

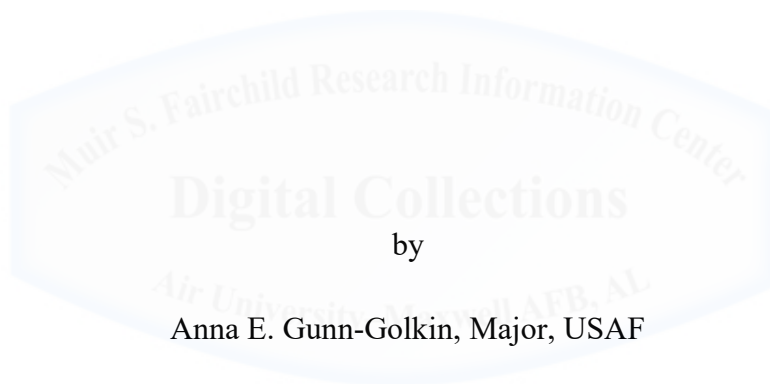
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COUNTERING SPACE PIRATES

THE UNITED STATES SPACE GUARD



by

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Preface

This paper is designed to take a look into the far future of our national security needs. I wanted to avoid the near-term debate associated with the development of an independent Space Force / Space Corps / Department of Space within the Department of Defense and instead focus on a longer-term challenge. If American entrepreneurs continue experiencing spectacular success in reducing the cost of space launch, they will soon open the new frontier to a rush of commercial and industrial ventures. Over the next century, significant portions of the American economy may move to outer space, so the United States government must have infrastructure, operations, plans, and personnel in place to defend those commercial and industrial interests. With this paper, I hope to spark discussion about the longer term planning for American government presence in space.

So many people were abundantly generous to help me write this paper. I'd like to thank my sister, who studied the great works of literature and helps me translate my technobabble into English. I'd like to thank my parents for their unwavering support and inspiration. Many mentors and friends endured my endless questioning and introduced me to the right people to inform this paper. Tremendous thanks go to: Jim Norman, Anne Sweet, Alvin Drew, Margaret Kieffer, Doug Loverro, Charlie Bolden, Robert Lightfoot, the Nields, Bill Gerstenmaier, Bradley Smith, Alexander Macdonald, Maj Nicholas Ervin, LCDR Mason Wilcox, and Lt Col Peter Garretson, Admiral Ellis, Dr. Pate-Cornell, Col Marty France, Lt Col Todd Nathaniel, Bernadette Maisel and her NextGen team at the Space Foundation, the Space Generation Advisory Council, and my fellow Fellows.

Abstract

Americans are explorers, always pushing to the next frontier. Despite its countless dangers, space is the next frontier. As such, American entrepreneurs will be living and working in space within the next century, and space will be a trillion dollar industry. The international community has not yet agreed to a comprehensive legal framework for such a vast industry, and enforcement mechanisms for space law are weak. Like on the high seas before it, space will certainly host pirates, hoping to profit from the labor of others. To establish the lead and set international norms in space, the United States government must have the foresight to defend its vast space-based commercial interests. The United States Space Guard is a construct that, within the next century, may be tasked with law enforcement, prevention, response, security, and traffic management in space. Just as the United States Coast Guard strengthens the Navy, the Space Guard will augment Department of Defense space functions in times of war.

To Boldly Go

“Space, the final frontier... ..boldly go where no one has gone before”

— Captain Jean-Luc Piccard, USS Enterprise¹

Humans have always been explorers, pushing into the frontier, over mountain ranges and across the seas. Maybe the drive to go over that next mountain range grew out of a need for more fertile soil for crops. Perhaps taking to the seven seas was driven by a quest for untold riches in unknown lands. Private individuals in search of gain break down boundaries, explore and settle. When Lewis and Clarke explored the American frontier at the government’s expense, they paved the way for future generations of explorers and settlers to expand our national boundaries. As settlements are established, governments eventually catch up and establish rule of law in order to protect individuals and their assets. The first government to establish a presence on a new frontier has its hands full – the work of expanding the boundaries of humanity is not for the weak hearted. But, for the government that takes on the task, wealth and prestige follow.

After millennia of terrestrial exploration, humanity now pushes on the boundaries of outer space. Poised to conquer the next frontier, national space powers, along with dozens of commercial companies and private individuals, stand ready to pursue the infinite riches to be held beyond Earth’s atmosphere. Who will protect American interests on this new frontier? What government will reap the rewards and gain the prestige from taming the wilds of space?

Recent debates in the United States government have centered on whether or not the United States needs a Space Force. Envisioned as a unique branch of the military, the Space Force – often referred to as a Space Corps – would be dedicated to deterring and fighting wars beyond our atmosphere. The question of a Space Force is timely and relevant to achieving and maintaining space superiority. Eager peer competitors would like to adopt space as their own high ground,

from which they could engage in space war, create terrestrial effects, or exploit its riches. This paper is not about the Space Force. Former NASA Administrator and astronaut, Major General Charlie Bolden, USMC (Retired), said that if there is a kinetic war in space, “we will have failed.”² This paper is not about failure. This paper is about how the United States of America can ensure its citizens and industry are safe and secure to engage in life, liberty and the pursuit of happiness beyond our Earth’s atmosphere.

This paper looks further out in time, when America will defend more than just government interests in space.³ Space is a dangerous place for business, but it will prove lucrative to those willing to invest. There is no existing construct to defend property rights, prevent and react to crime, and support imperiled persons and vessels in space. In its mission to protect United States private citizens, commercial, and industrial interests, the United States Space Guard (USSG) will provide law enforcement, prevention, response, security, and traffic management. Just as the Coast Guard augments the Navy, the USSG will be trained and stand ready to support the Department of Defense’s needs in times of war.

