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Master's Thesis

Advancing Space Security in the 21st Century - Private Actors and Governance of Space

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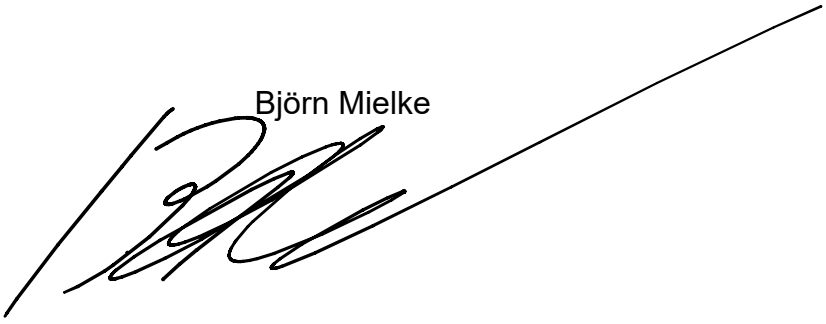
Bonn / Prague, 01.08.2023 Björn Mielke



Pressure is a Privilege

– Billie Jean King

Diploma thesis project

Advancing Space Security in the 21st Century - Private Actors and Governance of Space

Keywords Space Security, Private Space Actors, Space Debris, Space Policy, Space Governance, Space Law, Public-Private-Partnerships, *SpaceX*, *Blue Origin*

Abstract

In an era of space commercialization, emerging private space companies are changing the scope and structure of space activities and space security. This study explores the implications of these actors on space security, focusing on an in-depth case study of two leading space companies, *SpaceX* and *Blue Origin*. The thesis uses the theoretical framework of the Copenhagen School to examine the role of private space actors in this complex landscape. Through the use of qualitative research methods, an analysis of the profiles and activities of *SpaceX* and *Blue Origin* and their potential implications for space security was conducted. The selection of these companies is based on their essential role in pioneering private space exploration and their significant impact on space security paradigms. The findings reveal a complex interaction between private space actors, space security, and space law. The rise of private space companies has revealed pressing space security issues, amplifying questions about space debris, dual-use technology, and the weaponization of space. At the same time, it has exposed gaps and challenges in existing international space law and national policies. Moreover, the public-private partnerships which have been observed in the private military industry for decades already, similarly develop in the space sector, adding an additional layer of complexity.

The emergence of private space actors has significant implications for space security and future research should focus intensely on this nexus. Researchers should aim to support developing legal and policy frameworks that can adequately address the new challenges posed by the commercial privatization of space. The implications of these developments are impacting actors far beyond the classic, military security environment, underscoring the need for continued academic inquiry and robust policy responses.

Contents

List of Abbreviations and Acronyms

- A2AD Anti-Access/Area Denial
- ABM-Treaty Anti-Ballistic Missile Treaty
- ASAT-Weapons Anti-Satellite Weapons
- ASI Italian Space Agency
- BMD-Systems Ballistic Missile Defence
- CCP Commercial Crew Program
- CLPS Commercial Lunar Payload Services
- CONAE Argentinian Space Agency
- COPUO Committee on the Peaceful Uses of Outer Space
- COTS Commercial Orbital Transportation Services
- CRS Commercial Resupply Services
- CSA Canadian Space Agency
- DoD Department of Defense
- ESA European Space Agency
- ESPI European Space Policy Institute
- EU European Union
- FCC Federal Communications Commission (US)
- GPS Global Positioning System
- GTO Geostationary Transfer Orbit
- ICBM Intercontinental Ballistic Missile
- ISS International Space Station
- ITU International Telecommunication Union
- JAXA Japan Aerospace Exploration Agency
- LEO Low Earth Orbit
- M.A.D Mutual Assured Destruction
- NASA National Aeronautics and Space Administration
- NATO North Atlantic Treaty Organization
- NOAA National Oceanic and Atmospheric Administration
- NRO National Reconnaissance Office
- OST Outer Space Treaty
- PMC Private Military Company
- PPPs Public Private Partnerships
- SIA Satellite Industry Association
- *SpaceX* Space Exploration Technologies Corp
- STM Space Traffic Management
- SWF Secure World Foundation
- UN United Nations
- UNOOSA United Nations Office for Outer Space Affairs
- VTVL Vertical Takeoff and Landing

Introduction

Background and Context

In July 2021, the private space companies *Virgin Galactic* and *Blue Origin* defined new boundaries by conducting the first (suborbital) touristic space flights[1]. British billionaire Richard Branson with his company *Virgin Galactic* were followed a few days later by *Amazon* founder Jeff Bezos with his company *Blue Origin*. Special about the two flights was that the two billionaires and their passengers were not only traveling for research purposes – personal fulfillment and certainly also marketing were the main focus (The Planetary Society, 2021). In the future, both entrepreneurs – just like Elon Musk with his company *SpaceX* – want to regularly send private individuals into space via their companies' spaceships.

Even though the above mentioned two crews were not the first 'space tourists' – Dennis Tito spent several days on board of the International Space Station (ISS) in 2001 as the first civilian person (BBC, 2011) – the current development regarding space activity driven by private actors confirms an upheaval that has already been in progress for quite some time. Especially *SpaceX* has become a frontrunner regarding private space activity. This includes space tourism but is by far not limited to it.

After its launch on September 14, 2021 from Cape Canaveral, one of *SpaceX's* Dragon capsules had been orbiting the Earth for three days. Special to this mission was that all four crew members were civilians, not trained astronauts, making it the first ever space flight conducted by only civilians on board of the spacecraft (Wattles, 2021).

Space used to be an area dominated by government run operations only (Moltz, 2019). During the first decades of space exploration, only the global superpowers have had the technological and financial abilities to successfully operate to or in space. Precisely, space was the domain of only two states for a long time. The former Soviet Union launched the first ever manmade object into Space in 1957 (Al-Rodhan, 2012, P.45). With placing the Sputnik satellite into orbit, the USSR kicked off the space race (ibid). As a reaction, the USA created the National Aeronautics and

[1] It has to be considered that there is no universal definition for the boundary between aviation and space travel. The 'Kármán line', established by the Fédération Aéronautique Internationale, is an imaginary boundary at a height of 100 km above sea level and serves as a definition for a theoretical demarcation of the Earth's atmosphere from outer space. By this definition, *Virgin Galactic's* flight from 11 July 2022 would not have reached outer space. However, the United States Air Force for example, defines the boundary at around 80km.

Space Administration (NASA) just one year later. In his speech from 1961, former US president Kennedy set the goal to land a man on the moon by the end of the century. Just in time, Neil Armstrong was the first human to walk the Moon in 1969 (Al-Rodhan, 2012, P. 46). It took the People's Republic of China, which is only the third nation to realize independent human spaceflight, until 1970 to successfully launch their first satellite. In 2003, China completed their first manned space operation (Schmitz et al., 2022). The last two decades have shown a shift in the paradigm of space being a “nation-state-only domain”. Private entities have discovered this sector has potentially hugely beneficial from an economic perspective, and individual entrepreneurs might even see space as a “playground”, where not many before them have set foot in (de Concini & Toth, 2019).

Research Problem and Questions

This thesis shall examine the impact private space actors and their operations have on space security, while taking into account currently existing space law and contemporary space policy. The research will deal with the two main pillars of the thesis and their interaction: space security and private space actors.

The broader objective of the thesis is to address this research question, more specific sub-questions will focus on different aspects of the main question. These will be:

- What are the security implications of currently existing practices of private space actors?
- How effective is the legal framework of space governance when referred to private space actors?
- Is there a comparable development between the emergence of private military companies in the past and private space actors nowadays?

Scope and Limitations

This thesis primarily aims at understanding the impact private space actors have on space security. The scope of the research will be defined by these two main pillars, private space actors and space security. The research will focus particularly on two major players in the private space sector, the companies *SpaceX* and *Blue Origin.* The comprehensive analysis includes a detailed examination of their activity, strategy and potential risks and benefits that emerge from their activity. Furthermore,

the research will inspect contemporary space law and its efficacy when being projected on private space actors, if possible.

The study shall contribute to the currently not too extensively covered field of space security, especially in connection with private actors, and therefore expand the academic discourse and give insights into a study-field, that still seems to be in a rather initial phase. It aims at enlightening the dynamic interplay between the rapidly emerging private space sector and the established structures of space security. Furthermore, the diverse consequences of this interaction on a broader scale shall be investigated.

It is essential to acknowledge the inherent limitations of this research. First, there is the nature of the quickly evolving space sector which changes and developes extremely rapidly. Also important is the usually sensitive and well protected character of private space companies, which can lead to limitations when it comes to the availability and more importantly accessibility of data.

The study mainly relies on publicly available information and secondary sources, among them academic literature, media articles, government reports/ documents, company reports and journal articles. Although these sources provide significant information and insight, they can not comprehend the entire complex dynamics of these companies and government programs, especially regarding their classification due to national security reasons.

Furthermore, *SpaceX* and *Blue Origin* might be the most known and influential private space actors (Shammas & Holen, 2019), they nonetheless only represent a small segment of the diverse and rapidly growing commercial space sector. Therefore, the results of the study are not universally projectible on other actors in the field. Additional limitations might be possible changes or modifications in the regulatory landscape, which alter the course of the examined corporations and therefore influence the relevance of the results of this study.

Finally, the dynamic and constantly evolving nature of space security issues, affected by the emergence of new technologies, shifts in global power dynamics, and changes in international relations, may pose a challenge to the predictive aspect of the study. Nonetheless, it aims to provide an up-to-date and insightful analysis of the influence of private space actors on space security, thereby making a valuable contribution to both academic discourse and policymaking in the field.

Significance of the Research

During the last couple of years, the private space sector has seen an enormous increase in activity and financial volume. In 2015 it was worth around $350 billion, in 2019 already $449 billion and economists expect the growing space economy to more than triple in size in the next decade, with estimates forecasting it could even grow to become a $1.4 trillion market (Yee, 2022). This development is especially remarkable regarding the origins of space fare in general.

Today, private companies have huge ambitions regarding several different space projects. These range from launch services to space debris removal, space tourism, lunar missions of different kinds, mega satellite constellations or even space mining (United Nations, 2023). Since this is a fast-growing market, a growing number of companies try to compete with diverse new ideas or technologies for their endeavors (Yee, 2022).

An issue related to space operations that has become very prominent among security experts, military representatives, security scholars and even heads of states in recent years is the security in space. With more state and non-state actors developing the capabilities to either directly conduct space operations or assign private actors to do so, space security further moves into the focus (United Nations, 2022). As mentioned, space has been a domain only operated in by state actors until around two decades ago, the main question will be how to maintain and preserve security in space, while at the same time opening access to a more various set of actors and therefore foster science, economic value and possibly international cooperation.

Political relevance has been underlined by several actors.

From a classic security point of view, space has become a military domain just as relevant as sea, air, land and cyber. One could rather say that space actually enables the preceding domains through its' technologies in the first place (UK Ministry of Defence, 2022). The same applies to the societal relevance of space and its security. Modern society in all its facets is significantly dependent on safe and functioning space assets. Without them, among further aspects, today's communication technologies would not exist, the financial system would not function, and globalization as such would not exist in its current form (Mölling et al., 2021).

Structure of the Thesis

Followed by this introduction which provides the background and context of space security and private space actors, outlines the research problems/ questions and clarifies the scope and limitations of the study, the theoretical framework will be introduced by a conceptualization of space security, followed by introducing several space security issues. A description of the constructivist security concept of the Copenhagen School will be followed by an analysis of space security from this theory's perspective. A literature review will present an overview of the existing academic discourse on space security, the role of private actors in security, and the activities of private space actors. The methodology chapter details the research design, case selection rationale, and data collection and analysis methods. The subsequent chapter inspects the legal framework and governance related to space activity, examining international space law, national policies, the role of international organizations in shaping space law, and the existing gaps and challenges in the legal framework. The chapter, 'Public-Private Partnerships,' provides an examination of partnerships between governments and private military companies and might give an outlook how partnerships with private space companies might develop. The core of the thesis is the case study on *SpaceX* and *Blue Origin* representing the concept of private space actors. The case study provides background and context of each company, discusses their activities and the implications for space security, and analyses legal considerations, challenges, and potential recommendations. Finally, the findings of the case study will be compared and aligned, including the interactions between private space actors, space security and space law. Highlighting limitations, a summary of the key findings and future research possibilities will complement the study.

Theoretical Framework

Conceptualizing Space Security

Space security traditionally refers to military aspects, but this understanding has broadened since the end of the Cold War (Klein J. , 2006). Space security also includes the safety of satellites and spacecraft in orbit, safe access to space, and the contribution that various types of satellites make to the safety of people on Earth (Sheehan, 2020).

A broader understanding of space security includes the free access and use of space by all states and also non-state space actors for socioeconomic benefits, scientific exploration or possibly even personal fulfilment. In this context, "safe and sustainable access to and use of space" plays a central role (ibid.)

In the three-dimensional understanding by Mayence, space security is considered as follows: Space for Security (use of space systems for security and defense purposes), Security in Space (protection of space assets and systems), and Security from Space (protection from threats from outer space) (Mayence in Sheehan, 2020).

It is essential for a definition of space security to be broad enough to include human, environmental, and military dimensions. It should also include the security of terrestrial objects, critical infrastructure, and people from attacks from space.

Since outer space has never been the location of a battlefield, nor has a weapon ever been launched from outer space, it requires an examination of what the military value of outer space actually is (Fukushima, 2013). The awareness that space has military relevance should have transcended military opinion at the latest after the public announcement of NATO to recognize space as an official military domain (NATO, 2023). Jens Stoltenberg underlines both, the civilian and military significance of space assets, saying “space is part of our daily life here on Earth. It can be used for peaceful purposes. But it can also be used aggressively. Satellites can be jammed, hacked or weaponized. Anti-satellite weapons could cripple communications and other services our societies rely on, such as air travel, weather forecast or banking” (Banks, 2019).

There are four schools of thought assessing the military value of outer space, developed by Lupton. These are the sanctuary school, the survivability/vulnerability school, the high ground school, and the control school (Lupton, 1998). In the following, I will briefly present the key aspects of the four schools.

The *sanctuary school* “recognizes the military value of outer space in the observation of regions within the boundaries of other sovereign nations and asserts that outer space should remain off-limits to war in order to protect its value” (Lupton in Fukushima, 2013, p 37). Since undertaking reconnaissance via airplanes almost inevitably violates the sovereignty of a state's air space, the only way to ‘legally’ conduct this kind of espionage is via reconnaissance satellites, which orbit high enough above the Earths surface. Especially during the cold war, this kind of surveillance was of crucial importance for nuclear deterrence regarding the detection

of intercontinental ballistic missile (ICBM) launches. Because these early-warning satellites would help the Soviet Union and the US monitoring each other's intentions, this school argues that space should remain free of weapons like ballistic missile defense (BMD) systems for reasons of protecting the monitoring satellites (Ibid). Fukushima states that “the sanctuary school is also against the use of outer space for providing direct support for the land, sea or aerial military engagements as it may incite attacks on space systems” (Fukushima, 2013, p. 38). This school sees space as a sanctuary to prevent a (nuclear) war.

The *survivability/vulnerability school* states that space technology is considerably more vulnerable to attacks than assets on land, sea or in the air. This is because “[…] their orbits are predictable and maneuverability is limited. Since the systems are in principle unmanned, the threshold for the use of force against them could be lower than against terrestrial targets” (Fukushima, 2013, p. 38). Therefore the school argues that this kind of technology is only of military value in times of peace, because in times of war its elimination would be too probable. To prevent this kind of vulnerability, systems with similar capabilities could be deployed on Earth (Ibid).

