Ascending from Political Gridlock to Space Sustainability

Institutional Designs for the Dutch Government to Mitigate Debris-Creating Anti-Satellite Tests

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Foreword by Dr Eppo Bruins

As a former Minister for Education, Culture and Science, and a scientist by background, I truly understand how vital space has become in our daily lives. From communications and navigation to climate monitoring, so much of our modern world relies on a dependable infrastructure in orbit.

At the same time, I recognise the importance of security in today's rapidly changing world. Alihan Uzun's thesis draws our attention to a crucial, emerging challenge: space itself is becoming a new arena for both sustainability issues and a potential arms race. Though kilometres above our atmosphere, this domain directly impacts our daily lives and our safety on Earth. I am therefore particularly pleased to introduce this work.

As Minister for Education, Culture and Science, I came to know Alihan as an academic with exemplary rigour and integrity. He demonstrated these qualities to me when he visited my office as the spokesman for his student association. He was among the initiators in his group who sought to make the Ministry of Education, Culture and Science a structural dialogue partner. He has a drive to build bridges and create lasting impact.

Alihan and I share the experience of being the first in our families to attend university, and I have seen how Alihan navigates the academic world with focus and determination. Through this thesis on space governance and security, he demonstrates his pioneering character, audaciously exploring a complex and emerging research area.

This study offers a timely and essential analysis of how we can address the growing threat of space debris caused by anti-satellite (ASAT) weapons. It thoughtfully considers different approaches to international agreements for greater space safety and sustainability, amid the challenging realities of verification and geopolitics. And as always in policy and politics, there are no easy answers.

I believe the Netherlands, known for its innovation and cooperative skills, can take a leading role in making space safer and more sustainable. To achieve this, we need fresh and forward-thinking ideas, and Alihan's research makes a valuable contribution to this goal.

Dr Eppo Bruins

Former Minister for Education, Culture and Science

Executive Summary

The number of objects in Earth's orbits is growing quickly, making the orbital environment more fragile. One of the most damaging single events is a destructive anti-satellite (ASAT) weapon test that creates long-lived debris. These fragments can threaten civil, commercial, and military space services and increase the risk of further collisions. Current international law does not explicitly ban debris-creating ASAT tests, and diplomatic forums remain divided, slowing collective action.

This thesis treats the technical risks, legal gaps, and political barriers as a design challenge. It develops and compares institutional designs that the Netherlands can support to reduce and ultimately stop debris-creating ASAT testing. The research begins with a problem analysis that explains why debris, especially in low Earth orbit (LEO), can remain hazardous for years. It reviews the relevant international legal framework and shows why accountability mechanisms are currently weak. It also maps the gridlock between states that prioritise voluntary norms and states that advocate a new legally binding instrument.

The research applies a systems and institutional design lens. To structure each design clearly, the thesis uses Ostrom's ADICO "grammar of institutions" to specify who the rule applies to, what is required or forbidden, under what conditions, and what follows a breach. Each institutional design is structured around three core elements: agreement scope, verification, and consequences. The designs are assessed against three goals: debris prevention, accountability, and political feasibility. The design space is built from four main sources. First, comparative regimes provide working templates: the Antarctic regime (ATS) for transparency, inspections, and a living forum; the maritime regime (UNCLOS) for precise zonal rules and compulsory settlement mechanisms; and the nuclear arms regime (TPNW) for norm-building, positive obligations, and stigmatisation effects. Second, expert interviews provide practical insights into what is acceptable in current diplomacy and the possible role of The Hague. Third, verification lessons are drawn from the UNIDIR Handbook and NSO's 2025 verification report for techniques to detect fragmentation and sudden orbital changes. Fourth, the author's reasoning ties these pieces into effect-based, technology-neutral rule options. Together, the comparative regimes and the expert interviews are the core inputs that shape the menu of design choices.

Screening these ideas against the requirements gives a clear final design space. Agreement scope options range from a narrow DA-only ban to a broad, outcome-based debris-generation ban. Verification options range from unilateral NTM to multilateral data sharing to an independent technical body that fuses public and commercial data. Consequence options range from transparency-only to public stigmatisation and, at the high end, suspension of benefits and privileges within the regime. From this space, three contrasting institutional scenarios are built and then evaluated.

Firstly, Design 1: A direct-ascent (DA) debris ban in LEO. Verification relies on national technical means (NTM) and space situational awareness (SSA). The main consequence is public attribution and political pressure ("naming and shaming"). This option is the most feasible but provides limited accountability.

Secondly, Design 2: An all-kinetic debris ban across all orbits. Verification is supported by a multilateral data-sharing cell. This option offers a balanced middle path between feasibility and accountability.

Finally, Design 3: A technology-neutral ban on deliberate debris creation across all orbits. Verification is conducted by an independent technical body and may include suspending benefits and privileges. This option is strongest for prevention and accountability, but is the hardest to adopt in the near term. The evaluation shows a clear trade-off between political feasibility and accountability. The recommended approach is to start with Design 1 as a realistic first step.

The Netherlands can support this pathway by reframing the issue as space safety and sustainability, using middle-power diplomacy to build coalitions, including with Global South partners, promoting The Hague as an optional venue for arbitration and peaceful dispute settlement, and strengthening technical credibility through support for SSA/SST expertise and transparent verification practices. Together, these steps can help reduce debris-creating behaviour and contribute to a safer orbital environment.

In sum, this thesis contributes a comparable set of institutional designs, grounded in lessons from other regimes, expert views and verification practice. Starting with a credible DA-only ban can open the door to stronger, technology-neutral protection of the orbital environment in the future. The additional value of this research is turning an abstract and polarised governance debate into a clear set of comparable, actionable design packages. Using a stepwise method and a structured design space makes the reasoning behind each option transparent and easier to use in policy work. It also shows why effects-based, technology-neutral rules can be practical in this domain as they focus on observable outcomes (debris creation) rather than disputed capabilities or intent, which are harder to prove and politically sensitive. Finally, the thesis links design choices to a realistic phased pathway and to concrete Dutch roles, giving the NSO structured input that can be developed into draft language and negotiation strategy.

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List of Definitions

Acronyms	*Definition*
ASAT (Anti-Satellite)	A weapon system designed to disrupt, damage, or destroy satellites in orbit. This research focuses on ASATs that create long-lived space debris.
DA-ASAT (Direct-Ascent Anti-Satellite)	A specific type of ASAT weapon, typically a missile, launched from the ground, sea, or air that travels directly to its target in orbit to destroy it by kinetic impact, without first completing an orbit itself.
NTM (National Technical Means)	A state's own national assets used for monitoring and verification, such as its own reconnaissance satellites, ground-based radars, and telescopes. In this research, NTM is the basis for unilateral verification of an ASAT test.
OEWG (Open-Ended Working Group)	The UN Open-Ended Working Group on Reducing Space Threats. A diplomatic forum analysed in this thesis as the primary example of the political gridlock between states favouring behavioural norms and those demanding a legal treaty.
PPWT (Treaty on the Prevention of the Placement of Weapons in Outer Space)	A draft treaty proposed by Russia and China to ban weapons in orbit. It is analysed in this thesis as the main proposal from the "legal approach" bloc, which is critiqued by Western states for failing to define "space weapons" and for excluding Earth-to-Space threats.
COPUOS (Committee on the Peaceful Uses of Outer Space)	The UN's primary forum for developing international space law and cooperation. It is identified in this research as a more apolitical, expert-driven "space safety forum" where progress on sustainability guidelines, such as the LTS Guidelines, is possible.
ICJ (International Court of Justice)	The principal judicial organ of the UN, based in The Hague. It is discussed in this research as a potential, but currently unused, *optional* mechanism for states to settle space-related disputes by mutual consent.

ITU (International Telecommunication Union)	A specialised UN agency that manages global orbital slots and radio frequencies. It is identified in this research as a potential existing technical body that could be given a new mandate to help verify a future ASAT agreement.
NSO (Netherlands Space Office)	The space agency of the Dutch government. The NSO is the problem owner for this thesis, seeking policy advice on how the Netherlands can promote responsible behaviour in outer space.
OST (Outer Space Treaty)	The 1967 Outer Space Treaty is the foundational legal framework for outer space. It is analysed in this thesis as being outdated, as it does not explicitly ban ASAT testing and lacks effective enforcement mechanisms.
PCA (Permanent Court of Arbitration)	An intergovernmental organisation in The Hague that provides a forum for dispute resolution. It is discussed as a potential, *optional* mechanism for states to settle space-related disputes by mutual consent.

Technical terms	*Definition*
Celestial Body	A celestial body is any natural object located outside of Earth's atmosphere, including stars, planets, moons, asteroids, comets, and galaxies.
Kessler Syndrome	A theoretical scenario described by Donald Kessler in 1978. It warns that if the density of objects in orbit becomes too high, a single collision could trigger a cascading chain reaction of further collisions, creating so much debris that parts of orbit become unusable.
Kinetic (Destruction)	A term used to describe destruction or damage caused by a direct physical impact (a collision). A "kinetic ASAT" is one that destroys its target by striking it, such as a missile intercept or a co-orbital ramming attack.
LEO (Low Earth Orbit)	The orbital region ranging from approximately 160 to 2,000 kilometres above Earth. It is the most congested part of space, hosting most satellites, and is the primary location where ASAT tests have created long-lived debris.
Space Debris	Any non-functional, artificial object in orbit. This includes old satellites, rocket parts, and fragments from collisions or

	explosions. Due to extremely high orbital speeds, even tiny fragments of debris can destroy an active satellite on impact.
SSA (Space Situational Awareness)	The capability to monitor, understand, and predict the behaviour of objects in orbit. It is the *knowledge* derived from tracking data that allows for the detection of manoeuvres, collisions, or debris-creating events
SST (Space Surveillance and Tracking)	The technical *system* of ground-based and space-based sensors (such as radars and telescopes) used to find and track objects in orbit. SST is the *action* that provides the data needed to achieve Space Situational Awareness (SSA).

“To confine our attention to terrestrial matters would be to limit the human spirit.”

— *Stephen Hawking*

Chapter 1: Problem Context

Modern space activity began during the Cold War. At that time, space was closely linked to the rivalry between the United States and the Soviet Union. Major missions were not only scientific. They were also political signals of power and technological strength. The Soviet Union's launch of Sputnik in 1957 pushed the United States to respond, which later led to the Apollo moon landings. In this period, space achievements carried strong ideological meaning (Leib, 1999).

- *The Rise of the Space Economy*

In recent decades, space has changed from a state-led race into a fast-growing economic sector. One key driver is the large reduction in satellite launch costs, which have fallen by about 90% since the 1960s (Daehnick et al., 2020). This has enabled many more countries and companies to access space. The growth is visible in the number of satellites in orbit. In 1967, there were 127 satellites. By 2022, there were almost 7,000 satellites. By the end of May 2025, there were almost 12,000 satellites in orbit (Baker, 2025)

Private companies are now major players. According to McKinsey, the global space economy is expected to reach $1.4 trillion by 2030 (Brukardt, 2022). In 2023, the highest-ever number of satellites were launched, many of them as part of large commercial constellations (ESA Space Environment Report, 2024). This growth brings clear benefits, but it also increases congestion in orbit and raises the risk of collisions. Managing space traffic has therefore become more complex.

1.1 Satellites and National Security

Space is not only commercial and civil. It is now also a key part of modern defence and security. Satellites support communication, surveillance, navigation, and targeting. Armed forces depend on space-based services for secure messaging, real-time awareness, and precision operations (Defence Space Agenda, NLD, 2022). Many of these capabilities rely on satellites in low Earth orbit because they can provide frequent coverage and strong signals.

Recent events show how important this is in practice. During the war in Ukraine, Starlink satellites provided internet and communication services to both civilians and the Ukrainian military (Roulette & Shalal, 2025). This helped coordination when networks on the ground were disrupted.

Because satellites matter so much, many states now see space as a strategic domain. This increases the risk of misunderstandings and escalation, especially when there are no clear, shared rules for military behaviour in orbit. Space has become so crucial for national security that many states now view it as a strategic domain. However, this also introduces risks. Without clear rules, military activities could lead to misunderstandings, escalation, and even conflict.

- *Anti-satellite tests*

Anti-satellite weapons (ASATs) are weapons systems designed to disable, damage, or destroy satellites. They can work by physically hitting a satellite, or by non-physical means such as jamming, cyber operations, or directed energy. In modern security strategies, states develop and use anti-satellite weapons and space-based surveillance technologies (America Unveils Plan to Conquer Space, 2021). The United States and the Soviet Union both developed ASAT systems during the Cold War. The United States primarily focused on direct-ascent missile systems launched from Earth, while the Soviet Union developed co-orbital systems that could approach targets in orbit. Today, countries like China and India also have ASAT capabilities.

ASAT capabilities vary widely. Some systems destroy satellites through direct physical impact, while others aim to disrupt satellites without physical destruction, for example, through directed energy or cyber tools. States invest in these systems for several strategic reasons. Some view them as deterrence tools and signals of technological strength. Others treat them as a way to reduce dependence on vulnerable space infrastructure in a crisis.

However, the most serious concern arises when ASAT use involves physical destruction. In such cases, the consequences are long-lasting and affect all space users. A single destructive event can create thousands of debris fragments that can remain in orbit for decades, posing risks to civilian, commercial, and military satellites alike.

1.2 Fit in Complex Systems Engineering and Management

The space debris challenge cannot be solved by technical measures alone. It also involves law, diplomacy, and institutional choices. The Secure World Foundation's Handbook for New Actors in Space stresses that progress requires cooperation among engineers, scientists, lawyers, and policymakers(Martinez et al., 2024). In line with this, this thesis treats the absence of an ASAT ban as a complex design challenge rather than only a political dispute.

This study uses a systems engineering approach to structure the problem. It analyses the technical risks, the available options for verification, and the legal and political ways to connect rules to consequences. It then explores a design space to develop "institutional designs", meaning governance arrangements that can shape behaviour and reduce harmful outcomes.

This approach follows the idea that non-technical barriers also need active work. The report of the Secure World Foundation argues that once technical work starts, policymakers and lawyers should also address the non-technical challenges. This thesis, therefore, combines technical and institutional analysis and considers process management by developing options the Netherlands can use in international forums.

By designing and assessing technical and institutional solutions to this socio-technical problem, the thesis aligns with CoSEM's interdisciplinary scope. Responsible space behaviour is shaped not only by technology, but also by governance, legal rules, institutional arrangements, and behaviour change.

1.3 The Problem Owner

The Netherlands Space Office (NSO) is the space agency of the government of the Netherlands. It recognises the urgency of the challenges around space sustainability and security. As the problem owner, it seeks to inform and advise the Dutch government on how to define and promote responsible behaviour in outer space.

This research is set against the ongoing discussions in the United Nations Open-ended Working Group on Reducing Space Threats. In this forum, states negotiate what responsible behaviour means and how it should be expressed in norms or other instruments. The Netherlands aims to play a constructive role, promoting norms and advancing discussions.

This thesis supports that aim by clarifying which behaviours should be considered unacceptable, and how intentional debris creation can be addressed in future international rules. Intentionally created long-lived space debris can be produced through actions such as ASAT tests, deliberate satellite destruction, or other destructive acts in orbit. This kind of debris is especially problematic because it is created quickly and deliberately, poses long-lived risks to all space users, and threatens the safety, sustainability, and security of space.

Within this wider set of harmful actions, debris created by ASAT tests in the military domain represents some of the worst-case single events. Preventing such tests would reduce the risk of sudden major debris clouds and support long-term orbital sustainability. For this reason, this thesis focuses on preventing destructive ASAT tests as an urgent step towards more responsible behaviour in space.

Chapter 2: Research Approach and Methodology

In this chapter, I will lay out the foundation for my thesis. I will start by clearly defining the problem. From this problem, I will state my main research objective and the specific research questions that guide my study. Finally, this chapter serves as a roadmap. It explains the methodology I followed to answer my questions and outlines the layout of the rest of the document.

2.1 Problem Definition

As more governments and companies use space, Earth's orbit is becoming more crowded and more complex. This growth increases congestion and collision risk. Anti-satellite weapons are systems designed to disable, damage, or destroy satellites. This thesis focuses on destructive ASAT tests that physically break a satellite and create new debris. These fragments can remain in orbit for many years, increasing the risk of further collisions. This can disrupt services on Earth, such as communications, navigation, weather forecasting, and other space-based applications.

At present, there is no strong international agreement that clearly prevents destructive ASAT testing and links violations to credible consequences. Many states recognise the risks, but political tensions and different national priorities make it challenging to agree on firm rules and shared responsibilities. This makes the issue urgent because a single destructive test can create long-term harm to the shared orbital environment.

This situation is a complex engineering and governance challenge. It combines technical risks, political disagreement, and legal uncertainty. New institutional solutions are therefore needed to reduce the risk of further debris from destructive ASAT tests and to keep space safe and accessible.

The Netherlands is active in international discussions on space security, including United Nations forums and working groups on space governance. The Netherlands Space Office supports national efforts to promote responsible behaviour and the peaceful use of outer space. This research contributes by providing policy advice to support the Dutch position in future international negotiations.

2.2 Research Objective

The objective of this research is to inform the Netherlands Space Office by developing and assessing feasible institutional design options to reduce debris from destructive anti-satellite testing in the current geopolitical climate with existing verification technologies.

2.3 Research questions

Based on this objective, the research is guided by the following questions:

Main Research Question

- How can the Netherlands contribute to an effective institutional design to reduce destructive anti-satellite (ASAT) testing?

Sub-questions

1. What is the current international situation regarding ASAT testing and the absence of a ban?
2. What key elements should a successful institutional design for preventing destructive ASAT testing include?
3. What institutional or policy directions could be developed or supported to strengthen global governance in this area?
4. How could the Netherlands contribute to building international support for such initiatives?

2.4 Semi-structured Expert Interviews

To complement the document and literature analysis, I conducted four semi-structured expert interviews. The aim was to gather diplomatic and legal perspectives on the prevention of destructive ASAT testing and the feasibility of international governance mechanisms. To protect confidentiality, the four experts are referenced anonymously as space policy advisor 1, space policy advisor 2, assistant professor of space law, and policy officer of foreign affairs. The two space policy advisors provided insights into national and international space policy. The assistant professor contributed an academic perspective on space law and international regulation, while the policy officer shared diplomatic insights about the UN Open-Ended Working Group on responsible behaviour in outer space. These interviews helped validate the design assumptions, identify feasible institutional options, and assess the potential role of the Netherlands in supporting international governance efforts.

The interviews followed a semi-structured format, meaning a fixed set of core questions was used, with additional follow-up questions asked when relevant to the discussion. The questions focused on several main themes: the challenges of achieving an international ASAT test ban, the reasons behind geopolitical gridlock, the key criteria for a successful governance design, and the potential role of the Netherlands in advancing space governance. The experts were also asked to reflect on the accuracy of the problem statement and to suggest any missing factors or perspectives. This flexible format allowed me to ask more probing questions and focus on themes the experts knew better.

The interviews were recorded and later summarised, whereby I anonymised the experts. The experts were asked to check the summary before making my research public. The data is handled in accordance with my Data Management Plan, approved by TU Delft.

2.5 Thesis Structure

To provide a clear overview of my research, I have developed the following methodological flowchart. This diagram acts as a visual roadmap for the thesis.

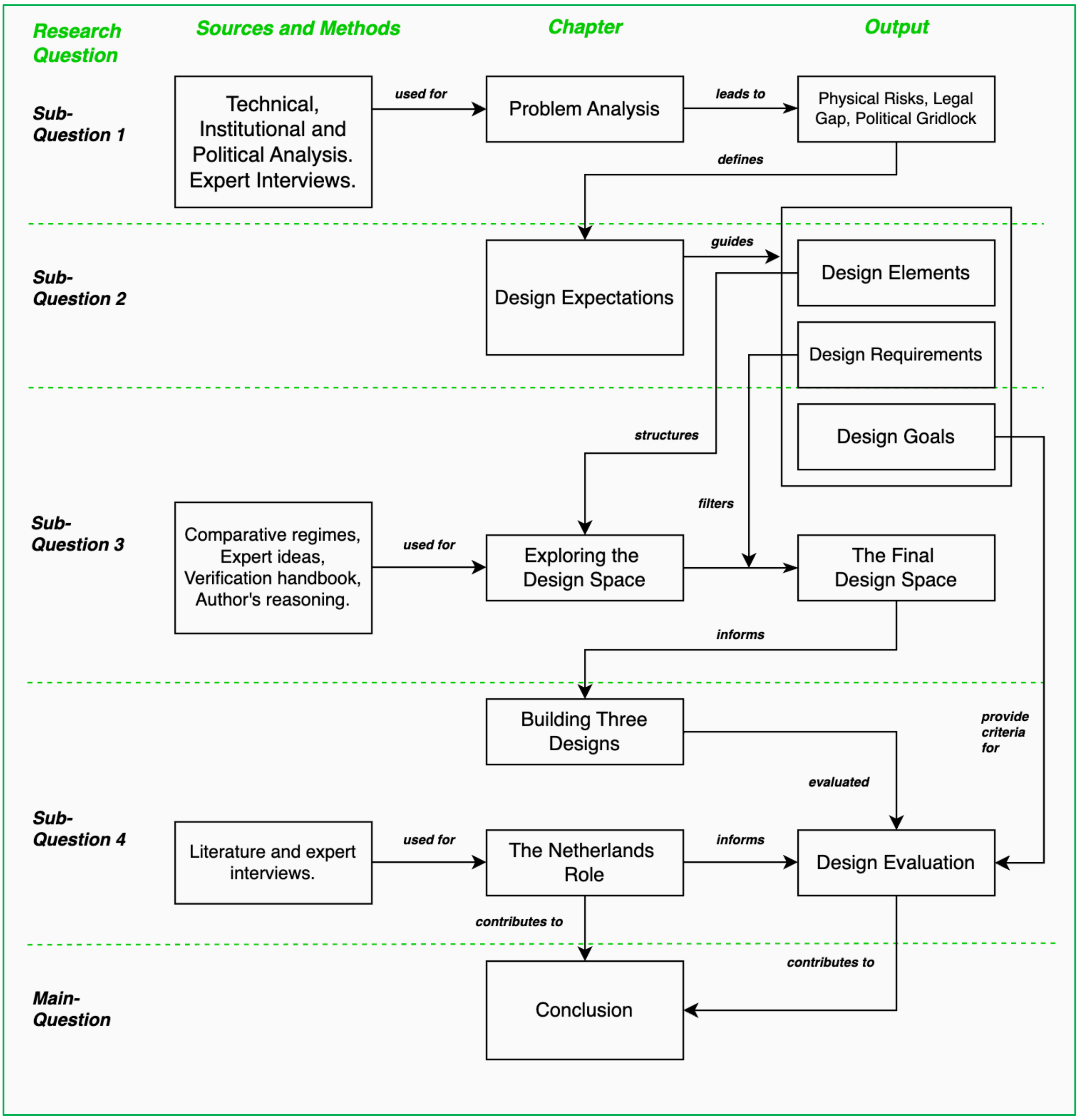

Figure 1: Thesis Structure Diagram

The Problem Analysis (answering RQ1) defines the Design Expectations. The Design Exploration (addressing RQ3) generates a wide menu of options, which are then filtered by the Design Requirements to create the Final Design Space. These options are built into three distinct designs and then evaluated using the "Design Goals." Finally, both the Design Evaluation and the policy recommendations for the Netherlands contribute to the Conclusion, which answers the main research question.