Dangers of Space

“I admit, it’s fatally dangerous.”

— Mark Watney, *The Martian*

The space domain is vastly different from all others in which humanity operates. It is largely unknown and unexplored. Its dynamics differ entirely from those intuitive to a sailor, pilot, or any human being. In Earth orbit, satellites must add power to slow down and slow down to speed up, and follow complicated laws of motion defined by Johannes Kepler. Contrary to popular fiction, spacecraft cannot hover over New York City to track Will Smith’s adventures.⁴ In low

Earth orbit (LEO), where imagery satellites are prolific, spacecraft whip around the planet in all directions at speeds beyond the realm of Superman, often in excess of 8 kilometers per second (17,895 miles per hour). With six different degrees of freedom describing orbital motion about the Earth, describing and tracking moving objects is complicated, and the complexity increases rapidly when moving beyond “simple” Earth orbit. A hover-like capability is possible farther away, 35,786 kilometers (22,236 miles) above the equator, in very specific geostationary (GEO) orbital slots. At this distance, the speed of satellite motion in space matches the speed of the Earth’s rotation, thus remaining above the same point on the surface below. Today, in the infancy of the commercial space age, the geostationary slots over populated landmasses are already near capacity.⁵ In very specific locations farther out in space, the laws of Kepler are thrown aside and Lagrange takes over. A Lagrange point forms in a two-body system of motion (like the Earth and the Moon), where the gravity of those two objects balance each other out. A visiting spacecraft can park at one of these strategic points and serve as a base of operations, communications, maintenance and resupply for transiting ships.

Going into space is a high-risk endeavor. Collisions at orbital speeds come with high consequences: at such tremendous closing speeds, a fingernail-sized chip of paint can crack a window.⁶ On the other side of that cracked window lies even greater challenges to space-farers: solar radiation, galactic cosmic rays, extreme temperatures (-250 to +300° Celsius), near zero air pressure, and atomic oxygen are just a few other difficulties. The financial barrier to enter space is also steep. Currently, it costs over \$10,000 per pound of payload sent to low Earth orbit, and that cost goes up when meeting more unique launch parameters or including human rated safety systems.⁷ With all these incredible hurdles and risks, one might surmise that space is not worth

the effort and that this paper is not worth reading, but the potential for boundless riches above the atmosphere make a compelling argument otherwise.

Follow the Money

“Space will become a trillion dollar economy sooner than people realize.”

— Wilbur Ross, Secretary of Commerce⁸

Why space? Space offers a clear view of the heavens, global perspective, a variety of different gravity environments, abundant resources, and an outlet for the human need to explore the frontier.⁹ Space offers near infinite wealth in every meaning of the term. Financial, scientific, cultural, and national prestige potential above Earth’s atmosphere is as limitless as space itself.

Uninhibited by terrestrial pollution and atmospheric interference, space offers a clear view of the heavens above, enabling scientists to better ponder the origins of life, the universe, and everything. This advantage does not currently offer significant financial gain, but the future may bring new opportunities.

Having a clear view of the heavens also means a clear view of the Earth’s Sun, which may prove exceptionally lucrative in the near future. Every hour, the solar energy arriving at the Earth could provide more energy than all of humanity uses in a day. Less than 70% of that energy gets through the atmosphere, and even more is lost through cloud cover before reaching solar plants. Terrestrial solar power is also, of course, not available at night. Space based solar power overcomes those hurdles, collecting “high intensity, uninterrupted solar radiation by using giant mirrors to reflect huge amounts of solar rays onto smaller solar collectors. This radiation is then wirelessly beamed to Earth in a safe and controlled way.”¹⁰ The cost to develop space solar power is expected to be high, perhaps over ten billion dollars. However, if an entity is willing to front

the initial investment, it will earn back that investment and potentially shift to pure profit in less than 17 years. Space-based solar power has potential to provide humanity with unlimited clean energy and still provide full return on investment at less than 9 cents per kilowatt-hour to the consumer (less than the 13.2 cents per kilowatt-hour I paid on my most recent bill).¹¹ If energy remains approximately 8 percent of America's gross domestic product (GDP), space-based solar power has the potential to be a \$2.7 trillion dollar industry by 2050.

From space, a user can achieve a truly global perspective for Earth observation, with utility from weather to reconnaissance. As an example, the GOES-R satellite series recently launched provide unprecedented insight into the formation and movement of atmospheric storms, large and small. In the violent 2017 hurricane season, accurate predictions and warnings from the GOES-R spacecraft directly saved 275 lives, and no doubt countless more who heeded the warnings.¹² In addition to providing forecasts through the National Weather Service, the US government provides the raw data from these spacecraft free of charge to anyone interested in developing their own algorithms to generate a unique weather forecast, which many Americans are familiar with through weather.com, Weather Underground, and their local media outlet. Without even considering the national security implications of accurate weather predictions, the commercial weather industry is valued at over six billion dollars per year.¹³ This immense industry is critically dependent on space-based assets, the locations of which are publicly advertised and accessible to anyone¹⁴ wishing to do them harm.