The *control school* gives space a higher value than the aforementioned schools, stating that it is crucial to control the “lines of communications in outer space” to make sure that continual utilization is secured (Fukushima, 2013, p. 39). The deployment and potential use of Anti-Satellite (ASAT) weapons are recognized by this school. The school however also states, that “space control is nothing more than preparatory, and ultimately ground military engagements will determine the outcomes of wars” (Ibid.)

The *high ground school* is the one that, of the four schools, assesses the highest military value to the space domain. It says “those who dominate the high ground also dominate the low ground” (Ibid), meaning, whoever is the most powerful actor in space, is automatically the most powerful (military) actor on earth. The school values space-based BMD systems, arguing that nuclear attack defense can be more achievable when conducted immediately after the attacks’ launch, preferably still in the airspace of the attacking party (Ibid). Klein adds that outer space can be seen as an “environment that supports combat operations on land, at sea, and in the air, because space is the "high ground" for any terrestrial military operations” (Klein, 2006). All in all, the four schools all recognize a military value of the space domain, the degree, however, depending on each schools’ explanations varies from a rather

low practical use to space being inevitable in nowadays ways of conducting military operations.

Having examined the different schools of thought regarding the military value of outer space, it is necessary to examine the practical implications of space security. The following part explains the dual-use dilemma, where technologies and capabilities developed for civilian purposes can also be utilized for military applications. By exploring this complex issue, theoretical concepts are connected with real-world challenges .

The Dual-Use Dilemma in Space

The concept of the dual-use dilemma has relevance for matters on Earth as well, however, it is considered especially important for space matters. According to the European Commission, “Dual-use items are goods, software, and technology that can be used for both civilian and military applications” (European Commission, 2020). The spectrum of items considered to be dual-use ranges from nuclear materials, facilities, and equipment, over sensors and lasers, to aerospace and propulsion systems and equipment (EUR-Lex, 2023).

The dual-use concept related to space originates not quite from the beginning of the space age. The national space programs of the United States and the Soviet Union were controlled and led by their militaries, with civilian engineers, etc. being subordinate to the military personnel (Handberg, 2007). Rocket technology was used for military use in the beginning only, being one of the major military technologies during the beginning of the cold war and therefore the beginning of the space age (Dobos, 2018). Gasparini Alves mentions that “For example, in rocketry, the line differentiating booster technologies from ballistic missiles is rather fine. It is a core issue in international security debates. Indeed, it is often thought that the possession of the former is a passport to obtaining the latter” (Gasparini Alves, 2000).

Photo reconnaissance via satellites was developed based on arms limitation treaties, helping to stabilize the concept of M.A.D[2]., just as early warning systems were developed regarding nuclear monitoring (Dobos, 2018). Communications satellites, weather satellites and navigation were all of military purposes at first. Handberg

[2] The concept of Mutual Assured Destruction (MAD) was a central principle of nuclear strategy during the Cold War. It states that in an all-out nuclear war, neither side involved could win because both would be able to completely destroy each other. This balance of deterrence was intended to prevent nuclear war, since the use of nuclear weapons would be self-destructive for all involved (see e.g. Hynek, 2010)

lables communication satellites “the lodestar of commercial space activity since their applications can generate significant revenues while also being militarily useful” (Handberg, 2007, p. 10). With further development, these technologies all generated a non-military use. Reconnaissance is being used for agriculture, environmental monitoring or agglomeration observation. Communications satellites enable services like telemedicine or natural disaster communication. Weather satellites and navigation via the “Global Positioning System” (GPS)[3], which is also used to enable financial transactions, is used by billions of civilians on a daily basis. According to Handberg, “The two areas most directly impacted by the dual-use concept are remote sensing and navigation” (Handberg, 2007, p. 11). NASA started developing space applications with a social/civilian utility after some time of solely military deployments of these technologies. Remote sensing produced great potential especially for environmental monitoring. Handberg highlights the evolution of navigation technology, which was an entirely military project at first. Of particular importance for the Navy, which operates beyond sight of landmarks, it was given access to the public after Korean Airline Flight 007 was shot down in 1993 when accidentally entering Soviet air space (Handberg, 2007).
Dual-use systems integrate the diverse attributes of civil and defense systems, creating versatile operational platforms with high service availability across both public and classified domains (Otani et al, 2011).

As an interesting example serves a project currently conducted by the European Space Agency (ESA). In the course of the “Clean Space” initiative, ESA is researching and developing technologies that could actively remove space debris. Proposals reach from harpoons and nets to literally catch space junk and drag it into Earth's atmosphere to burn when re-entering, to ground-based lasers that slow down the object by producing a backward-thrust (ESA, 2020). This is supposed to be an entirely civilian project - just like ESA is a civilian institution - with an almost altruistic character regarding the fact that all other space-faring actors would benefit from debris removal. However, “dual-use-hardliners” could argue that ESA might as well take down operational satellites of other actors to weaken their space capabilities. Just like almost all other space endeavors, this project cannot be exempt from having

[3] The international banking system depends on the Global Positioning System (GPS) primarily for time-stamping transactions, as the system offers precise, standardized, and universally accepted time data. This timing synchronization across different networks worldwide enables seamless, efficient, and secure execution of high-frequency trades, ATM transactions, and other financial operations (Fernholz, 2017).

the potential of being used with a military purpose. Regarding the dual use of satellites, they could, besides their function of transmitting signals and information for military and/or civilian purposes, simply be used as “battering rams” and be maneuvered into other satellites, which would cause a crash and the destruction of the satellites. It becomes obvious how it is almost impossible to certainly distinguish between a peaceful or military use of almost any man-made object orbiting Earth.

The Tthreat of Space Debris

Besides dual-use issues, space debris is a growing problem for the use of space, both civil and military. To underline why space weaponization and the destruction of satellites could have severe consequences for our society, I will briefly explain the phenomenon of space debris and its implications for space-fare and space-warfare. Since the launch of Sputnik 1 on October 4^{th,} 1957, humans have left behind not only satellites and space probes but also vast quantities of waste of various sizes in orbit. Some of this waste remains for decades or even longer and increasingly endangers the extraterrestrial activities of humans. These fragments may be inoperational satellites, burnt-out rocket stages, lost parts, flaked paint or debris from explosions of upper stages or satellites. A not inconsiderable part of this came about during military tests of ASAT-weapons, which are designed to destroy enemy spacecraft while orbiting (ESA, 2020). More than 3300 fragments were detected during a Chinese ASAT test in 2007, which was carried out 850 km above the earth's surface. The debris will orbit the Earth for decades to come (ibid). Most fragments are destroyed after a few weeks or months in the Earth's atmosphere, as the thin upper layers slow them down until they fall towards the atmosphere. Due to friction with the particles, they finally burn up. Nonetheless, the number of debris parts constantly increases. In February 2009, two satellites collided for the first time, resulting in more than 2200 fragments larger than 10cm (ibid). Meanwhile, serious risks are emerging for the operation of satellites. At relative velocities of 10 - 14 km/s in low-Earth-orbit (LEO), debris objects larger than around 10cm are capable of completely dismantling a satellite or an orbital rocket stage, creating hundreds or thousands of new debris pieces. If the density of the fragments is sufficient, a cascade effect occurs. The resulting fragments collide with other space debris, again producing fragments (ibid). Of these, some larger fragments can lead to further collisions with catastrophic consequences, resulting in an unstable concentration of space debris in some parts

of the orbit ("Kessler Syndrome[4]"), which would make these parts of the orbit “no-go-areas” for satellites or other manmade space objects (ibid). When thinking this scenario further, such a cascade of space debris could harm a large number of satellites with the aforementioned functions, essential for mankind’s everyday life and vital military purposes.

The Weaponization of Outer Space

It is necessary to briefly examine the difference between the “militarization of outer space” and the "weaponization of outer space”, as these are two different but related concepts. "Militarization of outer space" refers to the use of space for military purposes. This may include reconnaissance and surveillance (e.g., using satellites), communications, weather monitoring, navigation, and geolocation (such as GPS), etc. It is important to note that the militarization of space is already occurring and is widely accepted by the international community (Krepon & Clary, 2003). "Weaponization of space" refers to the deployment of weapons in space or the use of space to launch attacks on Earth or other objects in space. This could mean placing weapons in orbit that target Earth or weapons that can attack other satellites or spacecraft. Weaponization of space is far more controversial and is largely prohibited by international laws such as the 1967 Outer Space Treaty (ibid.).

For the discussion, it is assumed that a state manages to develop and deploy effective space-based weapon systems. This can, for instance, be ASAT-weapons which could target other states' space assets like satellites, or space-based BMD systems, that could intercept missiles launched from a ground-based launched site (Hostbeck, 2020). Not just yet developed are LASER ranging satellites, which instead of physical weapons would use strong LASERs that can destroy a target in space or on the ground, so a form of directed high-energy weapon (ibid.). The advantage of space-based BMD systems is that they can intercept an ICBM during its boost phase. During this stage, ICBMs are particularly vulnerable; they are relatively slow, their heat signature makes them easier to detect and decoys to deceive missile defense systems are not deployed yet (Grush, 2019). The state that achieves this comprehensive form of defense reaches an enormous advantage with maintaining its

[4] The Kessler Syndrome is a theory proposed by NASA scientist Donald J. Kessler in 1978, used to describe a self-sustaining cascading collision of space debris in LEO. It is the idea that two colliding objects in space generate more debris that then collides with other objects, creating even more shrapnel and litter until the entirety of LEO is an impassable array of super swift *stuff*. At that point, any entering satellite would face unprecedented risks of headfirst bombardment (La Vone, 2023)

national security and would also certainly quite heavily shake up the balance of power. This approach of gaining control over LEO can be regarded as an act of anti-access, area denial (A2AD). This concept of strategic defense “has as its center the idea of banning the opponent's access to certain areas and limiting his freedom of action” (Cîrdei, 2018).

Regarding the connection of the principle of sovereignty, outer space makes this indeed a very special case. Space is no territory that can be (naturally) populated. Furthermore, it is infinite – at least as far as we know – but definitely of such dimension that all of it can impossibly be dominated. In international law, there is no definition of the edge of space, meaning the altitude where national airspace ends, and outer space begins. The Kármán line is an attempt to define a boundary between Earth's atmosphere and outer space. It is set at the altitude of 100 km (62 miles) above Earth's mean sea level. However, the US Air Force and NASA, for example, define the limit to be about 80 km (50 miles) above sea level, so there is no universally accepted altitude (McDowell, 2018). Therefore, sovereignty cannot be defined by dividing space, or even LEO, into different “space territories”, so no legally based territorial claims can be made. With an actor being able to deny other actors access to space, this actor would, however, become a kind of sovereign of the area of outer space that is reachable by humans (ibid.) This would not directly impact all other states’ status of sovereignty but strengthen the space-actor’s sovereignty. The concept would, therefore, be shifted, regarding the relevant point of view and extend a state’s sovereignty into orbital space.

From a war-technology point of view, Kirkpatrick argues that sovereignty has mainly been influenced by the long-term trends in the costs of weapon systems. He refers to states in need of developing new and improved weapon systems to keep up with other possibly hostile nations and being able to deter them with a similar strong capacity. He states that in the course of history, “A longer spear, a sharper sword or more-robust armor has always conferred a disproportionate advantage on the warrior who was better armed than his enemy”, basically saying that whoever actor has the strongest capacities military wise, should be superior over other states that do not have that capacity (Kirkpatrick, 1997). If the weaponization of space makes a single actor gain the strongest military capabilities, supremacy would indeed shift into its direction and general sovereignty would decline.

Herz argues that especially air- and nuclear warfare have been the two developments that affected territoriality the most. “It came at least close to defeating one side by direct action against the "soft" interior of the country, by-passing outer defenses and thus foreshadowing the end of the frontier-that is, the demise of the traditional impermeability of even the militarily most powerful states “ (Herz, 1957). The development in war technologies does transform the foundations of state sovereignty, however they do not dismiss the concept entirely. Based on the assumption, the concept would be irrelevant already today since some states do have the means to annihilate other states entirely and bypass borders easily. Still, the concept of sovereignty remains relevant. Quite possibly the development of space-based weapons would be a seemingly revolutionary development at first, but eventually be settled by the international community with each state's sovereignty still obtaining, possibly in a different form though.

The potential weaponization of space emphasizes its central role in the field of security. The development and deployment of anti-satellite weapons and space-based weapon systems highlight the strategic importance of space. In addition, space debris poses a serious threat to civil and military space activities. The possibility of a cascading effect of space debris could lead to "no-go zones" in space and hinder the operation of satellites that are essential for communications, navigation, and reconnaissance-all of which are critical to global security. Moreover, the race for space dominance could lead to an extension of territorial claims to space, further underscoring the importance of space to state sovereignty. The complexity and vulnerability of space activities have certainly moved space further toward the center of the current security discussion. When examining the conceptualization of space security, it becomes evident that the understanding of this term is closely linked to a broader theoretical framework. The concept of space security does not exist in isolation, but reflects a variety of political, social, economic, and technological factors. The theory of the Copenhagen School offers an interesting perspective on the concept of space security and will be briefly examined below.

Copenhagen School and Space Security

Security policy considerations are playing an increasingly important role in the public debate on future-oriented and responsible foreign and domestic policy. As a result, scholarly interest in the topic of security, beyond questions of military strategy, has

grown steadily, and questions have increasingly been raised about the significance of security policy considerations in history. At the same time, the question of how to counter threats and how to make a sector more secure has become a pressing issue. The Copenhagen School of Security Studies has dealt extensively with these research perspectives on security in international relations.

Fundamentally, according to Buzan, Wæver, and de Wilde in their foundational work "Security. A new framework for analysis," security should be seen as something negative, "as a failure to deal with issues as normal politics" (Buzan, Waever, & de Wilde, 1998, p. 29). This may seem surprising at first, given that the creation of security is one of the major goals of contemporary politics and is generally considered a major stabilizing factor (ibid.) This is not denied, but the emergency character of such stabilizations due to threat scenarios is referred to (ibid, p.21). This is often done by giving defense arguments, which tends to lead to a strengthening of the political decision-makers. In turn, the disarmament of a threat occurs when an actor removes an issue previously considered to be in conflict from a particular public perception (ibid. p.123). This takes us to the core of the studies following the Copenhagen School, the question of the process of producing security: „securitization studies aim to gain an increasingly precise understanding of who securitizes, on what issues (threats), for whom (referent subjects), why, with what results, and, not least, under what conditions (i.e., what explains when securitization is successful)" (ibid. p.32). The neologism 'securitization' is used to refer to the act of producing security. This is defined in more detail as a speech act[5]. By speaking security, an actor is already acting in the sense of securitization (ibid. p.26). This is based on the assumption that some statements do more than just describe. They evoke reactions and thus act (Balzacq, 2010, p. 1). In this context, a recipient is required for the transmission. However, whether this can be assumed as a given or whether an empirical proof of the category 'recipient' must first take place is disputed in security research (ibid. p.2). The characteristic of the aforementioned speech act is its rhetorical nature: the emphasis of a danger threatening the existence and, as a reaction to it, the emphasis of actions without which any further solution would become irrelevant due to the destruction of the threatened good (Buzan, Waever, &

[5] This definition is based on the theory of speech acts described by John L. Austin. Thereby, the effect of the 'locutionary' and the 'perlocutionary' act is in the focus of interest. The acceptance of an expression as well as the consequences resulting from it form the criterion for the evaluation of a successful securitization (see (Austin, 1955)

de Wilde, 1998). In contrast to the strategic security studies of the 1970s and 1980s, which focused mainly on military aspects, social, economic and environmental security are also taken into account (Buzan & Hansen, 2012). Especially in relation to threats, the scope of examination is fundamentally broadened (Buzan, Waever, & de Wilde, 1998). In the perspective of securitization theory, there is no field that constitutes a threat by itself. Accordingly, a security problem only emerges through a discursive process (Balzacq, 2010). In most cases, the question of security is concerned with crucial issues such as the state, authority and legitimacy, politics, and sovereignty. The accusation of being state-centric is obvious here; according to Buzan, the reference to the above-mentioned subjects promises a high probability of being able to successfully provide security (Buzan, Waever, & de Wilde, 1998). To this argument, the following reasoning is given with reference to the extended frame of reference: „Security is an area of competing actors, but it is a biased one in which the state is still generally privileged as the actor historically endowed with security tasks and most adequately structured for the purpose. This explanation acknowledges the difference between a state-centric approach and a state-dominated field" (ibid. p.37).

