

Survivability of Space Control Assets in a Dynamic Threat Environment

Planning Implications for Success in the Indo-Pacific

Brig. Gen. Donald Brooks, U.S. Army

Maj. Brian Hamel, U.S. Army

Capt. Andrew Weliver, U.S. Army

The survivability of space control assets within a contested, multidomain environment is one of the Department of Defense's (DOD) most critical issues. Recognizing the increasing reliance on space-based capabilities for terrestrial military operations, this article analyzes survivability through three interconnected lenses: physical, tactical, and bureaucratic.¹ From the rudimentary camouflage of antiquity to the sophisticated force protection architectures of modern combined arms warfare, the imperative to preserve combat power has profoundly influenced military doctrine and operational art. This article examines the historical evolution of survivability principles in the terrestrial domain, extrapolating relevant lessons to address the unique challenges of protecting critical space assets in the contemporary multidomain environment.² While the Newtonian physics of space operations differ

from terrestrial warfare, the principles of minimizing vulnerability, maximizing resilience, and ensuring continued operational effectiveness remain paramount. By analyzing historical precedents, contemporary case studies, and emerging threats, the authors aim to contribute to developing an adaptable framework for ensuring the survivability of space capabilities in the increasingly contested and complex battlespace of the twenty-first century. The authors argue that a comprehensive strategy of space survivability must integrate historical insights through a contemporary understanding of the specific threats and vulnerabilities facing space-enabling infrastructure (SEI).³ The authors explore the interconnected dimensions of survivability, encompassing physical hardening, and maneuverability of space assets; tactical adaptations for operating in denied, degraded, intermittent, or limited



Soldiers with 18th Space Control Company, 1st Space Battalion, 1st Space Brigade, construct an expeditionary space control system after transporting it via a CH-47 Chinook helicopter during air assault training on 31 January 2025 at Fort Carson, Colorado. (Photo by Brooke Nevins, U.S. Army)

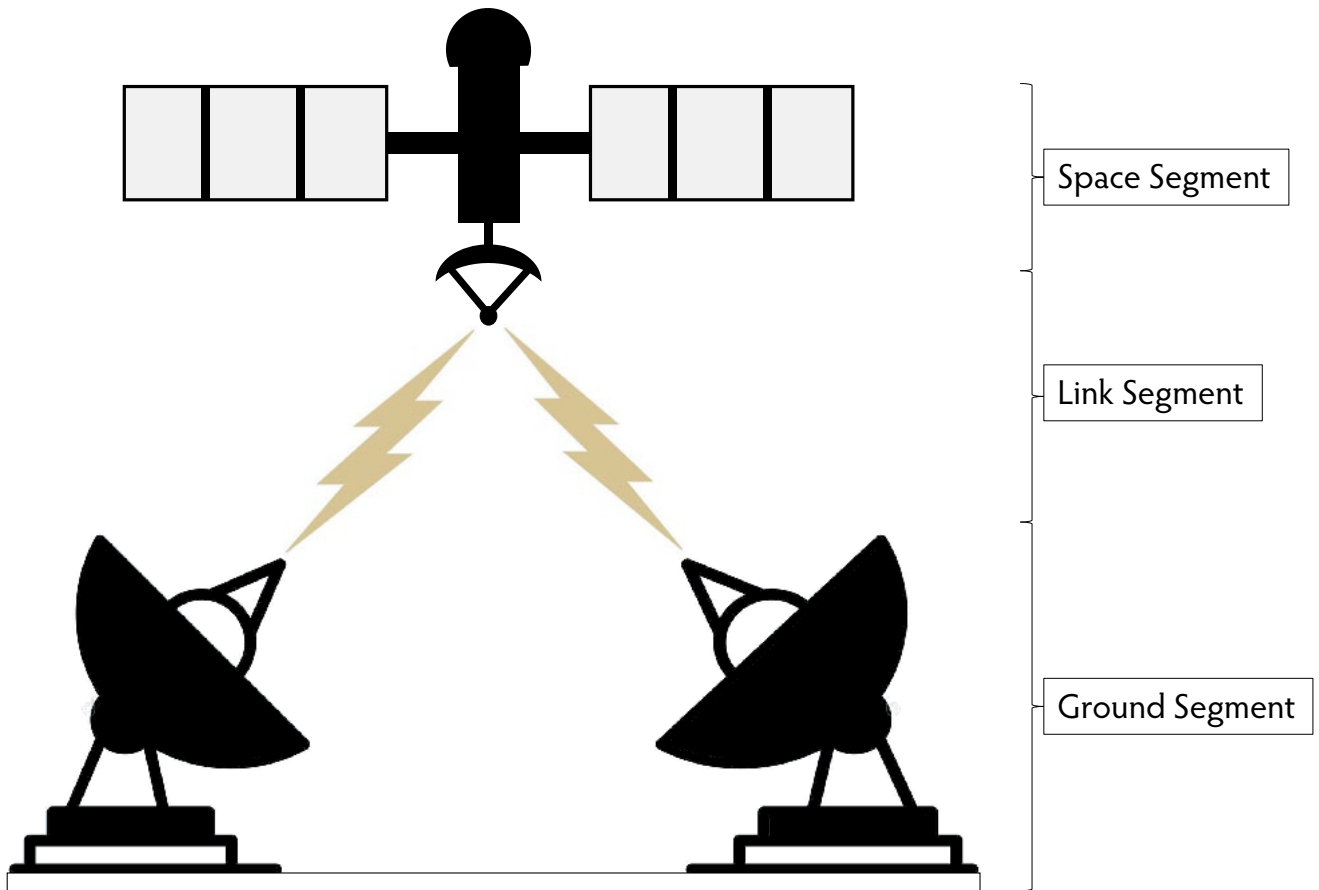
(DDIL) environment; and the integral role of bureaucratic and interorganizational collaboration across the joint, interagency, intergovernmental, multinational, and commercial (JIIM-C) landscape.