Space-based reconnaissance used to be strictly the business of nation state superpowers. Within just the last two decades, the number of commercial Earth imagery platforms has grown exponentially, with companies like HawkEye360, GeoOptics, Spire, ICEYE, Earth, Aerial Maritime, Planet, AstroDigital, Capella Space, Axel Space and Black Sky planning for, and in

some case already operating, large constellations of Earth observation spacecraft and payloads. These companies will provide exceptionally high return rate images, with daily or even hourly passes over every spot on the planet. With products used for everything from Google Maps to tracking forest fires, remote sensing was valued at \$10.68 billion dollars in 2017 and is expected to balloon to \$21.62 billion by 2022.¹⁵

Uninterrupted line of sight and relayed communication can be achieved through this clear view, as can precision position, navigation and timing as demonstrated through the United States' Global Positioning System, the Russia's Glonass, the European Union's Galileo and China's BeiDou. The commercial applications of these space-based position, navigation and timing (PNT) spacecraft seem limitless. Their timing signals are used to synchronize online and remote banking operations, ranging from automatic teller machines to the New York Stock Exchange. What else is GPS timing used for? I have 34 different GPS-reliant applications on my phone, offering different ways to navigate through a city, track my runs, conduct instrument approaches when I fly, or serve as a reference on a back-country hike. They allow me to connect with friends, take care of my banking needs, catch Pokémon and get food delivered. Some of these applications are fee based, some gain their wealth through advertisements, but the story is consistent – they are profitable ventures. In 2013, the economic benefits from GPS were valued at \$55.8 billion, and that number is only expected to increase.¹⁶ The havoc that would ensue without the GPS time signal is well documented in open source literature, with significant implications from national security to banking – a pirate's evil dream.

Arthur C. Clarke first proposed space-based communication (satcomm) in 1945.¹⁷ A few years later, it stormed the market with the launch of Telstar 1 in 1962 for the first space-enabled long distance phone calls and the first live transatlantic television broadcast. Early Bird satellites

quickly followed, making satellite enabled television commonplace in 1965. By the 1980s, mobile communications were common even at sea, facilitated by satellite communications. Today, satcomm is generating billions of dollars annually in sales of products and services.¹⁸ Already in 2016, commercial satellite communications produced \$57.4 billion revenue, and this is only the tip of the iceberg.¹⁹ Multiple companies (SpaceX, Boeing, OneWeb, Iridium, and Telesat) are on the precipice of enabling low-latency worldwide satellite-based Wi-Fi communication and Internet access, which SpaceX founder Elon Musk believes is worth hundreds of billions per year, with room for growth.²⁰

The clear view also holds amazing potential for an exciting and lucrative industry: space tourism. Virgin Galactic and Blue Origin sub-orbital private spaceflight systems are likely within two years of supporting paying customer flights. Even though Virgin's SpaceShipTwo is still in early flight test and hasn't successfully broken through the Karmen Line²¹, there are over 600 customers that have registered to spend \$250,000 each on a flight.²² There is clearly a market for tourism, even for trips that offer less than 10 minutes of freefall.²³ Companies like Bigelow Aerospace anticipate that once orbital space is more accessible thanks to reduced launch costs, space station vacations will also provide a lucrative market. Motivated by the fact that tourists have paid the Russian Federation over forty-five million dollars per person for trips to the International Space Station,²⁴ Bigelow has developed and flown inflatable space station habitats which can be used by paying customers as space hotels, configured as needed for tourism, science or manufacturing. Finally, space tourism won't be limited to suborbital or Earth orbital space. Even in the near term, SpaceX has taken two customer reservations for a trip around the Moon,²⁵ and they continue to plan for trips to Mars within the next decade.

A relative newcomer to the list of significant space utilities is rapid point-to-point transportation here on planet Earth. SpaceX's demonstrated ability to land a first stage booster back at its launch site safely and consistently opens up the possibility of using that same technology to enable "25-minute trips between New York and Shanghai."²⁶ When SpaceX lands a rocket back at a launch site, it uses an incredible amount of fuel to completely reverse its velocity vector. Instead, a rocket could launch, cruise, and then gradually slow down along the same vector, coming to a safe landing at a faraway spaceport, just like the commercial airlines today but significantly faster. A more conventional point-to-point concept lies with Virgin Galactic, where passengers will take off from an airport outside of Los Angeles in a spaceship attached to a large airplane. Just below 50,000 feet (above the bulk of the atmosphere), the spaceship will drop from the airplane, ignite its rocket and accelerate past Mach 4. Less than an hour later, the spaceship will glide to a comfortable airplane style landing at an airport in Japan.²⁷ No doubt, business travelers and tourists alike will be tempted by the promise of reducing a full day of travel to a quick hour-long trip. To support this eventuality, governments, commercial companies and private individuals are investing in spaceport construction all over the world.²⁸ Similarly, American companies are looking to the long term for productive in-space investments.

Space will almost certainly serve as a lucrative manufacturing environment. While the possibilities for space manufacturing are limited only by the imagination, two industries that will likely be pathfinders are optical fiber and pharmaceutical production. Optical fiber has many uses, but is most common in telecommunication, where it offers much faster data transmission than classic copper wires. The speed of the data is limited only by imperfections in the glass fiber cables. Grown under the effects of terrestrial gravity, fiber is prone to glass impurities and microcrystal formation, which scatter and absorb the signal – ultimately degrading the quality and

speed of long distance data transmission. Made in Space, an American company, is already investigating fiber manufacturing techniques on the International Space Station and may lead the way in this revolutionary new industry.²⁹ Similarly, space-based pharmaceutical research is beginning to launch. “Medically important chemicals, from proteins formed in the body to potential new drugs, develop into larger and better organized forms [in space].”³⁰ Scientific breakthroughs on the International Space Station pave the foundation for the future of a space-based medical industry.

