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Diplomová práce

2020 Bc. et Bc. Marie Němečková

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The concept of security dilemma in the environment of outer space: the case of the Galileo system

Diplomová práce

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Abstract

This diploma thesis applies the well-established concept of security dilemma to the relatively new domain of outer space. It constructs a comprehensive modification of the concept for the outer space – the space security dilemma – and establishes criteria for the assessment of it while also discussing previous approaches. The thesis then applies this concept and established criteria, to the issue of Global Navigation Satellite Systems (GNSS). More specifically, it focuses on the case of the European GNSS called Galileo and assesses the intentions behind its creation. Through this assessment, the thesis focuses on determining whether the European Union became a space security dilemma initiator by the development of the Galileo system. In order to confront the theoretical conclusions with praxis, the thesis then focuses on the case of the United States of America and the confrontation between GPS and Galileo. In its last chapter, the thesis replicates this approach on the cases of the Russian Federation (and its GLONASS) and the People's Republic of China (and its BeiDou/COMPASS).

Abstrakt

Tato diplomová práce se zabývá klasickým konceptem bezpečnostního dilematu a aplikuje jej na prostředí vesmíru. Ve své první části se práce věnuje modifikaci tohoto konceptu a identifikaci kritérií pro vznik bezpečnostního dilematu ve vesmíru. Upravený koncept posléze aplikuje na oblast Globálních družicových polohových systémů (GNSS). Konkrétně se věnuje případu evropského navigačního systému Galileo, jeho pozici ve světě a důvodům k jeho sestavení. Práce se na základě daných kritérií snaží zhodnotit do jaké míry se Evropská Unie skrze vývoj tohoto systému stala iniciátorem bezpečnostního dilematu ve vesmíru, v oblasti satelitních navigací. Za účelem porovnání teoretických závěrů s praxí se pak práce zaměřuje na vývoj vztahů Evropské Unie a Spojených států amerických v oblasti navigačních systémů, tedy Galilea a GPS. Ve své poslední kapitole práce replikuje tento přístup na případech Ruské federace (a jejím systému GLONASS) a Čínské lidové republiky (a jejím systému BeiDou / COMPASS).

Klíčová slova

Bezpečnostní dilema, vesmír, satelitní navigační systémy, Galileo, Evropská Unie

Keywords

Security dilemma, outer space, Global Navigation Satellite Systems, Galileo, European Union

Název práce česky

Koncept bezpečnostního dilematu v aplikaci na prostředí vesmíru: případ navigačního systému Galileo

Poděkování

Na tomto místě bych ráda poděkovala vedoucímu této diplomové práce panu doktorovi Dobošovi za neskonalou trpělivost a podporu. Dále bych ráda poděkovala své mamince za to, že mi svou neutuchající životní podporou a pečlivou výchovou umožnila stát se tím, kým jsem, čímž nepochybně velkým dílem přispěla i k napsání této práce.

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Introduction

The concept of security dilemma is a well established and used concept, and it has been used to address many different situations in international politics. The following thesis uses this concept and applies it to the relatively new domain of outer space. It tries to construct a comprehensive modification of the concept for the outer space and to apply it to the issue of Global Navigation Satellite Systems (GNSS), demonstrating it on the case of the European system called Galileo. Galileo is viewed as innovative in the GNSS area because of its advanced capabilities and civilian nature. In contrast to other existing GNSS, it is presented as strictly for civilian use and under civilian control.

Nevertheless, it is still a space asset, which means it possesses dual-use capabilities, which might trigger a security dilemma in other actors. The following thesis, therefore, tries to assess whether there is a potential for the existence of security dilemma in the outer space (and in the area of GNSS) by applying drivers and characteristics defined not only by the "founding fathers" of the concept (that is Herz, Butterfield, and Jervis) but also by using the understanding of the concept by Shiping Tang. Drawing on their respective approaches, the thesis tries to establish safe criteria for the assessment of a space security dilemma while also discussing previous approaches. After establishing the initial state of play, the thesis tries to apply the concept to see whether Galileo is or was a trigger for a security dilemma, therefore, making the European Union (EU) the initiator of it. Resulting from the analysis, the most crucial aspect in determining whether an actor is a potential security dilemma initiator in space, are benign intentions.

In the original proposal, this thesis intended to verify the presence of benign (or malign) intentions trough analysis of EU's Galileo narrative in official documents and resolutions, as well as through interviews with the European Global Navigation Satellite Systems Agency (GSA) employees. The original research design, therefore, expected in-depth, semi-structured interviews with "Galileo employees" and follow-up discourse analysis. Although I managed to get in touch with various employees of the GSA, I only conducted two out of all the agreed-upon interviews in the anticipated format (semi-structured, face-to-face) before the COVID-19 crisis emerged, resulting in the cancellation of the other meetings and effectively shutting down all of our communication. In the original structure, the interview asked about the feelings and personal beliefs of the employees towards Galileo to try to disguise the original purpose of the questions. Two hour-long interviews with fascinating insight were managed to be conducted. As useful as they were, I do not regard them as sufficient for research purposes, as I only managed to interview employees from the engineering and legal department. I tried to compensate for this unexpected interruption by creating a questionnaire (in Google forms[1]) for the remaining employees, asking some of the questions more straightforwardly, but only one response came back. Thanks to this failure, the following thesis primarily uses official EU, GSA, and ESA (European Space Agency) documents and scholarly insight, while employing the interviews only as a piece of additional interesting information.

The first initial hypothesis of this thesis stated that outer space is very prone to the emergence of a security dilemma, and it is to be proved or disapproved through the analysis and application of the original concept in the first chapter. The second hypothesis deals with the Galileo satellite navigation system and implies that by deploying Galileo, the European Union initiated a space security dilemma in the area of GNSS. First, it has to be established what the intentions behind the deployment of the system were. To answer that, the thesis asks three research questions: Does the European Union see the deployment of Galileo as benign and non-threatening? Does the European Union acknowledge and address Galileo's non-civilian character as well as the civilian one? And does the European Union realize that Galileo could be seen as a threat by other GNSS actors?

After establishing whether there is benign or malign intent behind the deployment of Galileo and therefore whether the European Union is a defensive or offensive actor in the field, the hypothesis is tested on the case of the United States of America (USA) and its GNSS, the Global Positioning Service (GPS). To support the findings from the first case application, two other cases are concerned: the case of the Russian Federation and its Global Navigation Satellite System (GLONASS), and the case of the People's Republic of China and its BeiDou/COMPASS Navigation Satellite System. The reason for choosing these three cases for the application of the concept is simple – these three are the only other GNSS currently available (see chapter 1.1.).

Thus, the following thesis proceeds as follows: First, it introduces the Global Navigation Satellite Systems and the issue of the inherent dual-use nature of space technologies. Second, the thesis presents the concept of the security dilemma, its theory, and different approaches to it. Third, the thesis applies the security dilemma theory on the outer space environment

[1] Available upon request

and constructs a derivative concept of space security dilemma while also discussing other approaches to it. Fourth, The Galileo system and its position are presented and assessed. Fifth, the thesis focuses on the relationship between the USA and the EU concerning GPS and Galileo. Sixth, two other cases, Russia and China, are presented. Finally, the thesis concludes with an assessment of the two hypotheses and suggests future research inquiry.

1. Conceptual Framework

This thesis is generally framed by the security dilemma theory (and its broader spiral model). In the following chapter, it will focus on the explanation of the concept and how we can apply it to the outer space and its environment. However, in order to understand the relevance of this concept for the outer space environment and, for the sake of this thesis, the relevance for possible future conflict in the area of global satellite navigation, it will first discuss the inherent dual-use nature of any given global navigation satellite system, with a specific focus on the European Galileo system.

1.1. GNSS and dual-use nature of space technologies

As already mentioned, the abbreviation GNSS stands for *Global Navigation Satellite Systems*.[2] It is a standard widely used term that refers to a constellation of satellites that provides signals transmitting positioning and timing data to receivers, therefore determining position, velocity (and even altitude or orientation) of said receiver. This receiver (user) can be on Earth or in space. However, most of today's applications focus on on-ground users. Simply put, or as the US government defines GNSS, it is "any satellite constellation that provides positioning, navigation, and timing (PNT) services on a global or regional basis" (National Coordination Office for Space-Based Positioning, Navigation, and Timing, 2020). This term, therefore, includes Galileo (Europe), GPS (United States of America), GLONASS (Russian Federation), and to some extent, BeiDou/COMPASS (People's Republic of China). Other Navigation Satellite Systems exist; however, they are only regional and, therefore, cannot be labeled as GNSS.

As of today (2020), the most widely used operational GNSS is GPS. The second oldest (and used – by the number of manufactured receivers) system is the Russian GLONASS. While much younger, the third globally used GNSS is the European Galileo. Even though Galileo is some 20-30 years newer, it has celebrated 1 billion (public) users last September – this figure is based on the total of smartphones using Galileo sold around the world, but the actual number is believed to be much higher (European GNSS Agency, 2019a). Passing this

[2] These satellite systems are sometimes referred to as Positioning, Navigation and Timing systems (PNT), however for the purpose of this thesis I will be using GNSS.

threshold gave Galileo the recognition as a viable and strong player in the field of GNSS. There are no complete data about the number of users of the Chinese BeiDou/COMPASS navigation system, which is essentially as new as Galileo. However, it is balancing on the edge of being global because its first and second generation has been only functioning in the Asian region, and the third generation, operational worldwide, is supposed to be finished in 2020. Other navigational systems worth mentioning are the Japanese QZSS and the Indian NavIC, both currently working only on a regional basis (RNSS) (European GNSS Agency, 2018a; Madry, 2015).

The quality of GNSS performance is usually assessed through the criteria of accuracy, continuity, integrity, and availability. Therefore, when speaking about GNSS, it is important to mention Satellite Based Augmentation Systems (SBAS), which can significantly enhance most of the attributes mentioned earlier by providing corrections to the received signal. The SBAS are working trough satellites on geosynchronous orbit together with on-ground facilities and help improve integrity and increase the accuracy of GNSS signals. Because SBAS satellites are geosynchronous,[3] the systems are region-based. For example, the USA system is WAAS (Wide Area Augmentation System), the Indian system is GAGAN (GPS and GEO Augmented Navigation), and in Europe, it is EGNOS (European Geostationary Navigation Overlay Service). These systems usually support most available GNSS and help their interoperability; therefore, they are an important part of the user experience (Gleason & Gebre-Egziabher, 2009; European GNSS Agency, 2018a; Madry, 2015).

