Outer Space Security: An exploration of the U.S. Space Force's area of operations

Abstract

Outer space was an uncontested domain after the conclusion of the Cold War and remained so for many years. However, in recent years, state and non-state actors have begun venturing into outer space. This has resulted in outer space shifting from a domain dominated by the United States to a domain that is congested with activity, competition for space services, and contested by near-peer adversaries. Whom of which are creating counter-space capabilities. State actors such as Russia and China are near-peer adversaries that are emerging into the outer space domain. Thus, a threat to the national security of the United States. This has led to outer space phasing from an uncontested domain to a contested one. The current bureaucratic setup was deemed inadequate to sufficiently compete with near-peer adversaries. This led Congress to legislate the creation of the U.S Space Force. This paper will explore the area of operations that the U.S Space Force is responsible for. This project will aim to identify the American perceived threats that exist in outer space. It will also explore what outer space security means. To analyze what is in space that a state actor wants to be secure from.

Introduction

Outer space security pertains to the activity in Earth's orbit. It is a topic that does receive its fair share of debate and discussion. However, it is seldom defined. This chapter will be dedicated to exploring the different existing definitions of outer space security and how they blend. Traditionally, state actors are the main actors in space and exploit them for military interests as a primary reason, with civilian interests as secondary. Security has always been intrinsic to state behavior. In that, they are always in the pursuit of self-preservation.

On the 20th of December 2019, the United States created a Space Force dedicated to military operations in outer space. This begs the question, what are the threats in outer space? How do they present a security threat to the state? This chapter will attempt to explore what different security issues there are and how they relate to defining outer space security. In recent years, more state actors have begun to venture out into space. Non-state actors, such as private enterprises, have also begun to conduct commercial space activity. Space is becoming more congested. Congestion will either lead to increased competition or cooperation in space.

The first section of this chapter will briefly discuss current definitions of outer space security and how they blend. The second section will discuss how outer space security can mean security from space. As in securing humanity's existence and access to space from natural and human phenomena. The third section will narrow the definition of outer space security as security for space assets from human and natural threats. The fourth section shall explore the third theme of outer space security by defining it as security from other human actors or military security.

Definitions

There are three identified themes identified by Mayence when it comes to defining outer space security. Mayence states that these are very different issues that are interconnected with each other. Outer space security is all three of these definitions (Robinson et al., 2010: p. 35).

1. Security from outer space: how to protect human life and Earth's environment against natural threats and risks from outer space.
2. Security in outer space: how to protect space assets and systems against natural and/or human threats or risks and to ensure sustainable development of space activities
3. Outer space for security: the use of space systems for security and defence purposes (Robinson et al., 2010: p. 35)

These different definitions also mix into each other in certain aspects. The first definition is environmental. There are human-made threats that fit into this definition. Space debris in Earth's

orbit will be inserted into this theme. The second definition somewhat trickles into the other definitions as it identifies threats from human and natural threats. However, it focuses on security for systems and satellites in orbit of Earth. The third definition is centred around military use but also delves into the second definition since satellite defence is included.

Another aspect that should be defined is orbit. The contemporary environment for outer space security is the region that begins where Earth's atmosphere ends and space begins. This is called the Kármán line (Córdoba, 2011). This border is about 100 KM from the Earth's Surface. This region extends across space and ends at about 40,000 KM. This vast area is where most human satellites and systems inhabit.

Is it security for space assets?

The cosmos is dangerous. There are things within it that could present an existential threat to humanity and the Earth. If not existential, then heavily devastating. Outer space security can be defined as security from space. A framework to secure humanity from phenomena such as asteroids and solar flares. When someone refers to outer space security, they could mean it in an anti-extinction sense. There are two avenues to think about when it comes to securing humanity's safety from outer space. They are space weather (solar flares/storms or cosmic radiation) and space objects (debris or asteroids).