In 2022, NASA is going on a mission to a near-Earth asteroid, Psyche. Thought to be made mostly of metal, Psyche is valued at \$10,000 quadrillion.³¹ This is just the start of humanity’s exploration and exploitation of the abundant resources of space. In the future, in-space resources may be collected and used in the construction of outer-space infrastructure to enable economic development. Such resources may also be mined for use in terrestrial industry or power development. Some asteroids may be filled with vast quantities of water. Through electrolysis, water can be broken into hydrogen and oxygen. Luckily for future space travelers, hydrogen and oxygen are the most efficient rocket fuel and oxidizer combination. As it can cost over \$10,000 per pound to bring fuel up from Earth, in-situ rocket fuel production will be extraordinarily valuable. Multiple American companies are also vying to lead the world in space-based resource collection. Planetary Resources has a goal to fuel industry and sustain life in space by taking advantage of the 16,000 near-Earth asteroids rich in elements and containing over 2 trillion tons of water, thus reducing the cost of space exploration and manufacturing development by 95%.³² Additionally, companies like Deep Space Industries, OffWorld, and TransAlta are already developing business plans and securing capital to enable asteroid exploitation.

The Moon also contains a wealth of water, along with minerals of industrial utility: iron, titanium, uranium, thorium, and potassium. Helium-3, which is exceptionally rare on Earth, is present in vast quantities on the Moon. If humanity is able to successfully develop a helium-3 nuclear fusion reactor, just 100 tons of the element could meet all of Earth's energy needs for a year (and the Moon has one to five million tons available).³³ American companies have their sights set on the Moon. Moon Express is just one example, treating the Moon as a new frontier for humanity, with "precious resources that can bring enormous benefits to life on Earth and our future in space." They intend to mine the Moon via a fleet of robotic landers, selling water and minerals to other space entrepreneurs and governments alike.³⁴ With space hosting such ridiculous riches, both the government and industry may consider developing in-space strategic reserves or stores. Pre-positioned in strategic locations like Lagrange points and the lunar surface, these strategic reserves will contain pre-processed construction materials, fuel, water, air, and spare parts. These depots may provide strong return on investment and enable even greater space commerce growth.

In addition to the direct wealth possible from all these space ventures, each one of these commercial endeavors will come with a significant logistics trail: building systems; launching spacecraft; collecting, downlinking and storing information; analyzing that data or retrieving space materials, and then marketing a product to a consumer. There is, and will be, an incredible amount of commercial wealth directly dependent on in-space assets. Finally, in the far future, humans will create settlements on the Moon and Mars. Much like the Revenue Cutter Service³⁵ did for the shores of early America and the Coast Guard does today, the Space Guard will defend US interests from pirates and enforce the rule of law.³⁶

Space Pirates

“There will absolutely be space pirates. You can quote me on that.”

— Robert Lightfoot, NASA Administrator³⁷

Space will kill you and your machines. Even without pirates hoisting a celestial Jolly Roger³⁸, space has 400 degree temperature swings, no breathable air, solar radiation, galactic cosmic rays, and micro-meteors and orbital debris that move ten times faster than the bullet from a modern pirate’s gun. Major spacefaring nations have learned to adapt to and overcome these natural boundaries, and humanity is on the verge of being able to sustain human life and industry in space for the long term. As happens in all things, the technology developed by the great nations enabling space exploration has already proliferated to commercial industry and may soon fall into nefarious hands. Even today, there are numerous potential space threats accessible to private individuals and disreputable groups. As the cost barrier to space drops, even more threats will develop.

By US law, an act of piracy requires robbery on the high seas.³⁹ More commonly, the term *pirate* is generally applied to a wide range of misbehavior, including raiding and intercepting ships, robbery, ransoming, kidnapping, and murder.⁴⁰ This paper extends the common understanding of *pirate* to apply not only in the high seas of Earth, but also in the infinite sea of space.

Space pirates can rely on cyber and supply-chain interference to disrupt space-based capabilities.⁴¹ Already, “a growing number of non-state actors are actively probing commercial satellite systems and discovering cyber vulnerabilities that are similar in nature to those found in non-space systems... ..and [this threat] will likely grow in severity over the next decade.”⁴² “A cyberattack on space systems can result in data loss, widespread disruptions, and even permanent loss of a satellite”,⁴³ but for the purposes of a space pirate, a ransomware-like attack on a valuable

space asset might be most profitable. “In a ransomware attack, malicious software cripples a victim’s computer or network and blocks access to important data until a ransom is paid to unlock it.”⁴⁴ A company making millions from providing world-wide wireless internet could have its satellites taken hostage by ransomware – and the company might be inclined to pay significant sums of money to regain the capability that is their lifeblood. Cyber-attack could be a valuable tool even if the hackers are not motivated by profit. In 2007, the Tamil Tigers “hijacked an Intelsat (communications) satellite and replaced the feed with its own propaganda,” and eventually, after over a year of unauthorized use, Intelsat had to deactivate the satellite.⁴⁵

Bad actors could also hold commercial assets at risk via directed energy or electronic attacks. An adversary could use a laser to “temporarily dazzle or permanently blind mission-critical sensors on satellites,”⁴⁶ either from a ground-based or even a space-based weapon. Unless authorities could locate and neutralize the source of the laser, a pirate could demand ransom to stop dazzling the satellite. Additionally, spacecraft uplinks and/or downlinks could fall victim to electronic attack, or jamming, and be similarly held hostage.