It has been pointed out that security in the Copenhagen School means the following: the shifting of a problem away from the normal rules of politics into a higher realm through the use of special rhetorical rules. Accordingly, if an actor highlights a subject as threatened, it is a matter of a situation that not only causes concern, but also involves something extreme, meaning the danger of the extinction of the good worth protecting (Buzan & Hansen, 2012). In order to meet this existential threat, extraordinary means are needed (Buzan, Waever, & de Wilde, 1998). To the authors of Securitization theory, it seems unimportant whether there is a 'real' threat or not, because „Security is thus a self-referential practice, because it is in this practise that the issue becomes a security issue – not necessarily because a real existential threat exists but because the issue is presented as such a threat" (ibid.). Underlying this is a strongly constructivist hypothesis that securitization is intersubjective and socially constructed. From the perspective of discourse history, it can be said that no danger can be described as what it is, but how it was perceived by its contemporaries (ibid. p.34). Important, however, is the consequence of the security move. Through the speech act of securitization, the actors (those who securitize, those who are threatened in this scenario etc.) behaved differently than they would have without the

move to the emergency realm. This makes the presumption of the use of extraordinary means by a target audience more likely (ibid. p.21).

In the framework of the Copenhagen School, a threat can be constructed by an actor. The actor defines a problem as existential for a certain subject, which does not necessarily have to be the state, but is often related to it (nation, identity, sovereignty), and thus elevates it to a higher-level context of meaning that justifies extraordinary means (ibid. p24).

The described actions do not create security by themselves. Securitization is only successful if it is perceived and accepted as such by an audience. This is the most important rule for successful securitization: without acceptance of the proposed measures, which may create new or even violate traditional rules, there is no creation of security. However, it would not require the application or implementation of the proposed responses to a perceived threat (Buzan, Waever, & de Wilde, 1998). Essential to these speech acts is always their future-oriented direction: only if we act there is a possibility to counter the threat. This applies in particular to threats to one's own identity (ibid.).

A previously missed aspect of the theoretical framework is the division of security into different sectors, which can be threatened from different directions:

“Generally speaking, the military security concerns the two-level interplay of the armed offensive and defensive capabilities of states, and states’ perceptions of each other’s intentions. Political security concerns the organizational stability of states, systems or government and the ideologies that give them legitimacy. Economic security concerns access to the resources, finance and markets necessary to sustain acceptable levels of welfare and state power. Societal security concerns the sustainability, within acceptable conditions for evolution, of traditional patterns of language, culture and religious and national identity and custom. Environmental security concerns the maintenance of the local and the planetary biosphere as the essential support system on which all other human enterprises depend” (Buzan, Waever, & de Wilde, 1998, p. 8).

The securitization of military matters is usually accompanied by a genuine fear of attack. Therefore, measures taken for this sector mainly revolve around the defense of government capability against internal and / or external attacks. A threat from the outside, even a minor influence, always makes it easier to invoke the security of the state as a threatened asset (ibid. p.152).

In addition, there is the aspect of territory and region, which has a decisive significance for so-called non-mobile units, especially states. In particular great powers and the spatial location to them influence actors in their actions. Through their geographic location, certain states are also assigned specific positions: „Geography shapes the perception and operation of military threats and vulnerabilities in two ways: through distance and terrain. Distance works on the traditional principle that military threats are more difficult to mount and easier to defend against when they have to travel over longer distances than over shorter ones. Most states have the capability to make threats of attack or invasion against their immediate neighbors. Great powers can generally project military power beyond their immediate neighbors and into their regions" (ibid. p.59).

In summary, the Copenhagen School of Security Studies is concerned with expanding the traditional concept of security and emphasizes the social construction of security. The authors argue that security is not only about military threats, but also includes social and political dimensions that affect people and states. According to this theory, security is understood as a social construct that is shaped by the discourse and perceptions of actors. Security is not objective and independent, but a result of social practices, interpretations, and norms. The Copenhagen School emphasizes the importance of security communities and identities, as perceptions of threats and security are influenced by a community's shared norms and values. Another important aspect of the theory is the idea of securitization. This process occurs when certain issues or actors are portrayed as existential threats and placed outside of normal political processes to justify extraordinary means.

The Copenhagen School offers a relevant approach to analyzing space security matters. In this context, it means that space security is not limited to military threats, but also includes social and political dimensions that influence the use of space by people and states. Space security is understood as a social construct that is shaped by the discourse and perceptions of the actors. Perceptions of threats and security in space are influenced by the shared norms and values of the space community. This includes not only states, but also private space companies and other relevant actors active in space. In the space context, the concept of securitization can mean that certain space activities or technologies are portrayed as existential threats to security in order to justify extraordinary measures or regulations. For example, this could be

the securitization of space debris, where it is considered an urgent priority to take action to reduce the amount of debris especially in LEO.

Space security can be applied with each sector of the Copenhagen School's framework in the following ways:

Military security: The militarization and potential weaponization of space are significant issues. Countries with space capabilities can potentially use these capabilities for military advantage, whether it is through surveillance satellites or, in a extreme-case scenario, deploying weapons in space.

Political security: The control and use of space have significant political implications. Political tensions can rise due to disagreements on space-related treaties or norms, or disputes over rights over celestial bodies like the moon. The geopolitics of space exploration can influence political relationships on Earth.

Economic security: Economically, access to space and the potential resources it contains is becoming increasingly important. This includes commercial space travel, mining of asteroids for resources, and the dependence of many sectors on satellite technologies. Disruptions in space can therefore have a significant economic impact.

Societal security: Space technologies, particularly satellites, are crucial for various societal functions, from weather forecasting and communications to navigation and scientific research. Threats to these technologies can pose a significant societal security risk.

Environmental security: Space activities can have environmental implications both on Earth and in space. The accumulation of space debris, like mentioned, is a growing concern for the safety and sustainability of space activities.

By applying the Copenhagen School's broad and interdisciplinary approach to space security, it is possible to examine related issues from multiple perspectives. This approach can facilitate a more comprehensive understanding of the different threats and challenges associated with space activities and can help guide the development of appropriate responses and policies.

Having highlighted the concept of the Copenhagen School in the context of Space Security, a comprehensive look at the existing literature will follow. The literature review will serve to examine various aspects of space security and its challenges, including the role of private space actors. This will provide an informed understanding of the current debate and state of knowledge in this field. Examining the literature will

allow for the identification of existing knowledge, potential research gaps, and provide a foundation for analyzing the specific role of private space actors in the space security landscape.

Literature Review

Space Security and Private Space Actors

The academic field of space security has not yet been as densely researched as other sub-disciplines of international relations or security studies. Nevertheless, there are a number of academics who are specifically engaged in this topic and have therefore published a solid foundation of academic works on the subject. Some of the fundamental works shall be briefly discussed as follows.

Moltz (2019) begins with a definition of "space security" and offers a brief history of the international politics surrounding the term since 1957. He discusses space security as an evolving environmental challenge, particularly including the risks to space activities from man-made radiation from orbital nuclear weapons testing and from space debris. He also traces the shift in U.S.-Soviet space competition toward passive military programs and civil space activities. Moltz examines the evolution and challenges of space security from 1976 to the present. From the growing space tensions between the United States and the Soviet Union in the late 1970s and early 1980s to growing space cooperation between the United States and Russia in the post-Cold War era and a return of space nationalism, marked by the U.S. withdrawal from the ABM Treaty in the early 2000s. He highlights the expansion of international norms despite heightened tensions, particularly with China's continued anti-satellite weapons testing and Russia's revival of its military space programs.

The author also highlights alternative future scenarios for space security and discusses the growing role of the commercial sector in space, with a particular focus on stability, rule of law, and peaceful space operations. In addition, challenges such as space traffic control and space situational awareness are discussed.

Klein (2006) explores military space strategy in the context of land and naval strategies of the past. He explains why and how strategists recognize the similarities of space operations to those of air and naval forces and shows why many of these strategies unintentionally overemphasize the importance of space-based offensive weapons and technologies. Klein argues that space-based weapons do not provide

superiority. He uses Corbett's maritime strategy while drawing lessons from the significant insights of other strategists-including Sun Tzu or Clausewitz. He shows how space strategy and related principles of space warfare can be drawn to anticipate concerns, develop ideas, and suggest previously unrecognized policies.

The ”Handbook of Space Security" (2020)was edited by Schrogl, Hays, Robinson, Moura, and Giannopapa. This work covers current developments and challenges in space security and analyzes how international policy makers are trying to maintain safe access and operations in space. This takes into account the fundamental role that space systems play in the daily lives of many people around the world. The authors provide a broad international perspective on space security and analyze how best to advance space security and protect space for peaceful purposes. It defines space security as the use of space (especially communications, navigation, Earth observation, and electronic intelligence satellites) for military and security purposes on Earth and also the maintenance of space (especially Earth orbits) as safe areas for conducting peaceful activities. The collection provides a sophisticated resource on space security and related technologies, applications, and programs. The authors cover the latest developments in space and security that have taken place in Europe and around the world in recent years, along with the new challenges that need to be addressed. Forward-looking recommendations are mentioned, particularly in the area of space governance and transparency and confidence-building measures. This work describes various dimensions of space security as well as space for security on Earth. It covers space policy and geopolitics of space, existing and planned applications and programs, and technological solutions.

Security and Private Actors

Private actors in security, especially private military companies, are much debated topics in international relations and security studies. Research has dealt intensively with this topic from various points of view. The discourse can be divided into different categories.

Avant (2008) focuses on the increasingly central role of private security forces in the global security landscape and the related issues regarding the control of the use of force. She puts an emphasis on the problem of the privatization of violence and addresses the control of the use of force. In particular, the role of state and private contracts and state regulation is discussed. In her work, she provides a thorough

examination of the role and impact of private security providers and shows how market mechanisms and private funding can change traditional understandings of state sovereignty and control over the use of force, raising important questions for the future of global security governance.

Schneiker (2009) questions the ambivalence between the potential and risks posed by PMCs, looking at various aspects including the range of services offered, market structures, and the legal framework.

The author emphasizes the lack of transparency often associated with PMCs and the issues surrounding the indiscriminate and excessive use of force.

The study sheds light on the lack of regulation of PMCs at both the national and international levels, discussing the deficiencies in the current legal system.

Particular noteworthy is the discussion of PMCs as actors in security governance, with the author considering the impact of globalization and the challenges of limited statehood. She argues that despite the existing risks and uncertainties posed by PMCs, these firms can also become actors of governance in the security sector.

Singer (2008) provides a comprehensive and in-depth analysis of the privatization of military services. Singer shows how PMCs emerged and how they differ from historical private military actors and mercenaries. He argues that the privatization of the military is the result of fundamental changes in the global security and business environment at the beginning of the 21st century. In the wake of globalization and the end of the Cold War, the private military market has expanded in ways not seen since the 18th century. The author distinguishes PMCs from traditional military players, emphasizing that the most important distinction is the corporate structure of these firms. They operate primarily as business enterprises, providing services that traditionally fall under the responsibility of national militaries. The book also discusses the difficulties and risks associated with outsourcing military services to PMCs. It addresses issues of control and oversight of these firms, as well as potential implications for the civil-military balance. Singer sheds light on the role of PMCs in carrying out government functions and discusses the ethical implications of their activities.

Khan, Fayaz and Khan (2022) examine the role and responsibilities of PMCs in the context of the privatization of war. During armed conflict, PMC personnel may violate international law, including provisions of international humanitarian law. This provides for individual criminal responsibility for employees of these companies. However,

there is no international legal framework to establish liability for the private military companies. The authors suggest that the idea of corporate criminal responsibility should be introduced at state level with the goal of holding PMCs accountable for violations of International Humanitarian Law and human rights norms. In addition, the authors call for greater government inspection and oversight of PMCs and suggest that the International Criminal Court should allow criminal prosecutions in the future. They argue that despite the notion of compensation and reparation at least partially at national level in the case of PMC violations, victims lack access to domestic remedies and are unable to exercise their international right to seek reparation. Overall, the authors call for a stronger legal framework to clarify responsibility and liability for violations of international humanitarian law.

Private Space Actors and their Activities

Because the phenomenon of private space actors is a rather recent one, there is not as much basic research on this topic as on the previously mentioned aspects.

Paikowsky (2017) uses the term New Space to refer to the change in the space industry to a commercially driven industry. The transition from the traditional space industry, which was primarily funded and regulated by governments, to the commercially driven New Space industry has brought about profound changes in the sector. The role of governments has changed, now being primarily customers and regulators rather than providers. Private companies bring innovative business models and new technologies. He argues that new models of research and development require a different approach and shorter timeframes. In addition, the author highlights the growing problem of space debris and says that efforts to address this challenge are being made at both the national and international levels, although geopolitical tensions make universal consensus difficult. In the context of the growing commercialization of space, Paikowsky points to the potential demand for greater regulation and standardization by the private sector.

The Secure World Foundation's Handbook for New Actors in Space (2017) looks to promote safe, sustainable, and peaceful use of space to contribute to global stability on Earth. The authors ask questions related to the entry of new players into the space sector, for example whether the growing number of new actors could destabilize the space environment and create new tensions among nations. New actors should consider several issues, such as the international and domestic legal

framework governing their space activities, regulatory authorities, their rights and responsibilities in space, potential liability risks, and government oversight of private space activities. The goal of the Handbook is to provide new actors with a comprehensive overview of the basic principles, laws, standards, and best practices for peaceful, safe, and responsible activities in space. It is organized into three main chapters that address the international legal and political regulatory system, national space policy and regulation, and responsible space operations.

Vernile (2018) provides a comprehensive overview of the increasing importance of private players in the space sector. She describes several trends within the New Space movement, including new players in the space sector, innovative industrial approaches, disruptive market solutions, significant private investment, and new space markets. Her work is the result of a broad review by the Italian Space Agency (ASI) and the European Space Policy Institute (ESPI). She collects and organizes publicly available data on the rise of private actors in the space sector and provides recommendations for future space policy research. The focus is on emerging private actors in the space value chain. Geographically, the study focuses mainly on the situation in the U.S. and Europe, where the rise of private actors is most evident. The New Space dynamic is identified as a complex phenomenon encompassing technical, political, and business trends.