Chapter 3: Problem Analysis

The first question I aimed to answer in the previous chapter concerns the introduction of the problem. Now, I will address the physical aspects of the issue. Next, I will examine the underlying reasons for the problem through an institutional analysis of existing agreements, drawing on current hard law and diplomacy. Finally, in this chapter, I will analyse who plays what role in the problem by conducting a political analysis.

3.1 The Technical Problem

Russia intentionally destroyed one of its satellites (Cosmos 1408) in November 2021, which created thousands of pieces of debris. These fragments directly endangered other satellites, significantly increasing the risk of collisions in already crowded orbital areas. Such deliberate actions not only threaten satellites used for military purposes, such as communication, navigation, and intelligence, but can also lead to conflicts if countries misinterpret each other's intentions, especially when a satellite suddenly stops functioning during a crisis (Defence Space Agenda, NLD, 2022)

Another notable example occurred in January 2007, when China intentionally destroyed an old weather satellite (FY-1C) using an ASAT missile test. This event created a massive cloud of debris, over 3,000 pieces large enough to track, at about 860 kilometres above Earth. Much of this debris will remain in orbit for decades (Weeden, 2011). Similarly, Russia's ASAT test in 2021 created around 1,500 pieces of trackable debris at an altitude of approximately 500 kilometres, in a very busy part of Earth's orbit. Although these tests are meant to demonstrate or test military capabilities, they cause serious, lasting harm to the orbital environment, affecting the safety of space operations for years to come.

- *Space Debris*

ASAT tests, especially those using kinetic ASAT weapons that physically destroy satellites, produce large amounts of space debris. This debris threatens both military and civilian satellites currently in orbit (Wright, 2008). Space debris includes any artificial object left in space that no longer functions, such as broken satellites, old rocket parts, or tiny metal fragments.

Many satellites that were launched into orbit are now inactive. According to the Natural History Museum in the UK, about 2,000 active satellites and 3,000 inactive ones are still orbiting Earth. In addition, there are millions of tiny pieces of junk, some as small as paint flakes, that can still cause severe damage if they hit another object. Around 34,000 pieces of debris larger than 10 centimetres are floating around in space (ESA Space Environment Report, 2024). As of June 2024, the Secure World Foundation reports that 35,000 pieces of space debris are being tracked and estimates that another 1.1 million pieces measuring 1-10 centimetres are too small to track but still dangerous. (Yang et al., 2024) explain that debris moves at an average speed of 10 kilometres per second to understand how dangerous this is. At such high speed, even a piece of debris the size of a grain of rice can puncture a satellite or spacecraft.

- *ASAT and debris*

Military programs have been responsible for some of history's most significant debris-generating events. Unlike civil uses, the military domain has seen the intentional creation of debris through weapon tests and demonstrations. Satellites have enormous economic and military advantages, but they are highly vulnerable. ASAT missile attacks or signal disruptions can disable them, drastically reducing their military and strategic value. This vulnerability is increased by the growing dependency on satellites for daily operations, as mentioned before.

(Bongers & Torres, 2024) warn of the enormous consequences that would result from a “Star Wars” type scenario, namely the mass destruction of satellites in orbit. They simulate a conflict in which 250 satellites are destroyed, showing that this would generate millions of pieces of debris, increasing the number of space fragments by more than 2,000%. This scenario has not only military and environmental consequences but also economic ones, as satellite-based infrastructure is essential for daily life.

- *The Kessler Syndrome*

In 1978, American astrophysicist Donald Kessler warned of a dangerous possibility now known as the Kessler Syndrome (Kessler et al., 2010). He described a chain reaction: if two satellites crash and break apart, their pieces can hit other satellites, creating even more debris. This process can continue and grow, eventually making parts of Earth’s orbit too full of junk to safely use. If this happens, future space missions, satellites, and even the International Space Station could all be at risk. The more satellites we launch, the more likely we are to create uncontrollable amounts of debris and the greater our risk of triggering the Kessler Syndrome.

- *Location of the problem*

The physical location of the ASAT testing problem is primarily in low Earth orbit (LEO), an orbital zone ranging approximately from 160 to 2,000 kilometres above Earth. LEO hosts most operational satellites, crucial for communication, navigation, and Earth observation (Pelton, 2013). Because many satellites occupy this orbital zone, debris from destructive ASAT tests can rapidly threaten operational satellites, disrupting critical services worldwide. Additionally, the missiles used for direct-ascent ASAT tests typically originate from ground-based launch sites or from naval vessels strategically positioned within a nation's territory or international waters. Prominent ASAT tests have been launched from ground installations, such as missile test facilities in China, India, Russia, and the United States (Weeden, 2025). Thus, the ASAT debris problem is found in both the crowded orbital region and at various terrestrial launch sites worldwide.

- *History of the Problem*

To understand the main contributors to the ASAT threat, Table 1 summarises the countries that have conducted ASAT tests. It includes the number of tests, years of activity, and the

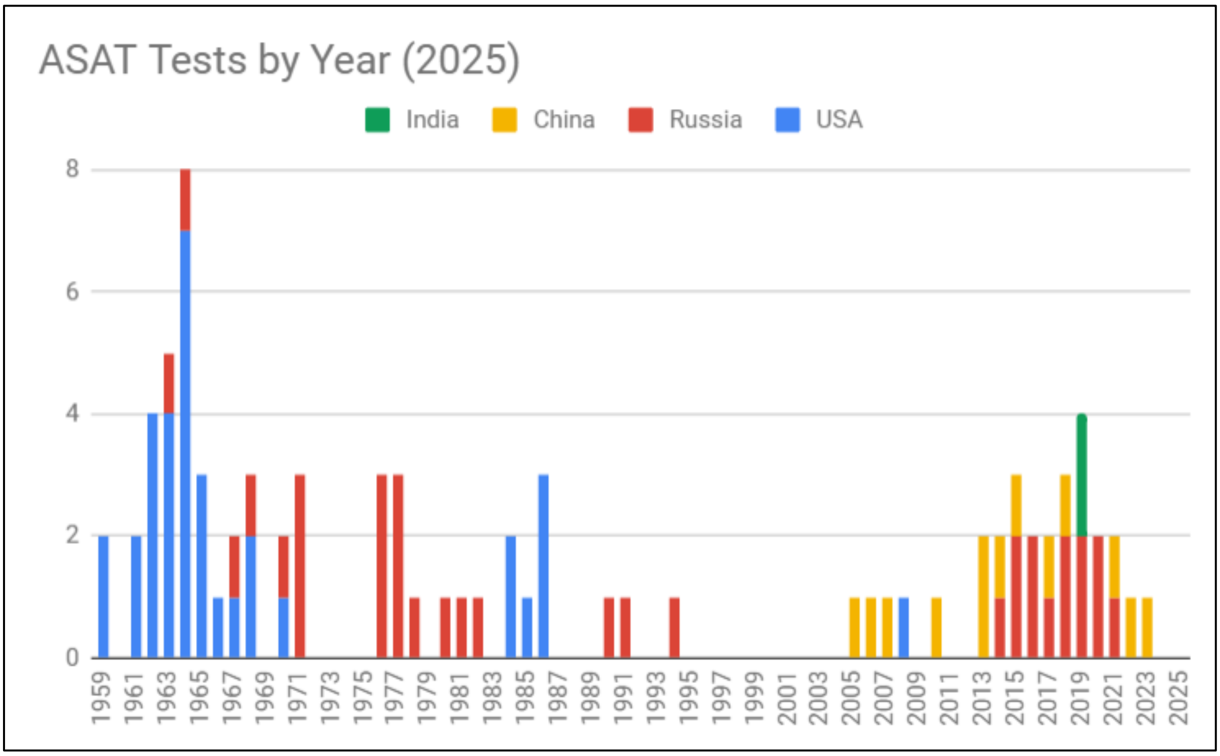

Figure 2: ASAT Tests by Year, Weeden (2025)

resulting impact on orbital debris. The data is based on the Secure World Foundation's historical overview of ASAT activity. These countries are significant because they have both the capability and strategic motivation to shape the future of space governance.

Country	*Total Tests*	*First Test Year*	*Last Test Year*	*Notable Impact*
Russia	44	1963	2021	2021 test created over 1,500 trackable debris pieces.
USA	42	1959	2008	2008 test (USA-193) created ~400 debris pieces.
China	14	2005	2023	2007 test produced over 3,000 debris pieces: worst in history.

India	2	2019	2019	Claimed “low orbit” test to minimise damage (~400 debris pieces).

Table 1: ASAT Tests by Country, adapted from ‘Secure World Foundation, U.S. Direct Ascent Anti-satellite Testing Fact Sheet.’ (Samson, 2025)

- *Expert Interviews*

One expert reflected on the technical dimension of the ASAT problem by emphasising the long-term risks posed by space debris in low Earth orbit (LEO). They described the 2007 Chinese ASAT test as a wake-up call for the international community, due to the massive number of debris it generated. The expert highlighted how the difficulty of tracking and attributing small debris fragments severely limits accountability, especially as this debris remains in orbit for decades. This creates lasting threats to both civilian and military satellites. Their insights show how the technical nature of ASAT debris intensifies the governance challenge, reinforcing the need for enforceable international norms and improved verification systems.

- *Reflection*

When examining the leading causes of space debris, I found that ASAT tests are among the most damaging single events because they can inject thousands of long-lived fragments into busy orbits at once. This indicates that to address the growing issue of space debris, we must confront the reality of ASAT tests. This supports the thesis's introduction, which focuses on the creation of debris. For my design later, it is important to note that ASAT tests occur in low Earth orbit (LEO), at altitudes of 160–2000 km above our planet, and that ASAT missiles are launched from Earth, primarily from ground- and naval-based launch sites.

Additionally, I observed that, regardless of the military motivations behind ASAT tests, the resulting debris also has civilian implications, as it can damage satellites used for daily activities. Another key technical point is that debris from these tests is difficult to trace back to its source, making it harder to verify which entity caused specific damage or debris. A final reflection on the countries' ASAT test history shows that, so far, four major players have demonstrated the capability to conduct these tests: the US, China, Russia, and India. The US stopped conducting these tests in 2009 and has made a national commitment to halt them (moratorium), which I will discuss in the next sub-chapter. However, the other major actors have not committed to such a measure. This suggests that if ASAT tests continue, they will likely originate from the remaining states I mentioned.

3.2 Institutional Analysis

Building on the earlier analysis of the key problems and stakeholder dynamics, this chapter takes a closer look at the legal and institutional tools currently available to govern anti-satellite ASAT testing.

3.2.1 Formal Agreements

To understand current institutional gaps, I will first examine the key "hard law" treaties to determine whether they impose any binding restrictions on ASAT testing.

- *The Outer Space Treaty (1967)*

The Outer Space Treaty (OST), signed in 1967, remains the most important and widely accepted legal framework for outer space activities. It outlines general rules that most countries agree upon, such as the peaceful use of space, equal access to benefits, and avoidance of harmful activities. Given its global influence, this treaty serves as a logical starting point for assessing whether current international law includes any direct or indirect restrictions on ASAT testing.

Article I states that activities in the outer space "shall be carried out or the benefit and in the interests of all countries" (The Outer Space Treaty, 1967) The non-binding nature of Article I was highlighted by the Committee on Foreign Relations of the United States, which stated that nothing in the provision "diminishes or alters the right of the United States to determine how to share its benefits and results of its space activities." (Jakhu et al., 2024). There cannot be any precise criteria for determining what is in the benefit of a state, as it depends on self-interested considerations (Chatterjee, 2014). Article I is arguably aspirational rather than enforceable. Because it does not explicitly prohibit ASATs, and because international law generally allows what is not expressly forbidden, the article offers no firm legal basis to challenge such tests.

A closer look at the OST reveals that it does not include any explicit ban on ASAT testing. The most relevant provision is Article IV, which prohibits the placement of nuclear weapons or other weapons of mass destruction in orbit, on celestial bodies, or anywhere else in outer space (*Outer Space Treaty,* 1967). This clause is clear and strong, but only applies to a limited category of weapons. It does not address conventional ASAT technologies (such as kinetic or laser-based systems), which are the types most tested today. (Chatterjee, 2014) highlights that most ASAT systems are ground-based or kinetic and therefore fall outside the scope of the treaty's ban on nuclear or WMDs. He also notes that the phrase "peaceful purposes" is subject to differing interpretations. While the U.S. sees it as "non-aggressive," others argue it should be read as strictly "non-military." This ambiguity enables states to justify ASAT activities under the label of defence or scientific research. As a result, states can technically carry out such tests, create loopholes and weaken the treaty's ability to prevent harmful activities (Bourbonniere, 2005; G. Robison, 2022)

It can be argued that this silence was intentional. Schellekens (2008) compares the OST with the Antarctic Treaty, which bans all military activity. The OST, by contrast, restricts only certain weapons to celestial bodies (not in Earth orbit), making it weaker at preventing space militarisation.

Several other OST articles are indirectly relevant to ASAT testing. Article VI and Article VII establish that countries are internationally responsible for the actions of their nationals in space and may be held liable for any damage caused by space objects they launch (The Outer Space Treaty, 1967). However, this framework only works if damage can be clearly linked to a specific country and object. ASAT tests typically produce small debris that is difficult to trace, as I mentioned before in the previous sub-chapter, which limits the possibility of legal accountability (Schellekens, 2008).

Article IX is also potentially important. It requires states to avoid "harmful contamination" of space and to act with "due regard" for the activities of other states. Some scholars interpret this as discouraging ASAT testing, given the debris it creates (Bongers & Torres, 2024). However, the treaty does not define what counts as harmful contamination. Moreover, it only calls for international consultation, not permission, if a country believes its activity might cause interference. The vague wording makes enforcement difficult and allows countries to bypass these provisions. Chatterjee (2014) emphasises that the consultation mechanism under Article IX lacks enforceability. There is no legal requirement to stop activities even after consultations, no clear threshold for "harmful interference," and no consequences for ignoring objections. This makes the article ineffective in preventing ASAT tests that threaten shared space infrastructure. However, these norms do not have the force of binding law but can still shape behaviour and support future legal developments (Bourbonniere, 2005).

Another relevant provision is Article XI, which encourages transparency. States are asked to inform others about their space activities "to the greatest extent feasible and practicable" (*Outer Space Treaty,* 1967). Yet this clause, like Articles X and XII, is weak. Chatterjee (2014) notes that these articles are based on reciprocity (mutual exchange between nations) and have no enforcement mechanism. States can choose to withhold information or deny inspections on national security grounds, undermining transparency and making it easier to conceal ASAT development. Schellekens (2008) adds that this undermines the article's intent to promote openness and coordination.

- *The Moon Agreement (1979)*

The Moon Agreement, adopted in 1979, builds on the foundations of the Outer Space Treaty. It focuses specifically on the Moon and other celestial bodies and aims to ensure they are used peacefully and fairly by all nations. One of the most critical aspects of the Moon Agreement is its strong language on banning military use. Article 3(4) states that the Moon and other celestial bodies must be used "exclusively for peaceful purposes," and explicitly forbids "the establishment of military bases, installations and fortifications, the testing of any type of weapon and the conduct of military manoeuvres on celestial bodies" *(Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 1979)*. This wording is more precise and stronger than the Outer Space Treaty's statements.

However, the ban only applies to activities on celestial bodies. It does not apply to actions in outer space more broadly, including low Earth orbit, where most ASAT tests take place

(Schellekens, 2008). This is a significant limitation, as ASAT tests that create debris typically happen in these orbital zones. Schellekens points out that, like in the OST, this legal gap may have been intentional. The treaty focuses on protecting the Moon and similar bodies but does not offer the same legal protection for activities in Earth orbit.

The bigger limitation, in my opinion, is the treaty's lack of support. Key space powers, such as the United States, Russia, and China, have not signed the Moon Agreement. Because the country most capable of conducting ASAT tests is not a party to the treaty, its impact is limited. The strong legal language does not bind the actors who matter most in this context.

- *The Artemis Accords (2020)*

The Artemis Accords, launched by NASA in 2020, outline voluntary principles for peaceful and responsible space activities. While not legally binding, it aims to strengthen cooperation and reduce risks, especially in future Moon and Mars missions. By 2025, more than 20 countries (including the United States) had signed, reflecting growing support for improved space governance. The Accords promote responsible behaviour regarding space debris. Signatories agree to avoid creating long-lived debris, follow disposal guidelines, and adopt best practices, such as the UN Debris Guidelines. These measures support the development of international norms.

However, the Accords do not include an explicit ban on ASAT testing (*The Artemis Accords, 2020*). They also lack legal enforcement and have limited reach, since key space powers such as China and Russia are not parties (Newman & Ralston, 2022). As a result, while helpful in promoting good practices, they fall short of addressing the legal gaps around destructive ASAT tests. For countries like the Netherlands, the Accords can support norm-building efforts, but stronger legal tools are still needed to ensure long-term orbital safety.

- *The Liability Convention (1972)*

The Liability Convention, adopted in 1972, makes states legally responsible for damage caused by their space objects (United Nations Convention on International Liability for Damage Caused by Space Objects, 1971). If a satellite or piece of debris harms people or property on Earth, the launching state must pay compensation. This principle of absolute liability was successfully applied in the *Cosmos 954* case: in 1978, a Soviet satellite disintegrated and scattered radioactive debris over Canada. Canada filed a claim under the Convention, which led to a diplomatic settlement (Bourbonniere, 2005). This case demonstrated that the treaty could work, but only when the damage is clear, traceable, and occurs on Earth.

Chatterjee (2014) critiques the treaty on the following grounds: difficulty proving intent, lack of verification, vague damage assessments, complications of shared liability, and the lack of penalties. The Convention distinguishes between damage on Earth (absolute liability) and damage in space (fault-based liability). In the latter case, the injured state must prove fault: that the ASAT-launching state acted negligently or with intent. This is an exceptionally high bar, particularly when the test is presented as scientific or defensive.

The Convention also suffers from a lack of independent enforcement mechanisms, as there is no formal process for conducting technical investigations into ASAT events, making it nearly impossible to verify whether a state acted recklessly. Chatterjee (2014) emphasises that this absence of an investigative body turns the process into a diplomatic and evidentiary struggle, limiting accountability. Even when fault is assumed, damage assessments under Article XII are vague. Compensation is to be awarded based on "principles of equity and justice," which gives broad discretion and may result in inconsistent or politicised outcomes. A further complication is the issue of shared liability. If debris from an ASAT test destroys a third country's satellite, Article IV may hold both the attacker and the original satellite's owner jointly liable. This can be criticised as unjust, particularly if the targeted satellite was not at fault. Finally, the Convention has no penalties for non-compliance. If a state refuses to pay or denies responsibility, the injured party must pursue optional arbitration, as there is no court or tribunal with binding authority. This creates a system where enforcement depends on political will rather than legal certainty.

- *The Registration Convention (1975)*

The Registration Convention, adopted in 1975, aims to improve transparency by requiring states to report all space objects they launch. Each object must be recorded in a registry maintained by the United Nations Office for Outer Space Affairs (UNOOSA), including launch date, orbital parameters, and general function. The idea is to help identify ownership and responsibility in the event of accidents or legal disputes *(Convention on Registration of Objects Launched into Outer Space, 1974)*.

In principle, this system could support debris mitigation by making it easier to trace objects and assign responsibility. However, the system has severe limitations. Many older, classified, or military satellites were never properly registered, and fragments from explosions or ASAT tests are often too small to track and are not recorded individually. As a result, the registry cannot reliably identify the source of most space debris.

According to Chatterjee (2014), the Convention is particularly inadequate for addressing ASAT weapons due to its weak transparency and enforcement provisions. The treaty requires states to declare the "general function" of a space object, but this term is vague and subject to broad interpretation. States often provide minimal or ambiguous descriptions, especially for satellites with dual-use capabilities, such as navigation or reconnaissance systems that may also serve ASAT purposes.

