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United States Marine Corps
Command and Staff College
Marine Corps University
2076 South Street
Marine Corps Combat Development Command
Quantico, Virginia 22134-5068

MASTER OF MILITARY STUDIES

TITLE:

**Laws-t in Space:
Danger, Will Robinson!**

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AUTHOR:

Major Brian A. Jaquith, USMC

AY 17-18

Mentor and Oral Defense Committee Member: *Amel Houssein Shabanoff*

Approved: *[Signature]*

Date: *10 May 2018*

Oral Defense Committee Member: *Nathan M. Packard, PhD*

Approved: *[Signature]*

Date: *10 May 2018*

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Table of Contents

	Page
DISCLAIMER.....	ii
REPORT DOCUMENTATION PAGE.....	iii
TABLE OF CONTENTS.....	v
LIST OF FIGURES.....	vi
LIST OF TABLES.....	vii
EXECUTIVE SUMMARY	viii
INTRODUCTION.....	2
RESEARCH QUESTIONS.....	3
INTERNATIONAL TREATY REVIEW.....	4
HISTORICAL CONTEXT OF THE CHARACTER OF SPACE OPERATIONS.....	10
THE FUTURE CHARACTER OF MANS' INTERACTION WITH SPACE.....	18
EMERGING LEGAL REQUIREMENTS	22
CONCLUSION.....	25
END NOTES	25

List of Figures

	Page
Figure 1. Space Faring Nations in 1966..	7
Figure 2. Strategic Defense Initiative Concept.....	15
Figure 3. Space Faring Nations in 2016.....	17
Figure 4. Deep Space Industries “Harvester”.....	21

List of Graphs

	Page
Graph 1. Active Satellites in Orbit by Purpose for Use	16
Graph 2. Active Commercial Satellites in Orbit by Country.....	18

Executive Summary

Title: LAWS(T) IN SPACE: DANGER, WILL ROBINSON!

Author: Major Brian A. Jaquith, USMC

Thesis: The character of man's interaction with space has changed drastically since the arrival of the space age in the late 1950s. While access to space has historically been dominated by nation states and focused on augmenting and enhancing existing terrestrial technology, this dynamic is unlikely to remain the status quo. As private companies continue to fund space exploration projects, commercial interests in space will grow. The current thinking about space solely as an enabling domain fails to consider a future in which there will be a competition to gain access to natural resources located on other celestial bodies. Thus, the body of international laws and national strategies will need to adapt to ensure access to vital resources and attempt to prevent conflicts from arising over competing interests in space.

“There’s a fundamental difference, if you look into the future, between a humanity that is a space-faring civilization, that’s out there exploring the stars...compared with one where we are forever confined to Earth until some eventual extinction event.”

—*Elon Musk, 2017*

“Man has always sought to expand his domain. In subduing the earth, man moved onto the water, under the water, into the air, and into space as technology allowed. With him, man took all his ways – the good and the bad. Onto the seas and into the air, man took war. If history is any guide, the domain of war will undoubtedly extend to space as well.”

—*Major Charles D. Friedenstien/Lieutenant Colonel Thomas J. Eller, 1981*

Shortly after midnight, on October 5th, 1957, a group of Soviet scientists working at a remote, desolate site east of the Aral Sea in the Kazak Republic were huddled tightly together in their workspaces. With radios tuned to several preset frequencies, they listened intently, waiting to determine whether their latest experiment was going to end as an astonishing success or in abject failure. As the crackling static was slowly broken by a repetitive beeping sound, they instantly knew their hard work had finally come to fruition, and the room exploded with excitement.¹ Their project, the Soviet Union's satellite "Sputnik 1," ushered the human race into the space age and was one of the catalysts that caused both the Soviet Union and the United States to greatly expand their space programs in the ensuing years.

Slightly more than 60 years after "Sputnik 1" was put into orbit, on February 6th, 2018, approximately 2.3 million people repeated almost the same activities as Soviet scientists did before them. At schools, workplaces, and homes throughout the world they huddled around computers, laptops, and mobile devices waiting to see how this latest space adventure would end. In contrast to the Soviet scientists, however, the world was not waiting to see the results of a government led initiative into space. They were waiting to see whether the Chief Executive Officer of SpaceX, a privately-owned company, could continue to deliver on his claims of making commercial space activity a reality. In what would be YouTube's second largest live streaming event, the world witnessed Elon Musk's success and characteristic flair, which was demonstrated by launching his own car into space on a path to orbit Mars.²

While seemingly similar events on the surface, these two anecdotes about mans' attempts to master the solar system and use it to gain an advantage on earth could not be more starkly different. In the case of "Sputnik 1," the world was in the midst of the Cold War and any technological advantage to be gained was as useful for the propaganda as it was the actual scientific advances. In the case of SpaceX, commercial access to the outer reaches of the solar

system and the resources it potentially holds could prove to be a lucrative business venture and offset the lack of certain resources here on earth. It is abundantly clear that the character of man's involvement with space has undergone a substantial transformation over the last 60 years. It has shifted away from the use of space by nation states to gain an advantage against an opponent and moved towards commercialization and exploitation of resources.

While man's use of space has evolved, the same cannot be said for the international laws and treaties that collectively govern our conduct in orbit. The last substantial United Nations (UN) treaty regarding conduct in space entered into force in 1972. Put in perspective, the international ratification of that treaty was just over 14 years from the launch of "Sputnik", there were only 11 countries with artificial satellites in orbit, and Elon Musk had just celebrated his first birthday. Today, it has been 7 years since the end of the Space Shuttle program, more than 80 countries have satellites in orbit, and in 2017 alone SpaceX completed 18 launches into space for 11 different customers ranging from the United States military to Eastern European allies and international corporations.³ In this era of increasing commercial competition and proliferation of space related technology, it is imperative that the body of international legal work keeps pace and accurately addresses the relevant actors and activities in space to attempt to mitigate the potential causes for future conflict. With these thoughts in mind, the following questions drove the research and assessments presented below:

- What are the legal parameters of the current body of international laws regarding man's conduct in space?
- When they were written, how were these laws affected by geopolitical events happening on earth?

- How will future drivers of instability on earth affect the character of mans' interaction with space?
- Are current agreements on state interactions in space sufficient to mitigate potential future causes of conflict over space?

International Treaty Review

The concept of an international body of laws used to govern the conduct of objects in flight existed well before man's ability to put objects into space. Following the rapid proliferation of aeronautical technology in the early part of the 20th century, there were a host of bilateral and multilateral treaties that governed the legal status of both balloons and aircraft. This ambiguous patchwork of standards initially served the international community well, but as air travel shifted from a regional capability to a more global capability, and from a primarily governmental purpose to a more commercial purpose, it was clear that a comprehensive legal review was needed. This change occurred in 1947, with the entry into force of the Convention on International Civil Aviation (Chicago Convention). This document established an organization under the UN, called the International Civil Aviation Organization (ICAO), which was charged with harmonizing and policing international air travel. The Chicago Convention also codified acceptable conduct between states concerning overflight of territory, and perhaps most importantly articulated in its first Article that "every State has complete and exclusive sovereignty over the airspace above its territory."⁴

The Chicago Convention was the last major international treaty concerning the standardization of laws pertaining to aircraft before the Soviet launch of "Sputnik 1" and the American response with "Explorer 1" only four months later. While the Chicago Convention may have proven adequate for the civil aviation community, these new forays into low earth

orbit (LEO) called into question its ability to regulate the use of space. For example, as “Sputnik 1” proceeded along its orbit, it passed over the United States and other party countries. By the standard of the day, which declared that states had sovereignty over their “airspace”, the Soviet Union may have violated the dominion of the United States. Likewise, the United States may have violated the airspace of other nations in the opening days of the space race. The evolving character of mans’ interaction with aerospace dictated a new set of laws.