Space pirates may also resort to more classical means of holding a spacecraft hostage or stealing treasure. Space robotics will likely be required to physically steal and capture space materials. Historically, space robotics has been the exclusive regime of NASA, JAXA and the Canadian Space Agency. More recently, China’s SY-7 satellite likely carried a robotic arm that regularly interacted with another satellite.⁴⁷ The United States is developing similar space technology, currently through NASA’s Restore-L⁴⁸ and DARPA’s Robotic Servicing of Geosynchronous Satellites (RSGS)⁴⁹ which could service satellites: refuel; repair; and replace parts. Commercial companies like Orbital ATK are also making big bets that satellite servicing will be highly profitable in the future.⁵⁰ Unfortunately, any technology that could be used by

authorized parties to capture and service a needy satellite could also be used by space pirates to capture, hold hostage, disable, or scavenge from a healthy spacecraft. As space robotics technology becomes more capable, space-based bad actors may physically steal space resources mined and retrieved by US commercial companies, creating a black market both in space and on Earth.

Space pirates could engage in a large variety of mission-specific raids. By re-orienting or re-directing space-based solar power, a space pirate could hold the planet's energy needs hostage and send civilization back to the dark ages by redirecting or manipulating the space-based solar infrastructure. Alternately, a pirate could siphon off power on its journey to Earth, stealing from all who are honestly paying for electricity. Housed in low Earth orbit factories, commercial space manufacturing plants may one day be sitting ducks for thieves, which could board and seize fiber optic or pharmaceutical manufacturing plants. Even their shipments home may fall prey to pirates, via blockade or interception. On remote sensing systems, a pirate could hijack the satellite's capability, pointing them elsewhere and using the images for their own purposes, selling the products to others, and preventing American companies from gaining return on their large investment. Pirates might raid space tourism flights, kidnapping rich travelers for colossal ransoms. Bands of pirates might even develop protection money rackets, demanding a tax of spacecraft operators to ensure *nothing bad* happens to them. In general, pirates will target spacecraft, and the US government must step up to protect American commercial interests.

Just as American companies once relied on the might of US law to protect their mineral claims on the western frontier, space ventures will need protection from pirates hoping to seize control of the great wealth found on asteroids and the Moon. Furthermore, America will need to maintain an official presence on and around the Moon, Lagrange points, and strategic asteroids to prevent

other nations or pirates from creating an anti-access area denial (A2AD) type environment for future American ventures. In an A2AD environment, Americans would be denied freedom of movement in space, significantly limiting commercial potential and degrading safety.

Law Abiding Earthlings

“We need to use space to make life better here on Earth. Let’s zone Earth as ‘residential’ and move heavy industry off the planet. We envision millions of people living and working in space... ..Just like in the high seas, industry may be reliant on government to protect them.”

— Clay Mowry, Vice President, Blue Origin⁵¹

The USSG will enforce laws and promote norms in space. International law regarding space is somewhat limited – currently there are just four major treaties through the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), each with varying levels of international support: The Outer Space Treaty; The Rescue and Return Agreement, The Liability Convention; and The Registration Convention. The United Nations also recognizes the Moon Agreement, though no major space powers have ratified or acceded to it. It is very unlikely that any spacefaring nation will sign up for additional space treaties or be willing to “break open and update” them,⁵² so this paper will assume that the existing international space law framework will remain static as space commerce grows.

The “Magna Carta of space law” is The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies, best known as the Outer Space Treaty.⁵³ One hundred and five (105) nations have signed the Outer Space Treaty, including all of the spacefaring ones, making it by far the most widely-accepted international space law. The Outer Space Treaty generally recognizes private and commercial

activities in space, but the responsibility and liability for those activities lie with the launching nation, regardless of whether the entity carrying out the activity is government or commercial.⁵⁴ The Outer Space Treaty assigns responsibility for orbital debris to the liable nation, making it impossible to (legally) totally abandon a space object.⁵⁵ Notably, such abandonment happens all the time. Launch vehicle upper stages are discarded in Earth orbit, derelict spacecraft are left in space without de-orbiting them, and a new generation of small cubesats are put in orbit with no way to maneuver them from collisions or back into Earth's atmosphere at their end of life. The Outer Space Treaty also establishes space as a location with some similarities to Antarctica.⁵⁶ With reasonable advanced notice, States must open space based stations, installations, equipment and vehicles on the Moon and other celestial bodies to representatives of other State Parties.⁵⁷

Other treaties signed by the spacefaring nations include The Rescue and Return Agreement, The Liability Convention and the Registration Convention. The Rescue and Return Agreement allows for the safety of returning space travelers, but it also requires the prompt return of spacecraft.⁵⁸ If astronauts accidentally land in an unfriendly nation, their immediate and safe return home is guaranteed so long as that nation is one of ninety-five (95) parties to the Agreement. Spacecraft that have survived atmospheric reentry must also be returned, though the details of the timeline and compensation are less clear.

The Liability Convention expands on the Outer Space Treaty's rules, establishing absolute liability of the launching state for damage caused on Earth's surface or to aircraft in flight by its space object.⁵⁹ The Liability Convention has only been exercised once, when the USSR's Cosmos 954 crashed in Canada, spreading nuclear waste.⁶⁰ Canada "considered there to be a norm requiring the USSR to make full payment for the [damage]",⁶¹ but it was never fully compensated

as international enforcement was somewhat tepid. Furthermore, there is no international law outlining liability for damage to an in-space object or facility.

