An Ethical Analysis of China's 2007 Anti-Satellite Test and Implementation of Such Weapons Utilizing Just War Theory

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

On January 11, 2007, China stunned the international community by conducting a kinetic anti-satellite (ASAT) test. While not the first or only kinetic ASAT test conducted, the Chinese test was the most destructive. China launched a ballistic missile equipped with a kinetic payload targeting a defunct Chinese weather satellite, the Fengyun-1C (FY-1C), orbiting at an altitude of 863 km (Weeden, 2010). As of January 30, 2024, of the total 3537 pieces of cataloged debris from the test, 2687 pieces are still in orbit (Weeden & Walton, 2024). Additionally, it is estimated that there are over 30,000 pieces of debris too small to be tracked (Weeden, 2010). The resulting debris field ranged from 200 km in altitude to more than 4000 km (Orbital Debris Program Office, 2007). Consequently, this debris field covers the entirety of Low Earth Orbit (LEO), which extends to about 2000 km in altitude.

What made this test so significant from others was the altitude at which the test was conducted and the amount of debris generated. Due to commercialization of space, about 85% of all active satellites in orbit around Earth are in LEO (Congressional Budget Office, 2023). The most significant mission that takes place in LEO is human spaceflight, where the International Space Station (ISS) and the Chinese Tiangong space station orbit. Astronauts' lives are at increased risk due to the deliberate creation of orbital debris. Additionally, the civil sector relies on access to space capabilities: weather forecasting, environmental monitoring, urban planning, disaster response, communications, broadband internet, mobile services, global positioning system (GPS), and much more (National Air and Space Intelligence Center, 2018).

There is a plethora of analysis done on the effects of orbital debris and the potential impacts to using space due to ASAT weapons. However, there is little discussion made on the morality of using these weapons. I will be utilizing a section of Just War Theory (JWT) based on

the principle of proportionality with a utilitarian foundation to assess the morality of utilizing these weapons. Through the lens of utilitarianism, I will assess how the consequences of using these weapons disproportionately affects the general civilian population. My analysis will demonstrate how China's ASAT test and use of these weapons are in fact immoral and violate the proportionality principle of JWT.

Background

Direct-ascent ASAT weapons are ballistic missiles meant to target and destroy a satellite on orbit. Brian Weeden's report with updates from Seth Walton from the Secure World Foundation summarize the history of ASAT tests in space. As of 2024, there have been 5 kinetic, debris generating tests conducted. The United States Government (USG) conducted the first test in 1985 targeting a satellite at 500 km in altitude creating 288 pieces of debris; the last piece of debris re-entered in 2004. The USG conducted another test in 2008 against a satellite at 225 km producing 176 pieces of debris; there remains one piece of debris in orbit. India conducted a test in 2019 against a satellite at 300 km producing 130 pieces of debris; the last piece of debris re-entered in 2022. Russia conducted the most recent test in 2021 against a satellite at 480 km producing 1807 pieces of debris; there remains 67 pieces of debris in orbit.

Literature Review

There has been a significant amount of research and analysis done on the motivations and deployment of the 2007 kinetic ASAT test. However, most scholars focus on the technical aspects of the test and resulting debris field, or the geopolitical motivations and analysis that led to the approval of a kinetic test and the United States Government's (USG) response.

Additionally, most articles touch upon the implications of orbital debris, but do not delve into ethical aspects of intentionally creating debris.

In their article "Understanding China's Antisatellite Test," Gregory Kulacki and Jeffrey G. Lewis provide an in-depth political analysis about the Chinese ASAT program and the Chinese Communist Party's (CCP) decision making process. They highlight how a possible contributing factor to approving the test was the lack of a USG and international response to two previous non-kinetic tests. Additionally, their Chinese sources, speaking under anonymity, stated that the kinetic test was meant to assess the maturity of the ASAT technology, not to send a message to any specific nation. Ultimately it was believed that the CCP decision authorities were not adequately informed on the amount of potential debris that would be created, and were not expecting the international backlash they received, particularly from the USG. The report mentions that China has a "willingness to suspend future testing" and a desire to negotiate arms control to ensure freedom of access to space for military and civilian satellites.