Even though historically, GNSS were developed for military use in the first place, today, they are present in many aspects of our everyday life. GNSS create a massive commercial market thanks to their world-wide, all-weather, and unlimited-user operation. However, we cannot forget that they are, in most parts, also vital for military operations and national securities. Today, most military vehicles, ships, airplanes, or drones rely on GNSS, and the so-called smart bombs use satellite navigation to reach their target, as well as ballistic missiles. For example, according to Madry (2015), GPS is “an aspect of almost every U. S. military activity” (p. 71), and so is GLONASS for the Russian Federation or will be BeiDou/COMPASS for the People’s Republic of China. On the other hand, GNSS are used for an extensive (and constantly growing) variety of civilian and commercial uses from

[3] Geosynchronous satellites are placed in geosynchronous orbit, which allows them to stay above one area of the world at all times – unlike the other orbits in which satellites move around the earth in cycles defined by the altitude.

precision agriculture, transaction timestamping, civil aviation, and search and rescue services, to synchronizing timing in big-production movie cameras, GNSS-integrated shoes, shopping carts or bras. Overall, GNSS provide applications for a wide range of civilian, military, and commercial users around the globe. However, what is essential, is that GNSS are, as any other space-based assets, inherently a dual-use technology (e.g., Gleason & Gebre-Egziabher, 2009; European GNSS Agency, 2018a; Madry, 2015; Johnson-Freese, 2007).

Dual-use technology is defined as a technology that has both commercial and military utility, and a crushing majority of space technologies, including navigation satellites, inherently possess dual capabilities. In other words, all technology deployed in space, with the exceptions of purely scientific applications (i.e., deep-space probes such as Voyager), has both civilian and military use. That, for example, means that a GNSS satellite, even though it was not explicitly designed as an offensive space asset, can be used as one. Not only GNSS can be (and are) used to guide missiles on Earth, the satellites can even be used simply as an ASAT (anti-satellite weapon). In other applications, an ordinary communications satellite can easily be used to jam other (for example, military) signals. As Johnson-Freese (2007) notes, "the primary difference overall is the intent of use" (p. 33). It is virtually impossible to recognize the true purpose of a satellite, posing an immense challenge to any potential space weapons ban. This troublesome nature of space technologies, therefore, not only helps to create perfect conditions for the rise of a security dilemma (discussed further in chapter 1.2.2.) but also makes even the fundamental issue of defining the term "space weapon" very problematic. That, of course, makes any verification in case of a weapons ban in space exceptionally hard (Lubojemski, 2019; Jaramillo, 2015; Mutschler, 2015).

Last but not least, when talking about these issues, we cannot forget to note, that also the non-state actors (i. e. commercial space agencies such as Space X or Blue Origin), that have been developing complex space technologies, are not immune to the dual-use capability problem (Hays, 2015).

1.2. (Space) Security Dilemma

The security dilemma theory focuses on the drivers of the action-reaction-overreaction cycle that begins international tensions and arms races or even conflicts. In short, the concept observes a phenomenon where certain actors in the international arena make others feel less secure by strengthening their own security or capacity. Security dilemma can change into a spiral process and often leads to tragic outcomes (many authors agree that for example, the world wars were partially caused by security dilemmas). The security dilemma works with concepts such as interpretations and (mis)perceptions (of the motives and intentions of other actors) and has been applied to a variety of issues.

First introduced in the 1950s by John H. Herz and Herbert Butterfield (separately), the security dilemma is one of the classical concepts in the field of security studies and international relations. As already mentioned, it has continuously been used to address major questions of international relations (and applied to a variety of conflicts), such as the effectiveness of deterrence and reassurance, alliance behavior, ethnic conflict[4], civil wars, arms control, and many others (Glaser, 1997), including the outer space. In the first part of this chapter, I will focus on the classical and fundamental approaches to introduce the concept used in this thesis. In the second part, I will discuss its application to the outer space domain as it is quite recent and emerging take on the traditional approach.

1.2.1. The classical concept and the spiral model

The security dilemma, in its traditional understanding, is a relatively simple concept with very complex outcomes. The theory describes general dynamics that, on the one hand, lead to conflicts and wars, and on the other, can help preserve peace and balance. Moreover, according to Tang (2009, p. 588), the security dilemma theory and the broader spiral model "constitute a powerful theory of war and peace via interaction."

Herbert Butterfield, one of the first two scholars who introduced this concept, presented the security dilemma as a situation that can push states to war even though they did not want to in the first place. In Butterfield's understanding, the ultimate source of the dilemma is the fear, as well as uncertainty over the intentions of others (Butterfield, 1951). John Herz (in

[4] For the founding paper of security dilemma in ethnic conflicts see Posen (1993).

fact, first to call the situation a ‘security dilemma’) explains the same phenomenon with the anarchic state of international politics. As Herz (1950) sees it, groups or individuals living in the anarchic state are concerned about their security from “being attacked, subjected, dominated, or annihilated by other groups and individuals” (p. 157) and therefore seek security preventing such attack. They do so by increasing their own power, which in turn makes others more insecure and afraid, forcing them to decide whether to increase their power in return. As Herz (1962, p. 241) puts it in his famous quote: “It is one of the tragic implications of the security dilemma that mutual fear of what initially may never have existed may subsequently bring about exactly that which is feared most.”

All subsequent security dilemma theorists, such as the later mentioned two, more contemporary scholars Ken Booth and Nicolas Wheeler, follow Herz in presuming the anarchy in the international politics as a fundamental condition which makes the permanent insecurity between actors inescapable. While Herz talks about any kind of group or individual, a vast majority of succeeding scholars specify those actors to be states and nations (e.g., Booth & Wheeler, 2008; Tang, 2009; Glaser, 1997; Posen, 1993), possibly following Jervis, one of the most influential and respected scholars regarding the security dilemma. However, for the sake of this thesis, Herz’s terminology is more viable because the European Union, the main actor in the case considered by this thesis, is neither a state nor a nation.

It would be almost heretical to leave out Robert Jervis from a chapter about security dilemma. He is rightfully considered the third founder of the concept after Herz and Butterfield, and his *Cooperation under the Security Dilemma* is a groundwork paper establishing key arguments of the theory. According to most scholars, it was Jervis’s work that made security dilemma a ‘mainstream’ concept and generated a large amount of (impressive) literature (Glaser, 1997; Tang, 2009). Jervis builds his security dilemma theory on the foundation of game theory and its scenarios, more specifically the Stag Hunt and the Prisoner’s Dilemma. He identifies two crucial drivers of the dilemma: the distinguishability of defensive from offensive weapons and the offense-defense balance. In his logic, it is easier to alleviate the dilemma when defensive weapons differ from offensive ones, and the opposing state can, therefore, see that the first state has benign intentions. According to Jervis, this so-called “offense-defense differentiation” helps us determine whether the dilemma is present and how strongly it is present. That is, the dilemma is present if the defensive weapons, policies, or technology have offensive capabilities as well as defensive – because states can never be sure that the other's current benign position will not develop into an aggressive one in the future (Jervis, 1978). And it is usually quite hard to distinguish offensive from defensive weapons. As Jervis (1976) notes, in yet another of his great works *Perception and Misperception in International Politics*, "arms procured to defend can usually be used to attack" and "economic and political preparedness designed to hold what one has is apt to create the potential for taking territory from others" (p. 64).

Jervis's other factor influencing the dilemma is the offense-defense balance. It means that in the situation when "the defense has an advantage over the offense a large increase in one state's security only slightly decreases the security of the others" (Jervis, 1978, p. 187) and therefore the dilemma is not really strong or even not present at all. What is meant by saying, "defense has an advantage" is the situation when it is easier for the state to defend its territory than to destroy the other's army and/or take its territory. In order to determine whether offense or defense has an advantage, Jervis identifies two main determinants: technology and geography. Both technology and geography can give the potential defender or the attacker an advantage. When speaking about states, the geographical advantage means barriers – such as oceans, wide rivers, mountains, or even buffer zones and demilitarized areas. Those barriers ease the security dilemma because both parties have the same chance to attack and because they allow better defense even against bigger armies. As Jervis (1978, p. 195) writes: "If all states were self-sufficient islands, anarchy [the ultimate condition for security dilemma] would be much less of a problem." The other major factor in the offense-defense balance is technology. Technology can help states change their capabilities to defend or to attack. As an example, we can mention the milestones that are the developments of firearms, railroads, or airplanes (Jervis, 1978).

Putting together approaches of all three 'security dilemma fathers,' Shipping Tang creates a more rigorous definition of the dilemma and defines specific criteria to recognize it. In his concise approach, the dilemma is conditional – it only exists between two defensive-realist states (or actors) – that is because when the two actors are intentionally threatening each other, there is no real security dilemma. The security dilemma is driven by security-seeking motives and benign intentions, and it is, therefore, not "an inherent property of anarchy" (Tang, 2009, p. 604). The benign intention is a necessary condition of the security dilemma, and the spiral or arms race are possible outcomes but not the source of the dilemma.

I have already mentioned the spiral several times; however, it is important to define specific terms precisely when speaking about the security dilemma theory. In my opinion, it is vital to distinguish between the dilemma itself, the following spiral (or as some refer to it, the spiral model), and the security paradox. A dilemma, from the linguistic point of view, is the presence of a difficult choice; therefore, it is the decision-making moment after one actor enhances its security. Wheeler and Booth (2008, p. 4) see this as a two-level strategic predicament, "with each level consisting of two related lemmas (or propositions that can be assumed to be valid) which force decision-makers to choose between them." The first level is about understanding the motives, intentions, and capabilities of the first actor and their interpretations, the second level is then about the response to that behavior. Decision-makers, therefore, must decide whether actions of the actor are defensive or threatening (desiring to change the status-quo) and then how to react to them – hence the difficult choice, *the dilemma* (Booth & Wheeler, 2008).