Methodology

Research Design: Qualitative, In-Depth Case Study

A qualitative approach is essential to this study because the interaction between private space actors and space security is complex and multifaceted. The study aims to explore the circumstances of space activities, space policy, and the corresponding security implications. For these areas, qualitative research is particularly appropriate to obtain information. Rather than relying on numerical data, a qualitative approach allows to examine how private space actors, such as *SpaceX* and *Blue Origin*, conduct their activities and how their actions may impact security in space. In addition, space security is inherently linked to political, legal, and social dimensions. Analysis of textual information from legal documents and (national) policies facilitates understanding of these layers.

The selection of case studies as a research design is supported by the need to explore the complex dynamics between private space actors and space security in depth. Case studies allow for an examination of the various phenomena in their real-world context. By focusing on *SpaceX* and *Blue Origin*, this research can thoroughly analyze the companies' specific ventures to understand how their activities impact space security. Case studies allow the research to draw from a variety of sources to develop a holistic understanding. In addition, they facilitate comparative analysis. By examining two different private space actors, research can identify similarities and differences in how they impact space security. This comparison has some importance in understanding the broader implications and trends in the private space sector. Ultimately, this research design brings depth and practical relevance to the study of private space actors and space security by contextually linking these.

A comparative analysis between private space actors and comparing them to private military companies highlights the diversity of private actors' engagement in traditionally state-dominated domains. Comparing the developments (over time) and structures of private space actors with those of PMCs reveals both similarities and differences in how private companies manage and influence security dynamics. Examining space companies alongside PMCs allows for exploration of how different regulatory environments, technological capabilities, and market forces influence the behavior of these companies. For example, the emerging nature of the private space industry compared to the more established private military industry may reveal how emerging sectors can learn from the challenges and experiences of previous entrants in the security sector. This approach enables an interdisciplinary analysis of how historical precedents, such as the rise of PMCs, can provide predictions and policy recommendations for the emerging commercial space sector. Lessons can be derived to anticipate and manage the growing influence of private space actors in the space domain.

Case Selection Rationale

The two companies were selected as case studies for various reasons. First of all, their product and service portfolio are adequate regarding the planned examination of space activities by private actors. Their scope of activities covers several different options to analyze and put into consideration with space policy and space law. *SpaceX* for example offers satellite launches for private and public customers, supply

flights to the International Space Station and astronaut launch services among others (SpaceX, 2023). *Blue Origin* also offers launch services and puts a high emphasis on further space tourism flights (Blue Origin, 2023). Furthermore, *Blue Origin* is designing a lunar lander called “Blue Moon”, which aligns with NASA’s goal of landing a new mission to the moon in this decade (ibid.). Both companies either already have or are aspiring to get national space agencies as their customers. *SpaceX* regularly conducts missions for NASA, especially as part of the Commercial Orbital Transportation Services (COTS) (Gerstenmaier, 2011), Commercial Resupply Services (CRS) (NASA, 2023), and Commercial Crew Program (SpaceX, 2023). *SpaceX* has also launched payloads for other national space agencies like the Canadian Space Agency (CSA), the European Space Agency (ESA) or the Argentinian Space Agency (CONAE) (Henry, 2018).

Blue Origin has primarily been involved in development partnerships and suborbital research flights rather than conducting full space missions for NASA (Stevens, 2021). As *Blue Origin* continues to develop its capabilities, particularly with its New Glenn orbital rocket, it is possible that the company could become more directly involved in future NASA missions. So far, *Blue Origin* has not conducted missions for any other national space agencies.

The activities of the two enterprises can have a significant impact on various aspects of space security. These will be elaborated and analyzed to draw conclusions on potential future developments regarding private space actors and security in space.

Data Collection and Analysis Methods

This thesis uses a variety of secondary sources to provide a comprehensive understanding of the research topic. Scholarly articles and books provide theoretical foundations and historical context on space security and private space actors. Documents such as *SpaceX* and *Blue Origin* websites, reports, and press releases provide direct insights into their missions, technologies, and goals. National space policies as well as international regulations clarify government positions and the regulatory framework. Media articles provide updates on recent developments and public perceptions regarding private space actors. Reports and articles from non-governmental organizations provide alternative perspectives, often focusing on ethical, environmental, and international cooperation issues. By combining data from these diverse sources, the research gains a greater and more balanced

understanding of the interaction between private space actors and space security. Relevant data was collected through document analysis and literature review, and then analyzed via the detailed case studies mentioned earlier.

Space Law and Policy

Overview of International Space Law, Treaties, and Conventions

Space Law consists of several international agreements, conventions, UN-resolutions and treaties. These cover a variety of different topics, like the preservation of the Space and Earth environment, liability for damages caused by space objects, the settlement of disputes, the rescue of astronauts, the sharing of information about potential dangers in outer space, the use of space-related technologies, and international cooperation. “A number of fundamental principles guide the conduct of space activities, including the notion of space as the province of all humankind, the freedom of exploration and use of outer space by all states without discrimination, and the principle of non-appropriation of outer space” (UNOOSA, United Nations Office for Outer Space Affairs, 2018). From the whole body of law governing space-related activities, there are five main treaties which can be seen as the international framework providing laws. These are the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967, ‘Outer Space Treaty’), the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (1968, ‘Rescue Agreement’), the Convention on International Liability for Damage Caused by Space Objects (1972, ‘Liability Convention), the Convention on Registration of Objects Launched into Outer Space (1976, 'Registration Convention’) and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1984, ‘Moon Agreement’) (UNOOSA, 2018). It is to mention that the Moon Agreement has until today only been ratified by 18 states, non of them are actively spacefaring. (Committee on the Peaceful Uses of Outer Space, 2023)

According the United Nations Office for Outer Space Affairs (UNOOSA), the Outer Space Treaty ‘provides the basic framework on international space law’ (UNOOSA, 2018). It sets, among others, the following principles: “the exploration and use of outer space shall be carried out for the benefit and in the interests of all countries and

shall be the province of all mankind; outer space shall be free for exploration and use by all States; outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means; States shall not place nuclear weapons or other weapons of mass destruction in orbit or on celestial bodies or station them in outer space in any other manner; the Moon and other celestial bodies shall be used exclusively for peaceful purposes; astronauts shall be regarded as the envoys of mankind; States shall be responsible for national space activities whether carried out by governmental or non-governmental entities; States shall be liable for damage caused by their space objects; and States shall avoid harmful contamination of space and celestial bodies" (UNOOSA, 2018).

The Rescue Agreement shall provide that states undertake all required steps to rescue and assist astronauts in emergency situations if necessary, regardless their nationality or host nation. This also applies to cases where astronauts have already returned from space but landed in territories outside of the launching sate. In these cases, astronauts must never be taken prisoners by the affected state for example (UNOOSA, 2018).

The Liability Convention ensures full responsibility of a launching state for any kind of damage caused by its (space-) objects on earth as well as in space. This also applies to inoperational objects like disabled satellites or pieces of space debris, even if the debris causing incident was not the object's owner's fault. The object's debris technically remains property of the owner of the damaged object. The treaty makes sure that the liable state pays compensation in case of caused damage (UNOOSA, 2018).

The Registration Convention is an additional tool to the liability convention to ensure all objects in space can be accurately related to their launching state. Without such a registry, it would be impossible to identify a spacecraft that has caused damage.

When launching an object into space, the following information about the object are supposed to be provided upon registration: Name of launching state or states, an appropriate designator of the space object or its registration number, date and territory or location of launch, basic orbital parameters, including: nodal period; inclination; apogee and perigee, general function of the space object (Art. IV Registration Convention). For this convention "the Secretary-General was, once again, requested to maintain the register and ensure full and open access to the

information provided by states and international intergovernmental organizations" (UNOOSA, 2018).

The Moon Agreement provides that the Moon and other celestial bodies shall be used only for peaceful purposes, that their environments should not be disrupted, that the United Nations should be informed of the location and purpose of any station established on those bodies. In addition, the Agreement provides that the Moon and its natural resources are the common heritage of mankind and that an international regime should be established to govern the exploitation of such resources when such exploitation is about to become feasible (UNOOSA, 2018). As mentioned before, the Moon treaty has been ratified by 18 states so far, none of them actively space faring, and can therefore be seen as a failed treaty (Bohinc, 2013).

Already at first glance, it becomes clear that all these treaties refer to purely governmental space actors. This is due to the fact that at the time of their draft, there were no other space actors except governmental ones. Remarkably, however, there have been no additions, e.g. amendments. It is therefore still very much a matter of legal debate as to how the objects of private space actors, e.g. rocket stages, are treated from a purely legal point of view.

National Laws and Policies Governing Private Space Activities

Due to the private and commercial part of the space sector growing rapidly, several states realized that a domestic legal framework is necessary to regulate and limit the activities of these actors. These national laws are mostly aligned with the international legal framework, but often address specific considerations and challenges that arise within each country's jurisdiction (Oduntan, 2016).

The United States, hosting the largest share of private space actors including the most significant, impactful corporations, can be seen as an international frontrunner with a solid legal framework regarding private space companies (Goessler, 2022). The Commercial Space Launch Act of 1984 and the Commercial Space Launch Competitiveness Act of 2015 are particularly important in regulating private space activities (Space Foundation, 2023). The Commercial Space Launch Competitiveness Act recognizes the right of U.S. citizens to own the resources they extract from space, thereby providing a legal basis for future commercial space activities (ibid.). This is potentially contradictory to the Outer Space Treaty, which has a strong non-appropriation emphasis. In 2018, former President Trump signed a

Presidential Directive to streamline the regulations for the commercial use of space, encouraging the growth of the commercial space sector by encouraging investment (NASA, 2018).

European countries have shown different approaches when it comes to the regulation of their domestic private space actors. In Germany, the Government continues to struggle to adopt a space act that would provide a legal framework for non-state space activities and limit liability for damages caused by private space companies. The absence of a legal framework leaves the state solely liable for damages. A national space act would be crucial not only for private space actors but also for enabling activities like launches from domestic launch sites (Sürig, 2021). France has enacted legislation requiring operators to demonstrate that they are capable of controlling their space objects in a way to avoid collisions which could result in creating harmful debris (Légifrance, 2022). Remarkably, Luxembourg has passed a law allowing companies to own the space assets they extract, mirroring the aforementioned U.S. position and prompting debate over potential conflicts with the Outer Space Treaty (Luxembourg Space Agency, 2017).

The European Union (EU) does not have specific regulations governing space activities, primarily because responsibility for space issues is largely national and lies with the respective member states (Tapio & Soucek, 2022). However, the EU does have a space policy that coordinates various aspects of member states' space activities and is carried out in cooperation with the European Space Agency (ESA) (ibid.). The European Space Agency (ESA), while not a global organization, has a significant impact on space law due to its member states' space activities and influence. ESA's conventions and decisions impact its 22 member states and their activities with other nations (Tapio & Soucek, 2022). Through its activities, ESA indirectly shapes the understanding and interpretation of international space law (ibid.). Despite this EU coordination, responsibility for regulating private space activities and other specifics of space law lies with individual member states. As a result, the approach to regulating private space activities varies widely across the EU, reflecting the different space capabilities, ambitions, and legal interpretation of member states.

In Russia, private space activities are currently negligible to non-existent, as the sector is dominated by the state agency Roscosmos. The Russian Federal Law on Space Activities, enacted in 1993, was the first to regulate space activity in Russia,

including licensing, insurance and security (World Trade Organization, 2003). This law also makes the state liable for damage caused by space objects under its jurisdiction, even if launched by a private company (ibid.).

While China's space activities are largely controlled by the government, private companies such as *LinkSpace* or *iSpace* are increasingly participating (Curcio & Lan, 2018). To address this, China has begun to develop regulations specifically for commercial space activities. The Interim Measures for the Administration of Licensing Commercial Space Launch Projects for example outlines licensing requirements for commercial launch activities (Australian Navigational Guide for Space Law, 2023). However, it is important to note that these regulations are still evolving and the majority of China's private space activities are driven by partnerships between private companies and government entities (Curcio & Lan, 2018).

While national laws and policies serve to regulate private space activities in individual countries, a gap remains between these laws and the international regulations. The challenge for the individual countries and the international community as a whole is to align national space law with the international regulations to create an environment that encourages innovation and investment in the space sector while ensuring the sustainable and peaceful use of space.

The Role of International Organizations in Shaping Space Law

International organizations play an essential role in shaping space law by facilitating discourse between nations, ensuring compliance with international law and driving new initiatives as a reaction to technological advancements in the sector (Goguichvili, Linenberger, & Gillette, 2021).

The UN has been the main actor in the development of space law through its Committee on the Peaceful Uses of Outer Space (COPUOS). Established in 1959, COPUOS is tasked with reviewing international cooperation in the peaceful use of outer space, reviewing space-related legal issues, and encouraging space research and technology development (COPUOS, 2023).

The International Telecommunication Union (ITU), an agency of the UN, is responsible for information and communication technologies (ITU, 2023). It has been crucial in shaping the structure and needs of the space industry, with a significant portion of its responsibilities revolving around the management of the satellite spectrum. It plays a pivotal role by coordinating the shared global use of the radio-

frequency spectrum, promoting international cooperation in assigning satellite orbits, working to improve satellite communication technologies and striving to ensure a high quality, globally accessible satellite communications infrastructure (ibid.). This generates a high relevance for a major amount of space actors and therefore a high degree of leverage for the ITU. The ITU's contributions to international space law and policy-making are significant. By establishing standards and promoting cooperation among nations, the ITU provides a platform for coordination and dispute resolution in space activities (Digital Watch Observatory, 2023). The ITU also helps shape the policy landscape by bridging the gap between technical requirements and legal frameworks (Frackiewicz, 2023).

The Secure World Foundation (SWF) is a private operating foundation dedicated to the sustainable use of space for the benefit of Earth and all its peoples (IAF, 2023). It promotes solutions for space sustainability and aims at protecting the space environment for future generations (ibid.). While it does not draft or enforce laws, the SWF plays a significant role in shaping international norms and practices by fostering dialogue and cooperation among nations, space agencies, and also commercial companies. The SWF very much acknowledges the rising impact private actors have in the space sector.

In sum, these international organizations act as platforms for cooperation, negotiation, and policy-making, playing a vital role in creating, shaping, and implementing space law to govern activities in outer space.

Gaps and Challenges in the Existing Legal Framework

Even though private actors have become relevant actors in space, space law still has a significant public character. When the aforementioned international treaties were drafted and ratified, state actors did not anticipate that today private corporations would play such a significant role in space. Accordingly, in the treaties, private actors are not mentioned or addressed. It is therefore to question whether space law is still contemporary and meets the requirements of todays situation in space, or whether it needs to be adjusted to nowadays environment.

The only article that to some extent recognizes a dual system is Art. VI of the Outer-Space-Treaty (OST), which says ‘States Parties to the Treaty shall bear international responsibility for national activities in outer space, whether such activities are carried on by governmental agencies or by non-governmental entities.’ (UNODA, 2018). This

means that private activities are permitted, however the state remains responsible for all activities conducted by the private actor. Hence, if a private actor violates any of the treaties, the liable launching state could be charged and would have to compensate a possible penalty for said misconduct. It is of course possible for a state to arrange an agreement via national law or a(n) (insurance) contract with the specific private actor to prevent such a case, according to international law however, the state remains responsible.