Physical Survivability: Historical Underpinnings of Survivability in Terrestrial Warfare and Its Relevance to Space Operations

From the earliest use of camouflage and fortifications to the sophisticated force protection measures integrated into the modern operational environment, survivability has been a cornerstone of military doctrine and a critical element of success on the battlefield. A key aspect of space control requiring protection in a multidomain environment is the essential combination of dedicated equipment, and the necessary SEI to conduct operations.

In his seminal work, *Fighting by Minutes: Time and the Art of War*, Robert Leonhard emphasizes the fundamental constraint that, at any given moment, a military actor can only truly “move, strike, or guard.”⁴ Assets on orbit challenge this principle by performing more than one of these functions simultaneously, but it remains a critical consideration for terrestrial components of SEI. Ground stations, for example, cannot simultaneously transmit commands, receive data, and actively defend against a physical attack. This limitation underscores the importance of survivability measures beyond the individual asset level. Redundancy, dispersion, and robust defensive processes become essential to ensure that even if one element of the space control architecture and SEI is engaged, others must continue to “move, strike, and guard” to support operational objectives.

Leonhard’s work lends itself as a model for the employment of deception. The evolution of military



(Figure by Maj. Brian Hamel, U.S. Army)

Segments of the Space Domain

deception has mirrored the advancement of technology and the changing character of warfare. While physical decoys remain relevant, modern warfare has seen a growing emphasis on manipulating the electromagnetic spectrum (EMS) to deceive adversaries. As Maj. Erik M. Pikner notes in “Leveraging Multi-Domain Military Deception to Expose the Enemy in 2035,” future conflicts will likely involve adversaries leveraging machine learning to fuse information from various sensors.⁵ This necessitates deception tactics that can counter these advanced capabilities like data poisoning, which can alter the results of a machine-learning script.