If they choose to react, by, for example, strengthening their power or improving their capabilities, a condition develops, which is called *the security paradox* – actions of one actor to increase its security instead increase mutual tension, resulting in less security (Booth & Wheeler, 2008). The security paradox is also what many scholars call the 'fundamentally tragic nature' of international relations – rational actors striving for peace and stability end up in conflict because of fear and insecurity.

From the paradox, it is indeed close to the spiral. Because states cannot deduce from other's military actions and preparations whether they are aggressive, states can (or tend to) only assume the worst (Jervis, 1976). Consequently, the other side takes countermeasures, which then, even more, reinforce the fears and uncertainties about intentions on both sides. That leads to a "vicious cycle in which each accumulates more power without necessarily making itself more secure" (Tang, 2009, p. 594). Jervis (1976) then coins the *spiral model*, which is the process that eventually drives states from the security dilemma to war. Tang elaborates on Jervis's model by using his key aspect of the security dilemma – the intentions:

> *"In a deep security dilemma, one or both sides may become so frightened (or provoked by the other side, objectively or subjectively) that they may decide that their security now requires them to pursue aggression. At this stage, one or both sides' intentions change from benign to malign: one or both states have metamorphosed from a defensive realist state into an offensive realist state. As soon*

as this change occurs, the security dilemma stops operating, and a spiral takes over: a security dilemma is now transformed into a spiral." (Tang, 2009, p. 618)

The most visible manifestations of this spiral are, of course, arms races. However, we can find many more, such as the competition for colonies at the end of the 19th century: "Even if all states preferred the status quo to a division of the unclaimed areas, each also preferred expansion to running the risk of being excluded" (Jervis, 1976, p. 66).

From these three terms, crucial for understanding the security dilemma theory, we can safely accept that there is no direct link from anarchy to security dilemma and then to war. If certain conditions are met, the security dilemma appears between two benign actors in the anarchic state after one actor increases its power. If the following reaction of the other actor fulfills the dilemma, we can witness the security paradox, which can further escalate to a spiral that most probably ends up with war,[5] however, all phases can be mitigated via transparency and confidence-building measures.

In this thesis, I will use a combined approach for assessing the existence of a security dilemma, specifically of Jervis's drivers and Tang's concise understanding of the concept. As mentioned above, by combining Herz, Butterfield, and Jervis, Tang identifies eight major characteristics of the dilemma:

> 1. *"The ultimate source of the security dilemma is the anarchic nature of international politics.*
>
> 2. *Under anarchy, states cannot be certain about each other's present and future intentions. As a result, states tend to fear each other (or the possibility that the other side may be a predator).*
>
> 3. *The security dilemma is unintentional in origin: a genuine security dilemma can exist only between two defensive realist states (that is, states that merely want security without intending to threaten the other).*
>
> 4. *Because of the uncertainty about each other's intentions and fear, states resort to the accumulation of power or capabilities as a means of defense, and these capabilities inevitably contain some offensive capabilities.*

[5] Or as Tang (2009, p. 595) sums up: „It can be captured as follows: anarchy generates uncertainty; uncertainty leads to fear; fear then leads to power competition; power competition activates a (dormant) security dilemma; and the activated security dilemma leads to war through a spiral."

5. The dynamics of the security dilemma are self-reinforcing and often lead to (unintended and bad) spirals such as the worsening of relationships and arms races.

6. The dynamics of the security dilemma tends to make some measures for increasing security – for example, accumulating unnecessary offensive capabilities – self-defeating: more power but less security.

7. The vicious cycle derived from the security dilemma can lead to tragic results, such as unnecessary or avoidable wars.

8. The severity of the security dilemma can be regulated by both material factors and psychological factors."

(Tang, 2009, p. 594-5)

These eight aspects define the security dilemma. However, only three of them are essential for it to exist: "anarchy (which leads to uncertainty, fear, and the need for self-help for survival or security), a lack of malign intentions on both sides, and some accumulation of power (including offensive capabilities)." The other five characteristics may or may not be present and are neither sufficient nor necessary for the existence of the dilemma - they are usually either its consequences or regulators (Tang, 2009, p. 595). For Tang, as well as for Butterfield, intentions are essential, and the difference between security dilemma and open aggression is established by them (they are either benign or malign, respectively). Drawing on that and on Jervis, to assess whether a security dilemma is present, I will first need to safely establish whether the state of anarchy is present in the space domain (1). Then the offense-defense balance will show the possibility for a rise of the dilemma, and if the offense has an advantage (defined by the two drivers – technology and geography), the environment is fertile both for the dilemma but also a conflict (2). To more specify whether a security dilemma is possible, there needs to be an inexistent offense-defense differentiation (offensive and defensive weapons not distinguishable from each other) (3). The security dilemma has to be triggered by an initiator (state or another actor) by accumulating some power (4), and most importantly, the actors considered (especially the initiator) must have benign intentions – the initiators' primary intention is not an attack when accumulating power (5).

1.2.2. Space security dilemma as a viable concept

For many scholars, the dual-use potential of space technologies is the critical component for the application of the security dilemma concept to the space environment. For example, Lubojemski (2019, p. 131) in his application paraphrases Jervis, noting, that "[t]he ability to differentiate between defensive weapons, that is those which are meant to ensure a state's own security, and offensive weapons, which are supposed to harm or damage the security of another state, is key to stopping the progression of a security dilemma." As I already mentioned, this distinction is blurred when it comes to outer space – whether the purpose of space technologies or systems is offensive or defensive, is difficult or virtually impossible to differentiate. This fact seemingly points towards security dilemma presence in space. However, in my opinion, it is important to take into consideration all the other aspects of the security dilemma (specified at the end of the last chapter) as well.

First of all, let me assess whether outer space has the potential for the development of a security dilemma by applying five previously defined characteristics and drivers, therefore constituting my approach towards the space security dilemma. Also, for simplicity serving the purpose of this thesis, I will focus on the Earth's orbit (where GNSS are stationed) when speaking about the outer space. First, there is the anarchy, which is crucial for the existence of a security dilemma. Outer space or Earth's orbit is, in fact, in an anarchic state. There is no sovereign or governing body. Some might argue, that the international legal regime mitigates this anarchy, but there are only a few signed agreements regarding outer space and none of them, bans weapons in space per se – only the weapons of mass destruction with an emphasis (in the sense of volume of agreements concerning it) on nuclear weapons.[6] In the current space law regime (constituted mainly by the Outer Space Treaty), there is not even a legal definition of a space weapon resulting in all the more anarchic environment. As Peoples (2008, p. 514) mentions, "lack of agreement on a precise definition of space weapons and the problem of potential dual-use civilian technologies in space render the task of negotiating restrictions on the weaponization of space inherently complex." Many scholars talk about outer space as congested, contested, and competitive,[7] and these three

[6] I elaborate more on nuclear weapons in space and the surrounding normative and legal regime in Doboš, B., Pražák, J. & Němečková, M. (2020). Atomic Salvation: A Case for Nuclear Planetary Defense. *Astropolitics*, *18*(1), 73-91 DOI: 10.1080/14777622.2020.1719003.

[7] For a great elaborate on this topic see Harrison, R. G. (2013). Unpacking the Three C's: Congested, Competitive, and Contested Space. *Astropolitics*, *11*(3), 123-131. DOI: 10.1080/14777622.2013.838820. ISSN 1477-7622

Cs, together with the lack of a stronger legal regime, result in states behaving 'out there' pretty much as they please. Therefore, we can safely say, the outer space is in a state of anarchy.

However, the security dilemma is not inherent to anarchy, and other drivers and characteristics need to be present. Hence there is the offense-defense balance and the offense-defense differentiation. As already mentioned at the beginning of this chapter, the lack of any possible offense-defense differentiation in space technologies is important and supports the outer space as a perfect candidate for the development of a security dilemma. Moreover, so does the offense-defense balance in space. The geography aspect shows us that it is equal for everyone because there is no physical barrier between states and the orbit. Therefore anyone who has sufficient technology (e.g., possession or access to a launch site) can easily attack the space assets of the others. In my opinion, this notion tilts the balance in favor of the offense because it is easier to harm an object in orbit from the ground (for example, by launching an ASAT) than to protect it.

Additionally, if we look at the problem from a different perspective, i.e., harming ground objects from space or space objects from space, we can see that again, it is technically easier to attack than to defend (e.g., simply driving the satellite into another one destroys it). As we can see, in outer space, the decisive driver is technology. In the current state of development, technology speaks in favor of the offense – simply put, it is more comfortable, cheaper, and better established to build an ASAT (in fact, China, Russia and the US all possess ASAT capabilities) than to maneuver or otherwise protect a satellite. On the other hand, upgrading satellites with advanced maneuvering skills has a tremendous offensive potential because nothing is more effective in destroying a satellite than crashing it with another one. Likewise, destroying or protecting an on-ground facility (crucial for proper GNSS functioning) faces a similar setting.

Because space is an anarchic domain, fear and mistrust play a significant role. Trough the combination of offense and its advantage, and impossible offense-defense differentiation, the outer space environment finds itself in a dangerous position. Not only it is very prone to develop a security dilemma, but it is also susceptible to conflict. As Johnson-Freese (2007) points out, the current situation in the outer space fulfills Jervis's (and others') criteria of security dilemma to an "alarming degree." Only two features established in the previous chapter are left: the benign intentions and the accumulation of power. We could simply say that because outer space is a relatively new and emerging domain, there will always be some kind of accumulation of power in the upcoming years. However, I believe that both the power accumulation and benign intention should be subject to individual assessment of each presented case because the power accumulation in space does not have much effect if its not a superior power being accumulated. I will, therefore, focus mostly on these two aspects in the analytical chapters in order to decide whether the development of Galileo is a security dilemma trigger.