Space weather is defined by NASA as "*conditions on the sun, in the solar wind, and within Earth's magnetosphere, ionosphere and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health*" (Zell, 2015). Space weather poses a security threat to humanity and its satellites can come from the sun and beyond the solar system. Threats that come from the sun are solar storms. Coronal mass ejection (CME) is a solar storm that does pose a security issue. A CME is an ejection of large clouds of plasma and magnetic fields that may stream out into the surrounding solar system (Garner, 2015). There is a chance of a CME impacting the Earth. A CME impacting the Earth will not be an extinction-level event but can cause considerable disruption to satellites in orbit (Pelton, 2013). A CME could also adversely affect human activity on the ground such as air traffic, computer networks, and electrical grids (Pelton, 2013:

pp. 45, 46). Damage from a CME could interrupt commercial and government activities that may result in billions of pounds of repairs to assets on the ground and space. It would also affect the global and local economies as well because of humanity's heavy reliance on outer space assets.

Ultraviolent and x-ray radiation from beyond the solar system and the sun poses a danger to astronauts and to the Earths biosphere. Radiation exposure to astronauts in orbit is higher than to the rest of humanity that is on Earth. To mitigate this issue, radiation levels of astronauts in orbits are closely monitored (Pelton, 2013: p.51). This also limits the amount of time they can be outside of their vehicles in a suit. Radiation can also affect life on Earth by causing genetic mutations within the fauna and flora (Pelton, 2013: p. 52). It can also cause skin cancer for humans (Pelton, 2013: p. 52). The Earth's ozone layer prevents the aforementioned from happening on a mass scale (Pelton, 2013: p. 52). However, manufactured chemicals are depleting the ozone layer (Nunez, 2019). This could be mitigated by reducing chemical production.

Space objects such as orbital debris present a threat to human space activity. Space debris in Earth's orbit is a security issue because it can damage satellites, space vehicles, and astronauts. There is an estimated 34,000 space debris larger than 10 cm, 900,000 objects between 1 and 10 cm, 128 million objects between 1 mm to 1 cm (European Space Agency, 2019). This debris is not just floating around in orbit. They move at high velocities, around 18000 MPH or 29000 KPH (NASA, 2011). Imagine all that debris moving at such a high velocity and consider that 29,000 KPH is just the average speed. Some debris are moving even much faster. With that kind of speed, an object as small as a paint fleck could cause some serious damage. Take for example, in 2018, the International Space Station (ISS) was impacted on a window by a small piece of space junk. It created a 2 mm-sized hole which was subsequently plugged (Knapton, 2018). Currently, the ISS must periodically change its orbital trajectory in order to avoid colliding with orbital debris (Pelton, 2013: p. 22). There are no methods to physically clean up the orbital debris other than waiting for them to slowly descend into Earth's Atmosphere. All that can be done presently is to track the debris and reduce the creation of more debris.

Asteroids possess the capability to cause an extinction-level event if one large enough impacts the Earth. An extinction-level event is where the majority of life on Earth is extinguished. Presently, there are only theoretical plans to defect or counter an incoming asteroid. Such as bombing an asteroid into small enough fragments so that it is no longer a threat

or simply shooting a missile at one (Pelton, 2013: p. 63). The most that is being done right now is tracking space objects in the solar system.

Is it security for space assets?

Outer space can be utilized to secure the well-being and safety of humans on Earth. Satellites in Earth's orbit can be and are used to look out for events that can cause considerable damage to humanity. Outer space security can be defined as security for satellites in space. Since humanity has grown to become heavily reliant on satellites for day-to-day activity, it would be prudent to invest in more durable satellites. They need to be able to sustain potential damage from human and non-human threats.

Satellite systems can be digitally broken into or hacked. Weather and GPS systems can be spoofed to overload an electric grid, disrupt traffic or to misinform a weather phenomenon (Schrogl et al., 2015). They could also shut down a satellite system or turn it into a kinetic weapon. These possibilities partly turn this into a cyber security issue. This is considered when it comes to maintaining security for space assets. The United States Air Force invited hackers to break into one of their systems at a conference (Whittaker, 2020). Within two days, a team of hackers discovered several vulnerabilities that could have resulted catastrophic damage if it was in a combat situation (Whittaker, 2020). Not only can satellites be hacked. They can also be jammed or outright destroyed by a kinetic kill vehicle, which is a missile without an explosive warhead.