Recent deception examples from the conflict in Ukraine suggest the increasing use of EMS operations for deceptive purposes.⁶ These techniques, which can include spoofing, jamming, and manipulating electronic signatures, aim to create a distorted picture of friendly forces’ disposition, intentions, and capabilities,

ultimately influencing enemy decision-making. Integrating EMS operations with traditional deception methods highlights the growing importance of the EMS and information dimension in modern military operations.⁷ Pikner further argues that the future of military deception lies in multidomain application, where actions in one domain, including EMS, can create cascading effects across others, ultimately exposing and deceiving the enemy.⁸

Over time, survivability principles have become ingrained in Army standard operating procedures, manifesting in practices such as dispersion of forces, redundancy in communication networks, and adopting protective postures. This emphasis has evolved as the United States pivoted from the Global War on Terrorism (GWOT) to a strategy of integrated deterrence in great power competition. This shift has brought a renewed focus on targeting the

command-and-control (C2) nodes of acute and pacing threats, a stark contrast to the counterinsurgency focus of the GWOT. As discussed in Grace B. Mueller et al.'s article "Cyber Operations During the Russo-Ukrainian War," targeting adversary C2 infrastructure has become a key element of modern warfare.⁹ The report details how both sides in the conflict have prioritized disrupting the other's C2 systems, highlighting the impact of such attacks on the overall course of the war. This focus on systemic disruption of C2 within the greater context of C-C5ISR (counter-command, control, computing, communications, cyber, intelligence, surveillance, reconnaissance, and targeting), rather than solely targeting individual actors that facilitate C2, as highlighted during GWOT, represents an evolution in targeting methodology. This demonstrates a paradigm shift in the targeting approach to modern warfare. This historical progression of terrestrial survivability through adapting to the complexities of each era's battlespace provides a framework for understanding the emerging need to protect critical space assets. Just as terrestrial forces adapt to survive and operate effectively, space capabilities must also be safeguarded in the increasingly contested multidomain environment.

The modern battlespace operates as a complex system encompassing land, sea, air, space, and cyberspace. This multidomain environment blurs traditional areas of operations established by the Goldwater-Nichols Act. Army Field Manual (FM) 3-0, *Operations*, defines multidomain operations (MDO) as the "combined arms employment of joint and Army capabilities across all domains to create and exploit relative advantages that achieve objectives, defeat enemy forces, and consolidate gains."¹⁰ The conflict in Ukraine has served as a litmus test of MDO integration and has highlighted the decisive role of information operations within the broader conflict. While the Ukrainian military has employed traditional kinetic means to defend its territory, its effective use of social media by the civilian population to crowdsource intelligence on Russian troop disposition (e.g., finding locations of convoys or identifying high-value targets) and disseminating that information to artillery units illustrates the integration of the information dimension and land domain. Furthermore, the widespread sharing of videos and images depicting Russian war crimes and Ukrainian resistance has demonstrably influenced international

opinion and support, as noted by numerous news outlets covering the conflict.¹¹ The disposition, technical prowess, and means for communication among the civilian population need to be a decision point for commanders when planning for their scheme of maneuver and dispersion of space control assets.

The planning considerations and implications at a macro level for operating in the Indo-Pacific are no different than those of eastern Europe. The number of islands, cultural nuances, and assured contact with the local population increases the difficulty of controlling the narrative, and securing sensitive information such as the disposition of space control assets. A campaign in the Indo-Pacific may demand greater emphasis on understanding and leveraging the information domain to effectively coordinate the dispersion of space control assets. Not every lesson learned from Ukraine can be applied to the Indo-Pacific. However, understanding and leveraging the local population where appropriate, to facilitate force protection measures is an imperative of operational planning that cannot be forsaken.

Whether in the Indo-Pacific or eastern Europe, adversaries pose a range of kinetic and non-kinetic threats that directly impact the physical survivability of space assets. Kinetic strikes pose a significant threat by potentially damaging or disrupting space ground layer, while non-kinetic threats present a persistent challenge. Electronic warfare in the form of jamming and other electronic countermeasures can disrupt, deny, deceive, degrade, or destroy space systems, severing critical services to maneuver units.¹² Furthermore, enemy special operations forces' (SOF) activities pose a significant threat, as space control assets are likely featured on their high-priority target lists given their strategic importance.