Chatterjee further highlights that there are no legal consequences for failing to register an object or for providing misleading or incomplete information. Nor is there a verification mechanism to assess whether the declared function aligns with the object's actual capabilities. This loophole allows states to register ASAT-capable satellites under the guise of peaceful use, effectively legitimising covert military programmes.

Moreover, the Convention does not prohibit ASAT testing or the creation of orbital debris. While it contributes to transparency in theory, its lack of enforcement and definitional clarity renders it ineffective in preventing space weaponisation. As with other early space treaties, the Registration Convention reflects the needs of a past era and does not adequately address the legal challenges posed by modern ASAT threats.

- *Case Study: China's 2007 ASAT Test*

China's 2007 ASAT test can be seen as a turning point in global awareness of space debris. Schellekens (2008) points out that this incident revealed significant weaknesses in the international legal system for governing such activities, from the lack of an explicit ban to the difficulty of applying liability and transparency rules in practice.

In the test, China destroyed one of its own ageing weather satellites using a kinetic interceptor. Because the satellite was under Chinese jurisdiction, the action did not violate Article VIII of the Outer Space Treaty (OST), which gives countries control over their own space objects. On paper, the test appeared to follow the law.

However, the consequences were severe. The explosion generated more than 3,000 pieces of debris, many of which remain in orbit and pose a risk to other satellites(*Understanding the Space Debris Dilemma: The Kessler Syndrome - AMPLYFI*, 2025). Under the 1972 Liability Convention, China could be held responsible for any damage caused by this debris. But in practice, proving fault is nearly impossible, especially when the fragments are too small to track or link to a specific event. This renders the liability rules ineffective for in-orbit damage.

China also did not notify other countries or international bodies before conducting the test. This raises concerns under Articles IX and XI of the OST. These articles encourage countries to avoid harmful interference with others and to share information about potentially risky activities. But the language is vague. Article IX only requires consultations when there is a "reason to believe" that interference might occur, while Article XI asks for information-sharing only "to the greatest extent feasible and practicable." Because these requirements are open to interpretation, China could argue it acted within the rules.

This case illustrates the gap in international space law. Although the test created long-lived debris that poses a threat to space safety, there was no clear legal violation. The existing treaties focus on broad principles, such as the peaceful use of space and responsibility, but do not specifically ban ASAT tests or provide robust enforcement mechanisms. This shows that dangerous actions occur without clear consequences.

Summary Table

Treaty / Agreement	*Legal Status*	*Covers ASAT Testing?*	*Debris Responsibility?*	*Main Weaknesses*
Outer Space Treaty (OST)	Legally binding	No explicit ban	General responsibility	Vague terms; no enforcement mechanism
Moon Agreement	Legally binding (limited ratification)	Bans military activity on celestial bodies only	No direct link to debris in Earth orbit	Very low participation; not applicable to LEO
Artemis Accords	Non-binding political declaration	No explicit ban	Encourages responsible behaviour	Not enforceable; major powers (e.g., China, Russia) not parties
Liability Convention	Legally binding	Indirect	Yes, but hard to prove in orbit	High threshold of proof; lacks verification body
Registration Convention	Legally binding	No	Supports attribution via registry	Many objects unregistered; no enforcement; no ban on ASAT tests

Table 2: Summary of Treaties and Agreements

This institutional analysis shows the fragmented and inadequate nature of the current legal landscape regarding ASAT activities and related space debris. As shown in the table, no existing treaty or agreement provides an explicit or enforceable prohibition on ASAT testing, particularly when states target their own satellites. The result is a permissive legal environment where (military) strategic interests outweigh environmental concerns. This analysis provides the necessary rationale for updated enforceable frameworks that reflect both the technical risks and the political realities of ASAT capabilities in the 21st century.

3.2.2 Soft-Law instruments:

Following the analysis of treaty-based mechanisms, this section examines the role of soft-law instruments in shaping ASAT-related governance. While these initiatives are non-binding, they contribute to the development of international norms and offer practical frameworks for responsible space behaviour. They form a growing part of the institutional landscape, especially where formal legal tools fall short.

- *UN Open-Ended Working Group on Space Threats*

The United Nations Open-Ended Working Group (OEWG) was established to build consensus on responsible behaviour in outer space, especially regarding threats such as ASAT testing. As a platform for dialogue, the OEWG has achieved notable milestones, including raising global awareness and encouraging voluntary moratoriums on ASAT testing. A moratorium is a voluntary, political commitment by a country to temporarily halt a specific activity, such as destructive ASAT missile tests. By 2023, more than 35 countries had joined a U.S.-led political declaration against destructive ASAT testing, and a UN resolution advocating for a broader moratorium was supported by 155 states (Hitchens, 2023). However, the OEWG also reveals key institutional limitations. It operates by consensus, which means any country can block progress. In 2023, Russia prevented the adoption of the final report, rejecting the concept of "responsible behaviour" as politically motivated. China, Iran, and Venezuela supported this stance (Hitchens, 2023). I will dive into this gridlock in the following chapter. Still, the OEWG arguably remains a valuable forum that has helped build momentum for soft-law initiatives and may serve as a foundation for future legally binding agreements.

- *UN Space Debris Mitigation Guidelines (2007)*

Adopted in 2007 by the UN Committee on the Peaceful Uses of Outer Space (COPUOS), the Space Debris Mitigation Guidelines offer technical and operational best practices for limiting orbital debris. They recommend avoiding explosions in orbit, designing satellites to prevent break-ups, and discouraging the intentional destruction of space objects. These guidelines relate directly to ASAT testing. Although these guidelines are non-binding, they are widely recognised and integrated into national licensing frameworks. Countries are encouraged to apply them "to the greatest extent feasible" (Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, 2010). However, as Bartóki-Gönczy et al. (2024) explain, the absence of legal consequences means compliance varies. Some states apply the guidelines rigorously, while others treat them as optional. As such, while they help shape expectations, they do not prevent harmful activities, such as ASAT tests.

- *EU Draft Code of Conduct for Outer Space Activities (2008)*

In 2008, the European Union proposed a Draft International Code of Conduct to promote responsible space behaviour, including limits on activities that generate debris (*EU Proposal for an International Space Code of Conduct, Draft | EEAS*, 2014). Although the Code was never adopted globally, it represented a serious attempt to formalise norms around transparency, safety, and restraint. These link to ASAT systems.

The draft Code called for prior notification of high-risk activities, data sharing, and the adoption of best practices. It included an explicit ban on the test and use of both space-based and ground-based ASAT weapons (Chatterjee, 2014). The EU led a series of non-public consultations with delegates from over 100 countries to further specify the text. Still, the EU held the meetings without an official UN mandate, and the negotiation framework did not allow other delegations to propose alternative text, which undermined the UN's principles for multilateral negotiations (Adamczyk et al., 2019). Major space powers, including the USA, Russia, and China, rejected the proposal because it did not broadly reflect their national foreign and security priorities. As consensus failed, the Code was not formalised.

- *IADC Guidelines and UN Long-Term Sustainability Guidelines*

In addition to the instruments discussed above, the experts I interviewed mention two further soft-law frameworks that play an important institutional role: the Inter-Agency Space Debris Coordination Committee (IADC) Guidelines and the UN Long-Term Sustainability (LTS) Guidelines. Although both are non-binding, they are widely referenced in national licensing systems and have helped shape expectations around responsible behaviour in space. Expert 1, the space policy advisor, explained that the guidelines are more frequently used in real diplomatic discussions than traditional treaties, such as the Outer Space Treaty. According to the expert, they are often integrated into national-level frameworks (such as licensing systems in Europe) and represent the main reference point for responsible behaviour in practice. While they are not enforceable, their widespread use gives them political and normative weight.

The IADC Guidelines, developed by a group of space agencies including NASA, ESA, and Roscosmos (Russia), provide technical recommendations for limiting the creation of orbital debris. First published in 2002 and updated in 2007, they focus on post-mission disposal, avoidance of in-orbit explosions, and minimising break-ups during operations. While they do not mention ASAT testing directly, the principles strongly discourage any intentional activity that would create long-lived debris. Many of these recommendations were later incorporated into the UN Space Debris Mitigation Guidelines (2025).

The UN Long-Term Sustainability Guidelines, adopted by the UN Committee on the Peaceful Uses of Outer Space (COPUOS) in 2019, aim to promote the long-term safety, security, and sustainability of outer space activities. These guidelines go beyond technical standards to include broader institutional issues, such as international cooperation, data sharing, and policy transparency(Guidelines for the Long-Term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space, 2021). Several of the guidelines, including those encouraging the avoidance of harmful interference and responsible behaviour, are directly relevant to ASAT risks. Despite this, the guidelines are non-binding frameworks. There are no legal consequences or penalties for states that do not comply; compliance is voluntary and varies between countries, with some applying the guidelines rigorously while others treat them as optional. While they strongly discourage the intentional creation of debris, they cannot legally prevent a state from conducting a destructive ASAT test.

- *Expert Reflections on the Institutional Dimension*

From a legal standpoint, the assistant space law professor emphasised that existing treaties, which I discussed before, are outdated and not designed to regulate the challenges posed by modern ASAT technologies. Although these treaties remain legally binding, they are vague, lack precise definitions, and lack effective enforcement mechanisms. This concern is also what I have found in the literature: states can carry out ASAT activities without facing real consequences, especially when they act unilaterally or under the guise of national defence. This weakens trust in the system and limits the ability of legal agreements to prevent or respond to harmful actions (Bhat & Mohan, 2009; Weeden, 2011).

The space law professor interestingly mentioned that, in theory, legal mechanisms such as the International Court of Justice (ICJ) or the Permanent Court of Arbitration (PCA) could be used to settle disputes; however, in practice, no such cases have been brought under space law. Political caution, difficulties with evidence, and the absence of precedent make formal legal action unlikely. This confirms that enforcement today relies more on national licensing and informal pressure than on international law.

Moving from theoretical frameworks to diplomatic experience, the policy advisor noted that formal treaties are rarely cited in practical discussions of ASAT threats or debris. Instead, progress is mainly made through non-binding agreements, such as the United Nations Long-Term Sustainability (LTS) Guidelines and the Space Debris Mitigation Guidelines. These soft-law instruments have been widely adopted into national legal systems, including in Dutch space policy, even though they are not enforceable. The advisor described this soft-law approach as the most viable option in today's geopolitical climate, especially considering divisions within the United Nations Open-Ended Working Group (OEWG) on space threats.

Both experts stressed the political challenges to a binding reform. When I inquired about the possibilities of building on existing agreements, the space law professor argued that existing treaties are often reinterpreted rather than revised, and that genuine legal progress may only follow a major triggering event. The policy advisor added that in the absence of enforcement, tools such as "naming and shaming," voluntary declarations, and diplomatic pledges are central mechanisms for shaping behaviour.

- *Reflection*

First, the foundational "hard law" treaties are inadequate. The OST is the most important and widely accepted treaty, but it suffers from critical loopholes. It contains no explicit ban on ASAT testing, and its ambiguous terms, such as "peaceful purposes," are interpreted differently by states, allowing them to justify military activities. Other treaties are similarly flawed on this point: the Moon Agreement is strict on military use but does not apply to Earth orbit, where the tests occur. Furthermore, the Liability Convention is practically unusable for debris in orbit because it requires proving "fault," which is nearly impossible without an independent verification body. Second, I found a fundamental mismatch between "hard law" and "soft law." In response to the treaty gaps, the international community has developed very precise and useful "soft law," such as the UN Space Debris Mitigation Guidelines and the Long-Term Sustainability (LTS) Guidelines. My expert interviews confirmed that these guidelines are used far more often in practical diplomacy than the old treaties.

3.3 Political Analysis

The UN Open-Ended Working Group (OEWG) on Reducing Space Threats offers a productive lens for understanding the fragmented stakeholder landscape in space security. The OEWG was established to take stock of existing space law, assess current and future threats arising from state behaviour, and make recommendations on norms, rules, and principles of responsible behaviour to help prevent an arms race in outer space. The discussions also considered ASAT tests. It aimed to adopt a consensus final report capturing areas of convergence and concrete next steps. The OEWG concluded its work in September 2023 without reaching consensus on a final report, an unprecedented development in a UN process (West, 2024).

Middle powers such as the European Union, Canada, Japan, and South Korea support soft law and transparency but remain hesitant about new binding treaties. Their diplomatic energy helps maintain dialogue but often defers to U.S. leadership in security matters. These states attempted to bridge the divide by arguing that the behavioural and legal approaches were complementary, not mutually exclusive. This was logically sound but failed because it did not change the core strategic aims of the major powers.

In summary, the failure was due to a diplomatic breakdown rooted in deep divisions, leading to a public "blame game" between the US and Russia *(Open-Ended Working Group on Reducing Space Threats through Norms, Rules and Principles of Responsible Working Paper by the Takshashila Institution for the Third Session of the OEWG on Reducing Space Threats, 2023; West, 2024).* From my reading of this OEWG case, the gridlock can be broken down into the following elements, in my own words: 1. Behavioural vs legal approach, 2. Narrow test ban vs a broad weapons ban, 3. Space weapon definition challenge, 4. Verification challenge, 5. Existing geopolitical tensions.

- *Behavioural vs legal approach*

Western countries, led by the United States, favour non-binding norms such as voluntary ASAT moratoria to reduce risks without compromising strategic flexibility. For example, the U.S.-led ASAT moratorium, endorsed in a 2022 UN resolution by 155 states, includes over 35 national pledges to avoid destructive ASAT testing (Hitchens, 2022, 2023). In contrast, Russia and China advocate for legally binding treaties. Their 2008 proposal, the Prevention of the Placement of Weapons in Outer Space Treaty (PPWT), seeks a total ban on weapons in orbit. However, it remains unratified, with U.S. officials objecting that it lacks verification mechanisms and could constrain defensive systems (Bongers & Torres, 2024; Borgen, 2021).

- *Narrow test ban vs a broad weapons ban*

Many states prioritised the debris risk from destructive ASAT activity. The United States and partners pushed a voluntary ban on destructive direct-ascent ASAT tests. Russia and China rejected a narrow test-only focus and demanded a prohibition on developing, placing, and using any space weapons. Bridge ideas, such as combining “no first placement” with a test ban, did not gain traction. While most states identified destructive ASAT tests as a key threat, they split on how to address them.

- *Space weapon definition challenge*

What counts as a “space weapon” remains unresolved because many technologies are dual-use and dual-purpose. This pushed Western states toward behaviour-based measures that avoid technology definitions. According to Acheson & Fihn (n.d.), U.S. officials argue that the absence of a clear definition of “space weapons” makes treaty-making unworkable, while Russia and China frame legal bans as essential to prevent military escalation. These frames shape stakeholder behaviour as much as actual technologies do.

Defining a "space weapon" is challenging due to the diversity of potential systems and the pervasive dual-use problem, in which peaceful technologies can be repurposed for hostile purposes (Britt, 2024; Coming to Terms with Security: A Handbook on Verification and Compliance, 2003). This definitional challenge is a primary reason why the US and its allies favour a behavioural approach, which sidesteps the need to define a weapon and instead focuses on irresponsible use.

- *Verification challenge*

A comprehensive weapons ban is seen as technically and politically challenging to verify. The West judged the PPWT “unworkable and unverifiable,” while Russia and China prioritised binding commitments first, with verification to follow (Further Practical Measures for the Prevention of an Arms Race in Outer Space, 2022). Verifying a comprehensive ban on weapons in space is technically challenging, as undeclared weapons could be disguised as benign satellites and are hard to detect without intrusive on-site inspections. To conclude, verification is a political judgment based on the level of trust between states (*Report of the Canberra Commission on the Elimination of Nuclear Weapons,* 1996). In the context of outer space, deep mistrust among major powers can therefore be seen as the greatest political obstacle to any verifiable arms-control agreement.

- *Existing geopolitical tensions*

The consensus battle was hardened by an action–reaction dynamics between missile defence and counterspace. The wartime use of commercial space services and the collapse of trust after the invasion of Ukraine hardened the negotiations.

- *Expert insights*

My expert interviews confirmed the central challenge in this field: a deep diplomatic gridlock. As several experts explained, discussions in forums like the UN Open-Ended Working Group (OEWG) are split. There is a clear divide between the Western bloc, which favours a "behavioural" approach based on non-binding norms, and a Russo-Chinese-led bloc, which insists on a "legal" approach and demands a binding treaty.

One expert clarified that the Western and Dutch opposition to the proposed Russo-Chinese treaty (the PPWT) is not purely political, but is based on major, substantive flaws. First, the PPWT contains no definition for "space weapons". This is a critical gap because many technologies are dual-use; for example, a satellite for debris removal could also be a weapon. Second, the PPWT focuses only on Space-to-Space and Space-to-Earth threats, failing to address Earth-to-Space threats, such as ground-launched DA-ASAT missiles, which are the focus of my research.

Other factors deepen this political divide. One expert linked it to broader foreign policy strategies, differing national interests, and a fundamental lack of trust. Another expert suggested the deadlock might even stem from cultural differences in legal and diplomatic traditions. Behind the scenes, this stalemate is also reinforced by powerful industry actors. According to an online article 'Outer space: Militarisation, weaponisation, and the prevention of an arms race' (Acheson & Fihn, n.d.), central defence contractors lobby against binding regulations that could threaten the profitability of their dual-use technologies.

This analysis suggests that if the debate remains in security forums, it will remain deadlocked. One expert confirmed this, suggesting a politically feasible path forward: bypass the gridlock by reframing the issue. Instead of a security problem, it can be framed as a problem of "sustainability and space safety". This approach would use more apolitical, expert-driven forums like the UN COPUOS, which has already achieved consensus on guidelines. Using existing agreements from this "space safety forum," such as the Debris Mitigation Guidelines and the UN Long-Term Sustainability (LTS) Guidelines, was identified as a much more practical starting point for building a governance model.

Table overview of the gridlock

State / group	*Preferred instrument*	*ASAT position*	*Verification view*	*Core aim*
United States	Non-binding norms of responsible behaviour	Supports a voluntary ban on destructive direct-ascent tests	Treaties like PPWT seen as unworkable and unverifiable. Focus on observable behaviours	Preserve freedom of action and manage risk while keeping advantage
Russia	Legally binding PAROS treaty based on PPWT	Rejects test-only bans. Wants bans on development, placement, and use of space weapons	Handle inside a treaty. Details to follow agreement	Constrain U.S. dominance and protect deterrence vs missile defence
China	Legally binding PAROS treaty, co-sponsor of PPWT	Rejects test-only approach as one-sided	Supports verification after hard law agreement	Limit U.S. hegemony and safeguard space assets and nuclear deterrent

India	Favors binding PAROS in principle, open to complementary non-binding steps	Kept strategic ambiguity. Abstained on UNGA ASAT-test moratorium	Points to feasibility and fair data access	Strategic autonomy and credible deterrent, mainly vis-à-vis China
EU and middle powers (incl, Brazil, Germany, Netherlands, Philippines)	Dual-track: Norms now, possible law later. Emphasises that behavioural and legal approaches are *not* mutually exclusive	Broad support for a destructive ASAT-test ban as a TCBM	Build trust through TCBMs and information sharing to enable later verification	Reduce risks, protect the space environment, keep pathways open to law. Act as a "middle power" to build cross-regional coalitions and "move the middle groups" (Global South) toward consensus

Table 3: Overview of the gridlock

- *Reflection*

Although one expert linked the political division to their national legislative culture, I can see an obvious military strategy from both blocs. The gridlock is driven by several structural issues that must be addressed in the design phase. It is also clear that national security is more important than reaching an agreement on the militarisation of space. As my research concerns space debris rather than a purely military issue, it offers an opportunity to frame institutional design within a 'space sustainability' context. Space debris is a shared problem that can affect people's daily lives around the world, as I described earlier. An agreement on ASAT from the perspective of space debris should therefore be built upon a middle ground.

Chapter 4: The design approach

This chapter forms the bridge between the problem analysis and the design phases of this research. I will translate the main insights from the problem analysis into design logic that will guide the development of institutional solutions. Based on the causes identified in the previous chapter, here I define what an effective design must consist of, achieve, and require. I will build these qualities on the basis of the summary of insights from the problem analysis and a theoretical framework of institutional design.

4.1 Summary of Key Problem Insights

The problem analysis showed that the challenge of destructive anti-satellite testing is multidimensional.

Technically, such tests create large amounts of long-lived orbital debris, especially in low Earth orbit (LEO), threatening the safety and sustainability of both civilian and military satellites. A single event can generate thousands of fragments that remain in orbit for decades, increasing the risk of collisions and contributing to the Kessler Syndrome.

Institutionally, existing space treaties such as the Outer Space Treaty and the Liability Convention do not explicitly prohibit destructive ASAT testing. Current norms are not explicitly ASAT-focused, are voluntary, and lack verification or enforcement mechanisms, leaving accountability largely absent. This legal and institutional gap allows states to conduct ASAT tests without clear consequences.

Politically, the issue is constrained by competing national interests and rising geopolitical tension. Conflicting arguments between the US, China, and Russia have prevented consensus in forums such as the UN Open-Ended Working Group.

4.2 Theoretical Framework

As a student in Complex Systems Engineering and Management, my deliverable is an institutional design rather than a physical object. An institution is understood as an "enduring regularity" in action, shaped by rules, norms, and shared strategies (Crawford & Ostrom, 1995). In other words, institutions are patterns that repeat because actors follow certain expectations and rules over time.

Based on this view, institutional design in this thesis means the deliberate design of rules, norms, and shared strategies that shape repeated behaviour in a specific setting. The purpose is to structure behaviour so that outcomes become more predictable and more cooperative.