These laws would not be immediately forthcoming, however, given the state of global affairs during the late 1950s and early 1960s. As the Cold War intensified during the Eisenhower and Kennedy administrations, it was clear that whoever could master the space domain more quickly could have a marked advantage at the onset of hostilities, if only because of strategic intelligence gathering capabilities that evolved in this era. A codified system of international laws dictating what was and was not permissible in space could have ruled out the ability to develop space related military technology. In this instance, a significant amount of legal “gray space” served to benefit both the United States and the Soviet Union as they each sought to gain the upper hand.

About the only thing that everyone, including the great powers of the day, could easily agree on was that detonating nuclear weapons in space seemed like a pretty terrible idea. On the heels of several terrestrial hydrogen bomb tests during which contamination from radioactive fallout exceeded the expected estimates, in October, 1963, 108 countries signed the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space, and Under Water, also known as the Limited Test Ban Treaty (LTBT).⁵ This was the first international treaty that specifically addressed impermissible conduct outside Earth’s atmosphere.

While at this critical stage it was important for the United States in particular to preserve national freedom of action to exploit emerging technology to gain leverage in the Cold War, it

was also eventually seen as necessary to support extending the rule of law into space, in keeping with liberal values. Following the LTBT, the General Assembly of the United Nations passed Resolution 1962, the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space. This declaration, which was adopted in December, 1963, laid down the basic standards for the exploration and use of outer space, and provided the first guidelines for claims of sovereignty over celestial bodies and spacecraft, liability for harm caused by spacecraft, and international conduct towards astronauts in the execution of their duties.⁶ Although quite useful as a framework, UN Resolution 1962 had one specific drawback. Because it was merely a resolution passed by the General Assembly, it lacked the force of international law. In Chapter IV (The General Assembly), Article 14 (Functions and Powers) of the Charter of the United Nations, General Assembly resolutions are addressed. Article 14 states that, “[...]The General Assembly may *recommend* (emphasis added) measures for the peaceful adjustment of any situation, regardless of origin, which it deems likely to impair the general welfare or friendly relations among nations, including situations resulting from a violation of the provisions of the present Charter setting forth the Purposes and Principles of the United Nations.”⁷ Without an actual treaty, nations were generally free to do as they wished in space.

That watershed moment for international space law occurred in January, 1967 with the passage of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty).

Expanding on the principles outlined in General Assembly Resolution 1962, the Outer Space Treaty sought to solve potential sources of conflict envisioned in 1967 and continues to serve as the foundational document for international space law today. In its 27 articles, this treaty accomplished quite a bit, including segments that guarantee access to space for all countries, prohibit claims of national sovereignty over celestial bodies, and ban the stationing of weapons

of mass destruction in space.⁸ In his speech prior to signing the treaty on January 27, 1968, President Johnson described his hope for the future. “We have never succeeded in freeing our planet from the implements of war. But if we cannot yet achieve this goal here on earth, we can at least keep the virus from spreading.”⁹ When the treaty entered force on October 10, 1967, President Johnson again indicated his hope for the future of space. “Until now our strivings toward peace have been heavily burdened by legacies of distrust and fear and ignorance and injury. These legacies do not exist in space. They will not appear there unless we send them on ahead.”¹⁰ The treaty’s most recurring theme, appropriately, is that space shall be used for peaceful purposes, and that space faring nations should strive for cooperation on all matters related to space exploration and research. This treaty is still in force today, with 107 countries that are party to the agreement, and another 23 that are signatories, but have not completed the ratification process. Importantly, every country that has ventured into space to date is party to the agreement.¹¹ Figure 1 depicts a map of space faring nations during this time compiled by the Union of Concerned Scientists.¹²



Figure 1

While the Outer Space Treaty covered most events that could be foreseen in 1967, it does fall short in several areas of relevance today. For example, it contains articles that require states to inform the UN of the “nature, conduct, locations, and results” of space exploration missions and dictates that any “installations, equipment, and space vehicles on the moon and other celestial bodies shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity.”¹³ As we shall see later, these provisions may have worked well when the dominant parties in space were nation states conducting activities to further national defense, but they can create some very difficult situations when the dominant parties are private industries competing for resources in orbit.

International space law continued to progress through the late 1960s and early 1970s, with the entry into force of the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Rescue Agreement) in 1968, the Convention on International Liability for Damage Caused by Space Objects (Liability Convention) in 1972, and the Convention on Registration of Objects Launched into Outer Space (Registration Convention) in 1976. These treaties expanded on concepts laid out in both the General Assembly Resolution 1962 and the Outer Space Treaty and moved away from the abstract and toward the more practical realm. For instance, the Rescue Agreement codifies the required national response should a foreign spacecraft experience an unanticipated crisis and either crash or be forced to conduct an emergency landing. It stipulates that a Party State shall take all necessary steps to rescue downed astronauts within their territory, and if it receives notification of foreign astronauts in emergency at sea or in a place not under the jurisdiction of any nation it shall extend all search and rescue assistance possible for speedy recovery.

The Rescue Agreement also requires Party Nations to safeguard foreign spacecraft or parts of foreign spacecraft that either land or crash within their territory, and repatriate them to

the nation that originally launched the spacecraft.¹⁴ While this particular Article of the Treaty appears reasonable for states conducting scientific exploration into space, it may create similar problems as the Outer Space Treaty when considering the ramifications of spacecraft owned and operated by private industry in a competitive market. Return of downed spacecraft to the launching authority, when that spacecraft may be returning full of valuable resources following a commercial extraterrestrial mining expedition, may be wishful thinking if that spacecraft lands in a resource poor country.

The Liability Convention of 1972 also expanded on the Outer Space Treaty and articulated some very clear requirements should damage occur as a result of a Party Nation's space launch activities. It declares that a "launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight" and that a "launching State" means: "1) A State which launches or procures the launching of a space object and 2) A State from whose territory or facility a space object is launched."¹⁵ If the spacecraft that caused the damage is a mutually owned and operated vessel, the Liability Convention makes specific provision that all party states are jointly liable for the damage caused.¹⁶ By this rationale, any Party Nation is completely responsible for the actions of spacecraft developed and launched by private industry from within its territory, even if that spacecraft is completely funded by a foreign client.

The Registration Convention, which entered into force in September, 1976, provided deeper context and specific rules for the broad principles agreed upon in the Outer Space Treaty and the Liability Convention. Because the UN wanted to promote responsible access to space and ensure Party Nations were aware of each other's actions, this treaty dictated that signatories must provide specific identifying information regarding their launches to the Secretary General of the UN. This information includes not only ownership and identification information, but also

some basic orbital parameters such as the nodal period, inclination, apogee, and perigee.¹⁷ In an era of increased space access, a public repository of such information may be used to prevent collisions between objects, help identify spacecraft involved in any mishaps, and attribute responsibility for accidents as required by the Liability Convention.