To mitigate these threats, various hardening measures can enhance the physical survivability of space assets. These include physical hardening of space control assets to withstand kinetic and non-kinetic attacks and physical sabotage, as well as implementing robust cybersecurity protocols. Redundancy in equipment and systems is also crucial, so rapid reconstitution of capabilities in case of failure or attack is paramount. This redundancy, imperative in large-scale combat operations, aligns with the concept of SOF and conventional forces integration, interoperability, and interdependence, striving to achieve cross-domain relative advantages. As



A CH-47 Chinook from 25th Combat Aviation Brigade carries an M777 howitzer from 25th Infantry Division Artillery on 7 November 2022 at the Pohakuloa Training Area in Hawaii. (Photo by 1st Lt. David Block, U.S. Army)

SOF operates in the strategic deep and on the periphery to facilitate sensing, a wider dispersion of space control systems between conventional forces and SOF can provide mutual support to the joint force commander and enhance overall mission efficacy.

Maneuverability is another aspect of physical survivability.¹³ Just as a platoon of howitzers can displace forward while another maintains fire support, space assets must be capable of maneuvers to evade threats and maintain operational effectiveness. This concept of maneuver as a form of protection is well-established in terrestrial military doctrine. For example, FM 3-04, *Army Aviation*, emphasizes the use of air assault operations to rapidly reposition forces and equipment, increasing their survivability by making them less vulnerable to attack. Air assault operations, specifically sling load operations, can facilitate an island-hopping campaign in the Indo-Pacific. This could allow space control assets to bypass heavily defended areas or strike at vulnerable points of

an adversary's C5ISR architecture. The dispersed geography and the antiaccess/area denial strategies imposed by the United States' adversaries in the Indo-Pacific make maneuverability hypercritical.

This nexus of sling load operations and maneuverability of space control assets is exemplified by the 18th Space Control Company's air assault and medevac training at Fort Carson, Colorado, on 31 January 2025. This exercise validated expeditionary deployment and delivery methods of Army space forces and equipment. The training involved loading and unloading a CH-47 Chinook helicopter, transporting troops and equipment to a landing zone, and conducting area and electromagnetic reconnaissance. These activities highlight the importance of air assault operations for rapidly deploying space control assets.¹⁴ These aforementioned sling load operations would enhance the resilience of SEI against attack in a theater of war and contribute to SOF and conventional forces integration, interoperability, and

interdependence, underscoring the critical nature of teamwork, precision, and decisive action in large-scale combat operations.

Given the constraints of modern low earth orbit satellite's increasingly smaller downlink footprints, these air assaults or sling load operations must be carefully planned and executed to minimize disruptions to support for warfighters.¹⁵ Maintaining continuous coverage and data flow requires precise coordination and timing. This necessitates specialized training and coordination with pathfinder elements to use sling load techniques for mobile ground stations and incorporating the access and placement, pre-positioning and authorities and permissions of our allies, partners, or the interagency to support the joint force commander's scheme of maneuver. FM 3-94, *Armies, Corps, and Division Operations*, articulates the importance of rehearsals and coordination in air assault operations not only due to their complexity but also because of the critical nature of their task that should extend to space asset maneuverability.¹⁶ Furthermore, the vast distances and unique terrain of the Indo-Pacific necessitate a combined, joint approach that reinforces the importance of working by, with, and through allies and partners. Just as air assault enables maneuver forces to overcome geographical challenges and increase survivability, these same principles can be adapted to the space domain to ensure space control systems can contribute to the joint force commander's scheme of maneuver through all phases of the operation, as demonstrated by the Army's 1st Space Brigade.

Tactical Survivability: Tactics, Techniques, and Procedures

Tactical survivability hinges on the ability

Brig. Gen. Donald Brooks, U.S. Army, is the deputy commander for operations at the U.S. Army Space and Missile Defense Command. He holds a bachelor's degree in civil engineering from the U.S. Military Academy and a master's degree in earth remote sensing/hyperspectral imagery from the Florida Institute of Technology. He completed the U.S. Army War College as a Fellow at the Georgia Institute of Technology in 2020. Brooks previously served as commandant of the Space and Missile Defense Center of Excellence.

to maintain critical space services in an EMS-DDIL environment. Redundancy and rapid reconstitution are paramount to achieving this objective. Redundant systems provide essential backup capabilities in case of attack or failure. This concept aligns with the principles of resilience discussed in Joint Publication 3-0, *Joint Operations*, which emphasizes the importance of having multiple means to achieve objectives and the ability to adapt to changing circumstances.¹⁷ As ground forces require redundant communication systems to maintain situational awareness in a contested environment, space operators also need redundant space control assets and ground stations to ensure continued access to critical space-based services. The ability to rapidly reconstitute lost or damaged space assets is equally vital. This reconstitution capability requires a robust military and space-industrial base capable of quickly producing and fielding space control systems. Leveraging the industrial base will be discussed more in the bureaucratic section, but understanding that a healthy and responsive

Maj. Brian Hamel, U.S.

