Integrating Space Operations at the Tactical Level

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The Army's role in multi-domain operations (MDO) is to "penetrate and dis-integrate enemy anti-access and area denial systems and exploit the resultant freedom of maneuver to achieve strategic objectives (win) and force a return to competition on favorable terms."[1] To assign responsibility for the execution for this role, former Army Futures Commander LTG Eric Wesley oriented MDO as a "tactical" fight, where tactical commanders need to be able to "think, assess, and employ" all domains of war in order to effectively "shoot, move, and communicate."[2] This ability to execute ground combat is the fundamental executive role served by tactical level formations in the Army and therefore requires a robust amount of cross-domain freedom of maneuver.

Yet often neglected by maneuver commanders, the space domain offers maneuver space that if not controlled will directly limit the freedom of maneuver available in ground combat. According to the Defense Intelligence Agency's (DIA's) 2019 report "Challenges to Security in Space," space operations provide ground forces with the space-enabled services of "geolocation and navigation, target identification, and tracking of adversary activities."[3] Position, navigation, timing (PNT) satellites; intelligence, surveillance, and reconnaissance (ISR) satellites; and orbital threat-based counterspace systems provide these services. The most critical among these services are the threat-based counterspace systems. They directly attack and counterattack ISR, PNT, and missile warning satellites critical for providing capabilities on the ground.

While there are tangible outputs tied to successful tactical maneuver from space-based assets, the Army's connection to these enablers are retained at the strategic level via the Army's Space and Missile Defense Command (SMDC). SMDC is a strategic-level Army service component command with the expressed mission to develop and provide "current and future global space, missile defense, and high altitude capabilities to the Army, joint force, and our allies and partners, to enable multi-domain combat effects; enhance deterrence, assurance, and detection of strategic attacks; and protect the nation."[4] Accordingly, SMDC retains how and when ISR, PNT and counterspace satellites are leveraged to aid the warfighter, not the on-the-ground commander who requires their capabilities.

This creates a gap in MDO. Joint Publication 3-0, *Joint Operations*, defines maneuver to be a "tactical" affair where "component commanders employ their forces in combination with fires and information to gain positional advantage in respect to the enemy."[5] Yet the assets — both offensive and defensive — to introduce this positional advantage in the space domain are strictly retained at the strategic level. Therefore, if actual fire and maneuver within MDO occurs at the tactical level, then tactical-level formations need to retain the assets that create that freedom of maneuver in all domains. LTG Wesley even acknowledged this gap, calling for a need to have "space assets at [the tactical] echelon."[6]

Furthermore, this is not a novel concept. The 82nd Airborne Division has organic and attached Short Range Air Defense Artillery (SHORAD) assets from the 3rd Battalion, 4th Air Defense Artillery that provide freedom of maneuver in the air domain during joint forcible entry operations, enabling more effective ground combat. The 915th Cyber Warfare Battalion, through expeditionary teams, "provides a scalable capability… to deny, degrade, disrupt, destroy and influence cyberspace effects for Army maneuver [tactical] commanders."[7] Their efforts in turn create tactically focused maneuver space in the cyber domain that is directly responsible for more freedom of maneuver for ground combat.

As proposed in the 2021-2022 Key Strategic Issue List published by the Army War College, the Army must flex organic SMDC assets of directed energy weapons (DEWs) and kinetic energy weapons (KEWs) to the tactical level to enable land-based forces to conduct cross-domain fire and maneuver during multi-domain battles.

Background

In 2018, the U.S. Army Training and Doctrine Command (TRADOC) published Pamphlet 525-3-1, *The U.S. Army in Multi-Domain Operations 2028*. As stated by then Army Chief of Staff GEN Mark Milley, the very "character of war" has changed for two reasons.[8] The first are "emerging technologies" whose military applications have changed how we conduct war to a degree that the scope of what constitutes a battlefield needs a complete redefinition.[9] The second is that strategic competitors (Russia and China) have "synthesized" these new technologies with their "analysis of military doctrine and operations" to fight the U.S. in all domains — air, land, sea, cyber, and space.[10] This creates a "military problem" of having to not only defeat our strategic competitors in all domains, but nest these efforts across domains to enable land-based forces to conduct cross-domain fire and maneuver.[11] Yet what does this look like? How do we operationalize this concept?

Thankfully, the Department of Defense has already done the leg work by producing what it calls "required capability sets."[12] Among these capability sets, the Space Capability Set must be able to use "operations in space" to complement land operations by supporting the "opening of and exploitation of windows of superiority that create dilemmas for the enemy while protecting the ability to conduct friendly operations…"[13] SMDC is the strategic component of the Army that fills this role. Specifically, the 1st Space Brigade within SMDC "conduct(s) space operations to deliver decisive combat power in support of the Army and joint warfighting communities."[14] The 1st Space Battalion owns the delivery of this decisive combat and conducts space technical operations.[15] Fundamentally, the execution of these technical operations during the global war on terrorism was operationalized through enhanced situational awareness provided by ISR, PNT, and cyber warfare satellite operations. Yet, there is a fundamental need to shift how we prioritize space operations. DIA's report "Challenges to Security in Space" highlighted two major conclusions.

