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SPACE WARFARE: THE FINAL FRONTIER OF 'WAR IN SPACE'

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Abstract

Given the unstipulated nature of conflict in the vast expanse of outer space, space warfare remains speculative and enthusiastically debated at relevant levels. The war through Space-based assets is making conventional warfare more lethal. However, constructing a space war in outer space requires everyone's serious consideration. If there were a war in space, it would have devastating effects on every person on Earth as well as on the accomplishments of the future human exploration of Space. Nevertheless, drawing upon contemporary high-tech advances and the intricacies of military strategies, one can conjecture regarding warfare's prospective conduct in the vast outer space expanse. Due to its intricate and demanding nature, space warfare necessitates in-depth and critical analysis for the utilisation of innovative and creative technologies and techniques. The study also references the need to focus on the challenges of Space warfare and address the areas in which we need to improve. However, in order to mitigate the likelihood of any military conflict in the space domain that may paralyse the humanity, it is essential to explore and initiate the necessary measures.

INTRODUCTION

Multiple engagements with space are rapidly transforming the global economy and geopolitics. Navigation, weather forecasting, research on

climate change, communication, and military operations depend on it. A growing number of countries are engaged in space missions, while many others rely on services provided in space. Private sector funding for space exploration has brought new capabilities and potentially more widely shared benefits; these interests are changing the direction of technology and the norms surrounding it. However, strict laws need to be enacted to ensure continued viability and security of the space.

Space technology is almost indispensable today, although the last century can be described as the 'golden age' of space exploration due to great scientific and technological advancements during the period between 1957 and 1975.[1] We use them daily, they are indispensable. Different satellites are used for various purposes, such as weather forecasting, television broadcasting, navigation or telecommunications. We get assistance from them when needed at any particular time. There are numerous satellites in various orbits around the Earth. Human civilisation is limited to a Low Earth orbit, a site for the International Space Station and high-resolution satellite imagery. Medium Earth orbit is essential for the Global Positioning System (GPS), so we have navigation on mobile phones or tracking sizeable commercial aircraft. In terms of weather tracking and telecommunications assistance, Geostationary, Polar and Sun-synchronous orbits may be used.[2]

A number of Global space activities are conceivable due to exploration of the 'Space'. With the advent of space technology, GPS, surveillance, and rapid communications have become crucial for contemporary military warfare. A few nations are in the process of weaponising space, aiming to establish military supremacy on all fronts of warfare. Civil and military operations are conducted using 'Space' as a 'medium only'. Space is generally mentioned as the final frontier. Satellites, therefore, have become essential components for the armed forces and non-military society.

War in space, as such, is still a 'distant' concept. How military operations in space will be conducted is to be seen. We all have seen 'Space Wars' in several movies. 'War in Space', so-called 'Space Wars' in

the cinema world, is a more theoretical/hypothetical/ simulated concept. With time, the density of flying objects in space is increasing. Hence, it merits studying various considerations and other dimensions of 'War in Space'.

SIGNIFICANCE OF SPACE FOR MODERN WARFARE

The general population, including the armed forces, is becoming phenomenally more dependent on space-based technologies. Therefore, The primary objective has been to enhance their technological capabilities in space, minimise their susceptibilities, and elevate their significance as a strategic sphere. Space systems are crucial in various areas, such as navigation, communication, and remote piloting. Additionally, they are indispensable for operating GPS-guided weapons, surveillance, and information warfare.

GPS signals have become essential to our day-to-day activities for various purposes, such as banking, travel, navigation, agriculture, and communication facilities, using the internet access. Reliance on satellite navigation accounts for approximately 6 to 7 percent of Western countries' Gross Domestic Product (GDP).[3]

Communications satellites are utilised not only for direct broadcast television but also to facilitate numerous terrestrial networks. In isolated regions of the globe, they could serve as the sole method of communication. In the foreseeable future, global broadband internet access could be facilitated by communications satellites.