A short scope note is needed. Crawford & Ostrom's definition refers to "human action", but this research applies the idea at the international level. The main actors in the analysed setting are states. A state is not a single person, but its external behaviour can be treated as a single "actor" because it reflects aggregated decisions by officials and institutions. Therefore, the "action" of interest here is state behaviour in repeated diplomatic situations, such as discussions in the UN Open-Ended Working Group. The institutional design developed in this thesis focuses on shaping these recurring patterns of state behaviour through clearer rules, verification, and consequences.

4.3 Core Design Elements

Before exploring possible institutional arrangements, it is useful to clarify the analytical elements that will structure the design space. In this research, three design elements are used to classify and compare institutional options: the agreement scope, the verification element, and the consequence element. These elements are chosen because any international regime must, at a minimum, perform three tasks:

A) Agreement scope: Define what behaviour is or is not acceptable.
B) Verification: Determine how compliance with this rule is observed, and
C) Consequence: Establish what happens if the rule is broken.

Using these three elements makes it possible to organise a wide range of institutional ideas (from treaties to soft-law measures) into a coherent framework. Each element captures a different aspect of governance, and together they cover the full policy cycle from rule-making to implementation and enforcement.

Stern (2011) argues that institutional principles developed from local commons need adaptation when applied to global commons and risk commons linked to emerging technologies. He notes that global commons involve many actors, heterogeneous interests, scientific complexity, and limited opportunities for learning from direct experience. This framing is relevant to, in this case, orbital debris from destructive ASAT testing. It supports the idea that effective governance depends on credible monitoring, mechanisms for handling disagreement, and institutions that can adapt over time as information and political conditions change (Stern, 2011). The designs I will develop aim to include elements of credible monitoring and mechanisms to address differing views. An adaptive agreement, in the form of a technology-independent scope, is also to be considered.

- *ADICO Grammar*

To argue for the three design elements used in this thesis (agreement scope, verification, and consequence), this study uses the Grammar of Institutions developed by Crawford & Ostrom, as also presented in the TU Delft Systems Modelling framework (*ADICO - Systeemmodellering*, 2020) This grammar is useful because it shows how any institutional statement can be written as a structured rule.

In the ADICO grammar, an institutional statement can be divided into five parts. Attributes identify who the rule applies to. In this thesis, this mainly means states that join an agreement. Deontic expresses whether the actor may, must, or must not do something. Aim describes the action itself, meaning what is being required or prohibited. Conditions clarify when and where the rule applies, for example, in which orbit, under which technical conditions, and with which exceptions. Or else describes what follows if the rule is violated, meaning the response or sanction.

This grammar also helps to distinguish between different kinds of institutions. A formal rule includes all five parts (ADICO), including an explicit “or else”. A social norm includes a right, duty, or prohibition, but without an explicit sanction (ADIC). A routine describes repeated behaviour without a clear duty or prohibition (AIC). In international politics, “sanctions” do not always mean force or punishment. They can also be reputational costs, loss of access to cooperation, suspension of benefits, or other collective responses, depending on what states accept as realistic.

4.4 Design goals

Building on the findings of the problem analysis, I define the main goals that guide the design of options to reduce debris from destructive ASAT testing. These goals translate the key challenges identified earlier (technical, legal, and political) into targets for what the design must achieve. They describe the qualities that should be maximised and serve as the criteria for evaluating and comparing alternative institutional designs later in this thesis. In other words, the more a design contributes to these goals, the more effective and desirable it becomes. The three central design goals are preventing the creation of debris**,** enabling accountability**,** and ensuring political feasibility**.**

- *Design goal 1: Preventing Debris Creation*

The main aim is to reduce orbital debris caused by destructive ASAT tests. We want any proposed method to prevent or greatly limit activities that create space debris. As highlighted in the problem analysis, debris from ASAT tests poses serious collision risks and may remain in space for many years.

- *Design goal 2: Enabling Accountability*

A second important goal is to ensure that states can be held responsible if they violate the rules. The analysis showed that, with current systems, it’s often challenging to assign blame and enforce penalties for activities that generate debris, creating a gap in accountability. That’s why the agreement should include clear provisions for verification and compliance, allowing us to detect violations and identify those responsible. This means destructive tests must be monitored, and there must be consequences for breaking the rules. Having clear accountability will discourage violations and help build trust and confidence among all parties involved, addressing the current lack of deterrence against actions causing debris.

- *Design goal 3: Political feasibility*

The third major goal is to make the institutional design politically and diplomatically feasible, which is essential for its adoption. In the problem analysis, I mentioned some constraints: major space powers are hesitant to lose military options, and any agreement needs broad support to succeed. So, the design should be realistic and acceptable to different states, especially the major ones. This might mean presenting the issue in a non-threatening way, emphasising space safety rather than disarmament, keeping obligations balanced and fair, and welcoming participation from both great powers and smaller countries. The aim is to develop a solution that a middle power like the Netherlands could confidently promote, knowing it must resonate with international partners and not be dismissed as too intrusive or one-sided. In short, feasibility should guide the ambitions. The mechanism needs to be practical and effective, not just ideal in theory.

4.5 Design Requirements (Pass/Fail Criteria)

Before exploring institutional solutions, it is important to establish a few minimum design requirements that any proposed idea must meet. These requirements serve as pass/fail criteria, ensuring that all options in the design space (the menu of possible design elements) are both relevant to the problem and feasible within existing legal and technical constraints. Whereas the design goals describe what a successful solution should maximise, the design requirements define the minimum conditions that must be satisfied for a design to be considered viable.

- *Requirement 1: Minimum verifiability*

The Netherlands Space Office (NSO) conducted a comprehensive *Feasibility Study on the Use of Space Situational Awareness (SSA) for the Verification of Responsible Behaviour in Outer Space* (2025) to explore how existing monitoring capabilities could support the verification of space agreements. The study assesses current SSA infrastructures, describing how networks of radars, telescopes, and sensors can observe and catalogue space objects, track their trajectories, and detect orbital changes. SSA refers to the capacity to monitor, understand, and predict the behaviour of objects in orbit by maintaining up-to-date positional data and analysing deviations from expected motion. Building on this understanding, the minimum verifiability standard in this thesis is defined in accordance with the NSO's conclusion that SSA can be used to verify actions in orbit, as space objects normally follow stable, predictable trajectories unless affected by natural forces, deliberate manoeuvres, or disruptive events such as collisions or explosions. By maintaining continuous orbital data, sudden deviations can be detected and analysed to determine whether they result from intentional actions or unforeseen incidents. SSA is particularly effective at identifying the outcomes of visible, physical activities such as debris-generating ASAT tests or proximity operations. Therefore, a design idea passes the minimum-verifiability requirement if its prohibited or required behaviour produces observable orbital consequences that can be detected using existing or cooperative SSA capabilities.

A design would fail the minimum verifiability requirement if it depended on proving a country's intent or motivation, since SSA can only see physical actions, not decisions. It would also fail if it focused on non-physical effects, like jamming or cyber operations, because these leave no visible trace in orbit. Finally, a design will not meet the standard if it requires intrusive inspections or access to military data that countries are unlikely to share. In short, a proposal fails this requirement when its success depends on information that SSA cannot provide or that states would not realistically make available.

- *Requirement 2: No disarmament*

The problem analysis showed that states resist any measures that resemble arms control or disarmament, as these touch directly on national security interests. At the same time, the debris problem stems from behavioural effects, not from the mere existence of weapons. The rule should prohibit the intentional creation of orbital debris regardless of technology, but must not ban the possession, development, or deployment of particular weapon systems. This keeps the focus on environmental and safety outcomes, rather than on military capability. A design that ventures into weapon prohibition would lose political feasibility and fall outside the preventive, cooperative purpose of this framework.

- *Requirement 3: Outer Space Treaty Compatibility*

In the problem analysis, I found that amending the Outer Space Treaty or other core UN space treaties would be politically unrealistic. Such processes invite years of negotiation and risk reopening sensitive balances among major powers. Also, this would make my research a purely legal-focused thesis. So, a design element would fail the **t**reaty-compatibility requirement if it violates the Outer Space Treaty's main rules. This would happen if the proposal violated one of the treaty's core principles. First, it will fail the due regard rule if it limits other countries' freedom to use space, claims control over certain orbits, or permits actions that could disturb others' peaceful use of space. Second, it would conflict with the principle of state responsibility if it removed the duty to supervise and approve their space activities, or if it allowed private actors to operate without national oversight. Third, it will breach the rule on avoiding harmful contamination if it allows behaviour that pollutes or damages the space environment. These conditions make it clear when a design would be incompatible with existing space law and therefore fail this requirement.

4.6 Design Boundary: Not designing for ASAT during wartime

The institutional models I develop in this thesis are intended to govern state behaviour in peacetime. My focus is on preventing debris from ASAT tests. This research, therefore, does not address the actual use of these weapons during an armed conflict. That scenario requires a different problem analysis.

4.7 Design Boundary: Defining the scope of space debris

A key design boundary, highlighted by expert interviews, is the definition of "debris creation". The term "space debris" can be ambiguous: it may refer to a non-functional satellite at its typical end of life, but it can also mean the thousands of fragments resulting from an explosion. For this thesis and all related designs, "debris creation" specifically refers to the deliberate, active production of new debris through a destructive event such as an ASAT test. My designs are not intended to regulate the status of satellites at their routine end-of-life.

Chapter 5: Exploration of the Design Space

In this chapter, I will explore the institutional design space. Instead of developing ideas from scratch, I will draw inspiration from existing international regimes and expert knowledge to identify effective institutional arrangements. The purpose is not yet to choose a final design, but to gather and structure a set of design options that can later be combined and evaluated against the design goals established in the previous chapter.

To build this, I shaped the design space by four sources of knowledge. First, I will examine comparative regime analysis, including the Antarctic Treaty System, the United Nations Convention on the Law of the Sea (UNCLOS), and the Treaty on the Prohibition of Nuclear Weapons (TPNW), to learn how other international regimes have addressed verification, compliance, and enforcement. Second, expert interviews provide valuable insights into politically feasible design options. Third, the UNIDIR Handbook on Verification and Compliance (2003)acts as a useful technical guide for the verification part of the design. Lastly, personal reasoning helps generate new ideas for agreements and compliance strategies.

These sources together form the foundation for identifying the key institutional elements (agreement scope, verification, and compliance mechanisms) that will structure the final design options in the next section.

5.1 Comparative regimes

To identify potential design elements, I will examine how other global regimes have governed activities in shared or common domains. I focused on three international treaties (in different domains) that manage environments beyond national jurisdiction while balancing security interests with sustainability and peace: the Antarctic Treaty System (ATS), the United Nations Convention on the Law of the Sea (UNCLOS), and the Treaty on the Prohibition of Nuclear Weapons (TPNW). Each of these domains gives inspiration into how international cooperation can be organised around shared resources and collective risks.

The aim is to highlight their most relevant institutional features. These treaties demonstrate different approaches to balancing military restraint with global safety. After introducing each domain separately, I will conclude by identifying transferable design elements that can inform the institutional design of an ASAT debris agreement.

5.1.1 Antarctic Treaty

The Antarctic Treaty System (ATS) can be an inspiration for space governance because of its success in preventing conflict before it starts. As the first international agreement created in the "interest of all mankind," it established legal principles designed to avoid disputes rather than manage them after the fact. Its core preventive measures include: A ban on all military activities and weapons testing (Article I). A prohibition on nuclear explosions and nuclear waste disposal (Article V). A freeze on any new territorial claims (Article IV).

These rules prevent disputes over sovereignty and militarisation from arising. This is relevant because, as Oz (2018) notes, outer space faces a similar "tragedy of the commons". This is where countries acting in their own short-term interest can damage a shared resource for everyone. An ASAT test that creates long-lasting debris is a clear example of this, as one nation's action poses a widespread risk to all other users. The Treaty has been strengthened over time with additional rules. Race (2011) points out that binding environmental protocols, codes of conduct, and the designation of protected areas have been added. These additions provide clear expectations for behaviour that go beyond the original treaty language.

The ATS also includes important mechanisms for building trust and ensuring compliance. Inspections: Article VII allows any treaty party to conduct on-site inspections of another's facilities, creating a transparent peer-review system. Consultative Meetings: The Antarctic Treaty Consultative Meetings (ATCM) serve as the main forum for coordinating activities and issuing legally binding decisions, forming a basic verification system. Data Exchange: The requirement to exchange scientific plans and results (Article III) acts as a tool for both collaboration and supervision.

As Race (2011) highlights, this adaptability makes the ATS different from the static Outer Space Treaty. The system evolves through regular meetings and scientific advice to respond to new risks. The Treaty also has unique legal solutions. To avoid sovereignty issues, Article VIII states that personnel are subject to the laws of their home country. Furthermore, Article X obliges parties to discourage treaty violations by anyone, including non-signatories, which gives the regime broader influence. Disputes are to be settled peacefully and can only be sent to the International Court of Justice if all parties to the dispute agree (Article XI).

- *Inspiration 1: Strong Transparency*

The success of the Antarctic Treaty System is fundamentally linked to its robust transparency mechanisms, which foster a culture of open data exchange among scientists from competing nations. This demonstrates that collaboration on matters of common interest can transcend Cold War rivalries. This spirit was codified in Article III of the Treaty, which obliges parties to exchange information regarding scientific programmes, personnel, and results "to the greatest extent feasible and practicable" *(The Antarctic Treaty, 1959)*. This ongoing exchange has been a cornerstone of the treaty's ability to build trust and maintain transparency.

A major threat in a congested orbital environment is ambiguity, as a satellite manoeuvre could be a routine station-keeping adjustment, a debris-avoidance action, or a prelude to a hostile act. A lack of transparency about intentions breeds mistrust and creates a risk of miscalculation and escalation. While the practice of sharing SSA data is already widespread, with the U.S. Space Command maintaining over 100 agreements with various partners (USSPACECOM Signs 100th Commercial Agreement to Share Space Data, 2021), an ASAT treaty should elevate this from a voluntary confidence-building measure (CBM) to a core treaty obligation. Drawing inspiration from Article VII of the Antarctic Treaty (1959), which requires parties to give advance notice of all expeditions, the ASAT treaty should mandate pre-notification of all satellite launches and significant orbital manoeuvres.

This requirement would serve two critical purposes. First, it would significantly improve space traffic management and safety for all operators. Second, it would create a baseline of normal, transparent behaviour that strengthens verification. By mandating transparency as the default, the treaty would make covert or ambiguous activities far more conspicuous and politically costly, thereby strengthening the prohibition on destructive tests.

- *Inspiration 2: Collective Consultation*

Normative pressure is most effective when it is focused and channelled through a legitimate institution. The Antarctic Treaty provide a model for such a body. The ATS is governed by the Antarctic Treaty Consultative Meeting (ATCM), an annual gathering of the decision-making parties. When an inspection raises a compliance concern, the report is submitted to the ATCM for collective consideration and action. The ATCM operates by consensus, a slow process that can be vulnerable to blockage by a single state. However, this consensus model also ensures that decisions are made with the full backing of all key parties.

An ASAT test ban agreement can establish a similar dynamic institutional body, for example, a Conference of States Parties (CSP), to serve as the political engine of the regime. A violation of the test ban would constitute a political crisis, not just a legal infraction, and would require a political forum for its management. The CSP should be given a clear mandate to manage the consequences of non-compliance, including the authority to:

A) Review Compliance Data: Formally receive and deliberate on reports from the treaty's verification body concerning ambiguous or potentially prohibited activities.

B) Facilitate Consultation: Serve as the primary venue for a state to request clarification from another state regarding its activities, providing an off-ramp for de-escalation before a formal accusation of non-compliance is made.

C) Make Determinations of Non-Compliance: Based on the evidence presented, the CSP should be empowered to vote on and issue a formal declaration that a state party is in violation of its treaty obligations.

D) Coordinate Collective Responses: Following a determination of non-compliance, the CSP would be the forum to discuss and coordinate appropriate responses. These could range from a collective diplomatic protest and suspension of treaty rights to recommending that states parties implement national-level countermeasures or formally referring the matter to the UN Security Council.

This model provides a flexible, graduated, and primarily political pathway for managing non-compliance. It is more adaptable and realistic for the geopolitical context of outer space than a rigid system that relies solely on judicial enforcement or the prospect of Security Council sanctions.

- *Inspiration 3: Consent-based resolution*

The Antarctic Treaty exemplify the traditional, consent-based approach to dispute resolution. Article XI of the Antarctic Treaty encourages parties to resolve disputes through negotiation, inquiry, mediation, or other peaceful means. Crucially, it states that any dispute that cannot be resolved by these means shall be referred to the International Court of Justice (ICJ) only "with the consent, in each case, of all parties to the dispute" (The Antarctic Treaty, 1959). This unanimity requirement effectively renders the ICJ's jurisdiction optional, leaving no mechanism to compel a recalcitrant state to comply with a binding legal ruling.

5.1.2 Maritime Regime: UNCLOS

The United Nations Convention on the Law of the Sea (UNCLOS) of 1982 governs the world's oceans as a global common by balancing military and security interests with clear rules of behaviour. While it is not a disarmament treaty, UNCLOS addresses military threats by establishing clear rights and limits on naval activities in various maritime zones (*United Nations Convention on the Law of the Sea, 1982).* The convention is based on the principle of peaceful use. Its key articles (such as 88 and 301) state the goal is to "promote the peaceful uses of the seas and oceans," which encourages non-aggressive conduct. Furthermore, UNCLOS creates rules against specific illegal acts that threaten security. For example, piracy is outlawed, allowing all states to act against pirates as *hostis humani generis* (enemies of mankind). Activities like drug trafficking and unauthorised broadcasting from the high seas are also condemned.

The norms in UNCLOS are enforced in several ways:

Reciprocal Interest: Freedom of navigation is widely respected because major powers expect their own rights of passage to be honoured in return.

Legal Processes: When disputes arise, UNCLOS provides legal channels for resolution, including arbitration and the International Tribunal for the Law of the Sea. This creates pressure to settle disagreements through law.

Peer Pressure and Demonstration: Norms are also upheld through global peer pressure and practical actions. For instance, when a state makes an excessive claim to a sea lane, other nations (like the U.S.) may conduct "freedom of navigation operations" by deliberately sailing through the area to demonstrate that it remains international waters.

Over time, these norms have become so widely accepted that even countries that have not formally joined UNCLOS (like the United States) treat most of its provisions as binding customary law, because they benefit from the stable maritime order it provides, as Marshall (2023) describes in his book *The Future of Geography: How Power and Politics in Space Will Change Our World*. The strength of these rules is evident in how countries justify their behaviour. Navies frame their actions as being compliant with international law, and accusations of violating UNCLOS carry significant diplomatic weight.

- *Inspiration 1: A Zonal Approach to Orbital Space*

The key inspiration from UNCLOS is its use of high precision to manage a complex domain with varying levels of risk and activity. This meticulous, zonal approach was essential for securing a "package deal" and can be adapted to the diverse orbital environment. This model allows for tailored rules based on risk. For an ASAT treaty, this translates into creating distinct legal regimes for different orbital regions:

Low Earth Orbit (LEO) as the Strictest Zone: As the most congested and critical region, LEO could be designated a zone where any destructive test is absolutely banned due to the high risk of cascading debris.

Medium Earth Orbit (MEO) & Geostationary Orbit (GEO) as Protected Zones: Home to vital navigation and communication satellites, these high-value orbits would also be subject to a comprehensive ban on activities that create debris.

Higher Orbits or Non-Standard Trajectories as Monitored Zones: In less crowded regions, the rules could focus more on transparency and pre-notification of manoeuvres, while still upholding the core prohibition against creating long-lived debris.

This zonal approach could improve the political feasibility of an agreement. It applies the strictest rules where the shared risk is most significant (LEO) while allowing for flexibility in other areas.

- *Inspiration 2: Tribunal*

UNCLOS, in stark contrast, established one of the most comprehensive and revolutionary compulsory dispute settlement systems in international law. By ratifying UNCLOS, states give their advance consent to be subject to binding third-party adjudication at the request of any other state party (*United Nations Convention on the Law of the Sea, 1982).* The case goes to the International Tribunal for the Law of the Sea, referred to arbitration under Annexe VII, ensuring that a binding decision is always attainable.

5.1.3 Arms Control Regime: TPNW

The Treaty on the Prohibition of Nuclear Weapons (TPNW) entered into force in 2021 and establishes a normative and legal standard against a specific class of weapons. It was developed as part of the “Humanitarian Initiative,” which focused on the catastrophic consequences of any use of nuclear weapons (Treaty on the Prohibition of Nuclear Weapons, 2017). Unlike treaties that regulate or limit the use of weapons, the TPNW is a comprehensive ban, making it a relevant case study for creating an unambiguous prohibition against a dangerous technology.

Looking at its core Principles, the TPNW establishes a clear and comprehensive set of prohibitions. Article 1 of the treaty forbids states that are party to it from engaging in any activity related to nuclear weapons. This includes developing, testing, producing, possessing, stockpiling, using, or threatening to use them. It also bans states from allowing nuclear weapons to be stationed on their territory and from assisting any other state with these prohibited activities *(Treaty on the Prohibition of Nuclear Weapons, 2017)*. This comprehensive approach leaves no room for legal loopholes.

- *Inspiration 1: Positive Obligations*

An interesting part of the treaty is the inclusion of "positive obligations," which require states to take proactive steps beyond simple prohibitions. The TPNW's Articles 6 and 7 oblige states parties to provide "adequate assistance" to victims of nuclear use and testing, and to take "necessary and appropriate measures" to remediate contaminated areas. This reframes the treaty from a purely preventive instrument into a remedial one, aiming to address the legacy of the inflicted harm.