Avgerinopoulou and Stolis argue about the liability convention that “it does not address the issue of who is the “owner” of and who is “responsible for” the space object causing the incident” (Avgerinopoulou & Stolis, 2017, P. 14). Article 2 of the conventions states “A launching State shall be absolutely liable to pay compensation for damage caused by its space object […]” The term ‘launching state’ is defined as ‘A state which launches or procures the launching of a space object; a state from whose territory or facility a space object is launched’ (Art I Liability Convention). Regarding the second part of the article, it can be questioned what the legal state of affairs is, if a launch is conducted from outside of a state’s territory (Avgerinopoulou & Stolis, 2017). The “Ocean Odyssey” complex for example is operated by the private company *SeaLaunch* and located in the Pacific Ocean south of Hawaii, which from an international law perspective is non-state-territory (Jakhu & Dempsey, 2016). Since the Liability Convention adresses only states, these would be the ones carrying full responsibility according to the registry. Again, it would be in the states interest to specify the international law regarding this issue.

The Rescue Agreement provides that states take the necessary steps to support astronauts in emergency situations. There are several companies that are planning to provide space tourism services, so for civilians to fly into space for a certain amount of time and return to earth. Since the term ‘Astronaut’ is not further defined in the articles of the treaty, it is arguable whether civil space tourists can be seen as astronauts in terms of the agreement, and therefore fall under the right of rescue. Avgerinopoulou & Stolis argue that ‘Even though there is a remarkable difference of opinion, the prevailing theory is that humanitarian considerations entail the applicability of the agreement and the existing general humanitarian obligations to assist humans in distress are sufficient without the qualifications as “envoys of mankind”’ (Avgerinopoulou & Stolis, 2017, P. 15). The international community would

be well advised to substantiate the term ‘Astronaut’ and distinguish it from the term ‘Space Toursit’.

One of the principles of the outer space treaty states that ‘The exploration and use of outer space shall be carried out for the benefit and in the interests of all countries and shall be the province of all mankind’ (Art I, OST). Regarding the space-mining ideas of a few space companies, it is doubtful whether these kinds of activities would be legal referring to the first article of the OST. The companies would certainly not invest enormous amounts of money and labor to develop and undertake such an extremely difficult and sophisticated task like mining on a celestial body, not to mention the return of the mined goods back to earth, to share their generated profit with ‘all countries’ or ‘all mankind’. The companies would naturally keep the profit to themselves. To be able to do so, it would be in the companies’ interest to obtain an adjustment or specification of that OST article. This, however, is due to current technological development and immense cost still a topic to be rather considered in the medium term.

In summary, projecting international space law onto private space actors presents numerous challenges. The existing legal framework was primarily established during the era of state-led space activities; thus, it lacks specificity for private entities. There is no universal interpretation of space laws among states, leading to discrepancies in national regulations that govern private space companies. The degree of private space actors being incorporated within national law highly varies between countries, therefore a general conclusion cannot be drawn here. Furthermore, technological advancements and innovative practices by private entities often outpace the development of space law. Lastly, the inherently global and shared nature of outer space necessitates international cooperation and consensus, which is often difficult to achieve, thus impacting the development of effective regulation for private space actors.

Public-Private Partnerships

Public-private partnerships (PPP) are an increasingly established concept in contemporary administrations across various states. This model leverages the strengths of both the public and private sectors and is increasingly utilized in a range of industries. This chapter addresses a comparative analysis of PPPs in two sectors,

focusing on private military companies (PMCs) and private space companies. PMCs have been part of the global security landscape for decades, providing governments with capabilities that complement or even partially replace conventional armed forces (Bailes & Holmqvist, 2007). Private space companies, in contrast, have emerged more recently and are challenging the state monopoly in space exploration and exploitation. Both sectors offer insights into how PPPs can reshape industries and how governments can utilize the resources, innovation, and efficiencies of the private sector. The choice to include an analytic comparison of these two sectors in this study stems from their common thematic core: in both cases, traditional public functions are being complemented or even replaced by private actors, although in very different circumstances. The question of whether private space companies in the future could have the potential to achieve a similar level of influence and dynamic as private military companies should be thoroughly examined and is of academic and societal relevance.

Public-Private Partnerships in Private Military Companies

Looking at the development of the deployment of military forces, there has been a noticeable shift for several decades already. Whereas there used to be a clear distinction between public and private (military) institutions, nowadays this separation is no longer as evident. When looking at contemporary armed conflicts, it becomes clear that the actors involved are no longer exclusively state actors. More and more private companies are becoming involved in such conflicts in various forms (Singer, 2008). They are contracted by governments and support the national armed forces in their tasks. These companies are commonly referred to as private military companies (PMCs). The deployment of these companies is seen as controversial for a number of reasons (Senekal, 2010). On the one hand, there are (international) legal ambiguities associated with PMCs. There have already been cases in which employees of these companies did not abide by the rules of international humanitarian law while deployed in a conflict region, yet it was not possible for the incidents to be fully dealt with in court because there was a lack of clarity about the respective responsibilities (ibid.). For example, at Abu Ghraib prison in Iraq in 2003, private service providers tortured inmates which by international humanitarian law is obviously illegal (Ackerman, 2014). There are also various reasons why the political legitimacy of these deployments is debatable. Among other things, researchers

discuss the extent to which the state itself undermines its monopoly on the use of force by contracting private actors to perform certain military tasks (Leander, 2005).

The scope of the private security industry is broad and includes a wide variety of services. A distinction must be made between several different types of companies (Förster, 2010, p. 13). The umbrella term of PMCs still includes too many different subcategories, requiring them to be defined in more detail. Initially, a distinction can be made between two different applications of this term. On the one hand, it describes the outsourcing of secondary military functions (Förster, 2010, p. 303). These tasks are of a logistical nature or can be allocated to the area of maintenance services. Service providers of this type are expected to reduce costs and improve quality in the respective areas. Boemcken refers to this as "privatization from above" (Von Boemcken, 2007).

To divide the various companies into subgroups, Singer uses the tip-of-the-spear typology (Singer 2008, pp. 91, 93). In the armed forces, units are often differentiated by how close they are to the front line, i.e., combat operations (ibid.) The private service providers can be classified in the same way. Hereby, the industry is structured by distinguishing how close the companies are to the actual combat action when providing their services. These structural spaces that Singer constructs are the general military environment, the general environment of the military in an operation, and the concrete area in which the combat operations take place, that is, in a sense, the battlefield itself (Singer, 2008, p. 91). Singer divides the firms into Military Support Firms, Military Consulting Firms, and Military Provider Firms (Singer 2008, p. 91). Military Support Firms are implemented primarily for economic reasons (Wulf, 2005, p. 60). These are therefore to be located in a general military environment but are by no means active in combat operations. Military Consulting Firms can be described as „Firms that provide advisory and training services integral to the operation (…) of a client’s armed forces (…). They offer strategic, operational and/or organizational analysis.“ (Singer, 2008, S. 95). These services include threat analysis, strategy development, technical services such as air traffic control or weapons maintenance, and passive reconnaissance activities (Wulf, 2005, p. 57). The third group, so called Military Provider Firms are directly involved in violent conflicts. Their employees serve, for example, as fighter pilots or form entire infantry units (Singer, 2008, p. 4). According to Singer's structuring, the Military Provider Firms thus form the spearhead as service providers in the specific area of combat operations. There are further

approaches to classifying these categories, but it must be noted that all these attempts reach their limitations as there are companies that overlap these blurred categorizations. With their wide range of tasks, they can be assigned to several categories simultaneously, or it is becoming increasingly difficult to distinguish precisely whether, for example, technical services for combat operations, such as recording troop movements, can be specified as direct involvement in combat operations (Wulf, 2005, p. 55).

Governments are increasingly engaging in PPPs with private military contractors for several reasons. First and foremost, cost efficiency is an important factor. By outsourcing specific military tasks, governments can reduce the costs associated with training, equipping and maintaining regular armed forces (Avant, 2008). In addition, PMCs offer extensive expertise and often employ former special forces personnel who can provide specialized military skills. Another motivation is plausible deniability; by using PMCs, governments can conduct covert or contested operations while officially not admitting to do so (Gutmann, 2011). In this way, the government can deny direct involvement if the operation becomes public. Although there are tangible benefits to using PMCs, there are also some challenges and controversies associated with such partnerships. One of the main problems is legal accountability. Critics of PMCs mostly refer to the lack of accountability and oversight of the companies, which puts the focus on legal legitimacy (Schneiker, 2009). Since PMCs operate as private entities, it is often uncertain to what extent they are bound by international humanitarian law. There have been cases in which PMCs have been accused of human rights violations and excessive use of force, and the ambiguity of their legal status has made it difficult to prosecute such cases (Emine, 2016). Ethical concerns also arise, as the primary motivation of PMCs is financial profit. This can lead to a conflict of interest where the profit motive may take precedence over ethical considerations (Harvey et al., 2021).

Furthermore, the use of PMCs can impact international relations and security dynamics. The use of PMCs in a foreign country can be seen as a violation of that country's sovereignty, especially if the PMC is involved in combat operations (Leander, 2005).

While PPPs involving PMCs offer certain gains in efficiency and military ability, they must be addressed with caution and strict national and international oversight to manage the challenges and controversies associated with their use.

A subsequent question is whether the advantages and disadvantages of using PPPs in the space sector can be categorized in a similar way as for the military sector.

Public-Private Partnerships in Private Space Companies

PPPs are becoming increasingly pivotal in the space sector as well, enabling shared risks, costs, and benefits between governments and private entities. Yet, they also bring about unique challenges. The entire complex of private space companies conducting governmental tasks is also commonly referred to as “New Space” (Paikowsky, 2017).

The *Space Frontier Foundation* defines “New Space*”* as ‘people, businesses and organizations working to open the space frontier to human settlement through economic development’ (Space Frontier Foundation, 2018). “New Space*”* companies see space as a resource for profit, they are therefore trying to develop very cost-effective initiatives with a high financial gain. Since development processes are shorter, project management in these fields is more inclined to take risks. It is tuned toward a ‘‘good enough’’ research and design model and performing technological demonstrations while in service instead of aiming for 100% success in orbit’ (Paikowsky, 2017, p. 86). Another feature of New Space companies is their expertise in a smaller, more precise number of areas. Some focus on launch services, others on satellite constellations, sometimes a company has more than one area of expertise, but never, like the public defense or space sector, do they try to cover all kinds of different topics. This is one reason for their higher efficiency (Brukardt, 2022). Since space as a market is growing rapidly, a number of companies try to compete with diverse new ideas or technologies for their endeavors.

Before the rise of private space corporations, research and development was rather conservative. Projects used to take long and were expensive, with need of a sustainable and successful outcome. Therefore, risk-taking was tried to be kept extremely low (Paikowsky, 2017, p. 86).

Today, it is not unusual that several operations in space are carried out solely by private contractors. Around “76% of global revenue in the space sector is now generated by commercial activity” (Quintana, 2017, p. 90).

During the last couple of years, the private space sector has seen an enormous economic increase. In 2015 it was worth around $350 billion, and economists estimate that by 2030 this number will have almost doubled (ibid).

At present, the space economy's estimated revenue stands at approximately $386 billion, and projections indicate a substantial increase to up to $1 trillion by the year 2040. Morgan Stanley's 2017 report "Space: Investment Implications of the Final Frontier" already forecasted a $1.1 trillion market by 2040 with an annual growth rate of 5%. These forecasts are further substantiated by data from the Satellite Industry Association (SIA), and the U.S. Chamber of Commerce also presents a similar range of estimations (Pongruber, 2023).

PPPs in the space sector continue to evolve in a direction where private companies are moving from rather support contractors to full partners in the exploration and exploitation of space. This shift is driven by the sophistication and innovation of private space companies, as well as the advantages these partnerships offer to governments (Kalms, Hacker, Mabbott, & Lanfranconi, 2020). These companies, equipped with significant financial resources, have demonstrated the ability to design, manufacture and launch spacecraft at competitive costs without compromising safety or reliability. For governments, these actors offer a number of advantages (Weinzierl & Sarang, 2021). The drive for profit and the competitive environment in which the private actors operate leads them to pursue more efficient, effective and economical ways to achieve their objectives. Therefore, PPPs enable cost reduction. By sharing of the financial burden with private companies, governments can significantly reduce cost of space fair projects (Weinzierl & Sarang, 2021).

Finally, PPPs allow governments to expand their capabilities without increasing their own resources. They leverage private sector expertise and capabilities to increase the volume and scope of their space programs and allow governments to focus on governance, policymaking, and regulation, while the private sector focuses on execution (de Concini & Toth, 2019).

Looking at the challenges, regulatory issues are the most significant concern. Space activities are subject to international and national laws that vary widely from country to country. The legal framework for PPPs in space is still in its early stages and needs to be further developed to ensure clarity and consistency (Weinzierl & Sarang, 2021). Aspects of space security are also among the challenges. PPPs could

potentially increase risks related to space debris, the dual use of space technology or even the weaponization of outer space (Goguichvili, Linenberger, & Gillette, 2021).

Despite the challenges that will be further exposed in the case studies, the prospects of PPPs in the space sector are promising. They can serve as a driver for advancing space exploration by pooling resources and expertise.

Economic development is another significant opportunity. PPPs can promote industrial growth by creating new market opportunities, increase competition and encourage technological innovation (OECD, 2016).

When comparing the two sectors, several parallels can be identified. For both PMCs and private space companies, significant similarities can be observed in their historical evolution and development and their current role in the respective sector. Originally, these companies served primarily as support functions for governments, assisting them in various roles. PMCs were initially involved in logistics, training, and other non-combat tasks. Similarly, private space companies contributed to satellite manufacturing, launch services, or maintenance tasks. As their expertise and capabilities expanded, they started approaching more challenging tasks and assumed strategic and operational responsibilities. In both sectors, the consolidated know-how as well as the associated cost reductions are a key factor in favor of PPPs. Within the legal framework, both PMCs and private space companies have encountered ambiguities in their respective domains. Legal issues related to the activities and responsibilities of PMCs are the subject of international debate and investigation. Similarly, the rapid growth of private space activities has raised a variety of legal issues related to liability, space property rights, and the regulation of space assets.

In summary, the development and current status of both private military and private space companies illustrate their remarkable growth and transformation from mere support functions to integral actors in their sectors. Their increasing importance in complementing traditional government structures is attributed to their cost efficiency, specialized expertise, and adaptability. However, they simultaneously face regulatory challenges that require a comprehensive legal framework to ensure responsible and sustainable operations in the future.

Case Study – Private Space Actors *SpaceX* and *Blue Origin*

Background and Profile of *SpaceX*

Space Exploration Technologies Corp. (*SpaceX*) was founded in March 2002 by Elon Musk, who has a vision to make space travel more affordable and ultimately enable humanity to evolve into a multi-planetary species (SpaceX, 2023). In its two-decade history, *SpaceX* has achieved several groundbreaking milestones and accomplishments that have revolutionized the private space industry. Musk founded *SpaceX* with the goal of lowering the cost of space transportation to eventually enable colonization of Mars (ibid.).

The company began developing the Falcon 1, its first orbital launch vehicle. The Falcon 1 rocket was the first privately funded liquid-fueled rocket to reach orbit. After three failed attempts, the Falcon 1 successfully reached orbit on September 28, 2008, marking an important milestone in the private space industry (ibid.).

In 2010, *SpaceX* introduced the Falcon 9 rocket as a more powerful and versatile launch vehicle. The Falcon 9 was the first rocket that was capable of vertical landing and reuse, dramatically reducing the cost of spaceflight. Its first flight took place on June 4, 2010 (Teitel, 2023).

In the same year, *SpaceX* launched the Dragon spacecraft program. This became the first commercially built and operated spacecraft to be launched and safely landed back on Earth after returning from orbit. In 2012, Dragon became the first privately funded spacecraft to dock at the International Space Station (ISS) (SpaceX, 2023). The Crew Dragon, an upgraded version of the Dragon spacecraft, successfully launched in 2019. Since May 2020, it is the first privately built spacecraft to carry astronauts to the ISS (ibid.).