Satellites facilitate the acquisition of weather forecasts and enhance agricultural productivity. In addition, they assist us in strategising for disaster relief efforts, locating and extracting natural resources, monitoring environmental well-being, and various other applications.[4]

The first Gulf War, which took place in 1991, is often denoted as the first space war, although it was not fought in space. Instead, the United States and coalition forces heavily depended on GPS and other satellite technology to further their interests in that conflict.

ASATS

The proliferation of anti-satellite weapons (ASATs) is gradually becoming challenging. In 2007, China utilised a ground-based missile to obliterate an inactive communication satellite, resulting in the creation of approximately 3,000 fragments of debris that can be monitored. Similarly, the United States launched a missile to target a reconnaissance satellite during its descent from orbit in 2008. It is worth observing that Russia has also conducted various tests with ground-based missiles.

India conducted a successful ASAT test, codenamed 'Mission Shakti', on March 27, 2019. The test successfully targeted and destroyed a live satellite in the Low Earth Orbit using indigenous technology. India's space programmes have achieved substantial growth. Like other nations, India possesses space assets that must be protected and preserved. This achievement brought India to join the select group of nations, the US, Russia, and China, that possessed this capability.[5] The use of Kinetic ASAT weapons has caused significant international concern due to the resulting creation of debris, which poses a potential threat to all space systems. Debris resulting from ASAT tests has penetrated orbits at higher altitudes than initially predicted, with a portion persisting in space. Currently, the potential for global disapproval has prevented kinetic ASATs from posing a more significant risk to security.

Subsequently, space-based resources have facilitated enhanced capacity for land, naval and air forces. Given the dual use of numerous satellites, an armed conflict in space could have catastrophic effects on modern life. These satellites are a crucial element of ballistic missile defence, capable of detecting missiles immediately after launch and tracking their paths.[6]

The establishment of the United States Space Force has evoked a plethora of imaginative conjectures about the prospect of warfare within the Space realm. This created suspicion about the conduct of operations in the observers' minds.[7]

SPACE WARFARE V/S CONVENTIONAL WARFARE

In contrast to terrestrial warfare, when opposing troops strive to control a specific physical area, satellites in orbit do not occupy invariably a

singular position. Satellites are commonly employed in circular orbits exhibit velocities ranging from 3km/s to 8km/s, dependent upon their respective altitudes. In contrast, an average bullet travels approximately 0.75 kilometres per second. They appear quickly and then disappear.

The volume of the section between the Low Earth Orbit as well as the geostationary orbit is almost 200 trillion cubic kilometres. The volume is 190 times greater than that of Earth. Placing a satellite in orbit requires significant time and delta-V (change in velocity) to execute phasing manoeuvres.[8]

Space operations, therefore, including moves and actions, necessitate meticulous pre-planning. Any conflict in space will exhibit a significantly reduced pace and heightened intentionality. Throughout history, warfare has invariably ventured into unexplored regions to achieve the element of surprise. It might not be possible to precisely quantify the prospective role that space could play in future conflicts. Future space conflicts will primarily revolve around satellites.

Several nations presently possess military satellites deployed within the space domain. The United States, Russia, and China are widely recognised as the prominent triumvirate in global power dynamics. However, it is noteworthy that nations such as France, India, Israel, and the United Kingdom have also made significant explorations to enter the competitive domain of military aerospace development.

However, could we anticipate the emergence of conflict solely within the dimensions of outer space? It is highly improbable that we shall witness any conflict exclusively transpiring within the celestial world in the foreseeable future. Space warfare remains predominantly theoretical today, as no tangible instance of armed conflict in outer space has transpired. Nevertheless, numerous concepts and technologies have been explored for implementation in space combat. As the existence of space technology continues to proliferate among countries, its implementation in various world conflicts is set to increase. There are two main strands through which satellites can be drawn into a war in space: "cyber-attacks" and "anti-satellite missiles."