Orbital space debris can also disable or destroy a satellite. The U.S Air force must constantly monitor space debris in so that a piece doesn't collide with a satellite. When debris does end up on the course to collide with a satellite. The satellite itself uses its onboard thrusters to maneuver out of the way of the incoming debris (Grosselin, 2020: p. 9).

The Global Positioning Satellite system is a network of satellites that provides navigation and time data for users on Earth (U.S Government, 2020). It is owned by the United States government and is operated by the United States Air Force (U.S Government, 2020). It is heavily relied upon, especially in the West. The loss of the GPS system would affect most of human

activity on the ground and could affect human security. Drivers on the road would be lost without it and would cause traffic jams. Airplane travel would also have traffic issues. Communications and the internet are also reliant on the GPS system and would be affected as well. Emergency services that are reliant on GPS systems would not be able to respond to crisis situations on time because they would be deprived of navigation and communication capabilities. Essentially, the loss of the GPS system would cause severe damage to human activities that are heavily reliant on it (Davenport and Ganske, 2019).

Satellites are also used to monitor the environment on Earth. Weather satellites are used to identify and monitor severe weather such as a hurricane or a blizzard. Identifying severe storms can warn communities of what is incoming and can give them a head start on preparing for life-threatening effects. There are also observation satellites that are utilized for disaster management. They can be used to benefit emergency services, governments, and environmental organizations (Earth-i, 2020) (Pisano, 2006). High-resolution images are often the only way to survey the damage wrought after a disaster such as a wildfire, flood, or tsunami (Earth-i, 2020) (Witze, 2016) (Duffy, 2018). They can also be used to combat an ongoing disaster such as an active wildfire. The path of a wildfire can be tracked and predicted. This provides intelligence on where to apply water or fire depressants. It also serves an early warning system to communities that may be in its path, providing additional time to evacuate the area (Earth-i, 2020) (Duffy, 2018). These observation satellites can be used to supplement authorities and organizations by providing topographical intelligence in planning for a natural disaster or responding to one (Earth-i, 2020). If any of these satellites were to be rendered inoperable by an external force, then users on the ground would be deprived of the capability to warn of inclement weather, to plan for disasters, or to react to disasters.

Humanity has become intrinsically reliant on outer space systems. If one of them were to fail or be hacked, the consequences could vary from a nuisance to a catastrophe. Outer space security can be defined as satellite security. There are natural threats such as a CME from the sun. One of those can zap or disable any of the satellites in orbit. There are human-made threats as well. Space debris could damage a space asset. They can also be hacked by terrorists. There are many ways to protect space assets. Turn all of them off when a solar storm hits, a stronger

firewall, or simply move them out of the way of incoming debris. This all revolves around the theme of satellite security.

Is it security from other actors?

Outer space security can also be defined under a military context. It can mean security from other actors on Earth. When humanity first started venturing out into space in the 20th century, the only nations that possessed military capabilities in space were the Soviet Union and the United States. Towards the end of the century, the Soviet Union dissolved and left the U.S as the sole remaining space power. However, as time progressed into the 21st century more and more actors began venturing into outer space. China already has satellites in orbit and are developing additional military and civilian space technologies to compete with other actors (Costello and Mcreynolds, 2018). India is also venturing into space. Russia is slowing re-emerging as a space power. The European Union is beginning and developing their own space operations as well. Not all space participants are state actors either, non-state actors have also begun exiting into outer space. Private enterprises such as SpaceX and Blue Origin are developing and utilizing space technologies for commercial reasons. As space slowly becomes more congested with activity from different actors, it also becomes more contested. Leading to an increase in competition for outer space. There are two themes to think about when it comes to military space security. The first is to defend assets in space. The second is to utilize satellites to support operations on the ground.