Army, is the space operations officer for Task Force 40-25 at Fort Bragg, North Carolina. He holds multiple advanced degrees and is a graduate of the School of Advanced Military Studies, the Red Team Leader Course, the Space Control Planner Course, and the Special Operation Military Deception Planner Course. His previous articles focus on special operations forces' contributions to space warfare and operationalizing celestial lines of communication to augment sustainment packages to the joint force in the Indo-Pacific. He has deployed to multiple theaters to support special operations.

Capt. Andrew Weliver, U.S. Army

is a space operations officer assigned to the XVIII Airborne Corp Space Support Element at Fort Bragg, North Carolina. His previous assignment was at the 1st Space Brigade at Fort Carson, Colorado, where he was the brigade space control and Army space-SOF-cyber triad chief. He is a graduate of Army Space Control Fundamentals, Army Space Control Planners, Special Warfare Brighton, and the Army Special Operation Forces Captains Career Course. His civilian education includes a BS in systems engineering and an MS in space operations.

industrial base has tactical implications is essential for gaining, maintaining, and exploiting space superiority.

Developing and implementing effective tactics, techniques, and procedures (TTPs) for operating within a DDIL space environment is paramount for ensuring the survivability and effectiveness of space control assets. These TTPs must prioritize minimizing the physical and electromagnetic signature of both space control components to reduce their detectability and vulnerability. This aligns directly with the principles of operational security as outlined in Joint Publication 3-13, *Information Operations*, which emphasizes protecting critical information and activities from adversary exploitation.¹⁸ The United States must treat its space control infrastructure with the same level of concern for concealment and deception as its terrestrial forces.

A core element of defensive TTPs in a DDIL environment revolves around emission control (EMCON). Just as terrestrial forces use camouflage and noise discipline, space control systems can leverage EMCON to minimize their electromagnetic signature. This can involve managing the power output of transmitters, using directional antennas to limit the propagation of signals, and reducing or eliminating unintended electromagnetic emissions from ground stations. For terrestrial systems, this includes shielding sensitive electronics, optimizing antenna placement to minimize inefficient radiation patterns, and implementing strict protocols for data transmission to reduce windows of vulnerability.

Beyond EMCON, deception plays an interwoven role in facilitating the survivability of space control assets. Deception techniques like transmitting false signals, conflating an adversary's common operational picture, or creating "phantom" satellites can confuse adversaries and complicate their targeting efforts. These practices must be carefully planned and executed to ensure they do not inadvertently reveal critical information or compromise other aspects of the mission. For example, a sudden, uncharacteristic signal could alert an adversary to the presence of a space control asset.

Robust cybersecurity practices are intrinsically linked to the survivability of space control assets. Protecting ground systems from intrusion and ensuring the integrity of C2 links is essential. Habitual vulnerability assessments, penetration testing, and the implementation of strong access controls are crucial

to mitigating cyber vulnerabilities. Coupled with cybersecurity, EMS surveys are necessary to understand the electromagnetic environment and identify vulnerabilities. Regular monitoring of EMS can detect anomalous signals that might indicate adversary activity or interference.

Finally, regular vulnerability assessments are essential for maintaining the effectiveness of defensive TTPs. As adversaries develop new technologies and tactics, our defenses must evolve to counter them. Regularly assessing the vulnerability of space control assets and SEI allows the United States to identify weaknesses and implement necessary improvements. This includes not only technical vulnerabilities but also procedural ones. By consistently evaluating and refining defensive TTPs, we can enhance the survivability of our space control architecture in the face of increasingly sophisticated threats in the challenging DDIL space environment.