In 2018, *SpaceX* launched the Falcon Heavy, the world's most powerful operational rocket. Capable of carrying heavy payloads, the Falcon Heavy is essential for possible deep space missions and large satellite deployments (Clark, 2018).

SpaceX is currently developing and testing the Starship, a fully reusable spacecraft for space exploration and even colonization. Regular orbital flights are expected in the near future (Davenport, 2023).

Besides launch vehicles and crew shuttles, in 2019 *SpaceX* began the deployment of the *Starlink* satellite constellation, which will provide high-speed global Internet access (eoPortal, 2019). By July 2023, more than 4,500 satellites have been

launched, and thousands more are planned to provide global coverage (Howell & Pultarova, 2023). This constellation of satellites is designed to provide high-speed, low-latency Internet access to people around the world, especially in remote and underserved regions (ibid.) *Starlink*'s potential to close the digital gap and connect people in areas with limited or no Internet connectivity can have a profound impact on social, economic and educational development. The *Starlink* concept consists of several Low Earth Orbit satellites operating at an altitude of around 550 kilometers. This relatively low altitude, especially compared to conventional geostationary satellites[6], reduces latency and enables faster Internet connections. The satellites are equipped with advanced phased array antennas that enable them to form multiple streams that can be dynamically controlled to ensure efficient coverage and capacity allocation. Eventually, the network could consist of more than 40,000 satellites and provide comprehensive global coverage (SpaceX, 2023). To manage increasing orbital congestion and minimize the risk of space debris, *SpaceX* has incorporated advanced features such as autonomous collision avoidance systems and end-of-life deorbiting capability into its satellites (ibid.).

Starlink's impact on global connectivity and its potential to support remote operations in industries such as agriculture, telemedicine and disaster relief highlight the transformative potential of this satellite system in promoting global development. *SpaceX* and its *Starlink* service are playing a critical role in the current Ukraine conflict. Despite initial funding debates and controversy, *Starlink* has enabled Internet access for the Ukrainian military and civilians, especially in areas where infrastructure has been destroyed. This has greatly improved wartime communications capabilities and enabled Ukrainians to defend themselves against Russian censorship measures (Hensen, 2023). However, *SpaceX* has restricted the use of *Starlink* for military purposes, such as piloting drones. These events underscore the growing influence and responsibility of private space companies like *SpaceX* on global security policy. In particular, controlling access to the Internet can prove to be a powerful tool in conflict situations (Hensen, 2023).

SpaceX is currently preparing to enter the defense market with its new product called "*Starshield*." The program aims to provide defense and intelligence agencies with customized spacecraft, sensors and secure communications services (Erwin, 2023).

[6] Satellites in Geostationary Orbit operate around 35,700km above Earth. An object in such an orbit has an orbital period equal to Earth's rotational period, one sidereal day, and so to ground observers it appears motionless, in a fixed position at the sky (ESA, 2020).

Starshield is focused on providing government agencies with a secure satellite network, with an initial emphasis on providing processed Earth observation data, enabling secure global communications through inter-satellite laser links, and providing satellite trains for demanding customer payload missions (Arevalo, 2022). The expertise and manufacturing capabilities *SpaceX* has developed through its *Starlink* business qualify the company to serve the demand in the defense market (Erwin, 2023). The company's proven track record in the space industry and commercial space ventures make it an essential player to meet the evolving needs of the defense sector (ibid.).

One of *SpaceX*'s main goals is to develop cutting-edge technologies that will revolutionize space transportation. These include the development and construction of reusable rockets that will significantly reduce the cost of transporting payloads and people into space (SpaceX, 2023). The relentless pursuit of innovation has enabled the company to dominate the commercial space transportation sector by providing cost-effective solutions for satellite deployment, cargo resupply and crewed flights to the International Space Station (ibid.).

Another important goal of *SpaceX* is to expand the human presence in space through manned missions beyond low Earth orbit. These missions include plans for lunar landings that pave the way for future human settlements on the Moon. *SpaceX* also wants to explore the feasibility of long-term space travel and life support systems needed for deep-space missions (Pereira, 2023). *SpaceX*'s ultimate goal is to establish a self-sustaining city on Mars that would represent a new chapter in the history of human civilization. This ambitious goal requires overcoming numerous technological and logistical challenges, such as the development of advanced propulsion systems, the use of on-site resources and habitat construction techniques (SpaceX, 2023).

Several key figures have been instrumental in *SpaceX*'s direction and success, with Elon Musk, the founder, being the driving force behind the company. Gwynne Shotwell, President and Chief Operations Officer, has been instrumental in managing day-to-day operations. Her experience in securing contracts and maintaining customer relationships has contributed significantly to the company's growth and financial stability (Steam, 2020). William H. Gerstenmaier joined *SpaceX* after leaving his position as NASA’s space flight safety manager. He is considered one of the leading experts in the field of human spaceflight safety (AIAA, 2023).

SpaceX has formed numerous partnerships and collaborations with private companies, government agencies and international organizations throughout its history that have been instrumental to the company's growth and success in space. One of the most important partnerships is with NASA. Already in 2006, *SpaceX* secured a contract under NASA's Commercial Orbital Transportation Services (COTS) program to develop and demonstrate cargo transportation capabilities to the International Space Station (ISS) using the Dragon spacecraft (NASA, 2006). This collaboration laid the foundation for *SpaceX*'s participation in NASA's Commercial Resupply Services (CRS) program, under which the company has conducted several missions to supply cargo to the ISS (NASA, 2015).

In addition, *SpaceX* has partnered with NASA's Commercial Crew Program (CCP) to develop and launch crewed spacecraft from U.S. soil (ibid.) Under this partnership, *SpaceX* developed the Crew Dragon spacecraft, which successfully carried astronauts to the ISS in May 2020. This was the first crewed spaceflight launched from the United States since the Space Shuttle was retired in 2011 (Hurley, 2020).

In addition to NASA, *SpaceX* has worked with various government agencies such as the Department of Defense (DoD), the National Oceanic and Atmospheric Administration (NOAA), and the National Reconnaissance Office (NRO) to launch satellites and other payloads (SpaceX, 2023).

Internationally, *SpaceX* has collaborated with organizations such as the European Space Agency (ESA), the Canadian Space Agency (CSA) and the Japan Aerospace Exploration Agency (JAXA) to launch satellites and research payloads (ibid.)

Furthermore, *SpaceX* has collaborated with academic institutions such as the California Institute of Technology on research and development projects related to advanced propulsion and space exploration technologies (Keck Institute for Space Studies, 2022).

These partnerships and collaborations have played a critical role in *SpaceX*'s growth and success in the space industry and have enabled the company to become a global leader in space flight and exploration.

Background and Profile of *Blue Origin*

Founded in September 2000 by Amazon founder Jeff Bezos, *Blue Origin* is a private space and aerospace company focused on developing reusable launch vehicles and technologies for space exploration and commercial activities (eoPortal, 2021). *Blue*

Origin envisions a future in which millions of people live and work in space, leading to a more sustainable and prosperous Earth (Blue Origin, 2023).

In its early years, *Blue Origin* operated in relative secrecy, developing basic technologies and refining its vision for the future of space exploration. It wasn't until 2005 that the company publicly announced its plans to build the New Shepard, a reusable suborbital launch vehicle (Adler, 2021).

The New Shepard is designed for suborbital space tourism and exploration missions. During the development of New Shepard, *Blue Origin* focused on perfecting vertical takeoff and landing (VTVL) technology to enable reusability, which is critical to lowering the cost of access to space. In 2015, the company achieved a significant milestone when New Shepard became the first rocket to fly into space, land vertically and then fly again using the same launch vehicle. This achievement illustrated *Blue Origin*'s commitment to reusability and laid the foundation for future efforts in their space endeavors (Giles, 2015).

In 2016, *Blue Origin* announced the development of the New Glenn rocket, an orbital heavy-lift rocket designed to deliver payloads to LEO, geostationary transfer orbit (GTO) and even beyond. The New Glenn is expected to become a major player in the commercial launch market, competing with other heavy-lift rockets such as *SpaceX*'s Falcon Heavy (Blue Origin, 2023).

Furthermore, the company introduced its plans for the Blue Moon lunar lander in 2019, a project that will support manned and unmanned missions to the surface of the moon (ibid.) This announcement coincided with NASA's renewed interest in lunar exploration and the Artemis program[7], which aims to return humans to the moon (NASA, 2020).

Over the past two decades, *Blue Origin* has evolved from a startup to a major player in the space industry. With a solid foundation in reusable launch vehicle technology and a bold vision for the future of space exploration, the company seems well positioned to contribute to the commercialization and development of space in the years ahead (Weinzierl & Acocella, 2016).

The company envisions a world where millions of people live and work in space to unlock untapped resources, drive technological advancement, and promote

[7] The Artemis program is a manned space program of NASA in cooperation with international partners such as the European, Japanese, and Canadian space agencies. The goal of the program is to land astronauts on the moon for the first time since Apollo 17. After that, manned lunar landings are planned to take place annually (Mann & Harvey, 2022).

economic growth. To achieve this vision, *Blue Origin* is committed to lowering the cost of access to space, which it believes will accelerate the large-scale exploration and commercialization of space (Blue Origin, 2023). At the center of *Blue Origin*'s objectives is the development of reusable launch vehicles that can significantly reduce the cost of access to space by eliminating the need for expendable rockets. The company's philosophy underscores its step-by-step approach to advancing space exploration and commercial activities, beginning with suborbital space tourism and gradually expanding to orbital launches and beyond (Adler, 2021). One of *Blue Origin*'s main targets is to make space tourism accessible and affordable to a wider population. Using the New Shepard suborbital launch vehicle, the company aims to offer short-duration space flights that give passengers the opportunity to experience weightlessness and observe the curvature of the Earth from the edge of space (Blue Origin, 2023).

In addition to space tourism, *Blue Origin* also intends to support various scientific and commercial ventures. With the development of the New Glenn heavy-lift launch vehicle, the company aims to meet the growing demand for satellite launches, space station resupply missions and crewed space exploration (eoPortal, 2021).

Blue Origin is actively working on the Blue Moon lunar lander, which will enable sustained exploration of the Moon, facilitate the use of on-site resources, and provide the foundation for lunar bases and other infrastructure (Blue Origin, 2023).

Blue Origin has developed a range of products, support services and technologies aimed at transforming the space industry through reusability, reliability, and affordability. The company's key offerings can be classified into three main areas: suborbital launch vehicles, orbital launch vehicles, and lunar landers.

The New Shepard suborbital launch vehicle is *Blue Origin*'s first major product. Designed for vertical takeoff and landing (VTVL), New Shepard is a fully reusable rocket and crew capsule system that enables short, exhilarating space flights for passengers and research payloads. By providing reliable, frequent, and cost-effective access to space, New Shepard is expected to enable space tourism and facilitate microgravity research for academic and commercial organization (Blue Origin, 2023).

In addition to launch vehicles, *Blue Origin* is working on the Blue Moon lunar module, a versatile spacecraft designed for manned and unmanned missions to the lunar surface. Blue Moon's modular architecture allows it to carry a variety of payloads, including rovers, science instruments and cargo (ibid.). By providing reliable and

cost-effective lunar transportation, Blue Moon is expected to support NASA's Artemis program, commercial lunar activities and international collaborations in lunar exploration (NASA, 2020).

Several key people within *Blue Origin* have played a critical role in the company's direction and success, most notably its founder, Jeff Bezos. He has provided strategic vision, financial support and a long-term perspective that has guided the company since its founding (Adler, 2021). Bob Smith is *Blue Origin*'s CEO and brings decades of experience in the aerospace and defense sector (University of Texas, 2019). Gary Lai, the chief architect for the New Shepard program, played a critical role in the design and development of the company's first reusable suborbital launch vehicle (Wilensky, 2022). Brent Sherwood's extensive experience in space systems and mission design has helped *Blue Origin* identify opportunities and chart a course for long-term success in the space industry (International Astronautical Federation, 2023).

Blue Origin's growth and success in the space sector has been supported by numerous partnerships and collaborations with private companies, government agencies and international organizations. These strategic alliances have enabled *Blue Origin* to leverage external expertise, share resources, and create synergies that advance the company's mission (Blue Origin, 2023). *Blue Origin* has developed close relationships with NASA through various initiatives and contracts. The company is part of NASA's Commercial Lunar Payload Services (CLPS) program, which aims to deliver science and technology payloads to the lunar surface (NASA, 2019). This partnership not only supports *Blue Origin*'s lunar ambitions with the Blue Moon Lander but is also aligned with the goals of NASA's Artemis program. In addition, *Blue Origin* participates in NASA's Launch Services Program (LSP), which aims to provide reliable and cost-effective launch services for the agency's missions (NASA, 2023).

Internationally, *Blue Origin* is working with organizations such as the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA) to explore collaborative opportunities in space exploration, technology development and commercial space activities (Blue Origin, 2023). In summary, *Blue Origin*'s partnerships and collaborations with private companies, government agencies, and international organizations have played a critical role in the company's growth and success.

Private Space Actor's Activities and the Implications for Space Security

The activities of *SpaceX* and *Blue Origin* have multiple security implications in the area of space policy and space security. However, their ambitious goals, such as the exploration of space for humanity or even the establishment of a multiplanetary species, are accompanied by challenges and risks that must be considered by governmental and international organizations. The implications for space security arise from the topics of national security, security of space infrastructure, technology transfer and proliferation, space traffic and space debris, and the dual-use issue. In the following, the most significant topics will be examined in more detail.

Dual-Use Issue

The concept is particularly relevant to spaceflight because many technologies developed for civilian spaceflight can also be used for military activities. The dual-use aspect is particularly evident in the areas of remote sensing and navigation (Steinberg, 2009). Navigation technology, once used exclusively for military purposes, is now available to the general public through the "Global Positioning System" (GPS) and supports numerous civilian applications such as navigation, financial transactions and telemedicine (Aerospace, 2023).

The dual-use problem is also a significant challenge for private space companies such as *SpaceX* and *Blue Origin*. The companies are, automatically, developing technologies and services that could serve both civil and military applications. An example of the dual-use problem associated with private space companies is the use of satellites for communications and observation purposes. Both *SpaceX* and *Blue Origin* have plans to or already are operating their own satellite constellations to provide global communications services. However, these satellites can also be used for military purposes, such as monitoring conflict zones or supporting military operations (Harrison & Strohmeyer, 2022). The ability to obtain high-resolution images from space can be of great benefit to military forces, but also carries the risk of surveillance or espionage. *Starlink*'s direct involvement in the current conflict in Ukraine, providing internet connection to areas where regular networks are currently not working, further underlines the argument of the dual-use issue of communication satellites (Lerman & Zakrzewski, 2022). Until recently, even the Ukrainian military heavily relied on the *Starlink* connection (Klaus, 2023). Another example concerns the spacecraft being developed by these companies. Both *SpaceX* and *Blue Origin*

are engaged in developing manned spacecraft (Ullevig, 2023). These could be used for both manned space missions or military cargo transport. The ability to transport people and cargo into space is essential for both civilian and military activities. This raises the question of how to control and monitor the use of such spacecraft to ensure that they are not misused for aggressive or dangerous purposes. An additional problem relates to space technologies developed by private space companies. These technologies may also be of interest for military purposes, for example with regard to rocket propulsion (NSTXL, 2023). It is important to ensure that technology transfer and cooperation between private space companies and government or military actors are properly controlled to prevent undesirable use of these technologies (Goessler, 2022). To address the dual-use problem associated with private space companies, close cooperation between the companies, governments, and international organizations is needed. Clear guidelines and regulations must be developed to control the transfer of technology and the use of space capabilities for military purposes.