Second of all, in the past year, two different articles considering the space security dilemma (in the Earth's orbit) have been published, and both Lubojemski and Townsend present an interesting take on the issue. It is important to recognize their respective approaches; however, I do not find them sufficient to safely conclude a security dilemma is present (only to establish the possibility of its development) in a specific case. Because my preferred approach is described in the previous paragraph, I would like to, to some extent, oppose their approaches. Lubojemski focuses on satellites and takes a strong stance towards them as an offensive means of gaining security. His arguments are derived from Jervis's offense-defense balance and offense-defense differentiation, pointing out the geography aspect (as mentioned above) and the inherent dual-use of space assets. According to him, "dual-use nature establishes the correlation between the security dilemma and satellites" (Lubojemski, 2019, p. 134), which is not a problematic proclamation if Lubojemski would not further imply, that in fact, there is not only correlation but also causality. Lubojemski's strong focus on the impossibility of differentiation between offensive and defensive satellites is shared by Townsend only to some extend. He focuses more on the offense-defense balance aspect of the dilemma. He sees space as "vital to the economic well-being of developed nations as well as to the ability to project military power" which strengthens the advantage of offense as well as "heightened dependence of conventional military capabilities on space support and the growing economic importance of space" (Townsend, 2020, p. 65). I agree that space is undoubtedly gaining importance in terms of strengthening one's power, tilting the balance towards offense, which reinforces the prospect of intense military competition or even conflict in orbit. On the other hand, Townsend believes that the more satellites in orbit, the more advantage goes to the defense because it creates more opportunities for cooperation. As nicely as it sounds, it is up to debate whether more satellites would not make the orbit more occupied and, therefore, more contested.[8] More satellites in orbit also inevitably mean more debris, which means higher demand for debris removal technologies. And as Townsend (2020) points out, debris removal technologies pose a security dilemma.[9] His approach is, therefore, somewhat contradicting in this aspect.

Townsend's, Lubojemski's, and my approach all agree that geography is speaking clearly in favor of an equal offense-defense balance because all states have the same conditions. Townsend (2020, p. 73) neatly sums it up: "*in space, unlike on Earth, all states suffer from the same constraints imposed by orbital dynamics, so geography affects all nations equally.*" Technology is, consequently, the main driver (as explained above) with Townsend even labeling it the sole driver of the offense-defense balance. And because technology development is closely associated with the dual-use nature of space assets, the problem of offense-defense distinguishability is, again, a very strong argument of his approach. Unlike Townsend, who warns against spiraling and the action-reaction-overreaction process in space in the upcoming years, Lubojemski treats the spiral and the dilemma interchangeably throughout his paper, while continually reasoning with the dual-use nature of space technologies. While this approach is certainly not wrong, I prefer differentiating those two and focusing on the decision-making moment itself. Also, as I already mentioned, dual-use nature is important, but the other aspects should not be overlooked. That is because impossible offense-defense differentiation does not assure the existence of a security dilemma by itself; it only assures anarchy driven uncertainty and fear. To sum it up, I believe that it is the lack of malign intentions on both sides, which is critical for the identification of a security dilemma in the outer space environment and will also be crucial for my application to the GNSS problem.

[8] Even today, the geosynchronous and the low-Earth orbits are getting dangerously full, resulting in competition for these spaces and subsequent tension.
[9] There are several types of debris removal technologies currently in consideration but they all possibly set ground not only for a dilemma but for an intense spiral.

2. Deployment of the Galileo navigation satellite system as a trigger of a space security dilemma

As established in the previous chapter, outer space is prone to a strong security dilemma thanks to the offense shifted balance, the inherent dual-use character of space technologies, and the anarchic nature of the outer space environment. To answer the question of whether the European Union initiated a space security dilemma in the field of GNSS by deploying the Galileo program, we need to focus on the two deciding aspects (for more, see chapter 1.2.1.) and that is the accumulation of power and benign intentions.

First, I will introduce the Galileo program, its development, capabilities, reasons for its existence, and its advantages (or even superiority) to other GNSS, therefore describing and evaluating the power accumulation aspect.

Second, I will assess the European Union's (or so to speak Galileo's) intentions to see whether they are truly benign. I will do so by analyzing the official narrative supplemented by insight from the completed interviews. Through this analysis, I will be, therefore, answering the three research questions: Does the European Union see the deployment of Galileo as benign and non-threatening? Does the European Union acknowledge and address Galileo's non-civilian character as well as the civilian one? And does the European Union realize that Galileo could be seen as a threat by other GNSS actors?

To put these two aspects together to be decisively sure whether Galileo triggered a space security dilemma, I will put it into the context of the other GNSS actors' position as well as their reaction to Galileo's deployment. Also, if the others reacted in any manner to the deployment of the Galileo system, I would try to assess whether a security paradox was achieved, spiral triggered, or if the security dilemma was successfully mitigated. Assessment of their previous and current relationship should be an answer to the question of whether Galileo increases insecurity in other space actors, and therefore whether the European Union is a security dilemma initiator. The three GNSS and their respective countries will be concerned – USA (GPS), Russia (GLONASS), and China (BeiDou/COMPASS).

2.1. Capabilities and power accumulation

The Galileo global navigation satellite system is a European, civilian, and relatively new alternative to the non-civilian American GPS or Russian GLONASS. The goal of Galileo is an independent high-precision PNT system that gives Europeans (but also the rest of the world) the freedom of not having to rely on GPS or GLONASS, which, thanks to their military nature, could be disabled or degraded basically anytime. However, Galileo is said to be interoperable with both of those systems, as well as with the Chinese BeiDou/COMPASS, and compatible with all other existing and planned satellite navigation system. Galileo is often seen as a symbol of European independence, political strength, and prestige.

To introduce the system: Galileo is a joint initiative of the European Commission and the European Space Agency (ESA), and it is legally owned by the European Union (EU). In the beginning, the system was funded through a sophisticated system of public-private partnerships in which funding was provided by the European Commission and ESA in cooperation with private companies participating in the project (Beidleman, 2006). Since 2010, following the changes in the rules of its government, Galileo had become a fully taxpayer-financed project, financed by the European Commission and ESA. Technically speaking, we can say that ESA takes care of the 'hardware' – that is, the design, technology, and deployment of the satellites and the associated infrastructure – and the European Commission administers the implementations and operational management of the system and covers it legally. It does so through a specialized body, the European GNSS Agency (GSA), which is currently headquartered in Prague, Czech Republic, and which also administers the EGNOS system (see chapter 1.1.). Although Galileo is live and operational, it is not at its full operational capability (FOC) yet. The FOC will be declared once the whole satellite constellation is in orbit and operable, and GSA expects this to be next year (2021). Right now, there are 22 operational, plus two testing and two non-operational satellites in orbit (European GNSS Service Centre, 2020a). The complete constellation will comprise 30 satellites (24 operational) orbiting around Earth every 14 hours and spread evenly in three orbital plains inclined at an angle of 56 degrees to the equator. In each orbital plane, there is accounted for two spare satellites on standby in case any active satellite fails (European GNSS Agency, 2020).

The first test satellite was launched in December 2005, the first two operational Galileo satellites were launched October 2011, and the whole system went live in 2016. However, the idea of European GNSS traces back to 1994, when the European Commission first targeted the issue of satellite navigation, and the European Council passed a resolution encouraging the development of EGNOS and possibly an independent European GNSS (European Council, 1994).

In 1998, the European Commission issued a communication to the European Parliament and the Council, proposing strategy and action plan for European positioning and navigation network. In this communication European Commission highlighted strategic, political, economic, industrial, employment, security, and defense importance and interest of GNSS, and it warned against the military control of the current GNSS (GPS and GLONASS). Interestingly enough, this communication sees addressing the dual-use potential and civil/military applications as a priority and recognizes both its risks and opportunities. Europe's own GNSS was to be an "efficient and cost-effective" system "for civil use and compatible with military needs" (p. 9). In some ways, the document, therefore, called for exploration of military application possibilities, but it also accepted that it is essential to ensure the system "cannot be used in a way that creates security concerns" (p. 7). The aspect of political strength and prestige was also emphasized in the document, seeing the GNSS as being essential for "European credibility in negotiations with other countries" (p. 4) and it acknowledged GNSS as a "strategic challenge impacting on Europe's position in the world" (p. 8). In these and other remarks, the document shows us, that the EU was aware of the insecurities and misperceptions (and possibly a security dilemma) a brand new GNSS could trigger, since the very beginning. On the one hand, the military potential was recognized and encouraged. On the other hand, an approach "as benign as possible for the current and future environment" (p. 9) was emphasized – mitigation of possible security dilemma was, therefore, core to the initial proposal as well (Commission of the European Communities, 1998).

The original idea for European independence in the satellite navigation arena was to, first, put into operation the EGNOS augmentation system (by 1998 already in development), and second, design and launch Europe's own civil-use GNSS, which would become a "successor of existing military systems" (Commission of the European Communities, 1998, p. 5). In many ways, the EU, together with ESA, managed to fulfill this proposal. In 2001 the Galileo project was officially agreed upon by the ESA Council; in 2002, it was authorized by transport ministers of the EU countries; and in 2003, the project officially began (Johnson-Freese, 2007; Wang, 2013). As already mentioned, it took two years before the first testing satellite was launched, six more years for the first two operational satellites to be launched, and then another five years for the system to come alive in a non-FOC mode.

Galileo services have five branches planned (three full services plus two sub-services). Since 2016 until today, three basic ones are operational: The Open Service, the Search And Rescue Service (SAR), and the Public Regulated Service (PRS). The Open Service is what the majority of ordinary citizens use; it is free of charge and can be used by all Galileo-enabled chipsets, e.g., in smartphones or car navigations. The Open Service's Ranging Service is made to be interoperable with GPS ranging services, which gives the user an even better experience and even more precision. Soon, the Open Service will be enhanced by two other services: High Accuracy Service (service achieving positioning accuracy of approximately one centimeter) and Commercial Authentication Service (enabling functions such as controlled access and authentication) (European GNSS Agency, 2019b). The Search And Rescue Service (SAR) is a very important part of the Galileo system. It is labeled as Europe's contribution to COSPAS-SARSAT, which is an international satellite-based search and rescue system. COSPAS-SARSAT is a global non-profit and intergovernmental organization, based on an international treaty signed in 1988. It is mostly based on detecting and locating emergency beacons, activated in distress or life-threatening emergency by a variety of users (from ships and aircraft to backpackers and mountaineers), and linking them to local authorities providing help. Galileo takes on the role of space and ground segment provider (International Cospas-Sarsat Programme, 2020). In one of my interviews, I had the chance to talk to a high-positioned engineer from GSA, who pointed out several times, that Galileo's SAR brings a whole new level of professionalism to the global search and rescue endeavor, therefore saving more lives every year. While this can seem a bit as self-promotion, the truth is that Galileo dramatically decreased the time it takes for help to arrive. Also, it introduced a new feature, the Return Link Service (RLS, operational since January 2020), which enabled the system not only to receive the signal from people in distress but also send a confirmation signal back, indicating that their distress alert has been received and help is on its way (European GNSS Service Centre, 2020b).