Such a framework would demonstrate that the treaty is a constructive tool for improving the space environment for all, rather than merely a restrictive measure. These provisions could include obligations for states to a) Share high-precision tracking data on existing debris. b) Cooperate on developing best practices for collision avoidance. c) Support research and development into debris mitigation and remediation technologies.

- *Inspiration 2: Stigmatisation and condemnation*

Since the TPNW was negotiated without the participation of any nuclear-armed states, its primary authority does not stem from universal membership, but rather from its role as a norm-setting instrument. The main goal of the treaty is to stigmatise and delegitimise nuclear weapons, making their possession and the concept of nuclear deterrence increasingly unacceptable in international politics (Sauer & Reveraert, 2018)

The strategy of stigmatisation aims to build political support in a positive way. By highlighting that nuclear weapons are illegal under international law for many countries, the treaty inspires and energises civil society campaigns, promotes financial divestment from companies involved in nuclear weapon production, and influences the political decisions of states that depend on nuclear deterrence (Vestner, 2015). Even without the backing of key military powers, this approach can positively influence international behaviour by shifting perceptions and reinforcing a worldwide taboo against a dangerous activity.

The primary consequence for a violation would be normative and political rather than military or economic. Such a declaration would trigger consequences:

Widespread International Condemnation: This would provide the factual and legal basis for a global diplomatic response, potentially isolating the violator in international forums.

Reputational Damage: It would brand the violator as an irresponsible actor who has wilfully damaged a shared environment, undermining its soft power and diplomatic standing.

Strengthening the Norm: A unified condemnation would reinforce the agreement's prohibitions, making future violations even more politically costly for any state to contemplate.

- *Inspiration 3: Life-cycle Ban*

The primary lesson from the TPNW is its approach to creating an unambiguous and comprehensive ban that covers the entire lifecycle of a weapon system. This approach is designed to close legal loopholes and establish a powerful normative standard against the weapon itself. Instead of a narrow ban on "testing," an agreement could prohibit states from engaging in a full spectrum of activities related to destructive, debris-creating ASAT systems, such as:

To Develop, Produce, or Stockpile: This would prevent the manufacturing and accumulation of dedicated ASAT weapons, limiting a state's ability to suddenly test or deploy them. To Test: This forms the core of the prohibition, banning any deliberate action that creates orbital debris by destroying a space object. To Use or Threaten to Use: This expands the prohibition beyond testing to include the use of such weapons in a conflict, thereby reinforcing strategic stability. To Assist, Encourage, or Induce: This crucial non-proliferation clause would prohibit states from assisting others in any prohibited activities, cutting off technology transfer and collaboration.

By adopting a comprehensive list inspired by the TPNW, the treaty would target the entire ecosystem required to field a destructive ASAT capability, making the ban more robust and effective.

5.2 Expert Perspectives on Institutional Design

This section presents ideas collected through my expert interviews. The goal here is to identify innovative directions and lessons from the practice that could inform my design.

- *Global Debris Tracking and Database*

One space policy advisor stressed the importance of developing a global debris database supported by shared Space Surveillance and Tracking (SST) systems. This idea aims to strengthen verification and transparency by improving data accessibility and accuracy. A shared SST network would allow states to collectively monitor orbital events, identify debris-generating activities, and verify compliance with potential future agreements. Such cooperation could serve as the technical foundation for an international verification regime, helping build trust and confidence among states.

- *Behavioural Commitment Mechanisms*

One of the experts emphasised the value of behaviour-based commitments, such as voluntary codes of conduct or political declarations reflecting responsible behaviour in outer space. These soft-law instruments could serve as transitional measures toward a binding agreement, establishing shared expectations and shaping norms of restraint. While not legally enforceable, such commitments can promote transparency, encourage restraint, and gradually build the legitimacy of more formal mechanisms.

- *National Licensing for Compliance*

A legal expert highlighted the potential of national licensing systems as indirect enforcement tools. By embedding debris-prevention standards into domestic licensing for space launches or satellite operations, states could extend accountability to private actors and ensure consistency with international norms. This approach could also reinterpret Article IX of the Outer Space Treaty, linking “due regard” obligations to modern sustainability and safety practices. National measures of this kind would strengthen compliance even without a fully centralised enforcement body.

- *Soft Power Approach*

One expert proposed using peer pressure and public accountability as realistic compliance tools under current geopolitical tensions. Instead of hard sanctions, international agreements could rely on collective reporting, public disclosure of violations, and moral censure to raise the political costs of debris-generating behaviour.

- *International Arbitration and Mediation Hub (The Netherlands Role)*

The legal expert suggested leveraging the Netherlands' reputation in international arbitration by positioning it as a neutral hub for dispute resolution in space law. The proposal involves extending the jurisdiction of existing bodies such as the Permanent Court of Arbitration (PCA) to cover space-related disputes, including debris creation and ASAT testing. The Netherlands could also facilitate mediation processes under the UN framework, offering impartial support for conflict resolution. This idea aligns with the country's broader diplomatic tradition of promoting the peaceful settlement of disputes.

- *Arms Control and Export Regulation*

Both Dr Renes and an expert noted that arms control frameworks, such as the Wassenaar Arrangement and EU export control lists, could indirectly address ASAT development. By limiting the transfer of dual-use technologies and promoting transparency in military exports, such measures could reduce the spread of ASAT capabilities. However, they also recognised that national development programmes would remain outside this control, meaning these mechanisms could serve only as complementary, not primary, instruments.

- *Sustainability and ESG Integration*

An emerging trend highlighted by one expert was the growing role of environmental, social, and governance (ESG) standards in the commercial space sector. Investors and insurers increasingly require start-ups to demonstrate sustainable practices before funding or coverage. Embedding debris mitigation and responsible behaviour into ESG frameworks could indirectly reinforce international norms, promoting responsible business conduct even in the absence of a binding treaty.

- *Building on COPUOS Guidelines*

Another practical proposal is to build on the existing space safety and sustainability guidelines developed under the UN Committee on the Peaceful Uses of Outer Space (COPUOS). These guidelines already enjoy broad international consensus and can serve as a foundation for extending existing soft-law commitments into a more structured regime. Using COPUOS as an apolitical forum could help shift the ASAT debris issue from a security-based debate to one centred on space sustainability, making progress more achievable.

- *ITU as a Verification and Enforcement Platform*

Finally, one expert proposed exploring the International Telecommunication Union (ITU) as a possible platform for verification and enforcement. Since the ITU already manages orbital slots and frequencies, its technical expertise and established membership could support data-sharing and compliance elements for a future ASAT debris regime. This idea would build on existing international infrastructure rather than creating a new organisation from scratch.

- *Legal Arbitration and the Role of the Netherlands*

One space law expert discussed the potential use of existing international legal mechanisms, such as the International Court of Justice (ICJ) and the Permanent Court of Arbitration (PCA), to settle disputes arising from space activities, including debris or ASAT-related incidents. Although these institutions already possess the jurisdictional capacity to address such cases, the expert noted that, in practice, no disputes have yet been brought under space law, primarily due to political caution, evidentiary challenges, and the absence of precedent. However, the expert underlined that this legal gap also presents a unique diplomatic opportunity for the Netherlands, whose reputation for neutrality and experience in international arbitration could be leveraged to strengthen the legal and procedural foundations of future space governance. The Netherlands could act as a “Switzerland of space,” facilitating mediation, arbitration, and dispute resolution through its existing institutions in The Hague. This could include expanding the PCA’s remit to explicitly handle space-related disputes. Another expert reinforced this view, emphasising that if the Netherlands wishes to play a central role in future verification or enforcement, it must begin building institutional capacity now. Whether the Netherlands remains purely advisory or evolves into an authority with legal and compliance powers will depend on the policy choices made in the coming years.

5.3 Verification Lessons from the UNIDIR Handbook

Verification is a central element of any institutional design aimed at preventing destructive ASAT testing. The UNIDIR and VERTIC Handbook on Verification and Compliance (2003) offers practical guidance on how international agreements can monitor compliance and deter violations. While originally developed for arms control and disarmament regimes, its principles are highly relevant to space governance, where verification must balance technical feasibility with political acceptability. In this section, I therefore explore how the handbook’s insights can inform the development of verification mechanisms for an ASAT debris regime.

The handbook identifies verification as both a technical and political process. It provides a systematic framework and a comprehensive "toolbox" of verification techniques, technologies, and institutional models drawn from decades of experience in negotiating and implementing both bilateral and multilateral agreements.

Technically, it focuses on gathering reliable data to determine whether states are meeting their obligations. Politically, it builds confidence between states by demonstrating transparency and deterring non-compliance. Verification thus serves not only to detect violations but also to prevent them by making secret activities more difficult and costly. UNIDIR emphasises that verification works best when it combines several complementary measures, rather than relying on a single method (Coming to Terms with Security: A Handbook on Verification and Compliance, 2003).

5.3.1 Levels of Verification Organisation

UNIDIR distinguishes between several levels of institutional verification, ranging from unilateral monitoring to fully independent international systems. Each level reflects a different balance between political feasibility and verification strength.

- *Unilateral Verification*

The most basic option is for each state to verify compliance independently through its national technical means (NTM), such as satellites, radars, or telescopes. This approach is politically realistic because it requires no shared institutions, making it acceptable even in competitive environments. However, it depends on the quality of national capabilities and on others' willingness to accept unilateral assessments. The handbook notes that some treaties “relied solely on NTM… used in a manner consistent with generally recognised principles of international law” (Coming to Terms with Security: A Handbook on Verification and Compliance, 2003). While this provides a minimal baseline for monitoring, it risks mistrust and disputes if states contest each other’s findings.

- *Multilateral Verification*

A more cooperative approach is multilateral verification, in which a limited group of states jointly oversee compliance. This can involve bilateral arrangements or regional inspectorates shared between a few key participants. The Handbook (2003) describes cases where “two States… set up a common inspectorate to verify nuclear facilities”. Such arrangements improve transparency and confidence within the participating group, though they provide less reassurance to states outside it. This model might suit early stages of an ASAT debris regime, for example, through regional cooperation between spacefaring nations.

- *Independent International Verification*

The most ambitious model involves a standing international organisation with its own professional inspectorate. UNIDIR highlights examples such as the International Atomic Energy Agency (IAEA), which operates permanent monitoring systems independent of national control (Fischer, 1997). This model offers the highest credibility and neutrality, as verification is carried out by an impartial body rather than the states themselves. However, it is also the most politically demanding, requiring consensus, resources, and acceptance of inspections.

5.3.2 Verification Techniques

In addition to institutional levels, UNIDIR outlines specific verification techniques that vary in intrusiveness and complexity. These can be grouped into three main categories:

- *Passive Data Declarations and Exchanges*

This is the least intrusive method. States submit baseline declarations when a treaty enters into force and provide periodic updates or notifications of relevant activities. Information is shared either directly between parties or through a central registry. Such measures encourage transparency and allow basic monitoring without requiring external inspection.

- *Data Exchange plus Multinational Remote Monitoring*

The second model combines information-sharing with remote monitoring using independent sensors. Technical systems such as radar or telescopes, often located outside the monitored state, track activities and feed data into a shared platform accessible to all participants. This allows continuous observation without breaching sovereignty. For an ASAT debris regime, this could translate into a global SST data hub pooling information from existing national and commercial sources.

- *Data Exchange, Remote Monitoring, and On-Site Inspections*

The most comprehensive model adds on-site inspections (OSIs), giving authorised inspectors temporary access to facilities to verify compliance or investigate incidents. The UNIDIR Handbook (2003)reports that “on-site verification activities have become almost a routine part of arms control and disarmament verification”. Such inspections provide direct confirmation of data and can detect violations that might otherwise remain hidden. A relevant precedent is the Antarctic Treaty, which allows any party to send observers to inspect stations and equipment to ensure compliance with its demilitarisation provisions.

- *Public-Private Partnership (PPP)*

After reviewing the UNIDIR Handbook, I examined the Netherlands Space Office's *Feasibility study on SSA for Verification* (2025). This study explains the concepts of SSA and SST. Space Situational Awareness (SSA) refers to the continuous monitoring of events in orbit, while Space Surveillance and Tracking (SST) is the sensor system that provides this information. The study confirms our ability to detect fragmentation events.

From this study, I found another verification technique to add to this list. A Public-Private Partnership (PPP) is a collaboration where the government (the "public" sector) works with private companies (the "private" sector) to oversee space. Instead of the government building and managing a global network of costly sensors, it pays for access to data and services provided by commercial firms that already operate such sensors. By integrating its own data with that from private partners, governments obtain a more comprehensive view, broader coverage, and cost savings. The study also highlights the primary trade-off: while this model allows for flexible, cost-effective expansion of sensor coverage, it offers less direct operational control to the government, which relies on commercial agreements.

This public–private option matters because verification in orbit is increasingly shaped by commercial capability. Commercial SSA providers can expand coverage and improve cross-checking, thereby strengthening credibility when states disagree. At the same time, reliance on commercial inputs raises governance questions about access, bias, and continuity of service. These trade-offs are therefore treated as a design choice in the scenarios developed later in this thesis.

5.4 Author’s Reasoning and Ideas

In addition to external sources of insight, I have developed several designs through my own reasoning to close gaps in existing frameworks. I have examined points of disagreement, such as the divide between voluntary norms and binding treaties, and the lack of credible enforcement mechanisms, and identified principles that could bridge these divides and could give workable institutional solutions.

5.4.1 Overarching Insights

Before specifying concrete agreement and enforcement options, several overarching insights I got from the problem analysis can guide my agreement scope for the institutional design of an ASAT debris regime.

Firstly, the idea is to prohibit observable debris effects to bridge legal and behavioural divides. This principle turns the debate between behavioural norms and legal obligations into a content question that both perspectives can support. It resolves two long-standing gridlocks: first, the tension between soft-law and treaty approaches, as effect-based language can fit either format; and second, the dispute between a narrow test ban and a broad weapons ban. By focusing on harm rather than technology labels, this approach enables states to agree that debris-creating tests are unacceptable without settling every question about "space weapons."

Secondly, using this principle allows the debate concerning behavioural norms and legal obligations to be reframed as a substantive question that both perspectives can support. It addresses the contention between a limited test ban and a comprehensive weapons ban. By emphasising harm rather than technological classifications, this approach permits states to agree that tests that generate debris are unwarranted, without the need to resolve every issue related to "space weapons."

Furthermore, I want to use effect-only drafting to avoid definition traps. Framing the rule around observable effects instead of naming specific technologies avoids endless definitional disputes. Because many systems are dual-use, fixed lists are impractical. An effect-based rule simply states that if an action produces a destructive or debris-creating outcome, it is prohibited. This makes the rule both technology-neutral and future-proof, ensuring that it remains valid as technology evolves. A key drafting choice in this thesis is to focus on effect-based rules. This approach supports the "no disarmament" boundary, because it does not regulate possession or development. It also supports verifiability, because the main compliance question becomes whether a detectable fragmentation event occurred, rather than why it happened or what system was used.

Finally, I see the value of reframing the issue as a debris and safety problem, not a military one. Placing the issue in the field of space safety and sustainability can bring together more allies and ease international tensions. ASAT tests generate significant long-lasting debris, threatening the civil, commercial, and scientific uses of space that all countries rely on. When we highlight protecting the environment and operational safety, it becomes easier to gain support from countries that aren't spacefaring, private companies, and even everyday people. This approach also bridges the test-ban versus weapons debate by focusing on how debris affects everyone, rather than on the motives behind military actions.

5.4.2 Agreement Scope Options

The reasoning above led to three possible ways to structure an ASAT test ban. By reframing the issue around observable debris effects rather than weapon definitions, it became possible to imagine three distinct agreement scopes**,** ranging from a minimal ban on direct-ascent tests to a broad outcome-based ban that addresses all debris creation. These three options form the foundation for the later design combinations.

- *Direct-Ascent ASAT Test Ban*

This option prohibits only direct-ascent (DA) missile tests that strike satellites from Earth, sea, or air. These tests have historically produced the largest debris clouds and are easily detectable by space-tracking systems. Because they are clearly identifiable events, verification is straightforward, and attribution is strong. Because they are clearly identifiable events, verification is straightforward, and attribution is strong. Politically, this represents the most feasible first step, though it leaves out other kinetic methods such as co-orbital collisions.

- *Ban on All Kinetic Destruction of Satellites*

This broader option covers any physical impact that intentionally destroys a satellite, including both missile intercepts and co-orbital attacks. It closes the loophole of the first approach and extends protection to higher orbits. The main challenge is distinguishing between hostile collisions and accidental impacts, which requires clearer rules and possibly shared incident-review procedures.

- *Outcome-Based Debris-Generation Ban*

The most comprehensive and technology-neutral option bans any deliberate creation of large, long-lived debris, regardless of method or intent. It sets a simple, outcome-focused rule: if an action causes significant and persistent debris, it constitutes a breach. This approach is verifiable (since debris clouds can be detected). Still, it would require agreed-upon quantitative thresholds to determine what constitutes significant debris.

5.4.3 Consequence and Compliance Options

During the design space development, I observed that the enforcement approaches I have analysed so far did not provide all levels of ambition. Therefore, I devised a series of graduated enforcement options that allow responses to scale with the severity of violations and the level of political trust. This resulted in three intermediate options: transparency-only, public pressure (which is also precedent-setting under the TPNW), and stigmatisation and suspension of benefits and privileges. Alongside the possibility of legal enforcement at the upper end, these options form a complete continuum of responses that make accountability both credible and politically feasible.

- *No Sanctions (Transparency-Only Model)*

This baseline option establishes an informational regime. Parties record debris events, share reports, and publish summaries without imposing penalties. It prioritises openness and learning, providing a low-pressure starting point that can build trust. However, it offers limited deterrence and would need to evolve toward stronger enforcement over time.

- *Public Pressure and Stigmatisation*

Here, the primary tool is reputation. A formal finding of non-compliance would be made public, followed by joint statements or listings of repeat offenders. Over time, this could create a political taboo against debris-creating ASAT tests, similar to how international stigma shapes nuclear and chemical weapon norms. The approach is inexpensive and politically mild but may have an uneven impact if some states prioritise security gains over reputation.

- *Suspension of Benefits and Privileges*

A stronger mechanism introduces practical consequences for non-compliance. A state found in breach could lose access to shared SST/SSA data, early-warning briefs, or technical cooperation programmes. It could also be suspended from participating in joint projects, chairing meetings, or voting in a (new) political forum. These measures raise the cost of violation while maintaining proportionality and offering a clear path back to compliance once corrective action is taken.

5.5 Screening of Design Ideas

This section assesses all ideas collected from literature, comparative regimes, and expert interviews against the three yes/no requirements defined earlier: minimum verifiability, no disarmament and Outer Space Treaty Compatibility. The aim is to transparently filter the design space and retain only those options that are technically observable, legally coherent, and consistent with the peaceful-use principles of the Outer Space Treaty. The assessment is organised around three main design elements: the agreement scope, the verification system, and the consequence and enforcement mechanism**.** The tables are divided into the three design element groups, with the design ideas I have placed accordingly, where they fit. The result of this screening is a refined set of viable design options that will form the basis for the final morph chart and the development of three coherent institutional scenarios.

Design idea (agreement scope)	*Minimum verifiability*	*No Disarmam ent*	*OTS-compatibility*
DA-only debris ban	Pass	Pass	Pass
All-kinetic debris ban	Pass	Pass	Pass
Any-debris creation ban (technology-neutral)	Pass	Pass	Pass
Soft-law declaration on debris outcomes (code/political pledge)	Pass	Pass	Pass
Positive obligations (share SSA data; cooperate on best practice; support mitigation/R&D)	Pass	Pass	Pass
Zonal stringency annex (stricter in LEO)	Pass	Pass	Pass
Lifecycle prohibitions (develop/poses/stockpile ASATs)	Pass	Fail	Pass
Export-control style clauses (Wassenaar-type bans)	Pass	Fail	Pass

Table 4: Screening of Design Ideas (agreement scope)

For agreement scope, all outcome-based ideas pass: DA-only, all-kinetic, and any-debris bans; soft-law framing; positive obligations; non-assistance/due diligence; zonal stringency; and post-incident remediation. These target what happens in orbit and are observable with today's SSA, while staying treaty-neutral under the OST principles of due regard, responsibility, and avoidance of harmful contamination. Ideas that regulate capabilities rather than outcomes (lifecycle prohibitions, possession bans, and embedding export controls as core treaty rules) fail the no disarmament test.

Design idea (verification)	*Minimum verifiability*	*No disarmament*	*OTS-compatibility*
Unilateral verification (National Technical Means)	Pass	Pass	Pass
Multilateral verification (shared SST data or regional cooperation)	Pass	Pass	Pass
Independent technical body (central data analysis without inspections)	Pass	Pass	Pass
Public–private verification (integration of commercial SSA data)	Pass	Pass	Pass
Transparency and pre-notification obligations (inspired by ATS)	Pass	Pass	Pass
National licensing for compliance (domestic supervision of operators)	Pass	Pass	Pass
Global debris database and data-sharing mechanism	Pass	Pass	Pass
PPP consortium for verification services	Pass	Pass	Pass
On site-inspections (Standing inspectorate with site access)	Fail	Pass	Pass

Table 5: Screening of Design Ideas (verification system)

All verification ideas relying on SSA observation and cooperative data analysis meet both the minimum-verifiability and treaty-neutrality standards. They build on existing sensor networks and promote transparency without requiring intrusive measures or access to classified information. Proposals involving intrusive inspections, cyber-attacks or intent-based verification fail the minimum-verifiability criterion, since they depend on information that SSA cannot (confidently) provide or that states would not realistically share, as described in the NSO report on verification. Specifically, on-site inspections go far beyond the "minimum" standard of using orbital SSA data to observe an effect.

