debris creates a challenging and dangerous space environment that could potentially impact the ability to launch more satellites into orbit.

The most frightening possibility is a collision in space where an active or inactive satellite impacts another or a debris field creating a new and larger debris field. It is not hard to imagine such a debris field impacting other nearby satellites in a sort of chain reaction that could render pieces of orbital space unusable.

With this exact issue in mind, Vice President Kamala Harris committed the U.S. to not conducting any destructive, direct ascent anti-satellite missile tests on April 18, 2022.[14] This commitment was meant to establish a norm of behavior in space that would set the tone for other nations to follow. The Biden Administration followed up the Vice President's commitment with a proposal before the United Nations General Assembly as a proposed binding resolution.

The policy and legal environment for space is still being addressed because emerging technology is making possible activities in space that were not conceived of when original policies were written. However, the issue of space debris creates an ideal subject for international cooperation because all spacefaring nations and all consumers of space data are affected by it. While the policy and legal environment may be unsure, the practical realities of collisions in space and debris are assured to have real impacts on how the space economy grows. Those same realities could have direct impacts on the security of the homeland and of the functionality of critical infrastructure.

International Treaty Issues

The major piece of international law that most point to in space is the 1967 Outer Space Treaty. The treaty was a wonder of international diplomacy as it was signed and ratified by both sides of the Cold War during the Cold War and remains in effect today. The issue is that many of the activities that emerging technology has made possible were never imagined in the Outer

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[13] David, Leonard; *China's Anti-Satellite Test: Worrisome Debris Cloud Circles Earth*; Space.com; November 2021; https://www.space.com/3415-china-anti-satellite-test-worrisome-debris-cloud-circles-earth.html

[14] White House; *Vice President Harris Advances National Security Norms in Space*; April 18, 2022; https://www.whitehouse.gov/briefing-room/statements-releases/2022/04/18/fact-sheet-vice-president-harrisadvances-national-security-norms-in-space/

Space Treaty and are today creating issues. An example is the ownership of a satellite launched from Earth. According to the Outer Space Treaty, the national territory from which the object was launched owns the object.[15] In other words, if it launches from the U.S., the U.S. is responsible for it. That construct worked well when only government launched satellites into orbit, but today commercial companies launch payloads from potentially multiple countries. If SpaceX launches a payload from a Belgian company into orbit, does the U.S. now own that payload? According to established and ratified international law, it does. This conflicts with the commercial space industry and the exact activities that brought the cost per kilogram down to enable this economic growth. Another example is launching a body from somewhere other than Earth. Suppose a company or country launched a new satellite from a satellite already in orbit. Or suppose a satellite is launched from the Moon or an asteroid. None of these issues were covered in the Outer Space Treaty.

The Outer Space Treaty also says that space is a demilitarized zone that is free for scientific exploration for all. The U.S. National Space Policy signed in 2020 states,

> *Consistent with the defense of those rights, the United States will seek to deter, counter, and defeat threats in the space domain that are hostile to the national interests of the United States and its allies. Any purposeful interference with or an attack upon the space systems of the United States or its allies that directly affects national rights will be met with a deliberate response at a time, place, manner, and domain of our choosing.*[16]

This language, combined with Space Policy Directive-4, certainly imparts an overtone of militarization that stands in contrast to the ratified Outer Space Treaty. Several other issues stand out, but the point is that the major guiding document for safe behavior in space is woefully outdated and is unlikely to be replaced with an equivalent.

The U.S. is, however, attempting to unilaterally create an agreement that nations can voluntarily sign on to by the name of the Artemis Accords. The Artemis Accords are tied to NASA's Moon mission program of the same name and "reinforce the commitment by the United States and signatory nations to the Registration Convention, the Rescue and Return Agreement, as well as best practices and norms of responsible behavior that NASA and its partners support, including the public release of scientific data."[17] Twenty-eight nations and one territory have signed on to the Accords.

The Artemis Accords, despite largely unobjectionable language, receive criticism from other nations such as Russia and China for their attempt to circumvent the international treaty process and for their unilateral approach to space governance. From a technical standpoint, Russia and China are correct because the Artemis Accords are an attempt to circumvent the treaty process because the U.S. and its allies know that any attempt to create a new treaty will be blocked by those same objectors.