SpaceX's *Starshield*

The security implications of private space actors are particularly demonstrated by *SpaceX*'s new program, *Starshield*. *SpaceX* is looking to increase its footprint in the defense market and *Starshield* aims to provide customized spacecraft, sensors and secure communications services to defense and intelligence agencies by drawing on the technologies and investments of the *Starlink* network (Erwin, 2023). This step takes place in the context of growing great power competition with China and Russia in the defense and space sectors (CRS, 2023). To stay ahead in this race, the Department of Defense (DoD) intends to increase its reliance on commercial innovation and work closely with the commercial sector (ibid.) The integration of commercial space applications into military operations is seen as promising in the defense sector, offering resilient and cost-effective solutions for various mission profiles (Erwin, 2023). However, the growing involvement of private space companies in security-related activities also poses challenges and potential security risks. At a time when space is increasingly becoming a key area of national security and geopolitical contention, dual-use companies like *SpaceX* must find a middle ground to balance commercial interests and national security priorities (You, 2023). This unique nexus of commercial space companies and national security represents a

transformative development that could have far-reaching implications for the future of space security.

Space Debris and Space Traffic Management

The security implications of private space actors in the context of space debris and space traffic management are of increasing concern as more and more private companies enter the space domain. One of the biggest security concerns is the increase in space debris. With each rocket launch and satellite mission, the number of objects in Earth orbit increases, increasing the risk of collisions and the creation of even more space debris (ESA, 2020). Private companies are often not subject to the same regulatory constraints as government space agencies, reinforcing the need for effective and comprehensive space traffic control. Space Traffic Management (STM) is becoming increasingly important to prevent collisions and potential conflicts in space (McClintock et al., 2023). Close collaboration between private and government stakeholders is needed to develop and implement effective STM strategies.

One of *Blue Origin*'s major activities is the development and deployment of the New Shepard spacecraft, which provides suborbital flights for space tourists. These missions raise issues regarding space debris and space traffic control (Frąckiewicz, 2023). It is critical for *Blue Origin* to ensure that its spacecraft are equipped with best practices for end-of-life management to minimize the likelihood of collisions and the generation of space debris.

Blue Origin also plans to conduct cargo and manned missions to the Moon (Blue Origin, 2023). This adds to the complexity of space traffic management. Lunar orbit will soon host multiple spacecraft and missions from different actors, requiring close coordination and communication to avoid conflicts and collisions. *Blue Origin* and other spacefaring parties should ensure that their spacecraft are equipped with appropriate navigation systems and communication protocols to enable safe and orderly use of near-Earth orbits (Colvin & Wusk, 2023).

SpaceX's activities are an even bigger issue regarding space debris and STM. With frequent rocket launches and the implementation of the *Starlink* satellite network, *SpaceX* severely contributes to the increase in space debris. As of July 2023, there are 4,519 *Starlink* satellites in orbit, of which 4,487 are operational (Pultarova & Howell, 2023). That means, *SpaceX*'s *Starlink* Internet satellites now account for over 50% of all active satellites in Earth orbit (Grossman, 2023). The dense crowding of

Starlink satellites in low Earth orbit poses challenges for space traffic management as they constantly have to maneuver to avoid collisions. According to a report *SpaceX* submitted to the U.S. Federal Communications Commission (FCC), *Starlink* satellites were required to perform more than 25,000 collision avoidance maneuvers between Dec. 1, 2022, and May 31, 2023 to avoid potential collisions with other spacecraft and space debris (Pultarova, www.space.com, 2023). This is a sharp increase in collision avoidance maneuvers and raises concerns about the long-term sustainability of satellite operations as thousands of new satellites are expected to be launched into orbit in the coming years (Pultarova, 2023). Currently, the number of maneuvers is doubling every six months. If this trend continues, *Starlink* satellites could be performing maneuvers nearly a million times in half a year by 2028 to minimize the risk of orbital collisions (ibid.). As one of the companies that conducts the most launches, *SpaceX* has a responsibility to implement best practices for end-of-life management to reduce the amount of space debris and avoid collisions with other satellites. *SpaceX* has already taken steps to reduce the altitude of its *Starlink* satellites to minimize the risk of collisions (Quach, 2022).

In 2021, there were two events that, on the one hand, drew attention to the urgency of developing and establishing effective STM processes and, on the other hand, also carried a (space) geopolitical aspect. China had filed a complaint with the U.N. Office for Outer Space Affairs over allegations that two *SpaceX* satellites flew too close to the Chinese space station, endangering the astronauts on board (Sample, 2022). The two encounters, which occurred in July 2021 and October 2021, forced the Chinese space station to take evasive maneuvers to avoid a collision (ibid.). Chinese state media reported the incidents and speculated whether *SpaceX* may have wanted to test China's capabilities and response awareness in space (Xiaoyi & Lanlan , 2022).

Such instances demonstrate the urgency of several issues at once: effective STM, liability questions in the event of a collision, and geopolitical issues that arise despite the fact that neither *SpaceX* nor it’s *Starlink* program are government initiatives. These events underline the need for better international cooperation to safely regulate traffic in space and minimize the risk of collisions.

Technology Transfer and Proliferation

Potential security issues related to technology transfer and proliferation arise in the context of Space X and *Blue Origin*'s activities in space. The two companies develop and use advanced space technologies. The transfer of technologies and know-how to other countries or non-state actors poses the risk of uncontrolled proliferation of space capabilities and knowledge (DIA, 2022). This could have destabilizing effects and disrupt strategic balances in space. Particular attention should therefore be paid to controlling and monitoring the transfer of technology from *SpaceX* and *Blue Origin* to ensure that the technologies do not reach actors who could use them for aggressive or military purposes (ibid.) In addition, it is important to establish mechanisms to identify and prevent potential risks and threats related to the proliferation of space technologies at an early stage (Goessler, 2022).

The security implications of private actors in space are diverse and complex. Private space companies such as *SpaceX* and *Blue Origin* are developing technologies and services that could have both civil and military applications, leading to questions about the control and transfer of dual-use technologies. Another security risk is the increase in space debris caused by the growing number of satellite launches. *SpaceX*'s *Starlink* program has already led to an increase in space debris, which poses challenges for space traffic management. Coordination among the various players in space is critical to avoid collisions and potential conflicts. Technology transfer and proliferation are other important issues that must be considered in the context of *SpaceX* and *Blue Origin* activities to prevent uncontrolled proliferation of space capabilities and to ensure space security. There is an urgent need for international cooperation and clear guidelines to address space security challenges and ensure sustainable use of space.

The Copenhagen School and Private Space Actors

Having examined the activities of private actors in space and their impact on space security, this section will consider the theoretical approach to analyze the role of private actors in the broader context of space security. In the context of the Copenhagen School, the role of private actors in space is increasingly important, particularly with respect to space security. The theory not only considers classical military issues as relevant to security but emphasizes that security is a social

construct that is not limited to military threats but also affects other aspects of society life and interstate relations (Buzan, Waever, & de Wilde, 1998, p. 8). It emphasizes the importance of perception and social construction of security, arguing that security threats do not exist objectively but are created by human actors and their discourses (ibid. p.24). The theory would emphasize that space security is shaped not only by state actors, but also by private entities and their interactions. Perceptions of space security are influenced by the actions and communications of these actors, and this can have implications for security policy and practice. The concepts of private space actors and space security are relevant under the umbrella of the Copenhagen School as these topics partially cover several different fields that would be considered security-relevant by the theory. As space has gained more and more military relevance in recent years (e.g. Banks, 2019) it would fall under the sub-category of 'classic' military security relevance within the Copenhagen school. However, further aspects must be included in this concept. The use of space can have political security implications due to disagreements between space faring states, disputes over orbits or the interpretation of space related norms. From an economical point of view, the dependence of almost all sectors on satellites, regardless of a specific country, involves significant security implications. Furthermore, future endeavors like extracting resources from space could become of relevance once materialized. Threats to technologies like communication satellites, weather forecasting or especially navigation satellites (international banking) can pose severe societal security risks. Also environmental security can be considered, for Earth and in space. Satellites deliver crucial data for environmental observation and natural disasters, which are essential for humans to respond to climate phenomena and disasters (Frąckiewicz, 2023). In space, congestion and pollution through the sheer number of satellites and especially the amount of debris can threaten the safe orbiting of functioning satellites (O'Callaghan, 2022).

The Copenhagen School emphasizes the importance of securitization processes in which certain issues or actors are presented as security risks. This securitization process refers to the way in which certain issues or actors are brought into the domain of security by presenting them as existential threats that must be dealt with outside of normal (political) processes (Buzan, Waever, & de Wilde, 1998). This process involves the construction of threats through linguistic and rhetorical means to justify policies and to draw the attention of the public and policymakers to specific

issues (ibid.). One example regarding space security is the handling of orbit congestion due to increasing amounts of satellites, especially in LEO. The rapid growth of *SpaceX*'s *Starlink* satellite constellation has led to an alarming increase in collision avoidance maneuvers, raising serious concerns about the sustainability and safety of satellite operations in an increasingly congested orbital environment (Adler, 2021). Besides the statements of NASA and ESA officials, several other private (aero)space actors expressed their disapproval of *SpaceX*'s plans regarding the *Starlink* constellation (Jahn, 2021). They warn of incalculable risks and potential environmental damage. By placing that many satellites in LEO, the likelihood of collisions would increase dramatically, which could compromise general access to space (ibid.). Stated as an existential threat (in terms of the Copenhagen School) to orbit accessibility and usability is the Kessler Syndrome, which states that a chain of collisions between space debris in Earth orbit could cause so much debris that spaceflight and satellite operations could be jeopardized (ESA, 2023). This scenario could progress relentlessly without human intervention, as each collision produces even more debris, causing more collisions (Jahn, 2021). In this example, securitization after the Copenhagen School becomes evident.

On the other hand, private space actors could depict their technologies or activities as critical to security. For example, companies that operate communications satellites could argue that strong and reliable satellite communications are critical to ensuring security and defense. In case of failure of these systems, severe consequences for security and social life could arise (existential threat). Through this securitization, they might seek to gain political support and government contracts.

In the Copenhagen School, reference objects and reference frames are central components that determine what actions are considered appropriate to address security threats (Buzan & Hansen, 2012). If we apply these concepts to private space companies and the perceptions of government space actors or international organizations, the following aspects could be identified: Government space actors might see unrestricted access to space and the sovereignty of themselves in relation to space as reference objects. The activities of private space companies could be seen as potential threats to Government space activities. The reference frame of government space actors includes the norms, laws, policy decisions, and international agreements that guide space activities and interests. Government space actors could assess private space companies according to these frames of reference.

A third pillar of the Copenhagen School that can be assessed in connection to private space actors are the relevant actors that 'speak security' (Buzan, Waever, & de Wilde, 1998). This approach can be applied to study the role and importance of certain actors related to space security. Governments play a critical role in shaping and implementing space security policy. In the case of private space actors, governments in the countries where these companies are located or conduct their activities could play an important role in regulating and controlling their space activities through an act of securitization. Similar to this, international organizations such as the United Nations (UN) are important players in space security policy as well and can securitize the activities of private space actors to ensure that they are in compliance with international norms and agreements. As seen in the example above regarding the deployment of additional *Starlink* Satellites, even other private space actors can be considered security actors. Competition and cooperation among private space companies can have implications for space security dynamics. For example, cooperation on certain space projects could increase security and efficiency, while competition and rivalry could lead to new challenges.

In summary, applying the Copenhagen School securitization process to private space actors demonstrates how security issues are constructed and politically negotiated in this domain. It highlights the importance of linguistic representations of security threats and how these representations can influence policy decisions and actions. Given the growing interest and involvement of private companies in space, a critical analysis of the securitization process is essential to understand the implications for security policy and regulation in the space domain.

Legal Considerations and Challenges

The increasing involvement of private companies in the space sector also raises a variety of legal considerations and challenges. When private space actors conduct their activities, complex issues of responsibility, liability, and regulation emerge that must be considered at both the national and international levels. One of the key legal considerations relates to the issue of liability for damage that might be caused by private space activities (Morozova & Laurenava, 2021). Given the increasing number of actors and man-made objects in space, there is the possibility of collisions or other incidents that could have serious consequences. In addition, there is the question of national regulation and legal framework for private space actors (Linden, 2017).

While government space agencies have been primarily responsible for space activities in the past, private companies bring new legal issues and frameworks. Clear rules and regulations need to be established to ensure that private space companies act responsibly and in accordance with international standards and treaties. Further important aspects are international political implications and the issue of sovereignty in space (Goosensen, 2020). Since private space actors often operate across borders, issues regarding the use of space and resources must be addressed. This requires close cooperation between different countries and international organizations to develop common standards and regulations.

International Legal Implications

In the international legal framework, liability is a critical issue in the area of private space actors, especially regarding companies like *SpaceX* and *Blue Origin*. With increasingly ambitious missions and space activities, the potential for accidents and other incidents grows. A significant example is the 2016 explosion of *SpaceX*'s Falcon 9 rocket on the launch pad, which resulted in the loss of a $200 million communications satellite (Chang, Isaac, & Richtel, 2016). Such incidents raise questions about who is accountable for damage and financial losses during space operations. Additionally, as *SpaceX* and *Blue Origin* plan manned missions to the Moon and Mars, the issue of liability becomes even more complex. Potential accidents or misbehavior during interplanetary travel or on celestial bodies require clear regulations and international agreements to assign liability (Reinert, 2020). While existing treaties such as the Liability Convention govern liability for government space activities, the involvement of private space actors introduces new complexities (Morozova & Laurenava, 2021). Clarifying liability issues will be critical to encourage private investment in the space sector, ensure fair compensation for damage, and promote responsible behavior in space that protects both commercial interests and global space assets.

Besides liability, the issue of sovereignty is of importance in the context of private space actors as some aspects of their activities could raise issues in this regard (Atkins et al., 2022). The planned manned lunar missions by *Blue Origin* and the potential manned Mars mission by *SpaceX* are examples of this. If these companies conduct manned landings on celestial bodies, questions of sovereignty over landing areas could arise. While the 1979 Moon Treaty (which also includes other celestial

bodies) prohibits national appropriation of the Moon, private companies are not explicitly mentioned in the treaty (UNOOSA, 1979). Therefore, landing activities by private space actors on Moon or Mars could raise sovereignty concerns from a legal and political perspective. Resolving sovereignty issues will be critical to avoiding potential conflicts and ensuring that space activities by private companies are consistent with international law and space law principles. This will require close cooperation between private space actors, governments, and international organizations to develop clear guidelines and agreements that respect sovereignty in space while promoting the peaceful use and exploration of space.

The issue of space debris is one of the most important current challenges associated with the activities of private space companies such as *SpaceX* and *Blue Origin*. Both companies have conducted a large number of rocket launches to deliver satellites and spacecraft into space. Existing space debris is a growing hazard, and the increase in commercial space missions could exacerbate this issue (FAS, 2022). The international community is working on policies and agreements to reduce space debris and use space sustainably. Monitoring and managing space debris plays an important role in the safety and sustainability of future space activities, especially given the increasing involvement of private space actors. There is a need for a coordinated international effort to address the problem of space debris and to ensure safety in space.