Design idea (consequence)	*Minimum verifiability*	*No Disarmament*	*OTS compatibility*
Transparency-only (information sharing and reporting)	Pass	Pass	Pass
Public pressure and stigmatisation (naming and shaming)	Pass	Pass	Pass
Suspension of benefits and privileges (loss of data access, cooperation rights)	Pass	Pass	Pass
Collective consultation / consultative body and response process (based on ATS model)	Pass	Pass	Pass
Optional PCA/ICJ arbitration or mediation (by consent)	Pass	Pass	Pass
Legal sanctions or compulsory tribunal (automatic binding decisions)	Pass	Pass	Fail

Table 6: Screening of Design Ideas (enforcement)

Most consequence and enforcement ideas pass all three requirements. Transparency, public reporting, reputational measures, suspension of benefits, and collective consultation are all observable, disarmament-neutral and align with the Outer Space Treaty's principles of due regard and peaceful cooperation. A consultative body of states, based on the Antarctic Treaty Model, functions as a political hub that ensures these measures are applied collectively rather than unilaterally, maintaining legitimacy while avoiding punitive enforcement.

During my screening process, I made a critical distinction between two types of legal enforcement: compulsory and optional. The idea of a "compulsory tribunal with automatic binding decisions" failed the OST compatibility check. I have made this decision after the expert interview with the space law professor. The professor explained that existing treaties like the OST are "outdated," "vague," and have "no effective enforcement tools". The current system is simply not built for automatic, binding legal penalties. A compulsory tribunal would require creating a new, powerful legal authority that goes far beyond the existing, voluntary framework of the OST.

In contrast, the "Optional PCA/ICJ (by consent)" design option passed the check. This option aligns with the expert's analysis. The professor confirmed that these institutions, such as the Permanent Court of Arbitration (PCA) and the International Court of Justice (ICJ), could, in theory, be used to settle disputes. However, the professor immediately stressed that this has never happened due to "political caution" and the "absence of precedent". This confirms that the only legally compatible path is one based on voluntary consent, where states must choose to use a court for a specific dispute.

5.6 The final design space

The screening of ideas against my requirements results in the following ‘menu of options’ as listed below. I have broken down my main elements into sub-elements. The idea is that one choice can be made per sub-element for all elements. The result of these choices is a ‘final design’ which I will explore in the next chapter. My design space can be drawn as follows:

Main Element	*Sub-Element*	*Option 1*	*Option 2*	*Option 3*	*Option 4*
Agreement Scope	1. Specification	**DA-only debris ban**	**All-kinetic debris ban**	**Any-debris creation ban (technology-neutral)**	
	2. Location	**Only LEO**	**All orbits**		
Verification System	1. Verification Technique	**Unilateral means (NTM / SSA)**	**Multilateral means**	**Public–private integration (commercial SSA)**	
	2. Verification Body	**Unilateral (NTM)**	**Multilateral data-sharing cell**	**Independent technical body (no inspections)**	**PPP consortium**
Consequence & Enforcement	1. Consequence Level	**Transparency-only**	**Public pressure & stigmatisation**	**Suspension of benefits & privileges**	
	2. Enforcement Body	**Unilateral state action**	**Consultative body**	**Optional PCA / ICJ (by consent)**	

Table 7: The Final Design Space

The design elements can be read as follows: My design will specify what the agreement is, at what altitude it applies, how it can be verified, by whom it will be verified, what the consequences are when the agreement is broken, and who will enforce those consequences.

Several cross-cutting or supporting ideas (mostly from expert input) were initially included as potential add-ons to strengthen cooperation and transparency across the design space. However, after screening and conceptual refinement, most of these elements are either already integrated within the existing design elements or fall outside the direct scope of this research. The positive obligations and non-assistance clauses, while valuable for norm-building, were excluded to maintain focus on verifiable outcomes rather than procedural duties. The idea of a global debris database remains a desirable long-term goal and is now framed as a striving objective for the independent technical body and public–private consortium, rather than as a separate design element. Pre-notification requirements are treated as a default component that can be applied under any agreement scope, reflecting standard transparency practice. National licensing mechanisms are considered outside the research scope, as they relate primarily to domestic governance rather than international institutional design. ESG integration is already implicit, since the agreement's focus on debris generation directly supports environmental and governance standards. The soft-law declaration remains included as one of the design scenarios itself. Finally, the zonal annexe concept is incorporated into the existing LEO/all-orbit division, while peer-pressure mechanisms are already represented within the public pressure and stigmatisation category. Simplifying the morph chart in this way ensures that only core, directly relevant institutional options remain, while still acknowledging the broader context in which such a regime could evolve.

Chapter 6: Building and Evaluating Institutional Scenarios

In this chapter, I explore institutional design options to build from my final design space. The goal is not to identify a single ideal solution, but to understand how different institutional choices relate to the design goals I have defined earlier. I use a structured design space that breaks down the problem into six sub-elements: agreement specification, agreement location, verification technique, verification body, consequence level, and enforcement body. Each sub-element offers a range of options that can be combined into distinct institutional configurations.

The chapter proceeds in several parts. First, I identify combinations of design choices that are infeasible or incompatible, and those that are naturally interdependent. Then, I present three internally coherent institutional scenarios, each anchored in a different agreement specification. After that, I qualitatively evaluate each scenario against three design goals: debris prevention, accountability, and political feasibility. I then compare the scenarios to highlight the trade-offs, showing how each prioritises different objectives.

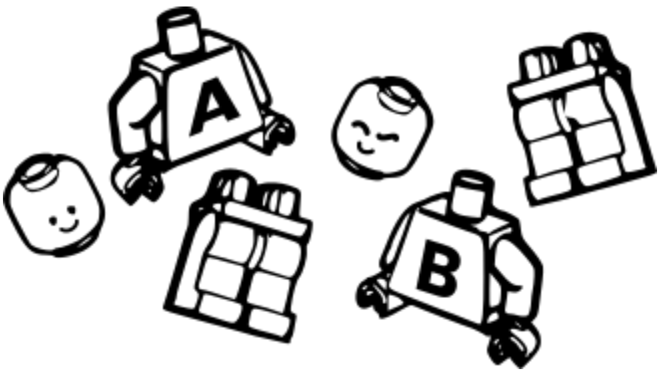

Figure 3: LEGO parts metaphor for design elements (Minifig Parts) – graphically edited by the author

This image illustrates the "design options" methodology I use in this chapter. Just as building this figure requires combining a head, a torso, and legs, building a complete institutional design requires choosing from different elements. My design space is structured into elements such as 'Agreement Scope', 'Verification System', and 'Consequence &

Enforcement'. To create a coherent design, I must select and combine complementary options from each of these categories. Not all parts fit together; my analysis first identifies these "infeasible combinations" before building three complete, functional "scenarios".

6.1 Infeasible, Dependent and Weak Design Combinations

The design space isn't a free-for-all. Not all mix-and-match options in the six sub-elements can work in practice. Some pairings are technically unworkable or institutionally contradictory. Certain options naturally lock together, while others repel each other. To create a realistic institutional design, I must select complementary elements from each sub-element.

- *Infeasible Design combinations*

Not all components from the design space can be combined. The following combinations were therefore deemed infeasible and excluded from my scenarios.

Cells combined	*Why it does not work*
Any-debris creation ban + Unilateral verification (technique) + Unilateral body	Scope is broad and multi-method; a single state's NTM cannot credibly attribute non-kinetic or small events on its own. Disputes would dominate.
Any-debris creation ban + Only LEO	Non-kinetic or indirect effects outside LEO would be unregulated. This breaks the technology-neutral logic of "any debris".
Public–private verification (technique) + Unilateral body	If the technique relies on mixed state–commercial data, the body cannot be purely unilateral. At minimum a PPP or multilateral node is needed.
Suspension of benefits & privileges + Unilateral state action	Suspension presumes shared benefits and rules. One state cannot suspend others from a regime by itself. Needs a consultative body.
Optional PCA/ICJ (by consent) as sole enforcement body	It is optional and case-by-case. It cannot stand alone and it an escalation method. A political forum is still required for routine findings and responses.

Table 8: Infeasible Design Combinations

- *Dependent combinations*

Conversely, some design choices naturally "lock in" others. The following combinations represent these logical pairings that help build coherent and functional scenarios.

Anchor choice	*Required*	*Reason*
DA-only debris ban	Only LEO (or clearly described LEO focus)	DA testing risk is concentrated in LEO; matching scope and location keeps the instrument tight and credible.
All-kinetic debris ban	All orbits	Co-orbital and higher-orbit risks exist outside LEO. All-orbit coverage closes obvious loopholes.
Any-debris creation ban	All orbits + Multilateral verification (technique)	Technology-neutral scope needs comprehensive coverage and pooled data to attribute incidents fairly.
Public–private verification (technique)	PPP consortium or Independent technical body (verification body)	Commercial data implies a body that can host, validate and publish mixed-provenance data.
Suspension of benefits & privileges (consequence)	Consultative body (enforcement)	Someone must decide and administer suspensions. That is a conference or committee, not a single state.
Public pressure & stigmatisation (consequence)	Consultative body	Joint findings give reputational effects legitimacy.
Transparency-only (consequence)	Unilateral or Consultative body (both feasible)	With a light regime, either states report individually, or a simple forum notifies incidents.
Multilateral verification (technique)	Multilateral data-sharing cell (body)	Pooled SST requires a hub to compare, fuse and publish results.
Optional PCA/ICJ (by consent)	Consultative body (primary)	The body handles routine business; rare, consent-based cases may be referred to PCA/ICJ.

Table 9: Dependent combinations

- *Possible but weak combinations:*

Finally, a third category of combinations exists: those that are technically possible but strategically weak. These pairings are not contradictory, but they are inefficient or create a mismatch between the problem and the solution. While functional, these combinations represent a poor institutional design and were therefore not selected.

Cells combined	*Why it is weak*
DA-only debris ban + All orbits	Over-broad for a narrow behaviour; invites bargaining on exceptions without added benefit.
All-kinetic debris ban + Unilateral verification	Kinetic events are visible, but unilateral findings will be contested. Better to use multilateral pooling.
Transparency-only + Independent technical body	Costly body for a very light consequence set. Works, but efficiency is poor unless stepping-stone to stronger measures.

Table 10: Possible but weak combinations

6.2 Building the three designs

In the previous section, I refined my "final design space" by identifying infeasible, dependent, and weak combinations. This leaves me with a refined 'menu' of viable options. My selection strategy is to anchor each design in one of the three 'Agreement Scope' options. This is my starting point. The scope of the ban (what is being forbidden) is the most fundamental decision, and it logically shapes all other institutional choices. As my "dependent combinations" table showed, the choice of scope (e.g., "DA-only" vs. "All-kinetic") strongly influences the required verification and consequence mechanisms. By starting with each of the three scope options, "DA-only," "All-kinetic," and "Any-debris", I will systematically build three distinct, internally consistent scenarios. I aim to select three clear archetypes: a narrow, feasible model; an intermediate model; and a broad, highly ambitious model. This approach allows me to highlight the core trade-offs of this research.

Design 1: DA-only debris ban (narrow)

Main Element	*Sub-Element*	*Option 1*	*Option 2*	*Option 3*	*Option 4*
Agreement Scope	1. Specification	**DA-only debris ban**			
	2. Location / Coverage	**Only LEO**			
Verification System	1. Verification Technique	**Unilateral means (NTM / SSA)**			
	2. Verification Body	**Unilateral**			
Consequence & Enforcement	1. Consequence Level		**Public pressure & stigmatisation**		
	2. Enforcement Body		**Consultative body (CSP)**		

Table 11: Design 1

The agreement in this scenario is a precise and limited rule: it bans only direct-ascent (DA) missile tests that create debris. In practice, this means the agreement targets the *most visible and high-risk* events, like the tests conducted by China in 2007 and Russia in 2021. By focusing only on this specific action, it avoids complex debates over other weapon types. The rule also applies only to Low Earth Orbit (LEO), the most congested and threatened region. This narrow scope makes the agreement politically realistic and a feasible first step.

Verification for this ban is based on Unilateral National Technical Means (NTM). This is the most practical, low-cost approach, as it does not require the creation of a new international body. It means that spacefaring nations (such as the US, China, Russia, and European partners) use their existing radars, telescopes, and SSA systems to monitor compliance. There is no shared, objective "truth"; instead, a state that detects a violation must present its own national findings as evidence.

When a violation is detected, the consequence is limited to public pressure and stigmatisation. The state that gathered the evidence brings it to a ‘Consultative Body of States’, which acts as a political forum, inspired by the body of the Antarctic Treaty. The body’s only power is to receive, discuss, and publicly report these findings. The only "punishment" is the political cost and reputational damage of being publicly named and shamed. This design is therefore high on political feasibility but low on formal accountability.

Design 2: All-kinetic debris ban

Main Element	*Sub-Element*	*Option 1*	*Option 2*	*Option 3*	*Option 4*
Agreement Scope	1. Specification		**All-kinetic debris ban**		
	2. Location / Coverage		**All orbits**		
Verification System	1. Verification Technique		**Multilateral means (pooled SSA / MRV)**		
	2. Verification Body		**Multilateral data-sharing cell**		
Consequence & Enforcement	1. Consequence Level		**Public pressure & stigmatisation**		
	2. Enforcement Body		**Consultative body**		

Table 12: Design 2

This design is more ambitious than the first. The agreement is a broad ban on all kinetic actions that create debris, and it applies to all orbits. This is a significant step up from Scenario 1. It bans *any* intentional physical impact, closing the loophole on co-orbital attacks (where one satellite rams another) and other collision-based activities. By covering all orbits, it protects vital assets in MEO and GEO, not just LEO, addressing a much wider range of physical threats.

Because this broader range of activities is harder to track, verification is a cooperative, trust-building effort. States share their observations through a multilateral data-sharing cell, using pooled SSA data. In practice, this central "cell" would receive and fuse tracking data from all participating members. This creates a single, more authoritative, and credible report on any suspicious event. This collective finding is much harder for a violating state to deny than a single nation's unilateral accusation.

The consequence in this model is public pressure and stigmatisation. This is a stronger tool than simple transparency. When the multilateral data cell confirms a violation, a 'Consultative Body of States' issues a statement of condemnation based on this authoritative report. This unified political response creates high reputational costs for the violator. This scenario still relies on "naming and shaming," but it does so by shared data, giving it a more ambitious level of accountability than in design 1.

Design 3: Any-debris creation ban (broad, technology-neutral)

Main Element	*Sub-Element*	*Option 1*	*Option 2*	*Option 3*	*Option 4*
Agreement Scope	1. Specification			**Any-debris creation ban**	
	2. Location / Coverage		**All orbits**		
Verification System	1. Verification Technique			**Public–private integration (commercial SSA)**	
	2. Verification Body				**Independent technical body (no inspections)**
Consequence & Enforcement	1. Consequence Level			**Suspension of benefits & privileges**	
	2. Enforcement Body		**Consultative body**	**optional PCA/ICJ can exist by consent if parties want.**	

Table 13: Design 3

This is the most comprehensive and future-proof design. The agreement is a technology-neutral, outcome-based prohibition on deliberate fragmentation events that create debris in all orbits. In this thesis, "debris creation" does not mean all sources of orbital debris. It refers to the deliberate, active production of new debris through a destructive event such as an ASAT test. Routine end-of-life situations, such as a non-functional satellite remaining in orbit, are not treated as a violation under this scope.

The core idea is simple: if a state deliberately causes the break-up of a space object into new orbital fragments during a test or demonstration, this behaviour falls within the scope of the rule, regardless of the method used. "Technology-neutral", therefore, means that the prohibition is not written around a list of weapon types. It is written around the observable outcome, namely, a fragmentation event that creates new debris. Actions that do not produce such an observable fragmentation outcome fall outside the main prohibition. This agreement also does not address wartime scenarios.

To keep this rule workable, the agreement separates deliberate tests from other break-ups through narrow procedural exceptions. Accidental collisions and verified non-deliberate break-ups are not treated as violations, but they trigger a duty to notify and to cooperate in clarifying the incident. This keeps the prohibition focused on preventing harmful behaviour, while avoiding intent disputes as the main legal test.

Verification for this advanced agreement is managed by an "Independent technical body". This body would be a neutral, impartial arbiter, removing the political bias inherent in states verifying one another. As one expert suggested, this could be a newly created entity or an expanded mandate for an existing organisation, such as the International Telecommunication Union (ITU). To create its reports, it would integrate data from *all* sources: national and commercial public-private partners. This gives it the most complete and trusted view of the orbital environment.

The consequence here is the strongest. When the independent body issues a neutral, technical report of a violation, a Consultative Body of States can vote on a "Suspension of benefits and privileges". This is a tangible, political sanction. In practice, the violating state could lose its access to shared SSA data feeds, its right to vote, or its eligibility for joint technical cooperation programs. This is a proportionate and reversible penalty that imposes a real cost for non-compliance, thereby enhancing accountability.

In addition to this political track, this design also provides an optional legal path. The verification body of states remains the primary body for managing compliance and imposing political consequences. However, if two or more states in a specific dispute *mutually agree*, they may choose to use existing legal mechanisms, such as the Permanent Court of Arbitration (PCA) or the ICJ, to reach a binding settlement. This keeps the system politically feasible by ensuring the legal path is based on *consent*, not compulsion, which aligns with expert insights on the current cautious state of space law

6.3 Evaluation of the designs

To assess these three scenarios, I used a qualitative and relative scoring method. I evaluated each design against the three main design goals I established earlier: Debris Prevention, Accountability, and Political Feasibility. This scoring is qualitative and relative, not a numerical measurement. The three goals are not weighted. Each score reflects how well a design meets a goal compared to the other two designs.

A “High” score means the design strongly supports the goal with only minor weaknesses. A “Medium” score means the design supports the goal in a meaningful way but leaves an important gap or trade-off. A “Low” score means the design supports the goal only weakly or relies on assumptions unlikely to hold under current political conditions.

The scores can be traced back to three key assumptions: 1. Scope drives effectiveness: A broader agreement scope (like banning all debris) is assumed to be better at preventing debris. 2. Verification strength drives accountability: A more independent and cooperative verification system (like a multilateral body) is assumed to create stronger accountability. 3. Institutional complexity drives feasibility: A more complex and intrusive design (like requiring shared data or an independent body) is assumed to be less politically feasible and harder to get adopted.

This reasoning leads to the following assessment:

Design	*Debris prevention*	*Accountability*	*Political feasibility*
1. DA-only debris ban	Medium	Low	High
2. All-kinetic debris ban	High	Medium	Medium
3. Any-debris creation ban	High	High	Low

Table 14: Evaluation of the designs

- *Evaluation of Design 1: DA-only debris ban*

This scenario scores High on Political Feasibility. It is the simplest and least intrusive option. It asks relatively for relatively less: do not conduct the one test that is already widely condemned. However, its Debris Prevention is only Medium. While it bans the most common type of test, it leaves a gap. It does not stop a state from developing and testing a co-orbital "ramming" satellite, which also creates debris. Its Accountability is Low. Verification is unilateral, meaning a finding of non-compliance is just one state's word against another's. The consequence of "transparency-only" has no real teeth. A state could conduct a test, deny it, and face no formal, collective consequences beyond bad press.

- *Evaluation of Design 2: All-kinetic debris ban*

This scenario scores High on Debris Prevention. By banning all intentional kinetic (physical) impacts, it closes the major loopholes left open by Scenario 1. It directly prohibits co-orbital attacks and applies to all orbits. Its Accountability is Medium. The multilateral data-sharing cell is a significant improvement. A finding of non-compliance is no longer one state's word; it is a collective, data-backed report. This makes the "public pressure" consequence far more credible and politically costly for the violator. This design has Medium Political Feasibility. It is the "middle-ground" compromise. It requires a higher level of trust, as states must share sensitive SSA data. On the other side, for political feasibility, it focuses only on observable physical actions and does not require a new, independent organisation or intrusive inspections.

- *Evaluation of Design 3: Any-debris creation ban*

This scenario scores High on Debris Prevention. By being “technology-neutral”, it bans any deliberate method that causes a detectable fragmentation event and creates new orbital debris, including future ASAT approaches that do not fit today’s categories. It also scores High on Accountability. This is the only design with *real* consequences. The "Independent technical body" acts as a neutral, trusted referee, making its findings hard to dispute.

Crucially, the "Suspension of benefits" is an ambitious penalty. Losing access to shared SSA data or technical cooperation is a relatively strong punishment. However, this scenario scores Low on Political Feasibility. This design is the most ambitious and the most intrusive. It asks major powers to share data with an independent body and to give that body the power to facilitate real consequences. This requires a level of international trust and cooperation that does not currently exist.

- *Reflection on the trade-off*

This assessment shows a fundamental trade-off between feasibility and accountability. From the design goals I formulated earlier, I assess that Design 1 is the most feasible but the least effective. Scenario 3 is the most effective but the least feasible. Design 2 is the balanced, middle-ground compromise.

Choosing one design goal as a priority directly shapes which design choice is most appropriate. Scenario 1 works best when political feasibility is the main concern, as it provides a light, acceptable first step. Scenario 2 increases prevention and verification, but it requires greater trust and coordination. Scenario 3 reaches the strongest levels of prevention and accountability, but this ambition makes it politically difficult to adopt.

Reflecting on the results so far, three designs can also be interpreted as a stepwise pathway rather than a single choice. A lighter, narrower rule can be a Phase 1 that builds shared language and lowers political barriers. A broader rule with cooperative verification can be a Phase 2 that increases credibility through shared reporting. A stronger regime with an independent body and tangible consequences can be a Phase 3 that becomes more realistic as trust and practice grow. This pathway view supports the idea that institutional strength can be built over time.