The Registration Convention also supports the Outer Space Treaty, dictating that a launching state must advise the United Nations of significant pertinent data about a space object, its function and its orbit.⁶² In doing so, the space object flies under the flag of its launching state, which must be identified and is not necessarily the nation from which the rocket was actually launched.⁶³ While this concept is already complicated and the subject of ongoing legal analysis, it will be muddled further when structures are built entirely in space or raw materials from space are brought to Earth.

The last international space law of note is The Moon Agreement. There are only seventeen (17) parties to The Moon Agreement, none of which are space powers. The United States, Russia and China have shown no interest in signing the Agreement, which dictates that property rights cannot be established over the surface or subsurface of the Moon, nor over natural resources in place.⁶⁴ As the major spacefaring nations do not recognize this Agreement, it will not be considered in the charter for the United States Space Guard.

As international space laws lack robustness, the United States must continue to develop and enforce national space laws, laying the foundation for international norms of behavior. The United States has taken the first steps towards establishing rule of law in the commercial space frontier through the Space Launch Competitiveness Act, which encourages Americans to “engage in commercial exploration for and commercial recovery of space resources.”⁶⁵ Similarly, the Space Resource Commercial Exploration and Utilization Act of 2015 (51 USC 51503 et seq.) is intended to “facilitate commercial exploration for and commercial recovery of space resources by United States citizens.”⁶⁶ In that same Act (51303), the government gives US citizens the right to

“possess, own, transport, use, and sell” asteroid and space resources they obtain.⁶⁷ There exists a natural tension between these American laws and The Outer Space Treaty, which states that celestial bodies are “not subject to national appropriation... ..by means of use or occupation, or by any other means.”⁶⁸ Such tension will need to be resolved peacefully as new space norms develop and countries compete for lucrative space resources.

The government of Luxembourg is posturing their small nation to become a flag of convenience in the benefits of space mining. Luxembourg wants companies to set up their headquarters within its borders in exchange for authorization and continuing supervision of space mining operations.⁶⁹ Luxembourg’s government contends that extraction of in-situ resources is not “appropriation” as per the Outer Space Treaty because it does not claim the entirety of the celestial body. Luxembourg’s law allows for nations to claim “appropriate parts of celestial bodies by mining them. Citing precedence from maritime law, Luxembourg notes that the sea cannot be appropriated, yet resources from the sea [can be appropriated].”⁷⁰ The United States must play a leading role in the future space mining industry: the legal framework must progress to incentivize American companies to remain headquartered within our shores before they venture to space.

The United States clearly intends for its entrepreneurial citizens to venture beyond the atmosphere and make a profit, but it has not yet established a framework for defending those resources or enforcing the laws that regulate safe and fair practice in space. Space law is already being broken. In early 2018, a commercial company in India launched a swarm of American “SpaceBee” spacecraft without the requisite licensing from either country. In fact, the operator was specifically denied the Federal Communications Commission (FCC) license in America, prohibiting any command and control, telemetry or data transmission.⁷¹ With relatively weak enforcement capability, the FCC has thus far only frozen SpaceBee’s future license applications

as punishment. While it is unlikely that the SpaceBees were launched for nefarious purposes, it is possible that someday operators with malicious intent will take advantage of the world's lack of enforcement capability. The United States Space Guard will be on watch to protect people and assets in space, enforce national and international law, and enable America to reap the rewards of space exploration and exploitation.

Space Guardians

“The Coast Guard exists for the particular and main purpose of performing duties which have no connection with a state of war, but which, on the contrary are constantly necessary as peace functions.”

— Captain Ellsworth Bertholf, first Commandant of the US Coast Guard⁷²

While pirates may target the vast wealth others collect in space, the people of spacefaring American industry will sleep well at night. The United States Space Guard (USSG) will stand watch, always ready to protect Americans and American property beyond the shore of our atmosphere. Inspired by the United States Coast Guard (USCG), its missions will be: law enforcement, prevention, response, space security operations, traffic management, and defense operations. A uniformed branch within a civilian Department, the USSG will promote and regulate the space industry, just as the Federal Aviation Administration (FAA) did for aviation. Furthermore, it will monitor the industrial base to “help ensure the availability of space-related industrial capabilities in support of critical government functions.”⁷³

The Space Guard will be a law enforcement agency, enabling the “stable, peaceful environment... ..for commercial operations” that the US government envisions.⁷⁴ It will work tirelessly to prevent legal infractions through its prevention program, and it will be ready to

respond and enforce the laws when needed. As part of this duty, the USSG will take on all aspects of commercial space management licensing. Currently, American companies hoping to launch a commercial satellite into orbit need launch (and reentry) approval from the FAA,⁷⁵ a radio frequency license from the FCC,⁷⁶ and approval to take pictures of Earth from space (remote sensing) from the National Oceanographic and Atmospheric Administration (NOAA).⁷⁷ This not only is a burdensome and lengthy process for the commercial operator, but it leaves glaring regulatory gaps for non-orbital vehicles, those that do not take pictures or communicate, and those that do not launch from US soil. The USSG will fill these gaps, serving as a one-stop shop to license and register all US commercial space assets. It will streamline the process to enable regular suborbital space tourism and point-to-point transportation with no more difficulty than filing an aircraft flight plan. Not only will this meet the intent of the Outer Space Treaty and The Registration Convention, it will take national accountability one step further, thus setting norms for the international spacefaring community.