The last substantial UN treaty regarding space is perhaps the most contentious space related treaty. The work on the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement) began in 1971, and it was not opened for signatures until 1979. Even then, the Moon Agreement did not have enough Party Nations ratify the document to make it effective until 1984, and to date it has only been ratified by 17 nations and signed by another six.¹⁸ No nation with its own manned spaceflight program is a party to the agreement, essentially making the treaty worthless as an enforceable document. The Moon Agreement is controversial because it further limits extraterrestrial claims to sovereignty beyond those articulated by Outer Space Treaty of 1967. In addition to reaffirming the illegality of stationing military forces on celestial bodies, it bans all use of extraterrestrial objects unless the use benefited all other Party Nations. It also seeks to prohibit the alteration of the environment of celestial bodies and requires that an international organization be established to ensure the sharing of all resources obtained from bodies in orbit.¹⁹ Given that the Moon Treaty in effect prevents a state from monopolizing resources obtained in space, it is clear why space faring nations that are members of the UN have thus far declined to sign or ratify the agreement, and why nations with either a fledgling space program or none at all decided to do the opposite.

While these five documents are not the only international agreements regarding space, they are the only international treaties and therefore form the backbone of the international legal regime that codifies acceptable conduct by space faring nations. They are imperfect documents, some of which took years to create and institute, and the writers lacked the benefit of a mythical

“crystal ball” with which to predict the future character of man’s interaction with the domain of space. The treaties are products of their time. It is therefore beneficial to review pertinent global events to better understand why these treaties were written the way they were.

The Historical Context of the Character of Space Operations

As the framers of the body of international space law knew, anticipating the future is a challenging endeavor, but an essential one for security professionals and enterprising individuals alike. Writing laws to govern all future conduct within the entirety of the universe proved to be problematic because of the immaturity of man’s interaction within the domain. In the case of the space treaties, international laws had to be crafted to solve the geopolitical problems of the day, while still keeping an eye on the future. Thus, the Outer Space Treaty provided the guiding principles, with the subsequent treaties articulating greater specificity as nations worked out the issues among themselves. Over the course of the past sixty years, man has developed primarily three reasons for extraterrestrial travel and research: use for military dominance, use for research in the sciences, and use for commercial or other economic advantages. While man has conducted activities for all of these reasons throughout his interaction with the space domain, they fall into four chronological phases, based on the preponderance of each type of activity: the early Cold War, Détente, the 1980s, and post-Cold War. International space law generally followed these trends as well.

As noted earlier, man’s initial forays into space were solely the province of highly developed, well-funded nation states and mostly focused on global posturing and national defense. Indeed, from the launch of “Sputnik 1” until the détente with the Soviet Union fifteen years later, only six more nations proved they were capable of putting anything into orbit. Joining the ranks of the United States and the Soviet Union were France, Australia, Japan, China,

the United Kingdom, and Italy. Although the latter two nations both had satellites in orbit by 1967, both were actually launched using American rocket technology.²⁰

Almost immediately following the launches of “Sputnik” and “Explorer”, the use of space for military purposes began. The United States quickly established an organization under the Department of Defense (DoD) with the express purpose of using space for national defense and military purposes²¹ and passed a law creating the National Aeronautics and Space Administration, which supervised all space activity.²² Using concepts proven by the Soviet Union during the “Sputnik” launches, American defense scientists working for these institutions pioneered the first satellite based terrestrial navigation system which was functioning in 1960.²³ In the event of global hostilities, this technology would be instrumental in guiding submarines to precise firing points to launch a strike. These submarines were armed with nuclear-tipped “Polaris” missiles, which borrowed technology from rockets initially intended to put satellites into orbit and were fully fielded to the fleet during the Kennedy Administration.²⁴ This guided missile was developed alongside others such as “Titan”, “Atlas”, “Thor”, and “Jupiter.” It was also during this time that the development of the first generation of satellites used to conduct intelligence, surveillance, and reconnaissance (ISR) occurred, and they were in limited operational use by 1962.²⁵ Because of America’s burgeoning involvement in Southeast Asia, the government also invested in advances in both satellite communications to hasten the decision-making capabilities of the National Command Authority²⁶ as well as weather reconnaissance satellites to aid in the prediction of weather patterns and their effects on military operations.²⁷

This rapid militarization of space technology hit its apogee around the time of the Cuban Missile Crisis in 1962. As the United States and the Soviet Union backed away from the brink of nuclear conflict, the prevailing attitude about the character of man’s interactions with space changed. Almost a year to the day following the crisis, the PTBT was passed with 108

signatories; 106 of them were incapable of putting an object into space, yet they all recognized, for the good of mankind, the need to establish some common rules for acceptable conduct in orbit. Less than two months later, UN Resolution 1962 was passed by the General Assembly without requiring a vote.²⁸ This laid the groundwork for subsequent expansion into the Outer Space Treaty of 1967 and the Rescue Agreement of 1968.

While advances in international space law were certainly important in the late 1960s, they were not the salient global issue of the day. This period was of course dominated by small wars fought around the world to stop the spread of communism following the post-colonial era. Most notably for the United States, this took the form of the Vietnam War. This conflict consumed a massive amount of national resources, and by the time President Nixon assumed office in 1969 it was clear that the United States would not be able to attain its national objectives in Southeast Asia. As the United States withdrew its military forces from the region, it began a period of reckoning and honest assessment about its capabilities and limitations. The massive expenditure of resources and capital, negative public sentiment towards military service, intellectual stagnation of defense strategies, and worrisome effect of social issues all had a deleterious effect on the capabilities of the national security apparatus of the United States in the early 1970s. Viewed in the geopolitical context of the Cold War, the reduced capabilities and capacity of the United States military weakened the nation's position vis-a-vis the Soviet Union. Given such a position of weakness, it was in the national interest to pursue assured peace, and this objective led to the policy of *Détente*.

While *détente* is typically associated with the first Strategic Arms Limitation Treaty (SALT I) and increased diplomatic efforts between the Soviet Union and the United States, it also had a marked effect on the character of man's interaction with space. Because of the potential for advances in scientific research, space exploration provided a medium for both

superpowers to demonstrate their resolve to cooperate. This resulted in some very tangible advances made in international treaties and agreements. In addition to the Liability Convention entering in force in 1972, both the Soviet Union and the United States signed the Agreement Concerning Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes in 1972.²⁹ This agreement expanded on the treaties to which both countries were already party and laid the foundation for additional bilateral space research projects which culminated in the joining of an Apollo spacecraft with a Soyuz spacecraft in orbit in 1975. The background work between the two countries to make this venture successful led to unprecedented levels of access to each other's space technology and contributed to the ongoing spirit of cooperation.³⁰ This transnational "group effort" resulted in tangible advances in human understanding of biology, human biology, physics, astronomy, and meteorology.

Détente also saw the entry into force of the Registration Convention in 1975, and other agreements such as the United Nations Convention Relating to the Distribution of Programme-Carrying Signals Transmitted by Satellite in 1974, which further expanded the cooperative rule of law between nation states into the space domain. In terrestrial terms, meanwhile, both the Soviet Union and the United States engaged in the SALT II negotiations, which were designed to further reduce the production of nuclear weapons and ballistic missiles. This period of cooperation was not to last forever, though. In the late 1970s, Soviet forces invaded Afghanistan; as a result, the United States Senate declined to ratify the SALT II treaty. This conjuncture of events also ushered in the return to the use of space for military purposes that dominated the period from the early 1980s until the collapse of the Soviet Union and the end of the Cold War.