Chapter 7: The Netherlands' Role

In this final part, I examine how the Netherlands could help advance these designs in practice. While the previous chapter compared how the designs perform, this part focuses on what the Netherlands can do to make them happen internationally. The Netherlands has a mix of strengths: it is respected for its diplomacy, known for hosting prominent legal institutions in The Hague and has strong technical expertise in space research and engineering. These qualities make it a country that can connect larger and smaller space actors and build trust between them. Based on insights from the literature and expert interviews, I discuss three possible ways the Netherlands could play a role: reframing the debate, using middle-power diplomacy, promoting arbitration and legal settlement in The Hague, and offering technical leadership.

7.1 Reframing the debate

A crucial strategy for the Netherlands, confirmed by expert interviews, involves reframing the entire debate. Instead of focusing on the deadlocked "security" and "disarmament" track, the Netherlands can achieve more by leading on sustainability and space safety. An expert specifically recommended using the UN COPUOS (Committee on the Peaceful Uses of Outer Space) as the primary forum for new ASAT-ban agreements, describing it as a more apolitical, expert-driven "space safety forum" where consensus is more achievable. This approach is practical because it builds on existing agreements, of which the Debris Mitigation Guidelines and the UN Long-Term Sustainability (LTS) Guidelines are another example. This strategy directly supports the implementation of all three of my proposed designs: it allows the Netherlands to introduce each of the designs not as a weapons rule, but as a critical debris mitigation measure.

One expert suggested that the Netherlands should frame its efforts not in terms of "arms control," but as environmental and technical cooperation. This approach avoids political tension while still promoting sustainability and safety in space. It also connects with the Netherlands' wider foreign policy image as a country that promotes peace, responsible innovation, and environmental protection.

7.2 Middle Power Diplomacy

The Netherlands is a good example of a middle power. According to the Clingendael Institute (n.d.), middle powers are not global superpowers, but they still have enough influence to shape international norms. They do this mainly by building coalitions, promoting dialogue, and supporting international law. For the Netherlands, this means helping to protect global public goods such as peace, the rule of law, and responsible behaviour in new domains, such as outer space. As a middle power, the Netherlands has a reputation for multilateralism and bridge-building, making it well-suited to serve as a connector between major space powers and smaller emerging actors. (Fritzler et al., 2025) notes that small and liberal states such as the Netherlands, Canada, and Japan often succeed by forming values-based coalitions. Working with these partners could help the Netherlands introduce new norms on responsible space behaviour, as it has in other policy areas.

Based on both the literature and the interviews I conducted, I learned that the Netherlands could use this position to lead coalitions of like-minded countries that want to limit debris and strengthen space security. One expert explained that the Netherlands can create momentum in discussions where larger powers are divided, because it is seen as neutral and trustworthy.

One expert clarified that the Netherlands is clearly a member of the Western bloc (NATO and EU) and supports the UK-led behavioural approach to develop norms. However, the Dutch position is not, in principle, against legally binding measures. Its opposition to proposals like the PPWT is based on substantive technical grounds, such as their unverifiability and lack of definitions. The Dutch diplomatic strategy is that a comprehensive treaty is currently unachievable; therefore, agreements on ASATs must be made step by step, beginning with norms. Here, it’s "middle power" diplomacy that gives potential. The Netherlands' diplomatic power lies in its ability to introduce challenging ideas and, critically, to "move the middle groups", as an expert explained. This refers to building coalitions with key countries in the Global South, such as India, Brazil, and South Africa, to build support. A concrete example of this strategy is the Dutch-led joint statement, which demonstrated that the behavioural (norms-based) and legal (treaty-based) approaches need not exclude one another.

Another potential is what (Behringer, 2005) calls fast-track diplomacy, in which small groups of like-minded countries collaborate with NGOs and experts to advance initiatives outside the slow UN processes. This approach has worked before, such as in the creation of the Ottawa Treaty on landmines and the International Criminal Court. The Netherlands could use the same method for ASAT governance by drafting proposals together with trusted partners, then promoting them more widely once they gain support.

Finally, Oosterveld & Torossian (n.d.) and one expert emphasised that to succeed as a middle power, the Netherlands must also reach beyond its traditional allies in the EU or NATO. Building ties with countries from the Global South or the Middle East can increase legitimacy and global support. This means using diplomacy that is not about taking sides but about enabling cooperation and building trust among all spacefaring nations.

7.3 Promotion of Arbitration in The Hague

Several experts said the Netherlands could leverage its strong reputation in international arbitration to play a central role in resolving future space-related disputes. The country already hosts important legal institutions such as the Permanent Court of Arbitration (PCA) and the International Court of Justice (ICJ), both based in The Hague. As one space law expert explained, these institutions could, in theory, handle disputes over debris or anti-satellite testing, but in practice, this has not yet happened due to political caution, the lack of legal precedent, and difficulties in collecting evidence.

Because of this, I think the Netherlands could position itself as a kind of “Switzerland of space”, as one expert put it: a neutral and trusted place for dialogue, mediation, and legal settlement. This idea was also supported by another expert, who suggested that the Netherlands could expand the PCA's mandate to cover space-related arbitration. This would fit naturally with the country’s diplomatic image and its long tradition of promoting peace and the rule of law.

In addition, an expert noted that if the Netherlands wants to remain a leader in this field, it should start building institutional capacity now. That could mean developing expertise, training legal specialists, and coordinating between government bodies, universities, and the space sector.

7.4 Providing Technical Leadership

Another way the Netherlands can support responsible space governance is by offering technical leadership. Small countries could increase their influence by focusing on areas where they already have strong expertise. (Fritzler et al., 2025) explain that countries such as the Netherlands, Denmark, and Sweden use what is called niche diplomacy, focusing on specific topics such as sustainability, international law, or human rights, and working with like-minded partners to make real progress. In the case of space security, the Netherlands could do the same by using its expertise in space technology, engineering, and law to support responsible behaviour and transparency. One expert noted that although the Dutch space sector is small, it is highly specialised and respected, particularly in optical and tracking technologies.

Kanie’s (2003) research also shows that strong domestic policies can increase a country’s international credibility. In the Kyoto Protocol negotiations, the Netherlands became more influential because it had ambitious climate goals and worked closely with businesses and researchers at home. The same logic can apply here if the Netherlands can strengthen its international position by supporting research through the Netherlands Space Office (NSO), improving Space Situational Awareness (SSA) capabilities, and maintaining a clear national stance against destructive ASAT testing. By maintaining EU-level cooperation, the Netherlands can combine its technical expertise with its diplomatic objectives.

Conclusion

This thesis explores how the Netherlands can help develop effective institutions to limit destructive anti-satellite (ASAT) tests and the debris they generate. I find that the Netherlands's best contribution lies in promoting a politically achievable, effect-based rule that addresses debris-generating actions and can be verified with current SSA tools. Additionally, the country can leverage its diplomatic and technical strengths to gather support. This conclusion is based on the key trade-off in the design options: while more ambitious policies could yield greater effectiveness and accountability, they currently face lower political feasibility.

Considering this trade-off, I suggest starting with Design 1, the DA-Only Debris Ban, as the most practical choice. This design implements a limited ban on debris-generating, destructive direct-ascent tests in LEO. It depends on unilateral verification and a consultative body to facilitate public reporting and influence reputation. The reason for choosing Design 1 initially is that it can be promoted without invasive verification or extensive enforcement, while still imposing political costs through transparency and public reporting. Additionally, I believe Design 1 offers a feasible initial step that can lead to stronger governance in the direction of Design 1 and Design 2 over time as broader support and consistent practice develop.

- *Policy implications for the Netherlands*

Design 1 can be linked to the Netherlands' role in several ways, as I have described the Dutch diplomatic strengths in Chapter 7. First, Design 1 depends on being understood as a practical measure to reduce debris risk. The Netherlands can support this by consistently framing the proposal as a space safety and sustainability measure, rather than as a disarmament initiative. COPUOS is possibly a suitable forum for this approach because it supports technical and sustainability-oriented discussion and helps connect Design 1 to existing space safety work. In this setting, the main Dutch contribution is to maintain focus on an effect-based rule that targets observable debris creation, so negotiations avoid capability debates and remain politically workable.

Firstly, a key strategy for the Netherlands, confirmed by expert interviews, is to reframe the debate. Instead of fixating on the deadlocked "security" and "disarmament" track, the Netherlands can lead on sustainability and space safety. An expert recommended using the UN COPUOS as the main forum for new ASAT-ban agreements, describing it as a more apolitical, expert-driven "space safety forum" where consensus is easier to reach. This builds on existing agreements like the Debris Mitigation and UN LTS Guidelines. This strategy supports all three proposed designs by framing them as debris mitigation measures rather than weapons rules. The Netherlands could frame its efforts as environmental and technical cooperation rather than arms control. This avoids political tension while promoting space sustainability and safety, aligning with the country's image as a promoter of peace, responsible innovation, and environmental protection.

Secondly, Design 1 becomes stronger in realising when many states repeat the same norm and treat violations as unacceptable. As a middle power, the Netherlands can build coalitions that make the norm appear shared rather than 'owned' by one bloc. This means that the Netherlands can coordinate a small group of like-minded states around a consistent, effect-based message: the rule targets observable debris creation from destructive direct-ascent testing in LEO, rather than weapons capability debates. Also, the Dutch diplomatic influence lies in "moving the middle groups", meaning key countries outside the traditional Western coalition. This matters because these states can increase legitimacy and reduce the perception that the proposal is only a Western preference. In practical terms, the Netherlands can use dialogue and bridge-building to show that Design 1 is a debris-mitigation norm that can be verified using existing SSA capabilities and does not require intrusive inspections. This aligns with the Dutch support for the UK-led behavioural approach, while not rejecting legally binding measures in principle, and opposing the PPWT mainly due to verifiability and definitional problems. The Netherlands can reach beyond EU and NATO partners to increase legitimacy, including ties with the Global South and the Middle East. The coalition work belongs mainly in the OEWG, where political positions and language are most visible. At the same time, the sustainability framing can be reinforced in COPUOS, which is to be treated as a more apolitical, expert-driven space safety forum connected to existing sustainability guidelines. Furthermore, fast-track diplomacy can be used to draft the core prohibition and basic transparency language, build shared talking points, and then carry them into the UN processes. This is to be done with small groups of like-minded countries working with NGOs and experts outside slow UN processes, and then promoting proposals more widely once support grows.

Third, Design 1 required unilateral verification through SSA and national technical means. In this case, the Netherlands can use its expertise in space technology, engineering, and law to support the knowledge of verification techniques and technology for design 1. Although the Dutch space sector is small, it is highly specialised and respected, particularly in optical and tracking technologies, giving the Netherlands credibility to take a leading role.

- *The Hague as The Netherlands' Unique Strength*

Beyond the specific mechanics of Design 1, I also conclude that the Netherlands can continue to promote The Hague as a neutral place for handling disagreements related to space behaviour, where states can voluntarily choose dialogue, mediation, or a legally binding settlement by consent. Several experts suggest the Netherlands could use its strong reputation in international arbitration to lead in resolving space disputes, as the country already hosts key legal institutions, such as the PCA and the ICJ, J in The Hague. While these could, in theory, handle disputes over debris or anti-satellite tests, political caution, a lack of precedent, and challenges in collecting evidence have prevented this. One expert compared the Netherlands to "the Switzerland of space", as a neutral, trusted hub for dialogue and legal settlement. Others proposed expanding the PCA's mandate to include space arbitration, aligning with its diplomatic tradition of peace and law. To stay a leader, the Netherlands should build institutional capacity by developing expertise, training specialists, and fostering coordination among government, academia, and the space sector.

This role is most naturally aligned with Design 3, the broader, technology-neutral, outcome-based prohibition supported by an independent technical function and tangible consequences, such as suspension of benefits. In that stronger model, a consent-based legal pathway can complement more formal findings and more severe consequences. However, across all designs, The Hague can remain available as a peaceful, voluntary route for dispute settlement if states decide that a legal or arbitral pathway helps prevent escalation.

Discussion

In this thesis, I developed and compared three institutional design scenarios. My evaluation shows a trade-off between political feasibility and institutional effectiveness. Designs that are more feasible under current political conditions tend to rely on lighter accountability tools, whereas designs that aim for stronger accountability are less feasible. I therefore interpret the three scenarios as alternatives and as possible phases in a longer-term pathway. To illustrate: an initial phase focused on a narrow, verifiable norm, followed by phases that strengthen credibility and accountability as political willingness and shared practice develop.

- *Discussing the results*

My results point to a practical and strategic direction: reframing the problem in terms of sustainability as an innovative way to respond to political gridlock in the OEWG. By focusing on the shared environmental problem of debris, this approach helps to avoid immediate deadlock in military "disarmament" debates. This strategy is supported by effect-based prohibitions, which focus on verifiable outcomes rather than unverifiable capabilities. By focusing on debris creation rather than specific technologies, the rule can remain technology-neutral and future-proof. This supports verifiability because sensors can detect the physical outcome of a test even when the actor's intent is contested.

I also found value in separating the ASAT testing question from wider "space sustainability" packages. Sustainability and safety measures are often discussed as a single, interconnected set of agreements, which can become rigid in diplomacy. For example, in security forums, ASAT restraints are frequently drawn into the wider PAROS and PPWT debate, where disagreements about definitions and verification can block progress. In parallel, space safety is often approached through a broad package of soft-law guidance, including the Debris Mitigation Guidelines and the UN Long-Term Sustainability (LTS) Guidelines. This kind of bundling can slow progress because states link issues together, so disagreement on one element can stall agreement on the whole package. By focusing on one concrete debris driver, I was able to make specific institutional trade-offs visible, even though this focus remains politically sensitive.

A further value of this research is that the design exploration shows how institutional tools from existing regimes, including the Antarctic Treaty, UNCLOS, and the TPNW, can inform governance approaches for problems in orbit. Beyond the specific design packages I present, these regimes demonstrate how shared-environment governance and security-related cooperation can be shaped by institutional structures, even in difficult political settings.

- *Discussing the method*

The formulated designs and the recommended starting point are results in their own right. They follow from explicit criteria choices, pass-or-fail screening, the use of verification literature, the selection of comparative regimes, and expert input. This design-oriented approach made my reasoning traceable and helps explain why certain options were excluded under binding constraints.

Ostrom's institutional grammar was valuable for structuring the components of an institutional design. It helped me to think systematically about rule components and to compare designs as packages of scope, verification, and consequences. At the same time, the framework does not, by itself, resolve political disagreement over whether a rule will be accepted, nor does it provide a detailed implementation strategy for highly polarised security settings. For that reason, I combined the framework with expert perspectives and feasibility screening.

I also deliberately chose a scope for membership. I did not specify a fixed list of state members for a future agreement, because the "who" is not a given and remains the central political problem. I focused on designing and evaluating the "what," namely, institutional models that were credible, verifiable, and feasible. The purpose was to support a pathway that can attract participation by key actors and by crucial "middle group" countries.

- *Discussing scientific insights*

One scientific challenge of this thesis is that it develops institutional designs for a governance problem in an emerging field. One of the contributions is therefore methodological. I aimed to show how an institutional design approach can translate abstract governance debates into comparable institutional packages, using explicit screening criteria and a structured design space. This improves transparency by making it clear why certain options become infeasible under my criteria.

A substantive lesson is that effect-based prohibitions can offer a practical design response in this domain because they focus on observable outcomes rather than disputed capabilities or intent. Disagreements about what a state possesses or intends are politically sensitive and hard to prove. An effect-based rule shifts attention to what can be observed in orbit, such as debris creation after a destructive event. This reduces ambiguity at the compliance level because discussion can focus on evidence of an outcome rather than on hidden military information.

A second lesson concerns the role of a middle power in a polarised setting. In this case, feasibility is not only a property of the rule itself, but also of the diplomatic pathway that can make the rule repeatable in real forums. Because A rule can look good on paper, but it only becomes "real" if states start using it in practice. In a polarised setting like ASAT governance, the big powers often disagree, making it hard to secure a strong treaty text. In that situation, feasibility depends on more than the wording of the rule. It also depends on whether there is a realistic diplomatic pathway that helps the rule become normal behaviour. That pathway consists of who repeats the rule, where it is discussed, how incidents are handled, and how trust is built over time. This is why the Netherlands' ability to reframe, build coalitions, and contribute technical credibility is relevant to institutional feasibility, especially when major power disagreement limits the prospects for comprehensive agreements.

- *Discussing scope limits and further research*

This thesis has several limitations that also point to directions for future research. First, the design space was informed by three comparative regimes. While this provided useful institutional tools, a broader study could analyse additional regimes and governance models to generate alternative options or strengthen specific design elements; the UNIDIR Handbook on Verification and Compliance, which I used in the design exploration, points to further relevant cases and verification practices. Examples of other models are the Paris Agreement and the United Nations Register of Conventional Arms.

Second, expert input was limited to four interviews. A next study could strengthen validation by conducting more interviews and expanding them across global regions and (non-Dutch) viewpoints. This could include additional expertise, such as technical SSA practitioners and more security-focused experts.

Third, the geopolitical climate affects feasibility. As one expert noted, the war in Ukraine has worsened the diplomatic environment, making consensus more difficult. This means that political dynamics in the OEWG and in future negotiations can change over time, depending on context.

Fourth, my analysis of private actors was intentionally limited. Commercialisation adds complexity and can connect commercial systems to conflict dynamics (Brown, 2022). It also raises questions related to State Responsibility under Article VI of the Outer Space Treaty, issues of neutrality, congestion pressures and competition for scarce resources. These developments were not fully addressed in my designs.

Fifth, my scenarios focus on banning testing in peacetime and do not address use in armed conflict. This is a different governance problem that would require a different legal and institutional scope.

Sixth, I focused on the military dimension of debris creation because a single destructive ASAT event can generate very large debris outcomes. However, this focus excludes other debris sources, including commercial and civil activities, as well as accidental events such as collisions or end-of-life break-ups. A next study could apply the same institutional design methodology to these other debris drivers.

Finally, Design 3 contains a scope risk if its language is not defined carefully. In this thesis, “debris creation” refers to the deliberate, active production of new orbital debris through a destructive fragmentation event, such as an ASAT test, and it does not cover routine end-of-life situations or other non-deliberate sources of debris. “Technology-neutral” means that the rule is written around the observable outcome, not around a list of weapon types. This improves resilience to future approaches, but it also creates a practical challenge because borderline cases may still be contested, especially when it is difficult to separate deliberate tests from accidental or unintentional break-ups. A next study could specify clearer thresholds and procedures for classifying fragmentation events and for handling uncertainty, while remaining consistent with the minimum verifiability boundary used in this thesis.

As a final scope note, I aimed to provide a holistic, macro-level institutional design rather than act as a legal, verification, or diplomatic specialist. This is why I focused on designing new institutional structures instead of providing a detailed legal amendment strategy for existing treaties. The same macro-level scope explains why I did not specify detailed legal procedures for a consultative body or the exact mechanisms for an optional referral to the PCA or ICJ. I present the designs as high-level blueprints that the Netherlands Space Office can use as structured input for further legal and diplomatic development.

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Appendix 1: Statement of use of AI

This thesis was written by the author. Generative AI tools were used in a limited and supportive way, mainly to improve clarity, organise notes, and support some formatting and visualisation. The author remains fully responsible for all research decisions, analysis, interpretations, and the final text.

The research topic, research questions, problem statement, background analysis, methodology, theoretical framework, requirements, and the overall thesis structure were developed by the author. The thesis title, the chapter order, and all chapter and paragraph titles were also set by the author. The layout of the document, including the cover page, was prepared by the author. Sources were identified by the author, with the help of experts and supervisors, but all sources were read and selected by the author, and the author decided how they were used in the thesis. All final writing decisions were made by the author, including what text was kept, removed, rewritten, or merged.

For writing support, Grammarly was used as a Microsoft Word extension to improve spelling, grammar, and style. In addition, ChatGPT (GPT-5) was used to help improve the readability of parts of the thesis. This included suggesting bridging sentences to improve flow between sections and helping rewrite some passages in clearer, simpler English. ChatGPT was also used to explain selected academic texts in simple English to support understanding, after which the author returned to the original sources and wrote the final text.

For interview work, the author designed the expert interview questions, conducted the interviews, and drew the conclusions. The interviews were transcribed using TurboScribe. ChatGPT (GPT-5) was then used to summarise parts of the transcripts and to help identify repeating themes and patterns across interview answers. These outputs were treated solely as support for organising qualitative material. The author made all interpretive judgments.

During the design work, ChatGPT was used to support brainstorming and organisation. It was used to produce a list of possible comparative regimes for the design space exploration. It was also used to organise design space ideas in a table to support an initial screening of options against the design goals. Gemini was used only as a navigation aid to locate potentially relevant parts of a UNIDIR document, after which the author read the original document and performed the analysis.

The list of definitions was also supported by ChatGPT through suggested candidates, but all definitions were verified and edited by the author before inclusion. For Chapter 7, all analysis and sources were found by the author, while ChatGPT was used to help organise notes and restructure paragraphs. ChatGPT was also used for practical support with reference management, including guidance on using Mendeley.

AI tools were not used to generate original empirical findings or to replace academic judgment. All arguments, interpretations, design choices, and conclusions are the responsibility of the author, and all AI outputs were reviewed and edited before being included in the final thesis.

Appendix 2: Expert Interview Summaries

Interview Summary Expert 1, Space Policy Advisor 1

This interview was conducted with a policy advisor involved in international space sustainability efforts. The advisor strongly confirmed that intentional debris generation, especially through ASAT (anti-satellite) testing, represents a major global risk. From both a safety and security standpoint, such activities are profoundly damaging—particularly because debris persists in orbit for decades and poses threats to civilian and military assets alike. The interviewee highlighted the interdependence of modern society on space infrastructure, pointing out that a single ASAT event in a busy orbital regime could trigger cascading failures. These failures might disrupt navigation, telecommunications, or emergency systems—impacting people on the ground and critical global infrastructure.