Ross Liemer's and Christopher F. Chyba's report "A Verifiable Limited Test Ban for Anti-satellite Weapons" argues that the international community should have ban on intentional damage of space systems above 250-300 km in altitude. They provide a history of ASAT testing and the hazards of space debris and explain the challenges of having a verifiable test ban. The report explains that technically anything in orbit could be used to collide intentionally with other objects, and that ASAT systems could be integrated has hidden payloads of satellites. The report continues that limiting tests above 300 km avoids "debris hazards to human spaceflight missions and to vital military, scientific, and commercial satellites."

While both articles provide insight into ASAT programs and their implication, neither addresses specific impacts on civilian access to space. Kulacki and Lewis do address the CCP's concern of reputational damage in the international community, and its desire to prevent further testing and continued access to space. Liemer and Chyba also address the concerns of testing weapons that can affect free access to space, and potentially harm astronauts in orbit, however it continues to advocate approval for kinetic tests. This paper will provide a description of the impacts to the civilian sector using ASAT weapons while making a moral judgement on the 2007 ASAT test using proportionality of Just War Theory supported through a utilitarian foundation.

Conceptual Framework

The morality of the conducting the 2007 kinetic ASAT test and using these weapons can be analyzed using a Just War Theory (JWT) framework supported through utilitarian concepts. Originally posited by Saint Augustine, Just War outlined how Christians were to conduct in and through warfare since it was permitted by God himself as a human experience (Mattox, n.d.). This is characterized through Augustine's *jus ad bellum* (just cause to go to war) and *jus in bello* (just conduct within war) scripts for the phases of war (Mattox, n.d.). Centuries later, Saint Thomas Aquinas expounded upon Augustine's work, which has become the traditional JWT studied in modern society (Moseley, n.d.). Many philosophers since have continued to expound upon JWT. Additionally, the devastating military campaigns of the 20th century shaped JWT into more modern concepts (Moseley, n.d.). This can be attributed to the indiscriminate bombing of civilians during World War 2 (WW2), the creation and use of nuclear weapons, the intentional burning of cities and civilian population centers, the holocaust, and more. The horrors from WW2 ultimately shaped the Geneva Conventions, which is still internationally adhered to today.

Under *jus in bello*, there are two broad principles that should be followed during war: discrimination and proportionality (Moseley, n.d.). Both principles exist in Protocol 1 of the 1977 amendment to the Geneva Conventions. Article 51 addresses the indiscriminate attack on civilian populations, and Articles 52 and 54 specifically address attacks on civilian objects and objects indispensable to human survival (Protocol 1, 1977). The proportionality principle states any military action should be strictly proportional to the desired objective (Moseley, n.d.). This is due to minimize the suffering of the affected population. This is broadly utilitarian under the idea of minimizing harm to others, as posited by John Stuart Mill's "harm principle" (Heydt, n.d.).

Due to the physics of orbital mechanics, I believe the use of ASAT weapons violates the rule of proportionality outlined by JWT and the Geneva Conventions. The resulting debris field generated by ASAT weapons cannot be controlled, thus the scope of destruction to civilian satellites cannot be limited. I believe attacking dual use military-civilian satellites disproportionately affects the civilian populace. Additionally, intentionally destroying any satellite in orbit could potentially trigger the Kessler Syndrome: a theoretical scenario where debris causes a collision, and the resulting debris causes additional collisions, effectively rendering orbits around Earth useless (Riley, 2016). If this were to occur, it would prevent the peaceful use of outer space by civilians for generations.

Analysis

My Analysis will first briefly explain how an ASAT weapon affects the orbital planes in which the attack takes place, along with the missions that occur in differing orbital regimes. I will also explain the current state of ASAT developing and testing. Finally, I will address how targeting specific systems and orbits disproportionately affect the civilian population rather than

achieving specific military objectives. It is important to first explain the missions currently in orbit that have impacts on civilian life before explaining how it is immoral to intentionally create debris in orbit and attack satellites.

Missions by Orbital Regime

Explanation of the various missions that occur in all orbital regimes around earth is necessary to provide the required context to develop a moral judgement under the JWT framework. There are three primary Earth orbital regimes: Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geostationary Orbit (GEO). LEO, the orbital regime in which all kinetic ASAT tests have taken place, contains about 85% of all operational satellites in orbit around Earth (Congressional Budget Office, 2023). Primary missions in LEO include mobile and data communications, earth observation, environmental monitoring, weather monitoring, disaster response, various scientific missions such as the Hubble Space Telescope, and human space flight, and government intelligence missions (Dragonfly Aerospace, 2022). In recent years, LEO has also seen the proliferation of mega-constellations providing internet and communication services due to the commercialization of space, such as Starlink and OneWeb. MEO is primarily comprised of navigation and communications satellites. Roughly 84% of all missions in MEO is navigation, with GPS being the most well-known satellite constellation in this orbital regime (Congressional Budget Office, 2023). GEO is primarily comprised of communications missions, making up 83% of all missions in GEO (Congressional Budget Office, 2023). In addition to communications, such as phone, television and radio services, GEO also supports weather monitoring missions, solar activity, and National Oceanic and Atmospheric Administration (NOAA) satellites provide search and rescue support to locate ships and aircraft in distress (Riebeek, 2009).