The return to a tenuous geopolitical situation, combined with the increased technological capabilities generated in the 1970s, led to an increased conceptual use of the space domain to

gain leverage over the adversary. Specifically, the United States sought to alter the balance of power by creating a system to protect the nation from the renewed threat of Soviet intercontinental ballistic missiles (ICBMs) and submarine launched ballistic missiles (SLBMs). This effort was manifested through the “Strategic Defense Initiative”, which was a concept for ballistic missile defense (BMD) that incorporated spaced-based sensors, weapons, and command and control systems that were theoretically capable of defeating a Soviet first strike attempt. Figure 2 is an artist’s conceptual design of the elements of the Strategic Defense Initiative working together to defeat an incoming missile threat.³¹ Fortunately, the internal collapse of the Soviet Union and subsequent end to the Cold War meant that the Strategic Defense Initiative and other space related military technological advances, such as anti-satellite missiles, never had to be used between the two Superpowers.

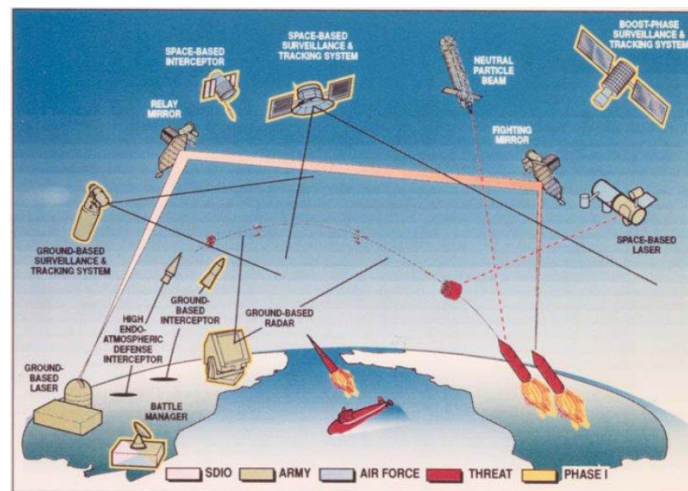
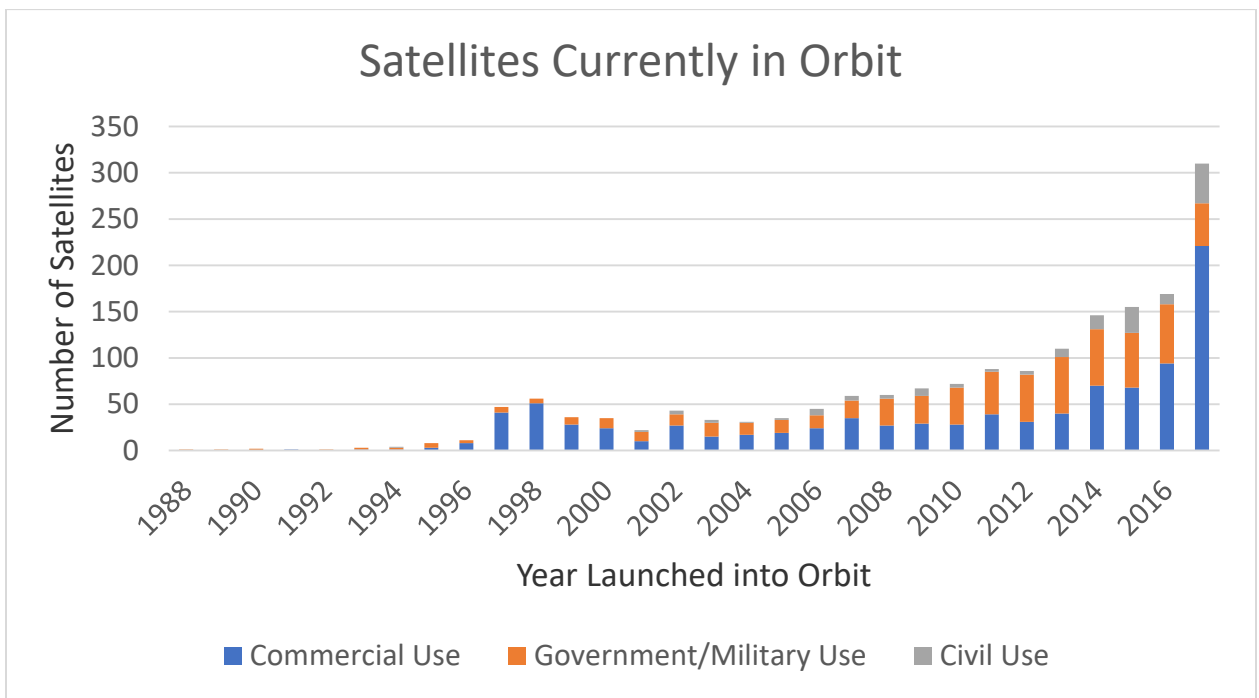


Figure 2

A byproduct of this collapse was that there was no longer a bipolar geopolitical struggle at all between the USA and USSR. As a result, nation states formerly aligned with one camp or the other could reduce military spending and use the “peace dividend” to reinvest in social programs. This also meant that there was reduced emphasis and spending by nation states in mastering the space domain, because the security situation no longer dictated such expenditures.

The gradual withdrawal of the nation state as the dominant actor in space created a vacuum in the 1990s, which was subsequently filled by private industry. This shift in the character of mans’ interaction with the space domain is the last significant shift and brings us to the current state of affairs.

To further examine this changing dynamic, it is helpful to evaluate some historical data about who has gained access to space, and for what purposes. Since “Sputnik 1,” humans have put approximately 8,000 objects into space, most of them satellites. Of those objects, about 5,000 have either left orbit or were destroyed upon reentry into earth’s atmosphere. This leaves approximately 3,000 satellites in orbit as of August, 2017, and of those only 1,738 remain in active use. More than half of these are used for commercial purposes, and as displayed on Graph 1 there is an overall rising trend of satellites being launched for commercial purposes.³²



Graph 1

Additionally, the proliferation of space related technology has significantly lowered the bar for access to space. While only a handful of countries have demonstrated the capability of conducting their own launches, many more countries have developed satellites and other space related technology and arranged to have it launched into orbit by another country. The majority of this type of activity has taken place since the fall of the Soviet Union. More than two times as many countries have gained some type of access to space since December, 1991 as had beforehand. This increased access has also led to increased commercial competition in satellite development as well as launch platforms. Figure 3 depicts the proliferation of space technology and the increased international access to space in 2016,³³ and Graph 2 depicts a breakdown of active commercial satellites by the owner/operator's country of origin.³⁴ It is clear that at this point in human interaction with the domain of space that access is no longer confined to first world nations, but rather has expanded to most developed nations and a rapidly expanding group of commercial entities.