The first theme is defending satellites from other actors. State actors possess several capabilities to attack assets in outer space. A cyber-attack, an attack from the ground, or an attack from another satellite in space. A cyber-attack can shut down or steal control of another satellite. From the ground, an actor can use lasers, missiles, or a jammer. A satellite in space can be equipped to attack another. Counter space capabilities will be discussed in further detail in the next chapter. Alternatively, diplomacy can be used to defend outer space assets. The 1967 Outer Space Treaty prohibits the stationing of Weapons of Mass destruction (United Nations, 1967). Another example is that the Partial Test Ban Treaty bans the testing of Nuclear weapons in outer space (United Nations, 1963). Although, there are no treaties banning the use or stationing of

conventional weapons in space. Currently, there are no conventional weapons in outer space. Presently, satellite defense from other actors is poor. Poor space defense in conjunction with more space actors exiting into space as led to a renewed interest in military space security.

The second theme is utilizing satellites to supplement terrestrial operations. There are three main methods satellites are used to support military operations. The first is the intelligence, surveillance, and reconnaissance (ISR) method. ISR satellites provide data on military activity, signals intelligence, and as an early warning system for missiles (Defense Intelligence Agency, 2019: p. 8). The second method is satellite communications (SATCOM). SATCOM allows military forces to connect with each other from around the world and with very little time delay. American commanders in the Middle East can relay information to the Pentagon for assessment or to receive new objectives. SATCOM also allows complex military operations to function efficiently (Sheehan, 2015: p. 12). An attack on SATCOM systems would render the U.S military blind (Sheehan, 2015: p. 12). The third method is Positioning, Navigation, and Timing (PNT). PNT provides information for troops on Earth or in Earth's atmosphere their precise location (Defense Intelligence Agency, 2019: p. 8). It is also relied upon to deliver precision-guided bombs and artillery strikes. These three methods are intrinsic to the U.S and its maintenance of remaining a superpower.

Outer space security can be defined as military security from other actors. Such as near-peer adversaries such as China or Russia. Satellites are used to assist the military in nearly every operation and activity. Almost every major military power has grown reliant on outer space, especially the U.S. Attacking space assets belonging to a major power like the U.S would cripple them. Not only would the U.S would be crippled militarily, but in the civilian sector as well. As stated in previous sections, the economy and society are intertwined with outer space systems. The U.S or any other actor that depends on American space systems would be broadly blind in civilian sectors as well as the military. After the Cold War, the U.S did not have much interest in satellite defense because outer space was not being contested at the time. Now that China and India are emerging as a space power along with Russia re-emerging as one, the U.S renewed has their focus on outer space in a military framework by creating their own space force.

Conclusion

Outer space security can and is defined as security in space, from space, and utilizing space for security. These definitions can be used separately or together. Security in outer space is themed to securing satellites and systems in outer space. Security from outer space pertains to securing humanity and Earth from natural phenomena in the cosmos. While outer space for security is military centric. This definition restricts itself to focusing on human threats. In some respects, the definitions can trickle into each other's spectrum. While two themes focus on either human threats or natural phenomena that can be a threat, the third looks at both kinds of threats but focuses on space asset defense.

More actors, state and non-state alike, have begun venturing out into outer space. The increased congestion will lead to more competition and cooperation. It is likely that there will be cooperation between all actors when trying to secure humanity and Earth from outer space as that stopping an existential or crippling threat would be in the best interests of all actors. Limiting the creation of space debris and cleaning up space debris will likely foster more cooperation. As that all interested actors want access to outer space. Too much space debris would result in what is called Kessler syndrome. It when there is so much debris in Earth's orbit that it renders outer space activities highly difficult or impossible.

With the three definitions of outer space security laid out, which one is the U.S Space Force supposed to focus on? It is certainly responsible for the military definition due to it being a military organisation. However, does it also have to focus on the other definitions as well or is it the responsibility some other space organization?

Erick Johnson

ErickJohnson03@gmail.com

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