Bureaucratic Survivability: Leveraging the Joint, Interagency, Intergovernmental, and Multinational-Commercial Environment

Establishing effective C2 structures for space operations in a multidomain environment presents significant challenges. The integrated nature of modern warfare requires seamless coordination across the five domains outlined in FM 3-0, *Operations*, necessitating clear lines of authority and responsibility.¹⁹ This is not an unprecedented challenge. Analogous to a joint force entry or a beach assault involving Marine and naval forces, space operations require well-defined transfer of authority procedures and fire coordination measures between commanders at specific junctures during an operation. Just as responsibility shifts between amphibious task force commanders and landing force commanders during a beach landing, MDO involving space assets necessitates a preplanned transfer of authorities to ensure unity of command and mitigate operational friction. This concept of phased responsibility provides a framework for managing C2 in the complex multidomain space environment and can act as a guidepost for coordinating, integrating, and synchronizing transregional fires.

Protecting space assets also requires robust JIIM-C and international coordination. Given the



diverse nature of space activities, collaboration among the DOD, the interagency, and allies and partners is essential. Leveraging various departments within an embassy or consulate can facilitate the dispersion and movement of space control assets into countries that provide unique access to enable space control operations. Prudent planning between the DOD and the Department of State facilitates a strategy of competitive statecraft and enables dispersion to support the scheme of maneuver at the speed of war. International coordination through the Department of State and the JIIM-C can also cultivate relationships with different host nations that possess valuable space capabilities that can enhance resilience, contribute to space domain awareness, and supplement operational effects.

The burgeoning partnership between the DOD and commercial space enterprises is fundamentally reshaping the landscape of space asset survivability. The recent strain on munitions stockpiles during the Ukraine

Soldiers with 18th Space Control Company, 1st Space Battalion, 1st Space Brigade, unload a small tactical vehicle and portable space control system after transporting them via a CH-47 Chinook helicopter during air assault training on 31 January 2025 at Fort Carson, Colorado. The exercise demonstrated rapid deployment of personnel and tactical space systems to provide close space support on the battlefield. (Photo by Brooke Nevins, U.S. Army)

conflict is a stark reminder of the defense industrial base's pivotal role in maintaining operational readiness. This lesson underscores the need for a dynamic and responsive industrial ecosystem, capable of rapidly adapting to evolving threats and demands.

Leveraging the JIIM-C environment is crucial for enhancing space asset survivability. Integrating commercial ground stations and deploying small form factor equipment delivers a strategic advantage by promoting a distributed architecture, significantly bolstering resilience against targeted attacks, and mitigating the risk of single points of failure. This



commercial integration fosters agility, enabling faster, more flexible, and more responsive support to military operations, and prioritizes technological advancement over bureaucratic inertia. This collaborative model extends beyond procurement, encompassing a deep integration of commercial innovation into the defense industrial base. These partnerships provide a cost-effective method for augmenting government-owned space assets, and could enable rapid-capability scaling predicated on the DOD modernizing its procurement process. The resulting synergy between public and private sectors cultivates a dynamic and adaptable industrial base, equipped to meet the challenges of an evolving landscape. By leveraging commercial innovation, the DOD could move at the speed of technology, not bureaucracy. Consequently, the relationship between the DOD and the commercial space industry is a strategic imperative for ensuring space asset survivability and maintaining a decisive advantage in the space domain.

The 1st Space Brigade's 1st Lt. John Zengel (*left*) demonstrates space control effects to U.S. Army Space and Missile Defense Command leaders. (Photo by Brooke Nevins, U.S. Army)

Conclusion: Safeguarding Space Assets for Future Operations

The pursuit of survivability has been consistent throughout military history, evolving alongside technology and the changing character of war. From rudimentary camouflage to sophisticated MDO, the imperative to protect forces and assets has shaped military doctrine and practice. This article has examined the historical underpinnings of survivability in terrestrial warfare and extrapolated their relevance to an increasingly contested space domain. As the lines between traditional domains and areas of responsibility blur in MDO, physical, bureaucratic, and tactical survivability become paramount for ensuring the effectiveness of space-based capabilities. The conflict