The USSG will have the authority to license operators and conduct rocket and spacecraft inspections to ensure a safe and secure environment for space commerce. USSG rules will be designed to minimize financial impact, and they will comply with the government's rulemaking process: soliciting and addressing concerns from industry and the public before taking effect. This oversight, the details of which will be developed and tailored as industry emerges, will enhance safety and provide a government stamp of approval and space-worthiness for commercial operations. Americans know they are safe taking routine commercial airline flights across the country because they know the aircraft has been properly certified, and the pilots and mechanics have been properly licensed. The same will be true for point-to-point space transportation. In being the first nation to establish a comprehensive government construct for safe and secure

commercial space operations, America will set international space operating norms for spacecraft, debris and astronauts.⁷⁸

In its “response” mission, the USSG will come to the aide of ailing spacecraft and astronauts. Uncontrollable satellites pose a great risk to other space objects in their orbital vicinity, and commercial astronauts in peril should benefit from the same lifesaving efforts of their government as distressed mariners. The USSG will develop robotic capability, augmented by Space Guardians as required, that will perform basic repairs to spacecraft that have been built in accordance with internationally accepted design standards. If repair is impossible, the USSG will propel the derelict spacecraft back into the Earth’s atmosphere to disintegrate so that it does not put other spacecraft at risk.⁷⁹ Just as the Army Air Corps cut its teeth delivering Air Mail, the USSG may come of age in its active debris removal role. As space commerce expands, a platform similar to the Oil Spill Liability Trust Fund may emerge to cover the cost of cleaning up after wayward spacecraft. Not only will the USSG remove derelict spacecraft to prevent collisions, it will spearhead the global plan to actively remove tens of thousands of pieces of space debris in Earth orbit that constantly threaten satellites and astronauts. In non-emergent cases, the USSG might charge fees for this service, and there are dozens of business models for companies that could provide this service to the government at a charge.

The USSG will perform space security operations, protecting US astronauts, ships, and cargoes. To take the Coast Guard analogy further; a commercial ship does not require missiles, a fire control radar, countermeasures and a battle-ready crew to protect its millions of dollars of precious cargo. Merchant Marines are licensed through the US government, their ships are certified, and they sail with confidence knowing that the Coast Guard is there to provide security and response in case of attack.⁸⁰ While military spacecraft will no doubt have counter-space

capability in their designs at the time horizon in which a USSG is needed, commercial spacecraft will likely focus on their trade, expecting the rule of law to protect them. While the European Space Agency Director General, Jan Wörner, has no desire to be “the mayor of the Moon village, not at all”,⁸¹ the USSG will be there to provide basic law enforcement functions to ensure the safety and civility of outpost inhabitants. As early as the 1790s, the Revenue Cutter Service, predecessor to the USCG, served as a law enforcement agency on the edge – where civilization met the water. The USSG will extend this role naturally to the next frontier.

The USSG will also take a leading role in space traffic management. They will maintain and expand upon the existing catalogue of all space objects, facilitate orbital maneuvers and manage spacecraft placement. They will collaborate with commercial industry, other government agencies, and international partners to represent the United States in a future international space traffic management authority. All of the roles discussed in this section provide the peacetime foundation for safe and profitable US space operations.

Space War

“The Coast Guard is the hard nucleus around which the Navy forms in times of war.”

— Swab knowledge, US Coast Guard Academy

Should international armed conflict arise, the US Space Guard will augment the Department of Defense’s space forces. The armed services, and elements within the intelligence community, will continue to develop and manage space assets specifically for the purpose of deterring conflict or fighting our nation’s wars in air, space and cyberspace. The USSG will have a peacetime infrastructure for spacecraft inspection, repair and defense that could be called upon in times of national crisis.

“As with the freedoms of the high seas, the freedom of use of outer space must be exercised with regard to the interests of other states so that their exercise of such freedoms is not unreasonably denied.”⁸² The United States must take great care to not find itself in an A2AD situation in highly strategic and valuable space locations – the poles of the Moon, Earth-Moon Lagrange points and in the vicinity of near-Earth asteroids. The assets and expertise of the USSG, a civil organization with a military structure, will augment America’s might to ensure freedom for our nation’s interests.

To the Future

“It’s a fixer-upper of a planet, but we could make it work.”

— Elon Musk, regarding Mars

As the new frontier of space becomes more accessible to the world, the United States must take the lead in protecting freedom of navigation and action in space for our nation, our commercial interests and our allies. Space is unforgiving, but its potential rewards are in the trillions of dollars within the century. The United States Space Guard will act as the rule of law in space, establishing norms of behavior to ensure safety. The Space Guard will conduct inspections to ensure quality and compliance, protecting the space travelers and consumers. If a spaceship or astronaut is in peril, brave Space Guardians will save the day. The USSG will maintain security of critical space infrastructure and strategic space locations, and it take on the role of space traffic management in cooperation with commercial partners and allied nations. It will actively remove debris from Earth orbit and monitor the US space strategic reserve. If war extends beyond the atmosphere, the Space Guard will be trained, capable and always ready to augment the Department of Defense.

In 2018, space is already recognized as a warfighting domain – a congested and contested environment where American superiority cannot be taken for granted. We must address the battles of today while keeping an eye on the far future, laying the foundation so that America will be ready when a space pirate threatens to commandeer the bounty of a hard earned asteroid mine, hold a satellite hostage or deny access to a lucrative lunar outpost. The United States Space Guard, America’s Space Guardians, will add a second century of Pax Americana, enabling unlimited American expansion into the final frontier.

Notes

¹ This line from Star Trek The Next Generation, was adapted from the Original Star Trek series which limited the scope to “boldly go where no **man** has gone before.” The original quote was influenced by a 25 March 1958 White House pamphlet encouraging the exploration of space so that men may “go where no one has gone before.”