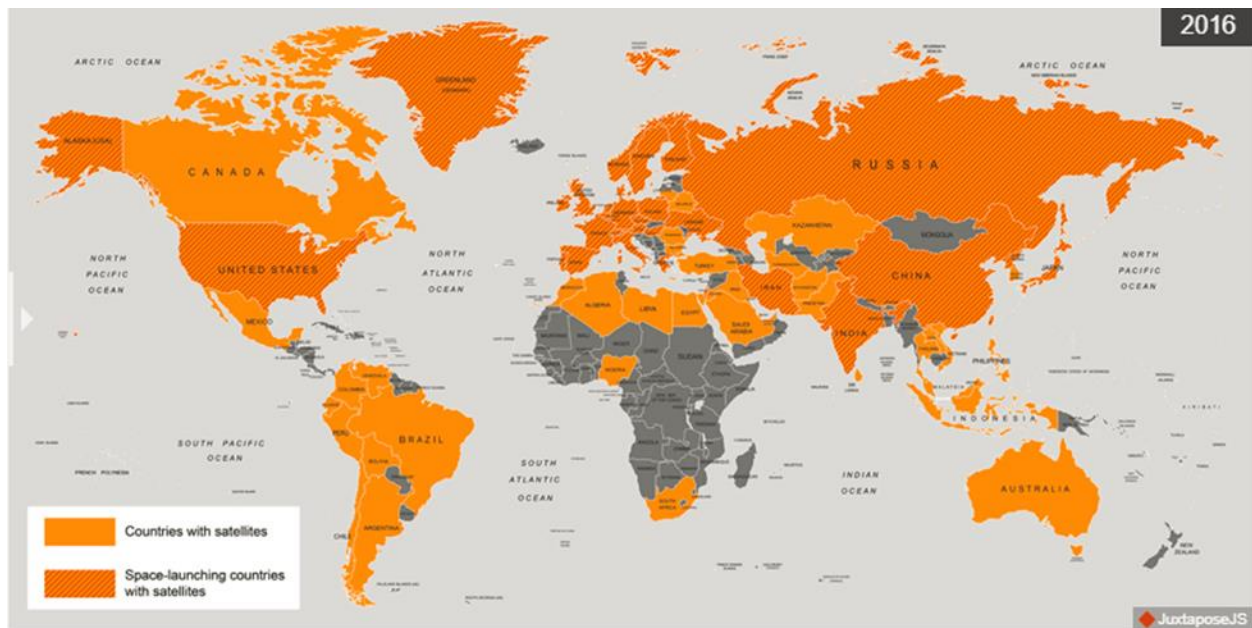
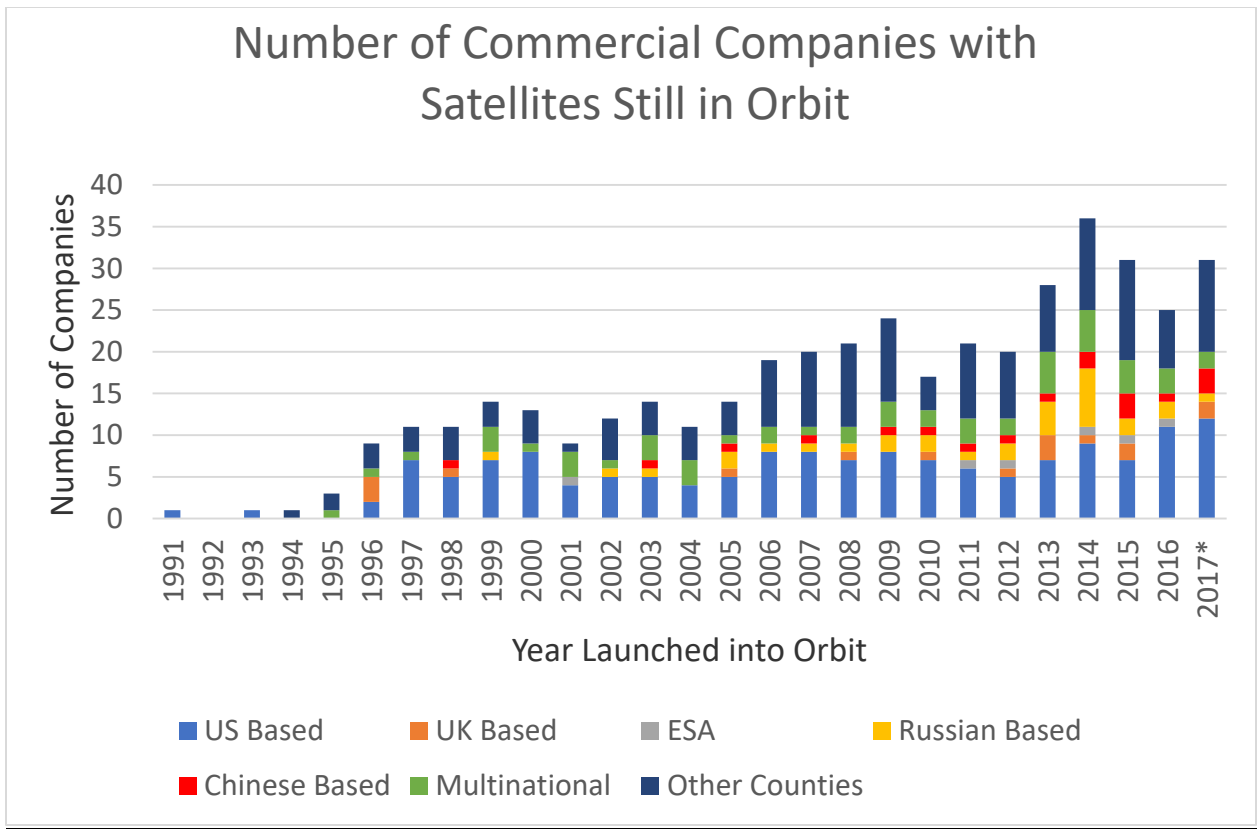


Figure 3



Graph 2

The Future Character of Man’s Interaction with Space

The way humans use space continues to have a direct correlation with geopolitical events happening on earth. In that respect, understanding the interaction between these domains can benefit from a holistic view of the future operating environment. In considering the terrestrial future, it is helpful to evaluate drivers of change and their relationship to emerging conflict. Perhaps the most important of these drivers are the rapidly growing world population and resource scarcity.

According to the United States Census Bureau, the global population reached 7 billion in 2012 and is projected to reach 9.7 billion by 2050.³⁵ During the same time, both the availability of and access to life sustaining resources such as water, food, shelter, and energy are going to

experience a corresponding substantial decline. Once again resource scarcity, which has been responsible for human migration patterns and subsequent conflicts over millennia, is likely to be the underlying cause of global tension. One would suspect that the laws of supply and demand will continue to apply in the future much as they do today, and as these resources become scarcer and the demand for them increases, their value and subsequent cost attached to the resource will increase as well.

Nation states seeking to provide for their citizens, alleviate human suffering, and mitigate potential conflict over resources will need access to a significant amount of capital to fund these endeavors. There are indications that this capital may be available, and currently orbiting the solar system. It is increasingly likely that in the future, harnessing these resources in space will be the key to generating capital on earth. In fact, some entities have already started the first steps toward this future.

In a press release in January, 2017, NASA highlighted an approved robotic research mission to be executed in 2023 to land on the “16 Psyche” asteroid in 2030. Only four months after the press release, it was announced that the mission will launch a year early, in 2022, and arrive at the asteroid in 2026 – four years earlier than initially projected.³⁶ This mission is designed to conduct research on an asteroid that is suspected to be the remnants of an extinct planet’s core in order to give scientists insight into the past and future of our own planet. What makes this different, and much more significant when evaluating possible futures for the domain, is that the asteroid is suspected to be comprised mostly of iron and nickel.³⁷ In an article for Forbes, using the known size and composition of the asteroid, it was projected that the value of the metals would surpass \$10,000 quadrillion. When compared with the estimated value of the entire human economy, \$74 trillion, it is evident that recovering just a fraction of this one

asteroid in all of space could create an immense economic advantage for a corporation or nation state that could develop ways to harness the resources.³⁸

Modern influential scientists seem to agree with this assertion. In his book *The Future of Humanity*, noted physicist and futurist Dr. Michio Kaku describes asteroids as “flying gold mine[s] in outer space,” and notes that asteroids containing iron, nickel, carbon, cobalt, platinum, rhodium and iridium could be especially useful to humans.³⁹ Renowned astrophysicist Neil deGrasse Tyson has also recently noted, “The first trillionaire there will ever be is the person who exploits the natural resources on asteroids. There’s this vast universe of limitless energy and limitless resources. I look at wars fought over access to resources. That could be a thing of the past, once space becomes our backyard.”⁴⁰