When asked about the most relevant legal instruments, the advisor noted that although they are not a space lawyer, their work deals extensively with the practical application of international norms. In that context, they considered the UN Long-Term Sustainability (LTS) Guidelines (2019) and the Space Debris Mitigation Guidelines as the most influential. Despite being non-binding, these guidelines are widely implemented at the national level—including within Dutch space law—because they were adopted by consensus through COPUOS (the UN Committee on the Peaceful Uses of Outer Space). The advisor stressed that while these norms do not directly regulate military ASAT activities, their principles apply universally: space debris is harmful regardless of its source.

On the military side, the advisor emphasized that no binding agreement currently exists to regulate ASAT activities or military-driven debris creation. The ongoing Open-Ended Working Group (OEWG) under the UN has become the central venue for addressing this gap. The advisor viewed this as a more promising path than relying on traditional treaties such as the Outer Space Treaty (OST). They acknowledged that the original space treaties are legally binding but outdated. They were never designed to deal with complex issues like intentional orbital denial or modern military technologies. The advisor highlighted that current enforcement mechanisms in international space law are virtually non-existent; naming and shaming remains the only tool in the absence of true accountability.

The conversation also examined the practical irrelevance of certain legal instruments in daily space diplomacy. For instance, while the OST and Artemis Accords may appear relevant in academic discussions, the advisor observed that they are rarely mentioned in operational or diplomatic practice related to debris or ASAT matters. In contrast, real progress is being attempted through diplomatic negotiations and consensus-building efforts, such as the OEWG or official UN statements where countries—including the U.S.—have pledged to abstain from conducting ASAT tests. These voluntary, diplomatic declarations represent a form of soft law that, while non-binding, help shape international norms.

When discussing why enforcement gaps persist, the advisor offered two main explanations. First, the existing treaties are technologically outdated and ill-equipped to handle the rapid evolution of space activities. Second, and perhaps more importantly, many countries resist creating new legal obligations, preferring instead to maintain operational freedom in space. For example, some countries are actively blocking negotiations within the OEWG process, as seen in Russia's recent behavior. Others may resist being held accountable due to the strategic advantages that space control can provide.

The interview then turned to the possible policy approaches for managing the problem. The advisor supported diplomatic agreements and soft law approaches—emphasizing that they are often more viable than attempting to negotiate new treaties. For instance, states have issued formal statements at the UN pledging to avoid ASAT testing. Though these statements are not enforceable, they represent shared commitments that can guide future action. Additionally, the advisor saw technology and innovation as playing a critical role in mitigating debris risks. Examples included: Reusable launch systems (e.g., space planes), Modular satellite design, In-orbit servicing and refueling, Material science advancements to improve breakup behavior and burn-up during reentry. These technologies, while largely driven by civilian initiatives, have the potential to significantly reduce unintentional debris and offer indirect tools for resilience against military-origin hazards.

On the subject of economic incentives, the advisor acknowledged the concept but noted that applying such mechanisms in space governance is still underdeveloped. However, they recognized the value of aligning sustainability efforts with market-driven or technological solutions.

Turning to the Netherlands' role, the advisor described the country as a small but influential diplomatic actor. The Netherlands has a strong reputation in legal fields—especially maritime and space law—and is an active participant in the UN and international dialogues. The government has signed and ratified all five core space treaties and has shown leadership in advocating for responsible space behavior. The NSO's involvement in supporting this research was cited as an example of the country's ongoing engagement. The Netherlands is seen as well-positioned to push forward constructive dialogue, especially by offering clear policy positions and contributing to the OEWG discussions.

When asked about specific strategies the Netherlands could use to influence more resistant states (e.g., in the Eastern bloc), the advisor declined to speculate, saying it was still too early to offer concrete answers. However, they reiterated that the Netherlands' current strategy—being an active, constructive participant in negotiations—remains appropriate and effective.

The interview closed with a discussion of potential analogies and lessons from other global governance domains. The advisor found the climate regime, particularly the Paris

Agreement, to be a useful reference point. Like space debris, climate change is characterized by global externalities, delayed consequences, and uneven responsibility. They suggested that transparency measures—such as reporting obligations and shared behavior expectations—could be imported from the climate context into space governance. While maritime law may be structurally more similar to space law, the political and environmental logic of climate agreements offered richer insights into how to manage diffuse, long-term, cross-border risks.

In closing, the advisor reflected that the combination of diplomatic agreements, responsible innovation, and multilateral dialogue offers the most realistic path forward in addressing ASAT threats. They encouraged further study into soft enforcement mechanisms, technology-driven mitigation, and cross-domain learning from other global governance models.

Interview Summary Expert 2, Space Policy Advisor 2

In this interview, the space law policy advisor shared perspectives on the increasing risks posed by anti-satellite (ASAT) tests and the broader challenges of regulating space debris.

The advisor acknowledged the validity of the problem statement: that ASAT testing presents a growing threat to space safety and sustainability, and that the current international legal framework lacks enforceable mechanisms. The expert pointed out that most existing treaties are based on state-to-state agreements, and enforcement through global institutions like the United Nations (UN) is limited. The UN, designed to foster peace among nations, would need a major transformation to take on a more active enforcement role in space governance, effectively turning it from a diplomatic forum into a space police authority.

The expert proposed that rather than assigning the UN a new policing function, it might be more realistic and politically acceptable to rely on international agreements or treaties that include social pressure mechanisms. These would obligate states to clean up space debris they cause, using soft power tools like public accountability and peer pressure to encourage compliance.

The conversation also explored existing legal mechanisms such as the Liability Convention, which states that countries are responsible for damage caused by their space objects. However, the advisor noted that enforcement of this principle is weak. The expert emphasised the importance of verifiability, feasibility, cost-effectiveness, and resistance to fraud as key criteria for any new regulatory framework. In the experts view, the lack of strong enforcement can allow countries to avoid responsibility, which undermines the whole system.

Another major point discussed was the geopolitical divide seen in space governance forums, such as the UN's Open-Ended Working Group. Western states, including the Netherlands, generally prefer soft law approaches and voluntary norms for responsible behaviour. In contrast, countries like Russia and China demand binding legal obligations, including on military uses of space. The advisor suggested this deadlock partly stems from cultural differences in legal and diplomatic traditions. The expert referenced cultural theories, such as Hofstede's dimensions, to explain why some nations prefer strict rules while others lean toward consensus and flexibility.

Rather than trying to force reconciliation between these opposing blocs, the advisor suggested a pragmatic strategy: identify shared goals and build cooperation from there. For example, mutual interests in maintaining access to space for economic and scientific purposes could form the basis for future agreements. The expert encouraged using analogies from other domains like maritime or aviation law, where cooperation in shared domains has a longer history.

When asked about the role of smaller countries like the Netherlands, the advisor stressed that although Dutch contributions to the space sector are relatively modest in scale, they are highly specialised and respected, particularly in technology and optics. This, combined with the country's strong reputation in international arbitration, gives the Netherlands a unique diplomatic opportunity. The expert suggested that the Netherlands could position itself as a kind of "Switzerland of space," acting as a neutral party that facilitates mediation, arbitration, and dispute resolution.

Specifically, the expert recommended that the Netherlands leverage its existing Court of Arbitration in The Hague to handle disputes related to space debris and ASAT tests. This role would align with the country's strengths and reputation, and would not require taking sides in the geopolitical divide.

Finally, the interview addressed how the Netherlands should prepare for the implementation of the EU's Space Act and similar international developments. The advisor highlighted the importance of anticipating future roles in regulation, oversight, and enforcement. If the Netherlands intends to play a central role in monitoring and ensuring compliance, it needs to start building the institutional capacity now. The expert emphasized that such decisions will have long-term implications for whether the country remains purely advisory or becomes an authority with legal enforcement powers.

Interview Summary, Expert 3, Assistant Professor in Space Law.

This interview was about the legal, institutional, and political challenges surrounding the regulation of anti-satellite (ASAT) technology. The discussion opened with an overview of the current international space law regime, focusing especially on the Outer Space Treaty (OST), the Liability Convention, and the Registration Convention, all adopted in the 1960s and 1970s. While these treaties still provide the core legal framework for outer space activities, the expert noted their provisions are outdated and not directly applicable to today's technological and geopolitical context.

The expert explained that Article IV of the OST prohibits the placement of weapons of mass destruction in orbit and mandates the peaceful use of celestial bodies, but this provision cannot be clearly linked to ASAT testing, especially since existing tests have involved countries targeting their own satellites. In contrast, Article IX, which requires states to consult others if an activity might cause harmful interference, is more relevant but remains vague and lacks enforcement. How consultations should take place and whether they must have a positive outcome are not specified. Moreover, ‘potentially harmful interference’ lacks a definition, so different parties may interpret it differently.

In terms of liability, the Liability Convention and Article VII of the OST provide a mechanism for holding states accountable for damage in space, although the practical application remains limited due to the absence of litigation or precedent.

Turning to enforcement mechanisms, the expert acknowledged that space law does technically have them. For example, states can theoretically bring claims to the International Court of Justice (ICJ) or the Permanent Court of Arbitration. However, the expert pointed out that no case has ever reached the ICJ under space law, largely and factually due to diplomatic caution and evidentiary difficulties. We have not yet had a damage or major conflict occurring Still, Article VI of the OST, which holds states responsible for private actors, has led many countries to implement licensing frameworks that include debris mitigation requirements, creating a form of indirect enforcement.

When formal legal tools fall short, states have turned to soft law instruments, such as the IADC debris mitigation guidelines, the UN COPUOS long-term sustainability guidelines, and other non-binding frameworks. These documents do not mention ASAT directly but strongly emphasise the avoidance of debris: implicitly covering concerns around ASAT. They are widely referenced in national licensing regimes, particularly in Europe.

The discussion then addressed recent political efforts, particularly within the UN Open-Ended Working Group (OEWG) on space threats under the UN Institute for Disarmament Research (UNIDIR). Although both the United States and Russia–China blocks submitted competing proposals discouraging ASAT tests, political divides blocked consensus. The expert saw this as emblematic of the broader impasse in international space diplomacy.

A major theme of the interview was the shortcomings of the current legal frameworks. The expert argued that while international treaties open the door to good-faith interpretation, they lack clear, enforceable rules, especially in the context of rapid technological development. There was a general sense that law is lagging behind political and technical realities. The expert viewed the lack of enforcement mechanisms as more a result of missing precedent than outright legal gaps, noting that many space activities remain under-regulated or ambiguously defined.

The role of politics in blocking regulatory progress was discussed at length. Although there is general agreement among states that ASAT testing is problematic, divisions over who should lead and how strict the rules should be have prevented meaningful agreement. The expert noted that countries like the United States tend to favour non-binding norms, while others advocate for binding instruments: a divide that is often linked to broader foreign policy strategies and trust issues. This politicisation has been a major roadblock to consensus.

Given this environment, the expert proposed a pragmatic approach: relying on flexible norms rather than rigid treaties. In their view, meaningful progress is unlikely until a trigger event (either an accident or intentional incident) pushes states into action. They also acknowledged that enforcement through legal mechanisms like courts is improbable in the near term, especially with politically sensitive actors like Russia, which may no longer see participation in cooperative frameworks as worthwhile.

The discussion also touched on how national interests and foreign policy shape space diplomacy. Smaller European countries, including the Netherlands, tend to be proactive and open in international dialogues, while countries like China prefer to operate within frameworks they dominate. The United States, for its part, champions commercial space development and the use of soft law, as seen with its leadership in the Artemis Accords.

In comparing outer space with other global commons like the high seas and Antarctica, the expert explained that while such analogies are common, they fall short. Outer space involves higher stakes and unique technical challenges, and existing analogues like the Antarctic Treaty System are exclusionary in practice. Additionally, arms control frameworks, especially export control regimes such as the Wassenaar Arrangement and EU blacklists, could be leveraged to address ASAT indirectly. However, countries can still develop capabilities domestically, limiting the effectiveness of these tools.

From a technical angle, monitoring and situational awareness were highlighted as critical. The expert advocated for the development of independent space situational awareness (SSA) capabilities, especially within Europe. These systems would allow states to monitor space activity and respond accordingly, even in the absence of formal agreements. SSA also links into broader EU objectives around resilience, sustainability, and cybersecurity.

The expert commended the Netherlands' active role in multilateral discussions, such as in COPUOS and UNGA committees. While smaller countries may lack unilateral influence, their consistent presence helps shape international dialogue. The Netherlands is also part of the EU SST (Space Surveillance and Tracking) initiative and has the capacity to impose national-level export controls, albeit with some economic trade-offs.

Regarding treaty reform, the expert was sceptical. Though all space treaties have review clauses, the political reality makes them hard to update. Countries would rather reinterpret existing terms than engage in formal revision processes. In contrast, new treaties are seen as more viable, though still difficult to achieve. Some provisions, like Article I and Article IV of the OST, may already have customary status, giving them weight beyond ratification.

Finally, the expert confirmed the accuracy of the thesis problem statement, which posits that ASAT testing presents serious risks to the sustainability, safety, and security of space, while existing legal frameworks fail to provide clear, enforceable restrictions.

They closed with reflections on the environmental and sustainability dimension of ASAT. Debris creation is increasingly viewed through the ESG (Environmental, Social, Governance) lens, particularly in commercial space. Start-ups now need to demonstrate sustainable practices to attract funding. While not directly solving the ASAT problem, this trend could help shape better practices among future space actors. Meanwhile, political instability and emerging conflicts make legal certainty and diplomatic consensus increasingly difficult.

Interview Summary Expert 4, Policy Officer Ministry of Foreign Affairs

The expert confirmed that in the UN's Open-Ended Working Group (OEWG) on reducing space threats, from 2022 till 2023, there were different views on how to enhance space security. The expert nuanced my views on the split between a behavioural approach, supported by many Western states, and a legal approach, promoted by Russia and China. The expert stressed that this should be nuanced, as the cross-regional joint statement shows that these approaches need not exclude one another. The key disagreement is not about legally binding measures in general, but about the specific Russia-China draft treaty (PPWT), which many states oppose because of substantive and technical flaws rather than because they reject legal commitments as such.

The expert specified that Russia and China are promoting their own draft treaty, the PPWT (Treaty on the Prevention of the Placement of Weapons in Outer Space). The expert then elaborated on the criticism of this proposed treaty. A major flaw, the expert noted, is that the PPWT contains no definition for "space weapons". This is a significant issue because many space technologies are dual-use; for example, a satellite intended for debris removal could also be used to attack another satellite. Furthermore, the expert highlighted a critical gap: the PPWT only focuses on Space-to-Space and Space-to-Earth threats. It fails to address Earth-to-Space threats, such as ground-launched DA-ASAT missiles. The expert provided a detailed, nuanced analysis of the Netherlands' (NL) diplomatic strategy. It was confirmed that the Netherlands supports the UK-led behavioural approach to develop norms for responsible behaviour.

The EU and the Netherlands are not, in principle, against legally binding measures. Instead, their opposition to the PPWT is based on substantive, technical issues, such as its unverifiability and lack of definitions. The Dutch position, as explained by the expert, is that in the current geopolitical climate, negotiating a comprehensive treaty is difficult; therefore, for the Netherlands, international agreements could best be made step by step, beginning with norms of responsible behaviour. The expert suggested that the Netherlands can build consensus, gain wider support, and aim for progress by making clear that a broad, cross-regional group already agrees on certain practical steps. This is in line with the joint statement, which was meant to show that, despite differences between blocs, there is still shared ground where progress is possible.

To this end, the Netherlands, together with Germany, Brazil and the Philippines, initiated a cross-regional joint statement with 39 countries to demonstrate that 'political commitments on responsible behaviours can be developed in support of, and without prejudice to, the pursuit of legally binding measures and instruments in this area. These two approaches are not mutually exclusive.'

The expert suggested that there is less political deadlock in multilateral forums focused on space safety and sustainability rather than space security. The expert pointed to the UN COPUOS (Committee on the Peaceful Uses of Outer Space) in Vienna, describing it as a more apolitical, technical, expert-driven forum for space safety. This body has already reached agreements on space sustainability that could also indirectly benefit the security context. The expert recommended using the Debris Mitigation Guidelines and the UN Long-Term Sustainability (LTS) Guidelines as a basis for a governance model. Promoting SSA (Space Situational Awareness) cooperation through a civilian "space traffic management" lens was seen as more politically feasible and could indirectly benefit space security.

The expert highlighted several persistent technical and legal challenges. Verification is a bottleneck. While behaviour in space can be monitored with sensors, the expert noted that much of this SSA data is collected by military sensors. Sharing this data might be challenging because data exchanges could potentially reveal sensitive information about a nation's sensor technology and capabilities. Enforcement was also described as "very difficult", currently limited to UN resolutions or "naming and shaming". However, the expert suggested the ITU (International Telecommunication Union) could serve as an enforcement body in some cases. The expert also gave specific advice on definitions: the term DA-ASAT must be defined very specifically as "Destructive Direct Ascent Anti-Satellite Missile Testing," as this precise wording gives more chance to gain international support. Finally, any concept of banning "all debris creation" must be better defined, as the expert pointed out that even a satellite at the end of its life is technically debris.

Appendix 3: Expert Interview Questions

Semi-structured question to Expert 1 and 3

This interview is part of my MSc thesis in Complex Systems Engineering at TU Delft, conducted for the Netherlands Space Office as the problem owner. The research explores possible legal and diplomatic designs to support an international ban on anti-satellite (ASAT) tests. Through this interview, I aim to gather expert insights on the legal, diplomatic, and institutional challenges regarding ASAT regulation. Your input will help validate findings from the literature and shape practical design recommendations.

- In your view, what are the biggest challenges in reaching an international agreement to limit or ban ASAT tests?
- Why do you think the U.S. and its allies tend to promote voluntary norms for ASAT tests, while Russia and China emphasise binding rules? What drives this divide?
- I am working on legal and diplomatic designs to ban ASAT tests. From your perspective, what should be the most important criteria for such a design to be successful?
- What design outcome is in the best interest of the Netherlands?
- What role could a country like the Netherlands realistically play in achieving new international agreements in the domain of space law and treaties?
- Is my problem statement accurate?
  The increasing threat of destructive ASAT tests poses significant risks to the safety, security, and sustainability of outer space. Current international legal and institutional frameworks lack clear, enforceable rules that prevent or regulate such activities.
- Finally, is there anything else that should be considered in this conversation?

Semi-structured questions to Expert 2

This interview is part of my MSc thesis in Complex Systems Engineering at TU Delft, conducted for the Netherlands Space Office as the problem owner. The research explores possible legal and diplomatic designs to support an international ban on anti-satellite (ASAT) tests. Through this interview, I aim to gather expert insights on the legal, diplomatic, and institutional challenges regarding ASAT regulation. Your input will help validate findings from the literature and shape practical design recommendations.

- In your view, what are the biggest challenges in reaching an international agreement to limit or ban ASAT tests?
- What is the current legal landscape relevant to the ban of ASAT tests?

- What legal gaps exist in current hard and soft law regarding ASAT tests?
- What role could a country like the Netherlands realistically play in achieving new international agreements in the domain of space law and treaties?
- Is my problem statement accurate?
  The increasing threat of destructive ASAT tests poses significant risks to the safety, security, and sustainability of outer space. Current international legal and institutional frameworks lack clear, enforceable rules that prevent or regulate such activities.
- Finally, is there anything else that should be considered in this conversation?

Semi-structured questions to Expert 4

This interview is part of my MSc thesis in Complex Systems Engineering at TU Delft, conducted for the Netherlands Space Office as the problem owner. The research explores possible legal and diplomatic designs to support an international ban on anti-satellite (ASAT) tests. Through this interview, I aim to gather expert insights on the legal, diplomatic, and institutional challenges regarding ASAT regulation. Your input will help validate findings from the literature and shape practical design recommendations.

- I have understood that the OEWG on Reducing Space Threats ended in a gridlock, defined by the division between Western countries favouring norms and the Russo-Chinese bloc advocating for a binding treaty. To start, could you tell me the most recent state of affairs of the OEWG?
- I have seen that the publicly communicated reason for this division is understood as pragmatic difficulties (verification problems, definition problems) of a binding agreement (US frame) vs the 'mistrust and anticipation of US hegemony in space' (Russia, China frame) From your perspective, are there underlying strategic interests / threat perceptions at play that go beyond these publicly made arguments?
- In this diplomatic field and gridlock, what is the stance of the Netherlands in the OEWG?
- And given the gridlock between the major powers, what role can the Netherlands play? (a middlepower as bridge builder?)
- I am working on legal and diplomatic designs to ban ASAT tests. With the deep divisions in mind, from your opinion, what are the conditions for an agreement to be reached?
- "My research is focused on developing politically feasible design options. I'd like to get your expert reaction to a few ideas that I have drafted.
- First, a purely consequence-based rule: A verifiable commitment against (just and only) deliberately creating significant, long-lived orbital debris. This would be technology-neutral and effects-focused. A bright-line rule, and no norm, but without any direct legal consequences.
- Second, an expanded plurilateral moratorium: This would build on the current US-led initiative against destructive DA-ASAT tests, aiming to create a broad coalition making politically binding declarations.

- Third, a narrow, focused treaty: Instead of a comprehensive PAROS treaty, this would be a more limited, legally binding instrument focused only on prohibiting destructive, debris-creating ASAT activities.

Finally, is there anything else that should be considered in this conversation?