Further Chinese ASAT Testing

It is equally important to explain additional non-kinetic ASAT testing since 2007 to provide context in how these weapons pose a danger to all objects in orbit. Due to severe international backlash the Chinese government received after their 2007 test, they have since conducted only non-kinetic tests. The Department of Defense (DoD) has suggested that a Chinese sounding rocket launch in May 2013 was an ASAT test to target satellites in GEO (Gruss, 2015). While China stated the launch was a scientific mission, the DoD asserted the launch profile was inconsistent with traditional space-launch and ballistic missile launches used in scientific research since the launch had a ballistic trajectory to near GEO with reentry of all rocket components (Gruss, 2015). Regardless of the true intentions of the 2013 launch, it shows that China, and by extension other nations, can develop missile technology for ballistic trajectories to any orbital regime up to GEO. This has implications on all satellites in orbit around Earth, from targeting of specific military satellites to increased risk of collision with satellites due to resulting debris fields.

According to Chinese military officers and civilian analysts, the 2007 ASAT test was justified to counter the USG's perceived dependence on space capabilities (Kan, 2007). Additionally, it has been argued by Chinese institutions that the test was meant to be peaceful and prompt the USG into negotiations on arms control in space (Kan, 2007). There currently is no international ban on conventional weapons in space and attacking space assets. The Outer Space Treaty only bans nuclear weapons from being placed in orbit and asserts that the moon and other celestial bodies can be used exclusively for peaceful purposes (Outer Space Treaty, 1967). Under the current Outer Space Treaty framework, China's 2007 test does not violate the international agreement.

Proportionality Principle

I have shown the various space mission areas that occur in all Earth orbital regimes. Given the criticality of these mission to the civilian sector, a country's decision to utilize ASAT weapons could have unintended consequences outside achieving military objectives. Governments with these military capabilities assert that ASAT weapons are necessary to secure their respective national security interests. This is further strengthened by the fact the US military heavily relies on its access to space compared to other foreign militaries. But this view fails to consider the impacts space debris will have on civilian supporting space systems. Additionally, this view ignores that deploying these weapons will also put that government's own national space assets at risk from the debris they caused.

ASAT testing fails justification reasoning under the proportionality principle of *jus in bello*. Additionally, I argue the 2007 test and the utilization of these weapons violate Articles 52 and 54 of Protocol 1 to the Geneva Conventions. Traditionally, proportionality under JWT applies to loss of civilian life when striking military targets. However, the Geneva Conventions defines proportionality to include prohibiting attacks and minimizing collateral damage to civilian objects in conjunction to loss of civilian life, which should not be excessive to perceived military advantage (International Committee of the Red Cross, 2023). This is a major contributing factor to the USG's decision in April 2022 to commit itself to not conduct destructive ASAT missile testing. In a White House release, it was stated the debris field from these tests threaten the long-term sustainability of outer space and threatens the objects "vital to all nations' security, economic, and scientific interests, and increases risk to astronauts in space" (White House Briefing Room, 2022).

The proportionality definition under the Geneva Conventions is an imperative distinction to understand regarding the protection of civilian objects from intentional or collateral damage. While during a conflict that extends into the space domain would likely see the deployment of ASAT weapons, it is reasonable to assume that civil satellites would not be targeted. However, Keplerian orbital mechanics does not discriminate between civil, government and military satellites. The intentional destruction of satellites on orbit will have collateral effects on civilian satellites, which would be protected under the civilian objects clause of the Geneva Conventions.

China's ASAT test had a strategic advantage to message the USG and world leaders that it has the capability to attack any satellites in orbit when they chose. However, this test resulted in over 3000 pieces of debris covering a span that encompasses all of LEO. The debris field is beyond the scope of achieving a technology demonstration, as it risks collisions with every satellite in LEO that civilians rely on to include risking the lives of astronauts in orbit. Satellites in LEO typically help civilian populations track and predict severe weather conditions to include dust storms and flooding, and track and monitor wildfires to help affected communities make informed decisions (Keck, 2022). The loss of these invaluable resources due to collisions with orbital debris could have the potential of increased loss of human life from natural disasters. These space systems are also used to help inform decisions makers of where to prioritize search and rescue operations after a disaster.