The fundamental nature of space warfare is expected to differ significantly from the typical forms of terrestrial warfare. However, the physical limitations of space may render its use impossible. In the huge expanse that is outer-space, there is no air resistance or gravity making it an environment where weapons can be used as much as one wishes. Besides some specific weaponry tactics, what else would distinguish space combat, are:

- Space warfare would have an extraordinary swiftness and span our long distances, taking place within seconds. Space amplifies weapon platforms by increasing velocities for missile trajectories, thus, enhancing speed and accuracy.
- Getting weapons into space would create tremendous precision, making it difficult for enemy spacecraft and satellites to try to hide. It is also important to note that aerial equipment cannot be shielded in the empty void of space, making aerial assets in the air highly vulnerable to potential acts of aggression.
- Ships in the sea and satellites in space are highly vulnerable to attacks due to a lack of relative shielding. Moreover, wars in space will be strongly interconnected with ongoing events on Earth.

CONSEQUENCES OF SPACE WAR

Any space conflict would have far-reaching implications since it could disable or destroy satellites that are indispensable to our planet. Nevertheless, the function of satellites underwent a transformation to support traditional military activities, as demonstrated by the involvement of the U.S. military in the 1991 Gulf War and subsequent operations. Space assets, therefore, were recognised as not just a means of gaining operational military advantage but also as a possible vulnerability.

Space weaponisation raises numerous strategic concerns, including fostering distrust, jeopardising commercial and scientific operations, contributing to space debris, and potentially monopolising orbits.

Space is a domain where assets are enormously valuable and massively exposed to risk, and the actions of any one individual — whether intended or

not — can trigger consequences that affect the interests of not just a few but everyone. Those consequences can be immediate, as well as cumulative and long-term. Indeed, one potential outcome of the physical deployment of such arms is the post-conflict political considerations as allies and adversaries consider new alignments.[9]

Incorporating space assets into land-based military operations has had significant strategic implications. In essence, the space systems that granted tactical advantages also became perceived as potential weak points that adversaries could exploit in times of conflict.

The potential outcomes of any space war would be wider and more devastating, affecting every aspect of human life. According to an expert, life would alter drastically from its current form. The following are only a few possible outcomes:

- **GPS Systems.** The vulnerability of satellites to attacks that can disrupt GPS systems needed across multiple industries such as supply chains (air, road and shipping), as well as military activities and other important spheres.
- **Banking Systems.** International banking systems may be significantly affected.
- **Power Grids.** Power supplies could be interrupted leading to extensive blackouts with hospitals, water, food supply networks being the most affected sector.
- **Emergency Call Centers.** Communication channels used by first responders might be disrupted, thus, hindering their response times for life-saving emergency services, like ambulances, fire brigades, etc.
- **Military Actions.** Satellite technology facilitates communication, intelligence gathering, and navigation for military operations worldwide. These operations may experience significant disruptions and may result in loss of lives. Specifically, distant Drone operations, Anti-Access and Area Denial (A2/AD), and Manned Unmanned Teaming (MUMT) missions will be severely impaired as satellite support is paramount in such operations.

- **Debris.** The wreckage resulting from a satellite's destruction can potentially a satellite which has the potential to cause additional harm. For example, even a minuscule fragment of wreckage from an obliterated satellite can cause significant harm to spacecraft such as the International Space Station.
- **Civilian Consequences.** The complete elimination of a space infrastructure that offers positioning, navigation, and timing services to civilians and the military could result in aviation disasters, vehicular collisions, and disruptions in the worldwide financial market.

The above-mentioned ramifications of any conflict in space are only a limited number of instances. Acknowledging that ongoing international initiatives are aimed at averting conflicts in outer space is crucial. Nevertheless, these endeavours need to catch up to the swiftly changing circumstances.