As exploitable as the SAR may seem, the third service is the most interesting in terms of this thesis. The Public Regulated Service is restricted to “government-authorised users, for sensitive applications that require a high level of service continuity” (European Parliament, European Council, 2011) and is only available to the EU, its member states, and the European External Action Service. Unauthorized users should not be able to access these signals because a specific receiver is necessary. It is said to be encrypted (governmental grade encryption), and resistant to jamming, meaconing, and spoofing, therefore ensuring resilience and robustness. Assuring these traits is entrusted to the Galileo Security Monitoring Centre (GSMC) (European Commission, 2020). In its decision from October 2011, the EU stressed the importance of ensuring unlimited and uninterrupted signal continuity accessible worldwide even in “the most serious crisis situations” to ensure the security of the EU and its members. The PRS is usually promoted as supporting service, for example, for critical infrastructure, fire brigades, police, coast guards, or border controls. However, more interesting can be the mention of peace-keeping forces and defense. The 2011 decision emphasizes member states’ sovereignty in the decision about which users and uses it authorizes (European Parliament, European Council, 2011). This last aspect, together with the lack of public information (as compared to SAR and Open Service), can potentially raise insecurity in terms of possible military use. When I had the chance to ask GSA representative about this aspect, the answer dismissed these possibilities, and I was roughly informed there could be no military use of the system with no further elaboration on the topic.[10] On the one hand, the confidentiality of information regarding the PRS and its functionality is understandable, on the other hand, it certainly does not help to ease a possible security dilemma – especially when its description echoes GPS’s M-code (more about the M-code in chapter 2.3.1). As Beidleman (2006, p. 22) points out, the PRS “presents a potential military capability in a system strictly trumpeted as […] navigation system specifically for civil purposes.”

Further, regarding the power accumulation aspect, or why Galileo could be seen as a threat, listing of Galileo’s superior capabilities is useful. In most documents as well as the interviews I conducted, the civilian control of Galileo is widely stressed as an argument why Galileo is better than the other GNSS, however, that is not a feature in terms of the power accumulation. First, Galileo has better technology than the already existing GNSS, and that

[10] From an informal conversation with GSA communication officer during a networking session after a public debate organised during Czech Space Week 2019.

is mainly for the simple reason of it being newer than them; also, thanks to the involvement of the commercial sector (and scientific communities) from a variety of different (European) countries, the research and development are inherently prone to better solutions than a one-party military-supervised project. Second, Galileo possesses dual-frequency technology that supposedly offers more precise positioning (down to decimetre or even centimeter-level), especially in problematic environments (such as forests or dense cities with tall buildings), and higher resistance to jamming. Third, thanks to its satellites being in orbits at a greater inclination to the equatorial plane than, for example, the GPS, Galileo should achieve better coverage and higher reliability in high latitudes (e.g., Northern Europe is not very well covered by the GPS). Fourth, when in FOC, it is expected that from most locations, six to eight satellites will always be visible (Galileo is positioned in higher orbits than GPS, GLONASS, or BeiDou), which even further increases the precision of Galileo's PNT. Even though those are only publicly claimed advantages of the system and must be further proven in praxis, just the declaration can cause increased insecurity in the competing GNSS. Additionally, the potential military misuse of some of Galileo's novelty features (such as the RLS) is yet another level of possible threat and uncertainty.

Galileo represents an enormous increase in the European Union's capabilities, position, and power on a global scale. In particular, possession of space assets or even GNSS is by itself generally viewed as an indicator of political power, which can give the actor a voice in international affairs – Johnson-Freese (2007) labels this "a new form of geopolitics." As Beidleman (2006, p. 37) already noted in 2006, "Galileo will play an important role in the future defense of Europe," and it already has been acting as a strong basis for the European Union's security and defense policy. Galileo helps the EU with lowering its security dependence on the United States and other major powers, and it helps establish Europe as a strong player in the international arena. Political autonomy or sovereignty, independence, prestige, and higher status are key words when speaking about the meaning of Galileo for Europe, as well as the increase in its economic competitiveness. Galileo (together with EGNOS) is the EU's most ambitious autonomous space initiative to this date, and we cannot forget that it has military implications (as discussed above). Speaking in terms of the security dilemma characteristics, Galileo means an enormous increase in the European Union's power and a valuable strategic asset. Based on many EU decisions and communications, we can simplify the driving force behind such power accumulation (next to the desired market share) as the need to increase Europe's autonomous capability as an assurance against the possible denial of GPS services from the US[11] – a defense strengthening move indeed. In these terms, the power accumulation criterion can be considered fulfilled.

2.2. Benign or malign intentions?

When reading through official ESA, GSA and EU websites, legal documents, and other materials available to the public, some words are constantly repeated: civil/ian (control, use), public (governance, ownership – of the program), independence (of Europe), and (European) security. When speaking with Galileo employees, the trend is the same. While I was not able to gather many interviews, the ones I managed to conduct were quite thorough, and the emphasis on civilian control, system transparency (leading to the possibility of control by public and therefore lowering down the possible military use), and independence was very strong throughout all of them.[12] When I asked the interviewees whether they thought that Galileo could be perceived as a threat by other GNSS or states, I only got surprised looks and dismissive answer. One of them summarized it: *"Galileo is made by civilians for civilians. There is nothing such a threat. Competition? Maybe…but not a threat.*[13]*"* From my small sample, I got the impression that Galileo employees do not realize that Galileo could present subjectively perceived danger because of its dual-use nature and were often downplaying the dual-use possibilities. The interviewee from the legal department surprised me by not even realizing Galileo possessed dual-use capabilities.

However, from a broader point of view, the official narrative is of interest here. Since the beginning, Europe has been labeling and marketing Galileo as a „public GNSS geared to civilian and commercial user requirements" and has constantly tried to downplay its military capabilities (Beidleman, 2006; European GNSS Agency, 2020). When reading through all publicly available documents, one gets the impression that non-military customers are quite the only focus of the system. It is usually advertised as 'a civil system, operated under public control' and 'a non-military program.' Even the aforementioned 2011 PRS decision which,

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[11] Which is "beyond the EU's control since its primary objective is to support the military operations of a third country" (European Commission, 2010)

[12] This was also the case in the informal conversation with the GSA representative mentioned earlier, and also appeared as an answer in the only filled questionnaire – that is why I did not write "both."

[13] From an interview conducted at the beginning of March 2020 at the GSA, Prague. Complete anonymity was promised to the interviewees, but I have the interview recordings available upon request.

from the point of view of the military-use contains some problematic parts, gives a strong emphasis on the civilian (and therefore benign) nature: *"The European Parliament and the Council have recalled on several occasions that the system established under the Galileo programme is a civilian system under civilian control, that is, it was created in accordance with civilian standards based on civilian requirements and under the control of the Union institutions"* (European Parliament, European Council, 2011).

Throughout legal documents concerning Galileo, the strategic and security aspect is emphasized, as well as the need for European independence from GNSS that are "financed and controlled by the military" (Commission of the European Communities, 2000) or which have "governmental, dual use or military nature" (European Commission, 2007). These often-identified drivers suggest, from the security dilemma point of view, that the EU is a defensive-realist actor and that building Galileo is internally viewed as a defensive step increasing European security. However, in 2007, the European Commission (2007) pointed out that "[w]hilst maintaining the system as a civil system, significant revenues could also come from military users," suggesting that a discussion about offensive or dual-use potential of Galileo took place.

As already mentioned above, even in the early stages of development (in 1998), the European Commission recognized the possible non-civilian character as well and advised to frame the narrative as benign as possible. Recognizing possible future issues with Galileo being seen as a threat or in the case international crisis emerges, The EU also established guidelines in case European security is threatened. In the Council decision from July 2014, the High Representative of the Union for Foreign Affairs and Security Policy was named as the key figure in mitigation of "*serious harm to the essential interests of the Union or of one or more Member States arising from the deployment, operation or use of the European Global Navigation Satellite System, in particular as a result of an international situation requiring action by the Union or in the event of a threat to the operation of the system itself or its services*" (European Council, 2014). The provision of such a decision hints that the European Union takes possible hostility into consideration. However, it does not seem to acknowledge in this or any decision, regulation, or other documents, that the malign actor here might be Galileo (and therefore EU) itself. Moreover, the EU often emphasizes that civilian control of Galileo and its focus on commercial applications guarantee its availability during war or political disagreement (Constantine, 2008; European GNSS Agency, 2020).

If we focus on the most problematic aspect of the system, the PRS (described in the previous chapter), it is again only depicted as a civilian asset in pamphlets and infographics for the public (for example, Pellegrino & Stang, 2016; European GNSS Agency, 2020). On the other hand, in the early stages of development, the information targeted towards governments and policymakers, marketed Galileo's PRS as suitable for monitoring troop movements, facilitating the transport of supplies, establishing perimeters, logistics planning, targeting and munitions guidance, and other military use, usually in the context of Petersberg-type operations (humanitarian, rescue, crisis management, peacemaking, and peacekeeping). Besides, PRS gives the user possibility to be used asymmetrically (Lindström & Gasparini, 2003). This way of informing about the system might bring problems in displaying Galileo as benign. However, since the early 2000s, the narrative tilted towards peaceful and civilian use, labeling the PRS mostly suitable for police, fire brigades, and other public services.

Overall, from how it presents itself, the European Union defines Galileo against other GNSS and their military nature, emphasizing over and over that "Galileo is a non-military programme" (e.g., Commission of the European Communities, 2000) and, as already mentioned many times, a civil system under civilian control.[14] Therefore, even though the reality of action might turn out to be different, from the perspective of the narrative presented by the EU and the GSA (as well as ESA), we can label Galileo as a benign actor (which sees and presents itself as benign). Additionally, Galileo looks even more benign in the light of recent development at the EU level, where the military role of the system will probably soon be taken over by the Govsatcom (governmental satellite communication system).