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[15] NASA: *The 1967 Outer Space Treaty*; January 1967; https://history.nasa.gov/1967treaty.html

[16] White House; *2020 National Space Policy*; December 2020; https://trumpwhitehouse.archives.gov/wpcontent/uploads/2020/12/National-Space-Policy.pdf

[17] NASA; *The Artemis Accords*; 2020; https://www.nasa.gov/specials/artemis-accords/index.html

While space policy can feel as far away as space debris, it directly impacts how the space economy will grow and what opportunities are created by emerging technologies in space. That in turn has an impact on the terrestrial users and by extension, the homeland.

HOMELAND SECURITY MISSION EVOLUTION

Traditionally in the U.S., homeland security organizations have not been considered as a part of space activities. Actors such as the Department of Defense, NASA, and even the Department of State spring to mind when considering roles of federal government agencies in space. Save for locales that were home to space facilities such as Cape Canaveral, FL and Houston, TX state and local authorities were likewise observers of space activities. Across the homeland security enterprise, those observers were also consumers of data that originated from space, such as PNT, but were not active participants in space activities. The space economy created accessibility and variety of space-based services and with it a far broader customer base. The ubiquity of data and services from space-based assets amplifies the risks covered above and creates a new attack surface for the homeland.

In previous year, the denial or disruption of a space asset was likely to impact a narrow scope of missions: national security, weather, scientific study, intelligence collection, and a few others. While those are important missions, the scope was limited and mostly, save perhaps weather observation, outside of the homeland security remit. However, today the exposure of negative impacts from an event, natural or humanmade, that causes a denial or disruption of space services is significantly broader and the attack vectors have grown as well. The users of commercial space products and services are in the homeland from individuals to businesses to critical infrastructure owners and operators. This adds up to a new way to attack the homeland in a way that directly impacts its security and the security of the economy.

The homeland security enterprise was not designed with a role in space in mind but has found itself with a role to play in increasing resilience to a denied or disrupted space environment, protecting space-related intellectual property, promoting the cybersecurity of space assets, and much more. In this section, we will explore a few of the ways that the homeland security mission should pivot to focus on space and what that means for the professionals working the issues every day.

Customs

Normally considered a distinctly terrestrial activity, the customs mission will have to begin to consider space as a part of its work. For instance, the commercial space industry will soon include space tourism with tourists subject to customs screening when leaving and reentering the country. Another example is in the mining of asteroids or other celestial bodies. The U.S. has legislation on the books that permits commercial mining of celestial bodies in the 2015 Commercial Space Launch Competitiveness Act. The bill limits governmental regulations until September of 2023 to catalyze mining activities.[18] If materials are mined in space and returned to Earth, they will have to clear customs just the same as mined material anywhere on Earth. The

[18] Hackett, Jennifer; *New Law Paves the Way for Asteroid Mining—but Will it Work?*; Scientific American; December 4, 2015; https://www.scientificamerican.com/article/new-law-paves-the-way-for-asteroid-mining-butwill-it-work/

customs mission will have to consider these possibilities and position its workforce to be able to execute this mission.

Security of Commercial Spaceports

Commercial spaceports are a new type of border crossing because spaceports have been exclusively secured government facilities for almost the entirety of space flight history. According to the Federal Aviation Administration (FAA) there are 21 spaceports in the U.S. across 10 states that host FAA-licensed space activities.[19] These are a mix of commercial and government facilities. While the FAA can license the flight activities, its authority does not extend to the physical and cybersecurity of the commercial spaceport itself. As an analog, the FAA has authority over the conduct of commercial passenger and cargo flights but not over the airports. The physical and cybersecurity of airports is the purview of the Transportation Security Administration (TSA), under the Department of Homeland Security and in close coordination with state and local authorities. The question over whether TSA owns the physical and cybersecurity of commercial spaceports is open. With plans for more commercial spaceports and more flights, the responsibility for securing commercial spaceports is likely to fall to the homeland security enterprise.

Resilience

DHS is, and always will be, in the business of resilience. Resilience and continuity of things like critical infrastructure and the economy in the face of disruptions of any kind are extremely important in both concept and practice. The growth of the space economy has created a new resilience domain in outer space because disruptions are no longer limited to narrow mission areas. Today, the proliferation of space services creates a broad base of vulnerability to space disruptions that could affect critical infrastructure. In a simple example, the use of space based PNT in critical infrastructure has the potential to cause widespread disruption of terrestrial services if GPS were to be spoofed or jammed. The loss of observation satellites during a disaster response would have a crippling effect on operations that could cost lives. Any organization touching the homeland security mission should build resilience to space disruptions into their preparation plans.