This vision of harnessing extraterrestrial bodies for natural resources and profit is not limited to scientists and futurists. In April, 2017, finance company Goldman Sachs released a research report on space mining to its clients. According to the primary analyst, Noah Poponak, “While the psychological barrier to mining asteroids is high, the actual financial and technological barriers are far lower. Prospecting probes can likely be built for tens of millions of dollars each and Caltech has suggested an asteroid-grabbing spacecraft could cost \$2.6 billion.”⁴¹ The estimated price to make space mining a reality may seem extraordinarily high, but the reduced prices for access to space generated through reusable rocket technology, together with the prospect for an extremely high payoff based on the sheer value of the resources harnessed, make this future highly probable. Private industries have seen the prospects of lucrative returns, and companies such as Deep Space Industries, Planetary Resources, and Offworld Incorporated, along with several others, are developing plans and concepts to make it a reality in the near future. Figure 4 is a conceptual drawing by Bryan Versteeg of Deep Space Industries of their “Harvester 1” project, which will perform extraterrestrial mining activity.⁴²



Figure 4

Given current realities and technological capabilities soon to come on line, the future of space is likely to be much more crowded than it is today. There are going to be both state and corporate actors present, with an ever-increasing amount of commercial activity taking place. Additionally, as the bar for entry into space is lowered, the sheer amount of states and companies putting objects into orbit will continue to rise. There will be a fledgling space tourism industry, and as noted by Major Timothy Riemann in his work on space-based logistics, there may be an increase in military activity, specifically in prepositioned supplies aboard spacecraft in low earth orbit.⁴³

Despite the current understanding of space as a resource rich environment, there will likely be only a few celestial bodies that are feasible candidates for extraterrestrial mining, especially as the technology is in its infancy. Because of the imperative to demonstrate success on the international stage and gain an edge in experience, there will likely be extreme

competition, and possibly a commercial “Space Race” to conduct this activity first. Once the capability is proven, more startups will be established with the goal of capitalizing on extraterrestrial resources. While there may be deconfliction between entities at first, there will likely come a time when access to mineral rich asteroids becomes the topic of debate. By overlaying this anticipated future on the current regime of international space law, it is not hard to conceptualize a future conflict beginning over either access to space or claims to valuable resources being harvested from space. Even short of outright war, however, the international environment in space will give rise to legal conundrums and commercial friction. To understand why, one must consider more carefully how future economic activity in space may evolve.

Emerging Legal Requirements

It is quite clear that international space law has not kept pace with the character of man’s interaction with the domain. The Outer Space Treaty, the Rescue Agreement, the Liability Convention, and the Registration Convention were entirely adequate to prevent conflict and encourage international cooperation when they were constructed. They kept the peace through the militarization of space during the 1960s and 1980s and formed the basis for international cooperation and both scientific and technological growth in the 1970s and 1990s. It is however, time to reexamine their usefulness, and apply some critical thought as to what new legal challenges will need to be solved in the future.

One of the first issues that needs to be addressed concerns the Liability Convention. As previously noted, Earth’s orbit is significantly more crowded today than it was when the Convention entered into force. The propensity for nation states to launch satellites with a limited life span into orbit has created a large amount of “space debris” that is no longer under the direct control of anyone on Earth. Additionally, the continued testing of anti-satellite missiles and

subsequent destruction of objects in LEO only adds to this debris field. These objects orbit at such a velocity that any collision with one would destroy a spacecraft, potentially causing a lethal event if there were passengers on the vehicle. Continued creation of space debris could make it almost impossible to put objects into orbit.

The Liability Convention does not adequately deal with the emerging problem of space debris, for two specific reasons. First, it stipulates that launching countries are only liable for damage if they act in a negligent manner. It stops short of actually defining negligence; furthermore, what was deemed to be responsible at the time of the Convention's passage may in fact be negligent today. It fails to address the deliberate creation of space debris in the form of objects of only temporary utility, which should be considered negligent if access to resources in space proves to be vital in the future. Secondly, the Convention only applies to nation states, not private citizens or corporations.⁴⁴ It also does not apply to damage caused to a resident of a launching state if the spacecraft that caused the damage originated from that state. This situation creates several problems. A private entity incorporated in State A that has a claim against State B due to damage must convince State A to file a claim on its behalf. Additionally, if a private corporation launches an object contracted by State A from within State B's borders, State B is deemed to be the launching state and is thus liable for damage caused by the spacecraft even though it may not have complete cognizance of the functionality of the object.

Updating the Liability Convention to address these issues must be approached carefully to avoid creating unintended consequences and making the problem worse. Any updates should be comprehensive enough to solve these issues, but at the same time must avoid creating a legal regime that invites loopholes. Increasing the requirement for a launching state to monitor the conduct of private corporations launching from within its borders is likely to cause these launching states to enhance the oversight of space programs by passing national legislation and

enacting standards that may impose prohibitive costs on industry. Such a development could drive commercial space companies to operate from nations that are not party to the agreement because regulatory laws would be laxer, essentially mirroring the “flag of convenience” problem with cargo vessels and cruise ships operating on the high seas. This trend could actually decrease international oversight, and thus make the space debris problem even worse.

Assuming that the emerging space debris problem is solved, and that access to space remains viable into the future, another issue that will need to be addressed is related to commercial spaceflight and space tourism. The Outer Space Treaty declares that astronauts shall be regarded as “envoys of mankind in outer space” and that while “carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to the astronauts of other States Parties.”⁴⁵ It essentially creates a legal status for people in space that requires certain actions from other nations. It is unclear, however, how this requirement will apply to commercial activity in space. Specific language regarding the status of private citizens in space acting in their own interests should be crafted to clarify international responsibilities.

Lastly, it is essential that an international treaty address access to resources in space. It is clear that the Moon Agreement is not the right vehicle to do this. It has been open for signature for almost 40 years, yet remains ineffective at actually providing a solution to the problem. At the heart of the matter are the articles requiring the international sharing of benefits obtained from harvested resources and the requirement of international approval prior to using celestial bodies. Lack of international consensus on this topic in the near future, could potentially set the stage for international disputes over scarce resources obtained in space. The problem certainly deserves more research and thought by legal scholars, and the United Nations Convention on the Law of the Sea (UNCLOS) may provide a decent framework on which to base future efforts.

Conclusion

Throughout the history of human interaction with the space domain, geopolitics and terrestrial events have proven to be the independent variable that determines the character of man's actions in orbit. Almost from the earliest forays outside Earth's atmosphere there has been a legal regime that has codified acceptable conduct between nations as an attempt to mitigate potential causes for conflict and to encourage peaceful cooperation and collaboration between nations. To date, these treaties and agreements have been capable of achieving those goals; but we are never guaranteed tomorrow.

Now is the time when the international community needs to reexamine existing treaties and determine whether or not they are suitable for the future. The decline of the state as the dominant actor in space, the rapid proliferation of space related technology in private industry, and potentially lucrative payoffs for harvesting natural resources from space have all combined to alter the "why" and "how" of man's extraterrestrial interactions. New times and new scenarios will necessitate a full legal review conducted by Party Nations to determine which treaties will need to change, and how. While some may likely remain adequate, others will require substantial overhaul. New agreements may even have to be written. To date, man has been able to keep war from spreading to this domain, and to prevent quarrels in this domain itself from becoming a cause of war on earth. The rival status of many current nation-state space actors makes the need for agreement imperative. If peace is to endure, the international legal regime cannot afford to be lost in space.