THE POTENTIAL MODUS OPERANDI OF SPACE WARFARE

The manner in which space warfare will be realised is thought to be that in a future war, only unmanned vehicles coded from the ground will do battle in space. Moving around in space might have to cope with all sorts of restrictions. Satellites have been indispensable for the military in recent years, and the U.S. is making substantial investments to maintain its military dominance in space. Other than land-based missiles, satellites can also be attacked by radio waves. Such waves can jam and confuse an opponent's satellites, forcing them to issue orders that are nothing but ugly covert messages.[10]

Among the paramount objectives within the arena of celestial conflict would undoubtedly encompass the neutralising of adversary satellites. Vital navigation, communications, and intelligence services are provided by these satellites. The act of neutralising or incapacitating adversary satellites possesses the potential to induce a state of sensory deprivation, rendering them incapable of visual, auditory, and navigational functions. This strategic manoeuvre confers a considerable upper hand upon the attacker.

In an enormous space area, the absence of an atmospheric medium renders the velocity of projectiles free from constraints, thereby endowing space-to-space combat with unprecedented pace and lethality. The utilisation of laser technology, particle beams, and kinetic projectiles presents a viable prospect for annihilating adversary spacecraft, including but not limited to satellites, spaceplanes, and space stations.

Cyber-attacks have emerged as a formidable armament in space warfare. By strategically targeting adversary communication networks, control systems, and navigation infrastructure, assailants can severely impair their opponent's capacity to engage in combat operations. Cyberattacks possess the potential to be employed to undermine adversary satellites, spacecraft, and terrestrial infrastructure.

It is imperative to comprehend the fundamental elements of space warfare to effectively mitigate the likelihood of any potential celestial confrontation, safeguard humanity's welfare, and preserve human civilisation. Various relevant components of space warfare are discussed in the following paragraphs.

POTENTIAL COMBATANTS

The domain of space warfare encompasses a diverse array of participants, encompassing not only nation-states but also non-state actors and even private enterprises. It is highly probable that nation-states possessing substantial spacefaring capacities, such as the United States, Russia, China, and India, shall assume the leading roles in any prospective conflict within the world of space. A few countries, like North Korea, Turkey, Iran, and Pakistan, may also be potential long-term or short-term players in Space. Nevertheless, it is imperative to acknowledge that entities outside the purview of governmental authority, commonly referred to as non-state actors, possess the capacity to obtain and harness space-related capabilities. This development, if realised, has the potential to generate a significant menace to vital infrastructure and communication networks. Private enterprises, particularly those engaged in satellite development

and operation, may be susceptible to becoming focal points in a conflict launched in outer space.

TYPES OF WEAPONS

The weapons used in space warfare may differ greatly from those on Earth. In the great emptiness of space, there is no atmospheric pressure to resist the motion of solid particles flying out of a gun and no medium to slow down these projectiles. Conventional kinetic armaments such as projectiles and missiles would multiply their destructive potential, greatly increasing their potential. Moreover, with no atmosphere to resist their movement through space, we could use high-powered laser and particle beam technologies to neutralise or utterly destroy enemy ships.

NON-KINETIC WEAPONS

Non-kinetic weapons like cyber warfare and electromagnetic pulses (EMPs) are also being used in space warfare. EMPs have the capability to render electronic systems inoperable, leading to the possibility of substantial disorder and disruption. Cyberwarfare has the potential to intrude and interrupt adversary's communication networks, command and control systems, satellite navigation and other systems.

STRATEGIC CONSIDERATIONS

Space warfare would necessitate a completely different set of strategic considerations than conventional land warfare. Rapid response to attacks in space would be challenging due to the immensity and severity of the environment and the speed of movements. It would be difficult to conceal spacecraft from detection because there would be no air resistance to contend with. Consequently, any space war in the future would probably be waged using long-range weaponry and emphasis on hitting enemy infrastructure instead of directly confronting enemy forces.