This is not a usurpation of missions that have been traditionally covered by other departments and agencies but the logical result of the growth in the space economy. Homeland security organizations are faced with a reality that include space as a major factor in their ability to secure the homeland and the continuity of critical infrastructure. In that pursuit, those organizations should have plans in place to respond to a disruption. The 2020 National Space Policy explicitly states that a disruption of U.S. space assets will be met with a response at the time, place, and domain of its choosing. The term "domain" is extremely important here because it also implies that attacks on space assets may be met with responses elsewhere like a cyberattack. The homeland should also be prepared for a conflict in space to escalate to such a point that the homeland is directly attacked through cyber or other means. Cutting off critical services has already been shown to be a favored tactic of our international adversaries and the U.S. cannot operate as if it is immune to such impacts.

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[19] FAA; *Spaceports*; n.d.; https://www.faa.gov/space/spaceports#map

Best Practices

Recognition of how the space economy has emerged and continues to grow is a critical step in the ability to respond to threats to the homeland. Below is a set of best practices that are applicable to all homeland security organizations that directly reflect this recognition. Based on this study, it is recommended that homeland security organizations adopt these practices to build their mission capacity.

1. Exercises: All organizations should run exercises to practice their ability to respond and detect weaknesses in their structure. Those exercises should include a space component forcing professionals to confront these issues and discuss how they may be impacted. Losing GPS or a communications disruption from a space asset should be a part of operational exercises to prepare responders for such a complication in an already difficult situation.
2. Study: After identifying potential impacts to missions through exercises, organizations should undertake studies that form mission and organization specific recommendations for incorporating space readiness into their mission area. These studies can help identify required training, policy gaps, partnerships, or other factors that can improve the ability to respond to a space disruption.
3. Cybersecurity: When using a space-based service, organizations should consider, and inquire about, the service's cybersecurity. Like the attack on Viasat, some space assets are considered relatively soft targets that could be disrupted for any number of reasons. Using the principles of SPD-5 as a guide, organizations can build cybersecurity into procurement guidance or contract language when using space services and improve their overall resilience.
4. Training: The first and perhaps most important step is that first responders are able to recognize that an incident has a space component and how to proceed. The root of the problem could be the disruption of a given space service but if that is not recognized, the problem will continue, and resilience will suffer. Proper training of homeland security personnel will help ensure continued mission success.

Practical Application

Progress in the space domain has been rapid over the last ten years and there are exciting advancements to come. Anytime a new domain of human activity has been opened throughout history, it has required new thought about what it means for security and opportunity. For most of human history, activities were limited to land and sea. At the end of World War I, the air domain was opened. The cyber domain followed in the 1990s and now we are seeing the space domain open in a way that is different from the first space launches in the 1950s. Space is no longer the exclusive domain of a few rich governments and a handful of industrial contractors. The cost per kilogram of launches is low enough to permit the huge increase in satellites discussed above, but that's just the beginning. Soon, NASA's Artemis mission will return to the Moon and establish a base. There are plans for missions to Mars, permanent habitations, and mining operations. Today,

we are concerned about activities and services in Low Earth Orbit, but the expansion is not limited to that one area. The space domain will continue to grow, and unexpected impacts and consequences will follow. In the same way that the homeland has found itself more exposed to space disruption, it will find itself affected by other advances. The homeland security mission is evolving, and space is a prominent example of that evolution.

Homeland security professionals will be faced with some form of space mission challenge or opportunity. Major outages in space services will affect the homeland and our critical infrastructure and building resilience against that outcome is extremely important. This is one example of what the homeland security mission is evolving into. A mission space that is dominated by emerging technology and that is directly vulnerable through the two newest domains of human activity, cyber and outer space.

INSTITUTE FOR HOMELAND SECURITY

Sam Houston State University

The Institute for Homeland Security at Sam Houston State University is focused on building strategic partnerships between public and private organizations through education and applied research ventures in the critical infrastructure sectors of Transportation, Energy, Chemical, Healthcare, and Public Health.

The Institute is a center for strategic thought with the goal of contributing to the security, resilience, and business continuity of these sectors from a Texas Homeland Security perspective. This is accomplished by facilitating collaboration activities, offering education programs, and conducting research to enhance the skills of practitioners specific to natural and human caused Homeland Security events.

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Reese, N. A (2023) Crowded Sky New Threats and Opportunities for Homeland Security in the Cislunar Economy. (Report No. IHS/CR-2023-1024). The Sam Houston State University Institute for Homeland Security. https://doi.org/10.17605/OSF.IO/BWHX6