GPS is the most well-known satellite system in the modern world. However, what most are unaware of is that GPS is owned and operated by the US Space Force and is in fact a military controlled space asset. Because of this, an attack on GPS would be lawful under the Geneva Conventions and would adhere to JWT principles because GPS is a military system. However, it is a dual use system supporting the civilian sector. In fact, GPS has a greater utility to the civilian

sector than that of the US military. The US military uses GPS for precision guided munition strikes, tracking friendly forces, enabling search and rescue operations, and remote piloting of unmanned aerial vehicles (National Coordination Office, n.d.). The civil applications are much far greater: agriculture, aviation, environmental monitoring support, marine operations, public safety and disaster relief, rail operations, recreational use, road and highway support, space support, surveying and mapping, and timing (National Coordination Office, 2014).

The farming sector, logistical supply chains, financial markets, ATM's, banking systems, communication networks, and even the power grid heavily relies on GPS (National Coordination Office, 2014). GPS impacts human lives by enabling emergency services to find the fastest routes, aids search and rescue operations during disaster relief, and enhances aircraft safety to prevent potential midair collisions (National Coordination Office, 2014). GPS is undoubtably crucial to maintaining modern society. It is estimated in a 2019 report sponsored by the National Institute of Standards and Technology that it would cost the US economy one-billion dollars a day if GPS was lost (O'Connor et al., 2019). In 2016, GPS had a 13-microsecond discrepancy due to the decommissioning of an old satellite in the constellation. This discrepancy affected emergency communications and caused power grid anomalies in parts of North America for hours (Datta, 2021).

It is important to understand how far-reaching GPS is in major critical civilian sectors globally. GPS impacts the lives of billions of users daily, compared to the roughly two-million users in US miliary operations. Additionally, earth monitoring and other civil satellites have a far-reaching impact on the daily lives of the civilian populations. Again, other civil satellite services impact billions of users worldwide, whereas respective global military forces using

those same systems fall within a couple million users. It is clear to see how significantly more the civilian population relies on access to space than any single professional military force.

While China's ASAT test does not violate international agreements, I argue it is still unethical to have conducted the test and develop these weapons since the impacts to civilians far outweigh strategic objectives. China acknowledges the need for an international arms control on attacking satellites in orbit yet continues to conduct non-destructive tests in all orbital regimes. The 2007 test put at risk satellites that civilians rely on for disaster and weather monitoring, and search and rescue support. Additionally, it put at risk the lives of astronauts in the ISS. If these weapons were employed against GPS or other systems in MEO, it would have a far more disproportionate effect on the civilian sector than impacts on the US military. These actions certainly violate the principle of proportionality under *jus in bell* of Just War Theory and the Geneva Conventions, and it is immoral to test such weapons and use them in war.

Conclusion

I have explained the types of missions in orbit that the civilian sector relies upon, and the critical importance of GPS to modern life. The impact to the civilian sector by intentionally creating debris or targeting dual-use military-civilian satellites far outweighs the impact to military and government operations. As outlined in this paper, the civilian sector relies on space systems for weather forecasting, disaster relief, and the plethora of critical sectors that GPS enables. Governments primarily utilize space systems for intelligence and to enable global military operations. Using the JWT framework with utilitarian foundational principles, the action of China's 2007 ASAT test and implementation of such weapons is deemed immoral as it disproportionately affects the civilian population over achieving strategic military objectives.

It is imperative that the international community convene and develop a true and total ban on the development, testing and implementation through war of ASAT weapons. It would not be in the best interests for the USG, China, Russia and India to continue further development of such weapons and kinetically test them. The implications of such weapons ultimately affect the entire world, not just our respective adversaries.

It is important for engineers to understand that even though they work on official government programs, they can also advocate for regulation based on their moral interpretations. Just War Theory is one of the many frameworks to use. In fact, Robert Oppenheimer, despite being called the "father of the atomic bomb," was active in USG committees advocating for arms control of nuclear weapons and promoting non-proliferation and disarmament. It is never apparent what a correct action is, but judging the actions and analyzing the consequences can help navigate an engineer's moral decision process.

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