Space Traffic Management is a critical aspect of space safety that is growing more important as more satellites and spacecraft are launched into space. STM refers to the monitoring, regulation and coordination of satellites and spacecraft in orbit to avoid collisions and ensure safe operations (Eurospace, 2021). An example of the importance of space traffic management occurred in 2021 when *SpaceX* needed to monitor the trajectory of a *OneWeb*[8] satellite during a critical approach to each other (Gohd, 2021). Another example concerns *Blue Origin*'s planned space tourism program, in which private individuals will fly into space as passengers (Polkowska, 2021). STM will play a critical role in ensuring that such commercial space flights are coordinated with ongoing space missions and do not pose a threat to satellites or the ISS. As traffic in space increases, close collaboration between government space

[8] *OneWeb* (formerly appearing as WorldVu) is a communications infrastructure company based in London. Founded in 2012, the company began building the *OneWeb* satellite constellation in 2019, a network of initially 588, and eventually up to 6,372, near-earth mini-satellites for residential Internet access (OneWeb, 2023).

agencies, international organizations, and private space companies will be critical to develop clear policies and regulations to effectively implement STM.

In the international legal framework, private space actors have not been explicitly mentioned so far, as existing international treaties and agreements mainly target states as the main actors in space (Goguichvili, Linenberger, & Gillette, 2021). This leads to a legal gap, as private companies sometimes carry out government tasks completely (ibid.). In order to adequately address the increasing activities and role of private space companies, it is crucial that international treaties and agreements are adapted or expanded. One possible solution is to expand the definition of "actors" in these treaties to include private companies (Isnardi, 2020). This would ensure that these companies are also subject to legal obligations and provisions that are consistent with the principles of space law. In addition, new specific agreements could be developed to specifically address the activities and challenges of private space actors. Such agreements could include provisions for issues such as liability and responsibility, technology transfer, environmental impact, and transparency of activities (US Department of State, 2022).

Adapting and expanding international treaties and agreements to adequately address private space actors is an important step in ensuring the safety, transparency, and sustainability of space activities.

National Legal Implications

Liability is also a significant issue at the national. When it comes to liability issues, the national law and regulations of the countries in which these companies operate apply (Morozova & Laurenava, 2021). Companies must ensure that they comply with applicable liability regulations to cover potential claims for damages from third parties. For example, if debris from rockets or satellites crashes into populated areas and causes damage to property or injury to people, this could lead to liability claim (ibid.). It is therefore important that private space companies carry adequate insurance and ensure that they can cover the cost of claims for damages. In contrast to international jurisdiction, many countries have developed national laws and liability regimes to address this matter (Linden, 2016).

Licensing is another essential aspect of the national legal implications for private space actors. Obtaining the necessary licenses and permits is critical for these companies to conduct their space activities within the jurisdictions of the countries in

which they operate (FAA, 2023). *SpaceX* has obtained licenses from the Federal Aviation Administration for its numerous launches from U.S. soil. The FAA issues launch licenses after rigorous reviews to ensure compliance with safety and environmental regulations (ibid.). Similarly, *Blue Origin* requires FAA approvals for its suborbital space tourism flights.

In addition, when private space companies enter international partnerships or conduct space activities in other countries, they need to obtain licenses from foreign regulatory agencies. For example, *SpaceX*'s *Starlink* project requires collaboration with multiple countries to provide worldwide coverage (Starlink, 2023). As such, the company must comply with the licensing requirements of each country in which it wishes to operate.

The licensing process plays a critical role in ensuring that private space actors comply with national laws and regulations, mitigate potential risks, and protect public safety and environmental interests. It also provides governments with the ability to monitor and control private space activities, which contributes to the responsible and sustainable growth of the space industry (Goessler, 2022).

National security is a key concern with respect to private space. As these companies develop and deploy advanced technologies and rocket systems, their activities can potentially have national security implications like the potential use of space technologies for military purposes (Popp & Stevenson, 2018). Although private space companies primarily conduct civilian missions, their technologies and capabilities could also be used by state actors for military purposes (ibid.). Another issue is the security of space infrastructure and data. As private space actors become increasingly involved in providing communications, navigation, and Earth observation services, it is important to ensure that these systems are protected from disruption, attack, or sabotage to ensure national security (Pellegrino & Stang, 2019).

Technology transfer is another relevant aspect in the context of private space actors. These companies are developing cutting-edge space technologies and systems that could be of great interest to other countries and actors (DIA, 2022). Collaboration with international partners or foreign governments can lead to technology transfers, where know-how and expertise related to space technologies are shared. *SpaceX* has already entered into collaborations with foreign governments and companies to use their rockets and spacecraft for various purposes (Frąckiewicz, 2023). However, these technology transfers may also raise national security concerns, as access to

advanced space technologies could also be of interest to potential adversaries (DIA, 2022). It is therefore important that national authorities and governments implement appropriate security reviews and control measures to ensure that sensitive technologies or information are not compromised.

There are a number of both international and national legal aspects that have so far only been partially tailored to private space actors. The international regulatory frameworks in particular are still very much outdated. National frameworks differ from country to country, however, the US as the "private space market leader," is already quite advanced. Altogether, we are at the beginning of a new era of spaceflight in which private companies are playing an increasingly important role. The legal considerations and challenges that arise are complex and multifaceted. It is critical to carefully analyze these issues and develop appropriate regulations to ensure sustainable and responsible use of space.

Conclusion

Summary of Key Findings

To conclude, the key results and findings of this thesis on the topic of " New Players in Space - Implications of Private Space Actors on Space Security" are summarized. The research focused on the activities and impacts of private space companies, in particular of the two US based companies *SpaceX* and *Blue Origin*. A special focus was put on (space) security aspects, legal implications and the nature of public-private partnerships between public and private space companies. Several topics were analyzed, including liability issues, sovereignty, space debris, national security, the international space legal framework and the development of space companies from classic service to providers to “state-substitutes”. The findings highlight the importance of proper regulation of private space actors and coordination with government state actors and international organizations to address potential risks and challenges in space. To present the key findings, the initial research questions will provide structure for a brief overview of the results:

Comparison and Synthesis of Case Study Findings

The case studies on *SpaceX* and *Blue Origin* reveal interesting findings regarding their activities, impact on space security and their approach to space regulation. Although both companies are active in the private space sector, differences and similarities in their approaches can be identified.

In terms of their activities, both *SpaceX* and *Blue Origin* have made significant progress in the development and deployment of space technologies. *SpaceX* has particularly distinguished itself through its successful rocket launches, rocket reusability and the introduction of the *Starlink* satellite constellation (Howell E. , 2022). *Blue Origin*, on the other hand, has focused on suborbital space tourism flights and the development of reusable spacecraft (Frąckiewicz, 2023). Both companies have a positive impact on space security by developing advanced technologies and making space travel more accessible. However, the increase in space debris due to frequent rocket launches and satellite constellations also poses risks (O'Callaghan, 2022).

In terms of government cooperation, there is a noticeable difference in their progress. *SpaceX* has focused on working with government space agencies such as NASA and has successfully signed commercial space contracts with the government (SpaceX, 2023). This allows *SpaceX* to participate in government missions and gain resources for its own commercial projects. *Blue Origin* is still in its early stages in this regard and has focused more on private funding and research projects.

A key observation from the case study analysis is that both companies have a strong footprint in the space sector and continue to develop innovative technologies that have the potential to improve space security (Starling et al., 2021). The implications of these observations are that the development of space policy and regulation requires a balanced approach that recognises the innovative contributions of private companies, while also taking into account security concerns and the need for international regulation. Close cooperation between private companies, government space agencies and international organisations is crucial to ensure safety and sustainability in space.

Security implications: Private Military Companies and Private Space Companies

Private military companies and private space companies are increasingly involved in activities that could have potential implications for national security and global stability. This comparative analysis aims to examine the different security risks and challenges of these two types of private companies, focusing on factors such as technology transfer, potential military applications, and regulation of their activities. There are some remarkable parallels between the development of private military companies in the past and the current phenomenon of private actors in the space sector. The emergence of private military companies and private space actors are a result of the liberalization and privatization of sectors that were previously solely state-owned. In both cases, governments have recognized the need to leverage the services of specialized private companies to reduce costs, increase efficiencies, and promote technological innovation. Private military companies have evolved from providing support services to governments to conducting core military operations.

However, the deployment of PMCs raises legal, ethical, and political concerns. Issues include violations of international humanitarian law, conflicts of interest due to profit motives, potential violations of the sovereignty other states, and a general lack of legal accountability. Private space actors also have transformed their roles, from service providers for individual aspects of spaceflight to strategic responsibilities and the execution of entire space missions, driven by cost efficiencies, specialized expertise, and a desire for innovation. Similarly, there are legal concerns with private space companies, too. In this case regarding the impact of space debris, the state sovereignty of space faring nations, and a potential monopolization of access to space. While private military companies function primarily as complements or replacements for state military capabilities, private space actors tend to have broader ambitions. They aim not only to support existing government space programs, but also to open new markets and opportunities, such as space tourism, asteroid mining, and even the colonization of other planets.

PMCs are often involved in providing military services, equipment, and expertise to foreign governments or nonstate actors, raising concerns about military technology transfer (e.g. drones, weapons-systems) (Senekal, 2010). In contrast, technology transfer from private space companies focuses primarily on technological aspects in the space domain, such as satellite communications, navigation, and space

capabilities (Cocco, Miranda, & Mendonça, 2023). While technology transfer in the space domain may not pose immediate military threats, it could lead to technological advances in other countries and potentially contribute to space weaponization, which could increase security risks in space (Nagashima, 2020). However, when regarding technology transfer of launch vehicles or propulsion systems, these usually also have a military implication, as they are classic dual-use items (EUR-Lex, 2023).

PMCs role in conflict and their ability to engage in warfare can be seen as conflicting. On the one hand, they could strengthen national security efforts, but on the other hand, they could create accountability and legal challenges for the deploying state (Leander, 2010). Private space actors, on the other hand, may not be directly involved in military operations, but their space assets, such as communications or navigation satellites, have inherent military applications (Borowitz, 2022). For example, the communications infrastructure provided by private space companies could monitor military activities and potentially enable espionage (ibid.). As the presence of private space companies in space grows, their assets could become strategic targets during military conflicts, creating new security challenges.

PMCs often operate within complex and intransparent legal frameworks, raising concerns about accountability, human rights violations, and lack of oversight (Leander, 2010). The involvement of PMCs in military activities requires strict international regulations to prevent potential abuses and ensure compliance with international law. Similarly, private space actors operate within a legal framework that was created for government space actors. This, accompanied by the rapid growth of the commercial space sector raises questions about the adequacy of current space regulation framework (Atkins et al., 2022).

This comparative analysis shows that PMCs and private space actors represent distinct security risks and challenges arising from the different nature of their activities and domains. While PMCs' involvement in military activities raises issues of accountability and human rights violations, private space companies raise potential implications for space security or liability issues. Governments, international organizations, and the private sector must work collaboratively to create transparent, comprehensive, and enforceable regulations to effectively address these security implications.

Interactions between Private Space Actors, Space Security, and Space Law

The complex interactions between private space companies (such as *SpaceX* and *Blue Origin*), space security concerns and the existing legal framework in space raise important questions and have significant implications for the future of space security. The activities of private space companies have increased significantly in recent years and include satellite launches, space tourism, satellite communication and navigation, and the development of space transportation technologies (Frąckiewicz, www.ts2.space, 2023). While these developments offer innovative opportunities, the role of private companies in space security raises concerns. On the one hand, private space companies could help improve space security by developing advanced technologies and offering commercial services that facilitate communication, navigation and observation. Private companies could also work with government space agencies to support scientific research, space exploration and rescue missions (de Concini & Toth, 2019). The rapid increase in space debris due to frequent rocket launches and the implementation of large satellite constellations such as *SpaceX*'s *Starlink* could increase the likelihood of collision in space and endanger other spacecraft (Colvin & Wusk, 2023). The excessive accumulation of space debris could also affect the future use of space for scientific research and commercial purposes. These activities by private companies also raise questions about compliance with international space laws and regulation. The current legal regime was mainly negotiated by states, for states and there are still no specific international rules for the involvement of private actors in outer space (Oduntan, 2016).

The international community faces the challenge of developing appropriate regulations and standards for private space companies to avoid potential conflicts and risks. The complexity of these interactions has implications for the development of space policy and the future of space security. Governments, international organizations and the private sector must collaborate closely to ensure balanced and responsible participation of private companies in space.

Prospects for Future Research

Given the rapid development of space actors and their increasing importance in the security sector, there are also further interesting research opportunities for the future.

An emerging issue from a more classical security or rather geopolitical point of view could be power relations in relation to settlements on other celestial bodies. If

humankind, be it through public space actors, private space companies, or, probably the most likely, a combination of both, will be successful in inhabiting other celestial bodies, most likely Moon and possibly Mars, new security theory related questions will emerge. An interdisciplinary approach could examine the political aspects and how political decisions are made in space. What is the political order and political system? What legal frameworks are referred to? Special attention should be paid to possible security and conflict issues that might accompany the increasing colonization and exploitation of celestial bodies. Another important field of research concerns sustainable development and the responsible use of resources in space. Normative considerations could help formulate international agreements on the sustainable use of resources on celestial bodies and thus prevent potential conflicts. Regarding the political infrastructure of space colonies, studies could analyze the necessary governance structures for such settlements and shed light on the challenges of international cooperation. The role of private companies as actors in the space industry is also of interest. The geopolitical implications of colonizing celestial bodies could also be a promising research prospect. What are the power relations between the most important space-faring nations and how does this influence cooperation or possible conflicts? The legal framework and governance structures for space settlements could also be the subject of research. How can international laws and agreements regulate human activities in space while promoting cooperation?

Another promising area of research would be an in-depth analysis of the development phases of private space companies and how they have keep evolving from originally supporting functions to full-fledged actors in the space sector. Can it be possible for a private entity to conduct space fare complete independently from a state? A propound comparison with the development of PMCs could provide insightful findings in this regard. A focus of the research could be to examine PPPs in the space sector while comparing them to PMCs. Similar to the security industry, collaborations between private companies and government actors have increasingly developed in the space sector. Analysis of these partnerships, how they operate, their impact on space security, and their legal frameworks could provide valuable insights for designing future collaborative models. Especially because PPPs in the space sector are still in their rather early stages, at least compared to PPPs in the ‘classic’ security sector, it is possible to accurately trace the evolution here and draw

precise parallels where appropriate. One aspect of research concerns the economic and technological advantages of private space actors and how they have been strengthening their role in the space sector. Here, it would be important to observe whether this development continues at this intensity or, if applicable, stagnates at some point. Research into business models, and investments could help to better track these developments. Comparison with PMCs could help identify parallels and differences in their respective development trajectories. Another important area of research concerns the 'classic' security aspects associated with private space actors. As mentioned earlier, these companies are increasingly active in strategically important areas, and as seen in *Starlink*'s connection to the Ukraine war, even in current conflicts, which poses potential security implications. Analyzing these risks and identifying security assurance mechanisms could help develop appropriate security policies and regulations for the space sector. In addition, research on international cooperation and conflicts related to private space actors could provide important insights. As these companies operate internationally and collaborate with various states and actors, it is critical to understand how this could affect space policy and security dynamics. Identifying potential cooperation mechanisms and points of conflict could help lay the groundwork for sustainable and secure cooperation in the space sector.

Finally, the legal development regarding private space companies with their possibilities and liberties should offer interesting research opportunities, especially as soon as individual states or possibly even groups of states or international organizations regulate the activities of private space actors more strictly or explicitly include them in the international legal framework in the first place. **8**

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