in Ukraine offers valuable insights into the interconnectedness of modern warfare, particularly the significance of information operations and the evolution of contemporary targeting methodologies against an adversary's C5ISR infrastructure. These lessons must be considered within their unique context and not be applied *carte blanche* to the Indo-Pacific. The challenges posed by antiaccess/area denial strategies and the potential for rapid escalation demand a robust and adaptable approach to space asset survivability. Physical hardening and maneuverability are crucial for protecting space assets from kinetic and non-kinetic threats. Just as terrestrial forces maneuver to defeat the adversary, space assets must reposition and evade threats to maximize support for the joint force. This necessitates specialized training, joint coordination, and innovative solutions for deploying and redeploying ground stations, especially in an EMS-contested environment.

Cultivating relationships with JIIM-C partners is essential for long-term space capability survivability. The growing reliance on commercial space entities and the unique capabilities of the United States' allies and

partners underscores the need for effective integration. A responsive space industrial base is critical for replenishing damaged assets and ensuring a technological advantage. Tactically, maintaining space superiority requires redundancy, rapid reconstitution, and effective, rehearsed TTPs. Minimizing the signature of space control assets and ground systems through emission control and cybersecurity practices is essential.

In conclusion, space asset survivability is a complex, multifaceted issue demanding a holistic approach. Integrating lessons from terrestrial warfare with the nuances of the space domain interaction with air, land, and sea, and embracing innovation and multinational collaboration, the United States can be postured to ensure the continued effectiveness of its space capabilities and maintain its strategic advantage in the contested multidomain battlespace. ■

The views expressed in this article are those of the authors and do not necessarily reflect the views of XVIII Airborne Corps, U.S. Army Space and Missile Defense Command, U.S. Army Special Operations Command, the Department of the Army, or the Department of Defense.

Notes

1. Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms* (U.S. Government Publishing Office [GPO], 2016 [obsolete]), 230. Survivability is the ability of a system, equipment, or personnel to withstand the hostile environment and remain operational with or without degradation, and the ability to restore to a specified level of performance after being damaged.

2. JP 3-14, *Space Operations* (U.S. GPO, 2020 [obsolete]), I-2-I-3. As depicted in the figure, the space domain consists of three distinct segments: the ground segment, encompassing Earth-based control and support infrastructure; the link segment, representing the communication pathways via the electromagnetic spectrum (EMS); and the space segment, including all orbiting assets like satellites.

3. Space-enabling infrastructure (SEI) is the "systems, physical facilities, services, support personnel, staff, and essential services necessary to support operations to, from, and through space. This includes but is not limited to the activities conducted on the electromagnetic spectrum, launch facilities, ground control stations, maritime vessels, celestial lines of communication, spaceports, computer hardware, computer software, and the cyberinfrastructure that enables these operations. At an operational and strategic level, SEI encompasses legal infrastructure to include regulations, resources, and policies that govern a country's commercial, civil, and military space program and its interoperability with other state-owned and civilian-owned SEI." Brian Hamel, "Reframing the Special Operations Forces-Cyber-Space Triad:

Special Operations' Contributions to Space Warfare," *Military Review* 104-5E (March 2024): 122, <https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/March-2024/Cyber-Space-Triad/>.

4. Robert R. Leonhard, *Fighting by Minutes: Time and the Art of War* (Praeger, 1994). Leonhard's *Fighting by Minutes* highlights that a military actor's fundamental actions at any given time are limited to moving, striking, or guarding.

5. Stephan Pikner, "Leveraging Multi-Domain Military Deception to Expose the Enemy in 2035," *Military Review* 101, no. 2 (March-April 2021): 82-93, <https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/March-April-2021/Pikner-Military-Deception/>. Pikner argues that future conflicts, where adversaries use machine learning to fuse sensor data, will require deception tactics like data poisoning to counter these advanced capabilities.

6. Pikner, "Leveraging Multi-Domain Military Deception." Recent examples from the Ukraine conflict indicate a growing use of electromagnetic spectrum operations (EMSO) to deceive adversaries by distorting their perception of friendly forces.