¹ Yanek Mieczkowski, *Eisenhower's Sputnik Moment: The Race for Space and World Prestige*, (Ithaca, NY: Cornell University Press, 2013), PDF e-book, 12.

² Micah Singleton, "SpaceX's Falcon Heavy launch was YouTube's second biggest live stream ever," *The Verge*, last modified February 6, 2018, <https://www.theverge.com/2018/2/6/16981730/spacex-falcon-heavy-launch-youtube-live-stream-record>.

³ SpaceX, "Completed Missions," *Launch Manifest*, accessed April 25, 2018, <http://www.spacex.com/missions>

-
- ⁴ “Convention on International Civil Aviation done at Chicago,” December 7, 1944, https://www.icao.int/publications/Documents/7300_orig.pdf, 2.
- ⁵ “Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water,” August 5, 1963, *U.S. Department of State*, <https://www.state.gov/t/isn/4797.htm>
- ⁶ “Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space,” United Nations General Assembly Resolution 1962, December 13, 1963, <http://www.un-documents.net/a18r1962.htm>
- ⁷ Charter of the United Nations. Chapter IV, Article 14, <http://www.un.org/en/sections/un-charter/chapter-iv/index.html>
- ⁸ United Nations Office for Outer Space Affairs, “Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies,” *International Space Law: United Nations Instruments*, (Vienna: 2017), 3-9.
- ⁹ Lyndon B. Johnson, Remarks, “Remarks at the Entry into Force of the Outer Space Treaty,” *Public Papers of the Presidents of the United States*, Lyndon B. Johnson, 1967, Book I, (Washington DC: Government Printing Office, 1968)
- ¹⁰ Lyndon B. Johnson, Remarks, “Remarks at Ceremony Marking the Entry Into Force of the Outer Space Treaty,” *Public Papers of the Presidents of the United States*, Lyndon B. Johnson, 1967, Book II, (Washington DC: Government Printing Office, 1968), 919.
- ¹¹ United Nations Committee on the Peaceful Uses of Outer Space, Legal Subcommittee, *Status of International Agreements relating to activities in outer space as at 1 January 2017*, (Vienna, Austria: April, 2017), 5-12. http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2017_CRP07E.pdf
- ¹² Union of Concerned Scientists, *Who has satellites? Then and Now*, map, in Union of Concerned Scientists, *UCS Satellite Database: In-depth details on the 1,738 satellites currently orbiting Earth* (Cambridge, MA: 2017), <https://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database>
- ¹³ “Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies”
- ¹⁴ United Nations Office for Outer Space Affairs, “Agreement on the Rescue of Astronauts, the Return of Astronauts and Return of Objects Launched into Outer Space,” *International Space Law: United Nations Instruments*, (Vienna: 2017), 10-14.
- ¹⁵ United Nations Office for Outer Space Affairs, “Convention on International Liability for Damage Caused by Space Objects,” *International Space Law: United Nations Instruments*, (Vienna: 2017), 14-24.
- ¹⁶ *Ibid.*
- ¹⁷ United Nations Office for Outer Space Affairs, “Convention on Registration of Objects Launched into Outer Space,” *International Space Law: United Nations Instruments*, (Vienna: 2017), 24-30.
- ¹⁸ United Nations Committee on the Peaceful Uses of Outer Space, Legal Subcommittee, *Status of International Agreements relating to activities in outer space as at 1 January 2017*, (Vienna: 2017), http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2017_CRP07E.pdf
- ¹⁹ United Nations Office for Outer Space Affairs, “Agreement Governing the Activities of States on the Moon and Other Celestial Bodies,” *International Space Law: United Nations Instruments*, (Vienna: 2017), 30-40.
- ²⁰ Gunter Krebs, “*Chronology of Space Launches*,” Gunter’s Space Page, (Denmark: 2018), <http://space.skyrocket.de/>
- ²¹ US Department of Defense, *Department of Defense Advanced Research Projects Agency (ARPA)*, Directive 5105.15, February 7, 1958.
- ²² National Aeronautics and Space Act of 1958 (as amended), 42 U.S.C. Chapter 26, §2451 (1958).
- ²³ Robert J. Danchik, “An Overview of Transit Development,” *Johns Hopkins Applied Physics Laboratory Technical Digest* Volume 19, No. 1 (1998): 21, <http://www.jhuapl.edu/techdigest/TD/td1901/index.htm>
- ²⁴ Mieczkowski, 206-207.
- ²⁵ Joseph W. Caddell, Jr. “Corona Over Cuba: The Missile Crisis and the Early Limitations of Satellite Imagery Intelligence,” *Intelligence and National Security*, Volume 31, No 3, (2016), 427.
- ²⁶ Sharon Watkins Lang, “Can You Hear Me Now? We Control the High Ground: USASMD/ARSTRAT and Satellite Communications,” *Army Space Journal*, (2011 Spring/Summer Edition), 34-36, <http://www.dtic.mil/dtic/tr/fulltext/u2/a559472.pdf>
- ²⁷ R. Cargill Hall, *A History of the Military Polar Orbiting Meteorological Satellite Program* (Washington, DC: National Reconnaissance Office, Office of the Historian, 2001), 14, <http://www.nro.gov/history/csnr/programs/docs/prog-hist-02.pdf>

-
- ²⁸ “Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space,” United Nations General Assembly Resolution 1962, December 13, 1963, <http://www.un-documents.net/a18r1962.htm>
- ²⁹ “Agreement Concerning Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes,” My 24, 1972, [https://history.nasa.gov/astp/documents/Agreement%20concerning%20coop%20\(Nixon-Kosygin\).pdf](https://history.nasa.gov/astp/documents/Agreement%20concerning%20coop%20(Nixon-Kosygin).pdf)
- ³⁰ Jennifer Ross-Nazzari, “Détente on Earth and in Space: The Apollo-Soyuz Test Project,” *The Organization of American Historians Magazine of History* (July 2010): 29-34, <https://web-a-ebSCOhost-com.lomc.idm.oclc.org/ehost/pdfviewer/pdfviewer?vid=4&sid=880f5395-50a6-41f0-a146-f5fa2a298c0b%40sessionmgr4006>
- ³¹ Constructed Worlds, “Strategic Defense Initiative.,” accessed April 25, 2018, [http://conworld.wikia.com/wiki/Strategic_Defense_Initiative_\(EV\)](http://conworld.wikia.com/wiki/Strategic_Defense_Initiative_(EV))
- ³² Union of Concerned Scientists, “*UCS Satellite Database: In-depth details on the 1,738 satellites currently orbiting Earth*,” (Cambridge, MA: 2017), <https://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database>
- ³³ Union of Concerned Scientists, *Who has satellites? Then and Now*, map, in Union of Concerned Scientists, *UCS Satellite Database: In-depth details on the 1,738 satellites currently orbiting Earth* (Cambridge, MA: 2017), <https://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database>
- ³⁴ Union of Concerned Scientists, “*UCS Satellite Database: In-depth details on the 1,738 satellites currently orbiting Earth*,” (Cambridge, MA: 2017), <https://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database>
- ³⁵ United Nations, Department of Economic and Social Affairs, “World population projected to reach 9.7 billion by 2050,” last modified July 29, 2015, <http://www.un.org/en/development/desa/news/population/2015-report.html>.
- ³⁶ Brid-Aine Parnell, “NASA Will Reach Unique Metal Asteroid Worth \$10,000 Quadrillion Four Years Early” *Forbes Science*, last modified May 26, 2017, <https://www.forbes.com/sites/bridaineparnell/2017/05/26/nasa-psyche-mission-fast-tracked/#1ca68a354ae8>
- ³⁷ NASA Jet Propulsion Laboratory, California Institute of Technology, “NASA Selects Two Missions to Explore the Early Solar System,” last modified January 4, 2017, <https://www.jpl.nasa.gov/news/news.php?feature=6713>
- ³⁸ Brid-Aine Parnell, “NASA Will Reach Unique Metal Asteroid Worth \$10,000 Quadrillion Four Years Early” *Forbes Science*, last modified May 26, 2017, <https://www.forbes.com/sites/bridaineparnell/2017/05/26/nasa-psyche-mission-fast-tracked/#1ca68a354ae8>
- ³⁹ Michio Kaku, *The Future of Humanity*, (USA: Doubleday), 2018.
- ⁴⁰ Neil deGrasse Tyson quote.... <https://www.dailystar.co.uk/news/latest-news/697701/space-mining-first-trillionaire-asteroid-mark-zuckerberg-bill-gates-jeff-bezos>
- ⁴¹ Jim Edwards, “Goldman Sachs: Space-mining for platinum is ‘more realistic than perceived,’” *Business Insider*, last modified April 6, 2017, <http://www.businessinsider.com/goldman-sachs-space-mining-asteroid-platinum-2017-4>
- ⁴² Bryan Versteeg, “Harvester 1 Conceptual Drawing,” Deep Space Industries, accessed April 25, 2018, <http://deepspaceindustries.com/mining/>
- ⁴³ Timothy Riemann, “Space Based Logistics,” (master’s thesis, United States Marine Corps Command and Staff College, 2017), Defense Technical Information Center. <http://www.dtic.mil/dtic/>.
- ⁴⁴ United Nations Office for Outer Space Affairs, “Convention on International Liability for Damage Caused by Space Objects,” *International Space Law: United Nations Instruments*, (Vienna: 2017), 14-24.
- ⁴⁵ United Nations Office for Outer Space Affairs, “Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies,” *International Space Law: United Nations Instruments*, (Vienna: 2017), 3-9.