[14] This phrase is used in nearly every EU document regarding Galileo, even in documents not concerning Galileo directly (e.g. 2472nd Council meeting on Transport, Telecommunications and Energy, Brussels, 5-6 December 2002, record available at https://ec.europa.eu/commission/presscorner/detail/en/PRES_04_345)

2.3. Galileo and the others

The following chapter has two parts. In the first one, the thesis focuses on applying findings from previous chapters on the case of the US-EU relationship in the field of satellite navigation. Looking into the development between the leading GNSS player and Galileo will identify whether there, in fact, was or is a security dilemma triggered by the deployment of the latter and possibly how it is or was handled. First, the system is briefly introduced. Then, focus on the development of the relationship, identifying whether the dilemma was or is present. The second part of this chapter focuses on the other two GNSS actors, China and Russia, trying to replicate the US-EU case in a different situational setting.

Although all the information is written throughout the thesis, a concise table (Table 1.) is presented before the following chapter to understand better the differences between the four concerned systems:

Table 1 – basic technical information[15]

GNSS Constellation	Number satellites[16]	Estimated Accuracy	Altitude	Inclination	Operated by
Galileo	22/24	up to 1 cm	23 222 km	56°	EU+ESA (civilian)
GPS	27/27	up to 30 cm	20 200 km	55°	USA (military)
GLONASS	24/24	up to 2,8 m	19 140 km	64°	Russia (military)
BeiDou	24/27	up to 10 cm	21 150 km	55°	China (military)

2.3.1. GPS

Global Positioning System, or simply GPS, has become a synonym for Global Satellite Navigation, especially for an ordinary user. Using proper terminology, we can even say that (not only) in the English language, GPS has become a proprietary eponym for GNSS.

[15] The table was created by the author of this thesis based on the official public information about the systems (same sources as throughout the thesis).
[16] Number of satellites currently in orbit / Number of operational satellites in FOC – without the spares and the geosynchronous satellites

GPS has become an international utility, which has been paid for by the United States. It is nowadays globally free for use and established itself as somewhat of a world's standard of how a GNSS should operate. Initially, it was developed by the US Department of Defense (DOD) in the 1970s (originally named NAVSTAR GPS), and thus it was created as a strictly military system. It was opened for civilian use in the 1980s based on US President Ronald Reagan's order from 1983. Initially, the civilian access had limited capacity and less quality positioning because the highest quality signal was reserved for military use. This so-called Selective Availability was, therefore, a feature that intentionally degraded signals available for civilian use. In 1996, a joint military and civilian management of the system was established, and in 1997 the US Congress introduced a law requiring the civilian signal to be provided without cost or user fees. The Selective Availability feature was turned off in May 2000, based on President Bill Clinton's policy directive from 1996. Since then, the same precision signal has been reportedly provided to both civilians and the military (Madry, 2015). However, military receivers (or military-authorized users) use the so-called M-code, previously known as P-code (P stands for precision), sometimes called the Precise Positioning Service (PPS), which is an encrypted signal that increases accuracy (Martin & Bastide, 2015).

The GPS operational constellation currently has 31 satellites (including spares), and its third generation (GPS III) is in development. The first satellite of GPS III, Vespucci, was launched into space in 2018. The GPS satellites orbit the earth every 12 hours and are positioned in the medium Earth orbit (MEO) at an altitude of approximately 20 200 km (for contrast, Galileo orbits at an altitude of approximately 23 222 km) (the United States Space Force, 2020). In comparison with Galileo, GPS receivers require an unobstructed view of the sky. Consequently, they can only be used outdoors and, unlike Galileo, often do not perform well in forested areas or places with a high density of tall buildings or high mountains. GPS is owned by the government of the United States, more specifically, the US Department of Defense. From 2001 to 2019, the Air Force, more specifically the Air Force Space Command (AFSPC), was the "executive agent" for the space sector of the military (Johnson-Freese, 2007). On 20 December 2019, Air Force Space Command was transformed and elevated to a new branch of the US Armed Forces and named the US Space Force. Since then, GPS is thus operated by the 2nd Space Operations Squadron at Schriever Air Force Base, Colorado.

The US military dependence on GPS has been growing, and today, it is heavily dependent on it throughout all its branches. The first documented use of GPS in combat goes back to 1990 and 1991 and operations Desert Shield and Desert Storm (the United States Space Force, 2020). According to Johnson-Freese (2007), intelligence sector assets are usually associated with the National Reconnaissance Office, whose very existence was classified until 1992.

In the Pentagon's narrative, space is simply a strategic asset, and so is the GPS. Although GPS is operated as a global public utility with partly civilian management and oversight, the military dependence is very heavy, and the United States government reserves the right to discontinue providing the GPS services to other countries and civilians at any time (for security reasons). That is the reason why countries without its own GNSS are anxious – they are aware that the US military can basically deny services to those it pleases. Many countries, including US allies, purely do not believe that the US would not execute the shutdown of the non-military part of GPS in case of crisis. And that is also the main proclaimed reason for the development of Galileo in a wide variety of official documents, together with the importance of European autonomy in space and independence from the United States in space activities. Europe has had a long experience of depending on the US, not only in terms of the positioning, navigation, and timing data but also through asymmetric cooperative "partnerships" (Johnson-Freese, 2007). Besides, GPS services provided by the US had a history of signals being sometimes interrupted because of "satellite malfunction, the US denial of PNT data provision, and signal degradation deliberately introduced by the US DOD unilaterally" (Wang, 2013, p. 110). Building independent GNSS capacities was, therefore, a reasonable and pragmatic step for Europe. Furthermore, Galileo brought multipolarity into the current system, giving other states the option of not relying on GPS unpredictable satellite navigation technology (Schmunk & Sheets, 2007). As already mentioned, the two GNSS are different in their very core, both in terms of purpose and funding. The creation of GPS was motivated by the need for increased accuracy in weapons and troops navigation, Galileo, on the other hand, was created to provide free, unlimited, and global PNT service. As Beidleman (2006, p. 19) wrote, "GPS places the military user above the civilian for reasons of national security."

Ever since the announcement of the Galileo program in the late 1990s, US scholars, analysts, and army members began publishing warning and concerned papers, and continued even after a treaty was signed between the parties. For example, in 2006, USAF Lieutenant Colonel Scott Beidleman (2006) wrote that "*Europe's pursuit of the Galileo GNSS approaches heresy from an American perspective*" and that "*Europe has broken ranks and is acquiring an independent space capability in a way that seems sure to conflict with American national interests*" (p.1). A year later, USAF Captains Schmunk and Sheets (Schmunk & Sheets, 2007, p. 38) labeled Galileo as "*collaborative European space program that clearly leverages partnership to improve European military space power,*" and in 2008, Lieutenant Colonel Roftiel Constantine expressed concerns about Chinese involvement in the project and identified Galileo as part of the broader US-China security dilemma: "*China's heavy involvement in the Galileo project presents a national security dilemma for the United States, as Galileo technologies shared by the EU nations will enhance China's military modernization and intelligence programs*" (p. 2). Taking into consideration that Chinese involvement played a significant role in the rise of the security dilemma initiated by Galileo is vital. However, the Chinese government dropped out of the Galileo project soon after that, which eased this tension.

The United States opposed Galileo from its beginnings, fearing its impact on security and economic interests. It expressed concern about the possible use of Galileo signals by hostile states or terrorists in military strikes against the US, and concerns about the signal interference caused by Galileo endangering US military operations. Weakening US position within NATO and breaking the US monopoly on commercial satellite navigation applications was also indirectly mentioned as a possible issue. Johnson-Fresse (2007) also sees the US opposition in the traditional transatlantic relationship setting, where the US "has traditionally led, and Europe followed, including on some originally European ideas" (p. 174). European emancipation expressed through pursuing independent space initiatives potentially competitive to the US ones seemed in this context as threatening to the US officials. Also, the United States views space as a strategic asset in general, and any space activities of any other world actor might trigger hostile response even if they are an ally. The reason is that the US takes a zero-sum attitude towards space, a Cold War legacy approach, I would say. Therefore, any capability increase on the side of other space actors is seen as a decrease in the US capabilities. Johnson-Freese (2007) sees this as merely a matter of losing control. In this case, it is therefore clear that the security dilemma was triggered even by the announcement that Galileo will be deployed.

Heated debates and meetings took place over a four-year period from 1999. Before any proper negotiations began, the Pentagon tried to discourage the development of Galileo (Wang, 2013). For example, in 2001, the pressure was expressed through letters written to the defense ministers of the EU countries, asking them to consider “scrapping the project” (Barry, 2001). The intense US opposition against Galileo is a beautiful demonstration of the security paradox. As established in previous chapters, Galileo was not meant to be an aggressive asset; on the contrary, it was meant to strengthen European defensive capabilities and autonomy. However, the US has seen it as a decrease in its own security, and its reaction has put the EU in a situation where Galileo was not even built, but its security situation worsened. Some sources even mention unverified claims that the US was considering shooting down Galileo satellites once they were deployed (e.g., Giegerich, 2007, p. 504; Lagan, 2014, p. 126).

Given the conclusions from the previous chapter, that Galileo is a potential security dilemma initiator, and given the reaction of the US after the development of Galileo has begun, security dilemma was clearly present since the beginning. Galileo, as benign as it tried to be, still threatened not only US superiority but also its security. The frequencies that were initially chosen for Galileo were technically equivalent to those of the US M-code (the military’s classified signal), indirectly threatening the US. That is because in case those frequencies would be implemented, the US would not be able to block the Galileo signals, in case an adversary used it to attack the US without also jamming the GPS M-code signals. Naturally, the US did not want to lose the capability of maintaining its own access while denying it to adversaries. Also, the overall frequency overlay would have the effect of degrading GPS performance and reliability (Lewis, 2004; Giegerich, 2007). The dilemma appeared and, at some points, was on the verge of conflict escalation. However, in this case, negotiations between both parties began and helped the security dilemma mitigation.

