



SPACE DEBRIS MANAGEMENT: AN OPPORTUNITY OF GLOBAL SIGNIFICANCE FOR THE US SPACE FORCE.

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The United States Space Force has devoted very little attention to space debris. This is a missed opportunity. USSF space doctrine must incorporate space debris management as a warfighting function. This provides domain-wide impact in peacetime and enables space control and persistent presence in wartime. Emerging technologies enable debris management to be taken one step further to the level of reversible manipulation. This effectively turns debris into terrain that can be used for tactical and strategic purposes.

The Center for Global Security (CGSR) last year completed a workshop titled "[*Rethinking Strategic Competition in Space and Space in Strategic Competition.*](#)" Panel discussions focused on

procurement, defense, offense, international competition, and strategy concerning national space forces and assets, with focus on the United States Space Force (USSF). There were many nuances to topics covered by the panels, and the perspectives presented here are solely those of the author and do not represent the views of CSGR or affiliated organizations.

Space is at the frontier of [competition](#), and the United States Space Force (USSF) is on the frontline of that competition. However, an ever-present shadow exists over all space operations that is today a drain on resources, a navigational hazard, and a possible barrier to human access to space. This hazard is Space Debris, which remains a persistent and growing concern in an increasingly crowded Low Earth Orbit (LEO) environment. Mitigation technologies range from [directed energy effects](#) to technologies as simple as [harpoons](#) and [nets](#). But today, there is no way to limit the effects of space debris.

Failure to address the space debris problem could mean that the first space war will be the last space war, as debris released from such a conflict could render low Earth orbit (and by extension all higher orbits) inaccessible.

The United States is dependent on space. The private sector, our military forces, and our allies all depend on the capabilities of satellites flying through it. But space debris is getting worse, and there is an upper limit. NASA has estimated that an [ISS-sized](#) quantity (~470 tons) of space debris injected into Low Earth Orbit (LEO) could degrade or eliminate access for centuries. The United States Space Force (USSF) has devoted too little attention to space debris, despite the potential of the force to make a positive and decisive impact on the problem.

The doctrine on Space Debris Management needs to be written. Then, capabilities to manage the problem must be procured and deployed. Finally, Guardians must be trained to implement these capabilities and have the institutional maneuver space to use them in operations below the level of armed conflict.

Space is a dynamic environment of electromagnetic, gravitational, and kinetic phenomena that can collectively form a deep and complicated terrain for warfighting operations. Space debris sits atop this as an additional navigational hazard, but it can be interacted with through measures to produce operationally relevant effects. With the proper technologies, space debris can be increased (via kinetic fires) or decreased (via directed energy fires) in accordance with operational needs.

This creates a warfighting domain that can be shaped in much the same way that a minefield can shape terrestrial or naval operations. Like minefields, space debris threatens bystanders, but it is different from land or sea mines for two reasons. First, land or sea mines constrain movement, while space debris forces movement through the expenditure of a delta-v budget. Second, land or sea mines are designed to be invisible to achieve operational effects, making their removal difficult. Space debris does not need to be invisible to produce the desired operational effects because knowing where it is does not eliminate the damage it can cause.

This environmental analysis demonstrates the degree of control humans have over the debris problem, a counter to the argument that it is another immutable variable to plan around, like weather or the sea in terrestrial conflict. Like planting mines, creating more space debris should be avoided whenever possible but, as with planted mines, there are measures that can be taken to address the problem.

Space Force thinking is beginning to consider debris as a problem that can be dealt with. The sole mention of debris in the USSF's recent [Space Warfighting: A Framework for Planners](#) emphasizes that, while debris can be a barrier to operations, the use of temporary and reversible effects can play an effective role in the denial of space superiority to opposition forces. Shaping the battlespace cuts to the core of the concept of Space Control. Outlined in [Space Force Doctrine Document 1](#)" as a USSF core function, Space Control is defined as:

"The activities required to contest and control the space domain. The desired outcome of space control activities is space superiority, a degree of control that allows forces to operate at a time and place of their choosing without prohibitive interference from space or counterspace threats, while also denying the same to an adversary."

Any discussion of Space Control must include debris. However, this does not preclude the offensive capabilities completely, it merely involves incorporating mitigation technologies into operational doctrine. This is because first, space debris persists only as long as it isn't moved. Second, all space debris mitigation measures can double as offensive space fires.

The best potential technology to meet the debris challenge is a concept proposed [on](#) and [off](#) over the last [ten years](#) called a laser broom. This uses laser ablation on the surface of a target piece of debris to change its velocity. This change puts the debris into a decaying or incomplete orbit, leading to disintegration upon impacting the Earth's atmosphere. It can be a space or ground-based capability, and is a dual-use capability that can function as offensive space fires. A directed energy capability of this type, perfected, enables a deep magazine approach to space debris mitigation in which ground or space-based fires can reduce or eliminate navigational hazards.

Recommendations

To address the space debris problem, the USSF should

1. *Implement Laser Broom Technology*: Laser brooms are still in development. Therefore, the USSF should develop, procure, and field such technology as an offensive and defensive capability for the joint force. This could take the form of dedicated satellites, ground stations, a combination, or even be mounted on other assets with available electrical power. Successful implementation of laser broom technology allows space debris manipulation and adds a new dimension to space control, overmatch in space superiority, and persistent orbital access during a

prolonged conflict. To utilize laser brooms or other debris mitigation technologies to their greatest effect, Space Debris Management should be doctrinalized, just as mining and mine-clearing are on Earth.

2. *Establish Space Debris Management as a Warfighting Function:* The creation, manipulation, and disposal of space debris must be a warfighting function. This function facilitates and shapes movement and maneuver through fires to create control over the space environment via terrain manipulation during a conflict, even after hostilities have begun to limit orbital access by debris creation. Doctrine specifically feeds into procurement decisions. Establishing Space Debris Management as a warfighting function can reinforce the need, and therefore the development of technologies like the laser broom.

3. *Operationalize Peacetime Debris Mitigation:* Space Debris Management has beneficial peacetime applications. First, by keeping debris levels low, other operators in space don't have to waste valuable propellant on avoidance maneuvers. The USSF can "keep the space lanes clear," serving the common good in orbital space and projecting hegemonic control over the domain. Second, this action creates a paradigm. Intervention on the part of the United States to maintain a common good encourages other major players in space to follow suit, if only to maintain the appearance of parity. Third, this mission further operationalizes the role of the space warfighter as a Guardian. The shadow this can cast in long, benefiting the USSF's emerging culture, public perception of the force, and morale among the soldiers and civilians that serve with the force.

Conclusion

Space debris is a universal problem. Capability and doctrine should reflect Space Debris Management as a warfighting function. Doing so, the United States Space Force has an opportunity to make a decisive impact in the global commons of Earth orbit, much as the United States Navy has done in the oceans and seas since 1945. Doing so, the USSF provides a space-

based version of freedom of navigation, ensuring safe passage of global satellite infrastructure from hazards and positioning itself as the key player in this new and largely anarchic global commons in the sky.

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