² (Bolden 2018)

³ (Loverro 2018)

⁴ Reference to the movie “Enemy of the State”

⁵ (Gangestad 2017)

⁶ (Griggs 2016)

⁷ (Marshall Space Flight Center n.d.)

⁸ (Ross 2018)

⁹ (France and Sellers n.d.)

¹⁰ (Wood 2014)

¹¹ (Werbos 2013)

¹² (NOAA 2018).

¹³ (Knowledge@Wharton 2013)

¹⁴ Anyone would need significant infrastructure and space maneuver capability. The Space Guard must be in place before this capability is widely available to malicious non-state actors (aka pirates).

¹⁵ (Mittal 2018)

¹⁶ (GPS World Staff, 2015)

¹⁷ (Tweney 2011)

¹⁸ (GlobalSecurity.org n.d.)

¹⁹ (Bryce Space and Technology, June 2017)

Notes

²⁰ (Mosher, Elon Musk is about the launch the first internet satellites, 2018)

²¹ The Karman Line is 100 kilometers (62 miles) above Earth's surface that represents the start of outer space for the purposes of treaties and record keeping. Sustained orbital flight is not possible at this altitude. As of April 2018, the new SpaceShipTwo has only had one powered flight test, to an altitude of approximately 80,000 feet.

²² (Wall 2017)

²³ The freefall environment is what is commonly referred to as zero gravity. Zero gravity (or zero G) is a misnomer, as the motion of the spacecraft and its occupants is still completely governed by the pull of Earth's gravity. The spacecraft is in a state of freefall, uninhibited by the Earth or its atmosphere, thus allowing it to experience a state that manifests as zero or microgravity for the occupants.

²⁴ (RT 2014)

²⁵ (Mosher 2018)

²⁶ (Brown 2017)

²⁷ (Koebler 2014)

²⁸ (Exploration Architecture Corporation n.d.)

²⁹ (NASA n.d.)

³⁰ (Meledez 2017)

³¹ (Parnell, 2017)

³² (Resources n.d.)

³³ (Pollpeter n.d.)

³⁴ (Express n.d.)

³⁵ Congress authorized the Revenue Cutter Service on 4 August 1790, under the administration of Secretary of the Treasury, Alexander Hamilton. This marks the officially recognized birthday of the United States Coast Guard. Revenue cutters were charged with suppressing piracy in and around the new country's waterways.

³⁶ (USCG n.d.)

³⁷ (Lightfoot 2018)

³⁸ As there is no atmospheric wind in space, the Jolly Roger would not wave in the wind. It is likely that future space pirates would have to augment their flag with wire to simulate a stiff wind, as the Apollo astronauts did with the American flag on the surface of the Moon.

³⁹ (Mason, 2010)

⁴⁰ (Editors of Encyclopaedia Britannica, n.d.)

⁴¹ (Samson 2018).

⁴² (Weeden and Samson 2018, 7-1)

⁴³ (Harrison 2018, 5)

⁴⁴ (Binder and Perlroth 2018).

⁴⁵ (Harrison 2018, 24)

⁴⁶ (Harrison 2018, 3)

⁴⁷ (Weeden and Samson 2018, 1-4)

⁴⁸ (NASA n.d.)

⁴⁹ (Roesler n.d.)

⁵⁰ (ATK n.d.)

⁵¹ (Mowry 2018)

⁵² (Hayes 2018)

⁵³ (Smith 2018, 50)

Notes

⁵⁴ (United Nations, 1967)

⁵⁵ (United Nations, 1967)

⁵⁶ (United Nations 1959)

⁵⁷ (United Nations, 1967)

⁵⁸ (United Nations 1968)

⁵⁹ (United Nations 1972)

⁶⁰ Notably, the US space station Skylab did crash into the Australian desert in 1973, but the Liability Convention was not invoked between the two allies. The Australian Park Service did fine NASA \$400 for littering.

⁶¹ (Cohen 1984)

⁶² (United Nations 1974)

⁶³ (Jessica 2017)

⁶⁴ (United Nations 1979)

⁶⁵ (Code 2015).

⁶⁶ (United States Code, 2015)

⁶⁷ (United States Code, 2015)

⁶⁸ (United Nations, 1967)

⁶⁹ (United Nations, 1967)

⁷⁰ (Smith R. , 2017)

⁷¹ (Harris 2018)

⁷² (Johnson 1988)

⁷³ (National Space Policy of the United States of America, 2010)

⁷⁴ (Page, 2017)

⁷⁵ (FAA n.d.)

⁷⁶ (FCC n.d.)

⁷⁷ (NOAA 2018)

⁷⁸ This construct is similar to international maritime standards, which were largely inspired by the norms established by the USCG: Safety of Life at Sea (SOLAS), International Convention for the Prevention of Pollution by Ships (MARPOL) and Standards of Training Certification and Watchkeeping (STCW) for vessels, pollution control and mariner licensing, respectively.

⁷⁹ Current US practices require that spacecraft in low Earth orbit reenter Earth's atmosphere after 25 years. Satellites in higher orbits are supposed to boost up to "graveyard" orbits after their mission is complete (and before they run out of fuel). Other concepts, including disposing of old spacecraft in the sun, are significantly more complicated from an orbital maneuver standpoint, but should be considered for this as a potential course of action in the far future.

⁸⁰ (USCG n.d.)

⁸¹ (Wörner 2018)

⁸² (Smith 2018, 51)

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