BIBLIOGRAPHY

- Ambrose, Stephen E. *Eisenhower: The President*. New York: Simon and Schuster, 1984.
- Caddell, Jr., Joseph W. "Corona Over Cuba: The Missile Crisis and the Early Limitations of Satellite Imagery Intelligence." *Intelligence and National Security* Volume 31, No 3 (2016): 416-438.
- "Convention on International Civil Aviation done at Chicago." December 7, 1944.
https://www.icao.int/publications/Documents/7300_orig.pdf
- Danchik, Robert J. "An Overview of Transit Development." *Johns Hopkins Applied Physics Laboratory Technical Digest* Volume 19, No. 1 (1998): 18-26,
<http://www.jhuapl.edu/techdigest/TD/td1901/index.htm>
- Davies, Merton E. and William R. Harris. *RAND's Role in the Evolution of Balloon and Satellite Observation Systems and Related U.S. Space Technology*. Santa Monica, CA: RAND Corporation, 1988.
- "Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space." United Nations General Assembly Resolution 1962. December 13, 1963,
<http://www.un-documents.net/a18r1962.htm>
- Dulles, John Foster. "The Evolution of Foreign Policy." Speech. Council on Foreign Relations, New York, NY, January 12, 1954. Nuclear Files, http://www.nuclearfiles.org/menu/key-issues/nuclear-weapons/history/cold-war/strategy/article-dulles-retaliation_1954-01-12.htm.
- Elliott, Derek W. "Finding an Appropriate Commitment: Space Policy Development Under Eisenhower and Kennedy, 1954-1963." Doctoral Dissertation, The George Washington University, 1992. ProQuest. <https://search-proquest-com.lomc.idm.oclc.org/docview/303977034/1509625AFBE44183PQ/6?accountid=14746>
- Hart, R. Cargill. *A History of the Military Polar Orbiting Meteorological Satellite Program*. Washington, DC: National Reconnaissance Office, Office of the Historian, 2001.
<http://www.nro.gov/history/csnr/programs/docs/prog-hist-02.pdf>
- Johnson, Lyndon B. Remarks. "Remarks at Ceremony Marking the Entry Into Force of the Outer Space Treaty." *Public Papers of the Presidents of the United States*, Lyndon B. Johnson, 1967, Book II. Washington, DC: Government Printing Office, 1968.
- Kaku, Michio. *The Future of Humanity*. United States of America: Doubleday. 2018
- Kennedy, John F. Address before a Joint Session of Congress." Speech. United States Congress, Washington, DC, May 25, 1961. <https://www.jfklibrary.org/Asset-Viewer/xzw1gaaeTES6khED14P1Iw.aspx>

- Lang, Sharon W. "Can You Hear Me Now? We Control the High Ground: USASMDC/ARSTRAT and Satellite Communications." *Army Space Journal* (2011 Spring/Summer Edition): 34-39, <http://www.dtic.mil/dtic/tr/fulltext/u2/a559472.pdf>.
- Mieczkowski, Yanek. *Eisenhower's Sputnik Moment: The Race for Space and World Prestige*. Ithaca, NY: Cornell University Press, 2013. PDF e-book.
- Newberry, Major Robert D. "Space Doctrine for the 21st Century." Master's thesis, Air Command and Staff College, 1997. Defense Technical Information Center. <http://www.dtic.mil/docs/citations/ADA398606>
- Riemann, Timothy F. "Space Based Logistics." Master's Thesis, United States Marine Corps Command and Staff College, Defense Technical Information Center. <http://www.dtic.mil/dtic/>
- Ross-Nazzal, Jennifer. "Détente on Earth and in Space: The Apollo-Soyuz Test Project." *The Organization of American Historians Magazine of History*. (July, 2010): 29-34. <https://web-a-ebshost-com.lomc.idm.oclc.org/ehost/pdfviewer/pdfviewer?vid=4&sid=880f5395-50a6-41f0-a146-f5fa2a298c0b%40sessionmgr4006>
- "Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water." August 5, 1963. *U.S. Department of State*. <https://www.state.gov/t/isn/4797.htm>
- United Nations Committee on the Peaceful Uses of Outer Space, Legal Subcommittee. *Status of International Agreements relating to activities in outer space as at 1 January 2017*. Vienna, Austria: April 2017. http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2017_CRP07E.pdf
- United Nations Office for Outer Space Affairs. *International Space Law: United Nations Instruments*. Vienna, 2017. http://www.unoosa.org/res/oosadoc/data/documents/2017/stspace/stspace61rev_2_0_html/V1605998-ENGLISH.pdf
- US Congress. House. *National Aeronautics and Space Act of 1958 as Amended*. HR 12575. 85th Cong., 42 U.S.C. ch. 26 §2451. (July 29, 1958): Pgs 426-438.
- US Congress. House. *Supplemental Military Construction Authorization (Air Force)*. HR 9739. 85th Cong., Public Law 85-325. (February 12, 1958). Pgs 11-14
- US Congress. House. *Communications Satellite Act of 1962*. HR 11040. 87th Cong., 47 U.S.C. ch. 6 §701. (August 31, 1962). Pgs 419-427.
- US Department of Defense. *Department of Defense Advanced Research Projects Agency*. Directive 5105.15, February 7, 1958.

Versteeg, Bryan. "Harvester 1 Conceptual Drawing." Deep Space Industries, accessed April 25, 2018, <http://deepspaceindustries.com/mining/>