REGULATORY CONTROL ON SPACE

Space warfare is a delicate and intricate concept in itself, yet a space confrontation could be on the horizon sooner than most people think. But if such a thing were to happen, the global population would feel the full force of it both immediately and later, and human space exploration would take a terrible blow. Some of these principles are well established but still lack precision. Studies are underway. The concept of touching on some basic principles or using them for this purpose is essential. A research team with members from around the world has been compiling what they call the space war law handbook for several decades. Universal knowledge law requires human society to make full use of the advantages provided by space, and this requires that no one will be injured or killed unjustly for simply occupying a certain position. Human effort for celestial dominions should be directed unwaveringly towards peace. Any potential dispute should smoothly be resolved by diplomatic means. It is of paramount importance for governments to place the highest priority on ensuring the maintenance of the physical and emotional welfare of all individuals while diligently refraining from engaging in any practices that may potentially result in adverse consequences or inflict harm. Let's focus on finding solutions that promote understanding and cooperation.[11]

Only five of the numerous international treaties pertain specifically to space activity. The primary one is the 1967 Outer Space Treaty, which prohibits the deployment of weapons of mass destruction into space. However, only one of its provisions (Article IV) specifically addresses military activity. Other methods of damaging or interfering with satellites are not illegal despite the fact that their use is subject to other legal frameworks, such as the Laws of Armed Conflict. This encompasses a range of advanced technologies, including anti-satellite missiles, directed energy weapons like lasers, electronic warfare capabilities, cyber warfare tactics, and the utilisation of dual-purpose technology, such as on-orbit servicing satellites commonly referred to as 'mechanic' satellites.[12]

In December 2022, the U.N. General Assembly passed a resolution that urged governments to refrain from conducting harmful direct-ascent (DA) anti-satellite (ASAT) experiments. The resolution received affirmative votes from 155 nations, while nine nations, including China and Russia, voted in opposition. Nine other nations refrained from voting. ASAT tests can have detrimental effects on global peace and security. These tests pose a risk to the long-term viability of the outer space environment and hinder countries' ability to explore and utilise outer space peacefully. Notably, such resolutions are non-binding, and countries are not legally obligated to comply.[13]

The idea of space warfare is both disturbing and risky. Preventing such a war requires a concerted effort to create global standards and agreements governing space usage.

THE CHALLENGES OF SPACE WARFARE

The concept of space warfare is intricate and demanding, and several hurdles must be surmounted before it can be realised. Satellites are susceptible to various threats, encompassing cyber-attacks, communication disruptions, electronic warfare, tangible assaults, and maintenance issues. Cyber-attacks targeting space capabilities resemble non-space systems, as they frequently entail endeavours to input user-derived data into a system, thereby inducing software to exhibit unforeseen behaviours. The financial burden of creating and maintaining essential infrastructure and technology to counter such issues is a significant challenge.[14]

Satellites are complex structures requiring significant financial resource allocation, personnel, and effort. However, in the event of fuel exhaustion or any malfunction in any component, the satellite is abandoned. Consequently, this generates a substantial amount of debris in outer space. On-orbit satellite servicing has brought this situation to the point where it is on the approach of becoming a thing of the past. On-orbit satellite servicing refers to the technology used to repair, refurbish, and refuel satellites already launched into space.[15]

The challenges in space manufacturing, as well as maintenance, entail the requirement for specialist equipment and materials, manufacturing processes affected by microgravity, quality control, and guaranteeing the compatibility of space-manufactured items with Earth's environment.

Any conflict within the realm of space will undoubtedly have a profound impact on the intricate mechanisms governing airspace management. The complex nature of the congested space environment has rendered the concept of 'Space Traffic Management' unduly complicated.

'Space Debris' is another challenge that Space operations are facing. Anything that is man-made and no longer in use in orbit is known as 'Space Debris'. Debris in space is generated by human-made objects such as defunct satellites, discarded rocket stages, and fragments resulting from erosion, collisions, and disintegration of items in orbit. Smaller components of space debris encompass remnants of vehicles that have undergone explosions or collisions, as well as shards of insulation and paint that have originated from space vehicles. The collision occurred in 2009 between the U.S. Iridium 33 communications satellite and the decommissioned Russian military communications spacecraft Cosmos 2251.[16] In general, the quantity of debris increases as its size decreases. The excessive number of debris necessitated the establishment of military space monitoring to avoid any collision issues. Space debris adds to the cost of operating satellites because if debris destroys a satellite, it may take years and hundreds of millions of dollars to restore that satellite's service. Even tiny debris objects can damage critical sensors and spacecraft components.[17]

WAY AHEAD

Notwithstanding the challenges, the possibility of space warfare is a genuine cause for concern. The likelihood of armed conflict in space increases as countries continue investing in spacefaring capabilities. This issue needs to be addressed by the international community as soon as possible before it is too late.