7. Mateusz Tomczak, "Ukraine's Phantom Tanks: A New Front in Information Warfare," *Daily Wrap*, 3 February 2025, <https://dailywrap.uk/ukraines-phantom-tanks-a-new-front-in-information-warfare,7121335521663105a>. The increasing integration of EMSO with traditional deception underscores the growing importance of EMS and information in modern warfare.

8. Pikner, "Leveraging Multi-Domain Military Deception." Multidomain military deception, leveraging domains like EMS, will be key to exposing and deceiving enemies in the future.

9. Grace B. Mueller et al., "Cyber Operations During the Russo-Ukrainian War," Center for Strategic and International Studies, 13 July 2023, <https://www.csis.org/analysis/cyber-operations-during-russo-ukrainian-war>. Targeting adversary command-and-control (C2) infrastructure has become a crucial aspect of modern warfare, as evidenced by its impact in the Russo-Ukrainian War.

10. Field Manual (FM) 3-0, *Operations* (U.S. GPO, 2025), 252.

11. Claire Press and Svitlana Libet, "How Russia's 35-Mile Armoured Convoy Ended in Failure," BBC, 22 February 2023, <https://www.bbc.com/news/world-europe-64664944>. The widespread sharing of videos and images from the Russo-Ukrainian War has demonstrably influenced international opinion and support.

12. FM 3-0, *Operations*, I-8–I-11, III-6–III-9, IV-4–IV-8, V-5. Disrupt: To interrupt or interfere with the enemy's activities, making it difficult for them to function effectively. This can involve causing confusion, slowing down their operations, or preventing them from coordinating their forces. Deny: To prevent the enemy from using something, such as access to a specific area, resource, or capability. This can involve physical actions, like blocking a route, or nonphysical actions, like denying access to information. Deceive: To mislead the enemy, causing them to make decisions based on false information. This can involve using decoys, spreading disinformation, or employing other forms of psychological operations. Degrade: To reduce the effectiveness or efficiency of the enemy's capabilities. This can involve

damaging their equipment, disrupting their communication networks, or weakening their morale. Destroy: To eliminate the enemy's ability to use a particular asset or capability. This usually involves physical destruction, such as destroying a command post or sinking a ship.

13. FM 3-0, *Operations*, 4-5. Maneuverability is the capability that allows Army forces to conduct effective maneuvers, enabling them to outmaneuver and defeat adversaries.

14. For example, see Brooke Nevins, "Army Space and Air Domain Partner to Deliver Close Space Support," U.S. Army, 11 February 2025, https://www.army.mil/article/282958/army_space_air_domains_partner_to_deliver_close_space_support.

15. "Footprint," Spire, accessed 21 July 2025, <https://spire.com/spirepedia/footprint/>. A satellite communications downlink footprint is the geographical area on Earth where a satellite's signal can be received. It's determined by factors like satellite power, antenna design, and the frequency used, essentially mapping the coverage area of the transmitted signal.

16. FM 3-94, *Armies, Corps, and Division Operations* (U.S. GPO, 2021), 4-68. The emphasis is on rehearsals and coordination in complex air assault operations, highlighting their critical nature, which should extend to space asset maneuverability.

17. JP 3-0, *Joint Campaigns and Operations* (U.S. GPO, 2022), I-11. Redundant systems, providing backup, align with JP 3-0's resilience principles of having multiple ways to achieve goals and adapting to change.

18. JP 3-13, *Information Operations* (U.S. GPO, 2022), 11-7.

19. FM 3-0, *Operations*, 1-6. The five domains are land, sea, air, space, and cyberspace.

JML Call for Papers

The *Journal of Military Learning (JML)* is the U.S. Army's premier peer-reviewed publication dedicated to advancing education and training for the U.S. Army and the broader military profession.

We invite submissions from practitioners, researchers, academics, and military professionals on topics related to adult education and training, including education technology, adult learning models and theory, distance learning, training development, and other relevant subjects in the field.

We consider a range of article types, including research articles using qualitative and quantitative methods, literature reviews, theoretical or philosophical analyses, position papers, book reviews, and letters to the editor.

For detailed author submission guidelines or to view past editions, scan the QR code or visit *JML* on the Army University Press website at <http://www.armyupress.army.mil/Journals/Journal-of-Military-Learning/>.