During the negotiations, European Union did not want to step down because it regarded the Galileo system as strengthening its own defense and did not want to, as France’s then-President Jacques Chirac said, remain an “American vassal” (Lewis, 2004). The US was therefore facing the dilemma, or to put it in terms, they were dealing with the Booth and Wheeler’s (2008) above mentioned two-level strategic predicament. The US eventually modified its strategy of opposing Galileo’s development, chose to respect Galileo as an independent defensive actor and to negotiate. This change in approach was undoubtedly caused by the fact, that European Union is not inherently an adversary actor, and as Wang (2013) mentions, the changes in the "international and domestic structures such as increasing security needs in the post-September 11 era" (p. 111) certainly played their role as well. In the negotiation, the US proposed a compromise in the conflicting frequencies and offered some concessions in return. The compromise proposed by the US government in 2003 suggested a different, not GPS M-code interfering frequency (BOC[17]) for Galileo's open service signals, and in return, the GPS III would be modified to work on the BOC frequency as well. This modification would ensure Galileo-GPS interoperability on the level of open services, benefiting both systems (and both actors in terms of business opportunities) and making Galileo's BOC a global GNSS standard for civilian applications. Moreover, the US proposed to give Europeans technical assistance in developing Galileo (Lewis, 2004; Giegerich, 2007; Wang, 2013).

Despite the extensive tensions, in 2004 an Agreement on the Promotion, Provision and Use of Galileo and GPS Satellite-Based Navigation Systems and Related Applications was signed. As Ralph Braibanti, Head of U.S. Delegation said: "*We have succeeded in converting issues that could have driven a wedge between the United States and Europe into a situation where satellite navigation now clearly appears to be an area that is going to add to the strength of the transatlantic partnership*." (Lewis, 2004, p. 1)

The Treaty addressed many of the concerns declared by the US. The parties agreed on a radio frequency "compatible with GPS and interoperable with civil GPS services at the user level" (Official Journal of the European Union, 2011) giving the civilian users benefit of multi-constellation service (the data obtained from the two constellations combined are mostly better than what could be achieved by either system alone) and assurance that neither of the two systems would degrade the other. However, the radio frequency compatibility clause clearly states that it does not apply to areas of military operations. Both parties also agreed to address other individual and mutual security concerns and establish four working groups (Official Journal of the European Union, 2011).

Although the agreement was signed in 2004, tensions persist even today. The US was voicing their disagreement with Chinese involvement in the Galileo system until the People's Republic of China ceased cooperation on the system. Furthermore, up until November 2018, using Galileo was essentially banned in the US. Regulations of the Federal

[17] Binary Offset Carrier

Communications Commission (FCC) were in place, which prevented ground receivers from being in contact with foreign satellites. At the end of 2018, The FCC finally responded to a request from the European Commission and permitted consumers and industry in the US to access satellite signals from the Galileo system legally, allowing them to benefit from combined GPS-Galileo reception, 14 years after the agreement (European GNSS Agency, 2018b).

In conclusion, in the case of the United States, a space security dilemma was triggered by the deployment of the Galileo system. The European Union threatened the status quo in which the US was a leading actor in the GNSS sector. Through the deployment of Galileo, the US felt its security was threatened and found itself in a classic example of a security dilemma. Through successful mitigation, the dilemma did not escalate into a conflict, even though the US took a belligerent stance in the first moments. Since the Chinese left the Galileo program, further reconciliation was possible, and the relationship was stabilized. However, the dilemma can resurface again soon because, at the moment, European Union is in a stage of transition from a purely civilian approach towards space into acknowledging and embracing the military dimension (European Commission, 2018).

2.3.2. GLONASS and BeiDou/COMPASS constellations

GLONASS stands for Globalnaya Navigatsionnaya Sputnikovaya Sistema (or Global Navigation Satellite System), and it was the USSR's response to GPS in the context of the later phase of Cold War space race. It was initiated in 1976, with its first satellite launch in 1982, and it was declared operational in 1990. Complete constellation was positioned in space in 1996. As well as GPS, it is a military-based system, today operated by the Ministry of Defense of the Russian Federation, and it is in many aspects similar in its design and operation. The system comprises 24 operational satellites, two spares, and one in a testing phase. The satellites are in three orbits at the altitude of approximately 19 130 km, 120 degrees apart, and inclined at an angle of approximately 64 degrees to the equator (Information and Analysis Center for Positioning, Navigation and Timing, 2020; Madry, 2015). Similarly, to the GPS, its satellites orbit the Earth every 12 hours. GLONASS is usually labeled as the most expensive program of the Russian Federal Space Agency because it consumes more than a third of its budget. GLONASS's accuracy is said to be lower than of the GPS, but it has better coverage in northern latitudes (which is understandable, because it was designed to cover the Soviet Union in the beginning). Unlike GPS, GLONASS does not have the capacity to degrade civilian signals (the Selective Availability) (Constantine, 2008).

With the breakdown of the Soviet Union, GLONASS lost its funding as well its FOC, and in 2000 only six satellites were operational. Since Vladimir Putin became president of the Russian Federation, GLONASS has been receiving more attention and funding and became fully operational again in 2011. The same year, Russia also began to work on the third generation of satellites (similarly to the US). GLONASS was made available for public use (while still maintaining an encrypted military section) as late as 2007. The Russian Federation has a very strict approach towards GLONASS, and since 2018 (by a decision of the Russian Ministry of Transport), all civilian and commercial aircrafts operating over the Russian territory are required to use systems and receivers that use GLONASS. According to Madry (2015), Russia has also "threatened to block imports of cell phones and other electronic devices that do not also include GLONASS systems as well as GPS" (p. 88). Today, the vast majority of produced smartphones, car navigations, and other civilian receivers is equipped with chipsets supporting GPS+GLONASS signal reception. As mentioned in chapter 1.1., Galileo is not yet as common, but a majority of new products features GPS+GLONASS+Galileo capability.

The relationship between Galileo and GLONASS is very complicated to establish. When looking at the official GLONASS website, Galileo is not even mentioned while other GNSS are (including the Chinese BeiDou). GLONASS is, to some extent, interoperable with Galileo because it partially uses the BOC frequency that was agreed upon between the US and the EU. Also, the European SBAS EGNOS has been augmenting GLONASS signals since the time it was designed. In the early talks about the establishment of European GNSS, Russian Federation was one of the considered partners in building an international civil system on the basis of GLONASS. Talks between European representatives and Russian Federation regarding this matter took place in May 1998, and Russia proposed a joint approach encouraging joint ownership and management of the constellation (Commission of the European Communities, 1999). However, the EU chose to pursue its own GNSS, and since then, the cooperation slowly declined. A Joint Declaration from the EU/Russia Summit from 30 October 2000 states that the two states "recognise the importance they attach to pursuing the cooperation initiated between the Russian and European satellite navigation systems (Glonass/Galileo)" (Commission of the European Communities, 2000). However, the communication concerning cooperation slowed down in early 2001 (Commission of the European Communities, 2001), and later any major cooperation is not mentioned in any following EU documents. Johnson-Freese (2007) briefly mentions, that "Russia [was] interested in creating synergies between Galileo and the Russian Glonass navigation system" (p. 192), however, there is not much documentation of the cooperation except the Cooperation Agreement from 2006 designed to ensure interoperability and compatibility between Galileo and GLONASS (implementation of the BOC frequency). In the *Interim Evaluation of Galileo and EGNOS programmes and evaluation of the European GNSS Agency* from 2017, it is simply mentioned, that "little progress has been made in cooperation activities with the Russian system GLONASS" (European Commission, 2017).

The only more significant cooperation, therefore, took place in terms of Roscosmos (Russian space agency) and ESA in the launch of early stages Galileo satellites. The first two satellites were launched in 2005 and 2008 from Russian spaceport Baikonur carried on board of the Russian Soyuz rocket. All other satellites were launched from the Guiana Space Centre (European spaceport to the northwest of Kourou in French Guiana) using the Soyuz rockets until 2016. After the 2014 failure, when two satellites were launched into incorrect orbit, speculations appeared that the failure was a product of sabotage caused by the tensions between the EU and Russia over Ukraine (Gutierrez, 2014). In 2016 the cooperation ceased, and Ariane 5 launchers have been used to launch Galileo since then.

Because of this lack of interaction, together with cooperation on the side of ESA, there is no evidence of security dilemma whatsoever. The reason for the security dilemma not being triggered might also lie in the fact that at the time of Galileo's deployment, Russia was focusing on rebuilding its own capacities. However, this focus on rebuilding GLONASS capacities can be partially explained by the rising capacities of Galileo, because, as Constantine (2008) also mentions, not keeping up with Galileo could mean that GLONASS "risks fading into obsolescence" (p. 16). In conclusion, a security dilemma approach towards the Galileo-GLONASS relationship could not be fully recognized, and the hypothesis, therefore, could not be proven in this context.

A similar case is the Chinese BeiDou/COMPASS navigation. The BeiDou Navigation Satellite System is similar to GPS and GLONASS in its military origin. The system was initially developed only as a military system (the civilian part should have been shared with

Galileo – more about that in the next paragraph). The system is administered by a state agency, the China Satellite Navigation Office, and is vastly used by the Chinese military (People's Liberation Army). Chinese documents considering this system use the name BeiDou (usually translated as the Northern Dipper) or BDS, but in many foreign reports and scholarly articles, the name COMPASS is used instead, because that is the name of the newer constellation (the original BeiDou-1 constellation is not functional anymore). According to the official website and other Chinese documents, China has been planning a navigation satellite system since 1980 (China Satellite Navigation Office, 2019). However, the first satellites were launched in 2000 and in comparison to its US and Russian counterparts, the system did not perform well. The first generation of the system required two-way communication between the user and a central control station which made the whole process more complicated and provided accuracy of only 100 meters (Constantine, 2008; Cliff, Ohlandt & Yang, 2011). The second generation of satellites named COMPASS, which has introduced better accuracy and only one-way communication, has been regionally operational since 2012. The third generation promises global coverage available this very year. The BeiDou full constellation will be slightly bigger than the constellations of the other GNSS. In FOC, it is expected to have 35 satellites. However, out of those 35, only 27 are intended to be stationed in the MEO and therefore covering the whole world. The other eight satellites will be positioned in the geosynchronous orbit, therefore only monitoring China and the Asia-Pacific Region (Cordesman & Kendall, 2016). As of today (May 2020), the constellation consists of 30 satellites, with 24 satellites in MEO (China Satellite Navigation Office, 2020).