To avert such a disastrous occurrence, it is paramount to prevent the weaponisation of space and promote peaceful exploration of outer space. Exploring international laws about Earth that could be relevant measures to conflicts in outer space is imperative. The subject comprehension could facilitate the practice of diplomacy and the establishment of treaties to avert such hostilities. The objective is to prevent such conflicts in the initial stages or to ascertain the most suitable and commensurate measures in reaction to any activities in outer space. A global team of experts is currently working to create an authoritative manual that delineates the legal principles governing military activities in outer space. The objective is to create a comprehensive Manual on International Law Applicable to Military Usage of Outer Space (MILAMOS) that encompasses periods of heightened tension and open conflict. The primary objective of this project, launched in May 2016, is to cultivate a universally embraced compendium elucidating the core principles governing the utilisation of celestial expanse for military purposes during periods of tranquillity, encompassing the various obstacles that may impinge upon the preservation of peace. It is stipulated that the study will facilitate the establishment of transparency and trust among nations engaged in space exploration. This measure aims to mitigate the likelihood of a conflict occurring in outer space and, if it does happen, minimise the consequences on the space infrastructure that is crucial to our daily operations.[18]

Besides legal measures, defensive, offensive, and diplomatic alternatives exist to prevent confrontations in space. Defensive measures encompass the advancement of technologies to safeguard satellites against attacks, and offensive measures involve the development of weaponry designed to hinder or annihilate adversary spacecraft. Diplomatic measures involve negotiating and establishing treaties and accords to constrain space militarisation and avert space weaponry creation.

The following measures may be considered to facilitate the execution of military operations if space assets are wholly or partially non-functional:

- **Advanced Strategies.** Given the intrinsic features of space combat, such as velocity and range, tactical manoeuvres may not be relevant.

Hence, it is imperative to integrate the constraints while formulating the initial offensive or defensive operations missions.

- **Alternative Means of Communication.** Efficient communication systems are required for interoperability and collaborative operations. One could consider utilising existing resources for other communication methods, such as LoS-based tropo and fibre optics-based communication.
- **Redundancy in the Context of A2/AD and MUMT.** A2/AD and MUMT are military strategies encompassing various capabilities across various domains, including space. Multiple strategies may be attempted to mitigate the impact of a conflict in outer space on A2/AD and MUM-T in case of failure or disruption.
- **Training and Exercises.** Acquiring knowledge empowers the workforce. Hence, skilled military personnel enhance the effectiveness of the operations. It is imperative to ensure the capacity building associated with space warfare is well in time. Regular military training and operations are necessary to acquaint the armed services with the intricacies of space warfare. Simulated and live exercises can serve as effective means to accomplish the objectives.

India's inception of appropriate steps to deal with any potential danger merits consideration in light of the Chinese space projects and the Chinese government's efforts to establish its dominance in space.

CONCLUSION

Space warfare, as a concept, still remains speculative in nature and energetically debated at relevant levels, given the unstipulated nature of conflict in the vast spread of outer space. While the concept of a war in outer space may seem like a plot from a science fiction story, it is a matter that requires everyone's serious consideration. A space war would have catastrophic consequences for all individuals on Earth and for future human space exploration.

Nevertheless, drawing upon contemporary technological breakthroughs and the intricacies of military tactics, one can conjecture regarding warfare's prospective conduct in the vast outer space expanse. The domain of space warfare necessitates the utilisation of innovative and creative technologies and techniques due to its intricate and demanding nature.

Nations capable of achieving mastery in space warfare will own a substantial edge in the future of military conflict, which may result in inhuman dividends. In view of catastrophic consequences, the international community should create and adhere to rules for its regulation to avoid the possibility of space warfare becoming a global conflict.

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