Regarding the relationship with Galileo, the People’s Republic of China was a partner of the project for approximately four years. In 2003, China expressed the intention to join the Galileo project and to invest approximately 200 million euros and to take part in the civilian part of Galileo. By then, China had operational RNSS (the BeiDou-1 Constellation), which was planned to become GNSS dedicated solely to military use, counting on Galileo to take care of the civilian publicly available part. In October 2003, the People’s Republic of China and the European Union signed an initial Agreement, which made China a stakeholder in the Galileo project (Commission of the European Communities, 2004; Johnson-Freese, 2007). Since 2004, China and the EU then signed altogether twelve contracts for the delivery of technologies. In January 2008, information about China planning on leaving Galileo due to its dissatisfaction with its role in the project appeared. The 2006 announcement of BeiDou as a new Chinese civilian GNSS, thus a competing system for Galileo, foreshadowed the dissolution of the partnership together with the European Commission decision to nationalize the program and therefore transform Galileo to a publicly funded EU program.

The breakup of the partnership left both sides in a somewhat hostile position toward each other. Moreover, reports appeared that the Chinese BeiDou system was, in some aspects, a copy of Galileo or using technologies acquired during the partnership (e.g., Lague, 2013).[18] Another conflict arose over a BeiDou signal overlap with Galileo's PRS. Some of the BeiDou frequencies were initially overlaying the Galileo PRS band and, to a lesser extent, the GPS M-code. However, in 2012 the *EU-China Cooperation on Space Elements of Consensus* was signed, and in 2016 the parties announced successful coordination of the frequency issues. Nowadays, only the civil frequency is shared, and BeiDou is said to be highly interoperable with corresponding Galileo and GPS signals based on the BOC frequency. A working group has been established as well to maintain dialogue and deal with future disputes (Sitruk & Plattard, 2017; Lu, Li, Yao & Cui, 2019).

Similarly to the case of GLONASS, the presence of a security dilemma cannot be identified to a successful extent. In contrast to the GLONASS case, the creation of BeiDou can be seen as a Chinese reaction to the European deployment of Galileo, and therefore a weak security dilemma can be identified. The following dispute could be consequently assessed as a hostile reaction with the tendency to spiral towards conflict. However, due to the lack of clear and specific information on the topic, the presence of a security dilemma cannot be safely established. We can only claim that the conflict was successfully mitigated pro tem. In this case, the hypothesis is, therefore, only half proven as more detailed research into this particular case would be needed.[19]

[18] This was also discussed during an interview with the GSA employee (engineering department) and indirectly confirmed.
[19] My suggestion would be interviewing both concerned parties, and thorough analysis of Chinese documentation on the topic. However, I do not posses the required language skills nor sufficient funding.

Conclusion

A common understanding of the security dilemma states that it arises when an actor's attempts to increase its own security threaten others. As established throughout the thesis, the European Union fits this definition in the field of GNSS. Galileo was a successful attempt to increase Europe's security and independence, but it threatened the GNSS status-quo. Galileo also fits all the criteria established by the security dilemma concept, especially in its benign intentions. On the theoretical plane, Galileo was supposed to trigger a security dilemma in other states, and it did so in the case of the US. Even though the other two cases did not prove the existence of such a dilemma, they were also not able to disapprove it.

Moreover, one security dilemma is more than enough to cause tragic outcomes, were it not mitigated. As Jervis (2001, p. 36) says: "Although other motives such as greed, glory, and honor come into play, much of international politics is ultimately driven by fear." And because even if at one point, actor and its actions are understood and meant to be benign, one can never "neglect the possibility that the others will become aggressive in the future nor credibly guarantee that they themselves will remain peaceful" (Jervis, 2001, p. 36). Drawing on these claims and the performed analysis, we can state that the Galileo system can, in its nature, trigger a security dilemma, therefore making the European Union a security dilemma initiator. The currently changing approach of the EU towards its space activities (as discussed in chapter 2.3.1.) is also in line with Jervis's claims.

The first initial hypothesis of this thesis stated that outer space is very prone to the emergence of a security dilemma. Hence, in its first part, the thesis tried to assess whether the environment of outer space and the field of GNSS is prone to security dilemma based on drivers and characteristics defined by more or less traditional security dilemma scholars such as John Herz, Herbert Butterfield, Robert Jervis, Ken Booth, Nicolas Wheeler, or Shiping Tang. Based on their combined approaches, criteria for recognition of security dilemma were established: the presence of anarchy, the offense-defense balance, the offense-defense differentiation, and the power accumulation and benign intentions on the side of the initiator.

In the first part, these drivers and characteristics were not only identified but also applied to the environment of outer space. Through the analysis and application of the original concept in the first part, the thesis concluded that the outer space is very prone to the existence of a security dilemma, therefore proving the first hypothesis to be correct. However, it concluded, in order to safely determine whether the dilemma is present, the last two drivers shall always be applied to individual cases.

In the second part, the thesis applied the power accumulation and benign intentions identification to the case of Galileo and tried to establish whether the European Union initiated a security dilemma in the field of GNSS by the deployment of the Galileo system, hence applying the second hypothesis. As a result of the previous analysis, benign intentions were identified as a crucial aspect in determining whether an actor is a potential security dilemma initiator in space. Therefore, the thesis first established the intentions behind the deployment of the Galileo system by answering three research questions:

1) Does the European Union see the deployment of Galileo as benign and non-threatening? Yes, the European Union sees itself as a benign, defensive actor, and Galileo is regarded as a cutting-edge technology made to serve civilian purposes and to free Europe of its dependence on the United States.

2) Does the European Union acknowledge and address Galileo's non-civilian character as well as the civilian one? Yes, the European Union understands the issue of dual-use space technology and addresses it in many of its documents. Also, it takes into consideration that the PRS could be used by the military. However, access to it is strictly limited, and the PRS has been marketed to be used in public services such as the police, fire brigades, or border control.

3) And does the European Union realize that Galileo could be seen as a threat by other GNSS actors? In the first stages of EU GNSS proposals, the EU acknowledged the possibility and warned to behave as benign as possible. However, since the development stage, Galileo has been surrounded by a narrative that does not acknowledge Galileo is anything but maybe a business competition.

By analyzing the narrative surrounding the Galileo program and answering the three research questions, the thesis established that the intent behind Galileo is benign, describing the European Union as a defensive actor. Thus, chapter 2.2. concluded that Galileo fits all the criteria and should thus trigger a security dilemma in outer space. To fully prove the hypothesis that by deploying Galileo, the European Union initiated a space security dilemma in the area of GNSS, the case of the United States and its GPS program was introduced. In this case, the hypothesis was successfully tested, and the application proved that the deployment of Galileo triggered a security dilemma between the United States and the European Union.

To confirm this application and therefore prove right the hypothesis that by deploying Galileo, the European Union was a space security dilemma initiator in the area of GNSS, the thesis then tried to replicate the application. It did so by applying the hypothesis to the cases of the Russian Federation and its Global Navigation Satellite System (GLONASS), and the People's Republic of China and its BeiDou/COMPASS Navigation Satellite System, which are the only other GNSS currently available. In these two cases, the hypothesis could not be fully proved, and three common causal factors were identified.

First, neither of these two systems was at its full operational capability (FOC) by the time Galileo was deployed. GLONASS lost its FOC after the demise of the Soviet Union (USSR) and has been rebuilding its capacities since 2000. The BeiDou/COMPASS constellation did not reach its FOC yet and possibly derived some of its capabilities from Galileo.

Second, both countries were Galileo's partners in different stages of its development but ended up pursuing their own capacities instead. GLONASS was considered as a foundation system in the initial stage of Galileo development, but the European Union decided to begin its own GNSS "from scratch." China was a partner in the Galileo project (mainly between the years 2004-2008) but initially dropped out for being unsatisfied with its role in it and decided to build its own capacities. While, to some extent, the pursuit of its own GNSS in those two countries might be seen as a demonstration of a security dilemma, there is a lack of evidence to support it at the moment.

The lack of evidence brings us to the third and most problematic common factor of those two cases: lack of information and clarity about the relationship. While the dispute between the USA and the EU in the field of GNSS is well documented (and equally importantly, it is documented in the English language) by both parties and by scholars, the other two relationships are a grey area with not much information (in English). The last chapter, therefore, concluded that in order to apply the established concept to individual cases and assess its validity, more information and more in-depth academic inquiry would be needed for each case. Possible future research with better linguistic, temporal, and financial capacities is suggested.

To conclude, this thesis agrees with other scholars that outer space is very prone to the development of a security dilemma, but it does not see it inherent to the environment. The thesis also claims that the deployment of the Galileo system created a security dilemma in the GNSS field between the European Union and the United States. However, in the two contextually different cases of Russia and China, the thesis was not able to approve (nor disapprove) the hypothesis. Although theoretically, Galileo and the European Union fit all the categories, in the two other cases, this could not be currently decided. In the context of practical concept application, this thesis, therefore, only states that (1) a space security dilemma rose between the United States and the European Union after the EU began building its own GNSS, Galileo; (2) the security dilemma has been successfully mitigated via extensive negotiations and legally binding agreements. This successful mitigation complies with a statement presented by Johnson-Freese (2007), that formal, legally binding agreements such as treaties "appear to be the only way to break away from the security dilemma currently defining the space environment" (p. 244).

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List of Abbreviations

AFSPC = Air Force Space Command

ASAT = anti-satellite weapon

DOD = United States Department of Defense

EGNOS = European Geostationary Navigation Overlay Service

ESA = European Space Agency

EU = European Union

FCC = Federal Communications Commission

FOC = full operational capability

GAGAN = GPS and GEO Augmented Navigation

GNSS = Global Navigation Satellite Systems

GPS = Global Positioning System

GSA = European GNSS Agency

MEO = Medium Earth orbit

NATO = North Atlantic Treaty Organization

PNT = positioning, navigation, and timing

PPS = Precise Positioning Service, also called the M-code (feature of GPS)

PRS = Public Regulated Service (feature of the Galileo system)

RLS = Return Link Service

RNSS = Reginal Navigation Satellite Systems

SAR = Search and Rescue service (feature of the Galileo system)

SBAS = Satellite Based Augmentation Systems

USA or US = United States of America

USSR = Union of Soviet Socialist Republics or Soviet Union

WAAS = Wide Area Augmentation system