First, strategic competitors Russia and China view the space domain fundamentally differently than we do. They view the capabilities provided in the space domain as an avenue to reduce U.S. effectiveness in all domains.[16] This is evidenced by both threats entirely restructuring their forces in 2015.[17]

Secondly, the capabilities flexed by Russia and China surpass our present capabilities. Both have satellite capabilities that can provide superior space situational awareness and are ahead in the developmental race for mobile DEW systems and ground-based anti-satellite missiles.[18]

In 2015, China established the Strategic Support Force (SSF) which integrates cyber, space, and electronic warfare (EW) enterprises into the joint fight.[19] The integration of the SSF with decentralized private competitors to drive civil-space technology and the China National Space Administration (CNSA) have seen China outpace the United States in the development and implementation of ground-based DEWs that are effective as far as low earth orbit (LEO) — the primary orbit where ISR satellites operate. This marked advantage in the space domain disables friendly ability to effectively use ISR and PNT. This reduced situational awareness on the ground provided by a space asset is an example of how China has more enhanced cross-domain fire and maneuver than current U.S. capabilities allow.

Also in 2015, Russia created the Aerospace Forces as part of a deliberate restructuring effort. This re-focus on space operations placed all space enterprises under state control.[20] These focused efforts have resulted in Russia becoming the dominant state in on-orbit counterspace systems.[21] Dual-purpose satellites have proximity orbit capabilities that outpace the United States. Russian satellites can adjust course and orbit where their new trajectory brings them close enough to U.S. satellites to cause a permanent damaging effect.[22]

Given this context, I will accomplish two objectives in this article. First, since space technical operations is how we create freedom of maneuver in the space domain, I will examine current U.S. capabilities in DEWs and KEWs. Secondly, I will provide a recommended framework for how these assets can be implemented at the tactical level for ground-force maneuver commanders.

Directed Energy Weapons

DEWs use directed and concentrated focused energy beams to "disrupt, damage, and destroy enemy equipment."[23] DEWs can be space based or ground based.

Space-based DEWs are strategically positioned satellites in specific orbits armed with weaponized directed energy

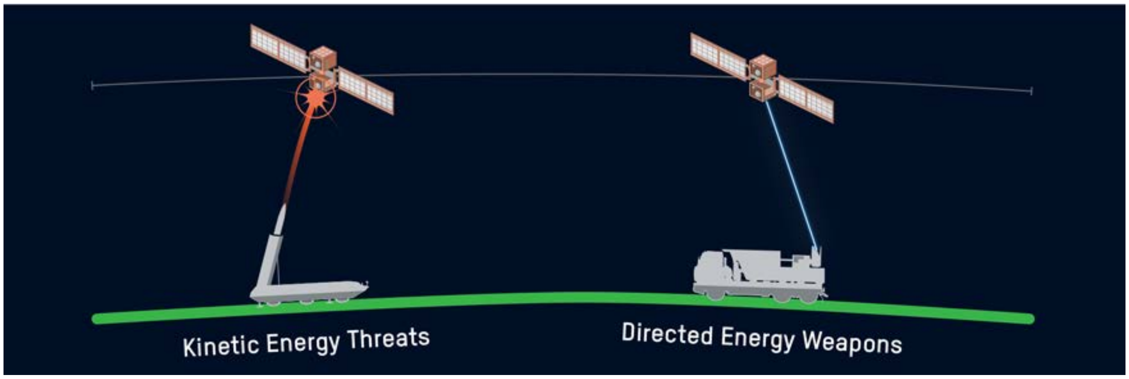


Figure 1 — Ground-Based Kinetic Energy Weapons and Ground-Based Directed Energy Weapons (Challenges to Security in Space, Defense Intelligence Agency)

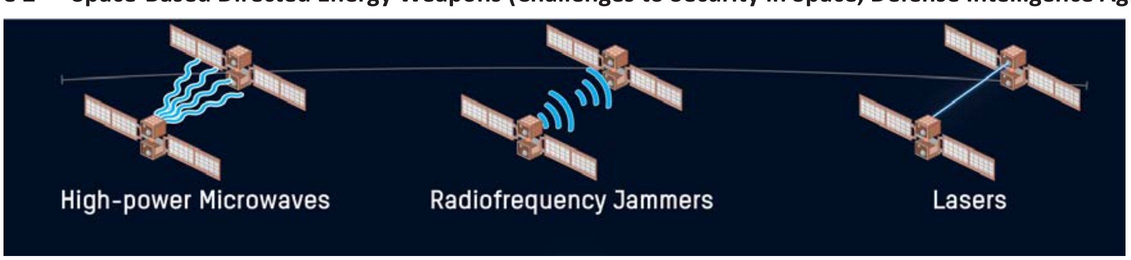
variants. While the satellite is in orbit, these energy variants are focused on an enemy satellite to disrupt its capability or destroy it. Effects are limited to the range of the directed energy variant. Typically, maximum effectiveness is reached where satellites target an enemy satellite in the same orbit. For example, LEO DEWs target and/or destroy enemy satellites that are also in low earth orbit.

The use of space-based DEWs turned space into a war-fighting domain, a battlefield of its own with effects reaching forces on the ground. When used, U.S. space-based DEWs target and destroy enemy satellites in satellite-on-satellite combat. This combat in the space domain creates cross-domain freedom of maneuver in the land domain due to a categorically massive reduction of enemy capabilities. Reduced enemy capabilities in PNT and ISR directly hinder enemy ground movement and situational awareness. This tactical advantage consequently provides enhanced freedom of maneuver for friendly forces on the ground. At end state, the control gained in the space domain enables freedom of maneuver for ground-based fire and maneuver.

While the theory above is nested with MDO as a warfighting discipline, in practice there is a massive disconnect. Presently, SMDC and the 1st Space Brigade retain all space assets at a strategic echelon, including space-based DEWs. Consequently, tactical maneuver commanders have to request the use of space-based DEWs from the strategic level to achieve their desired battlefield effects on the enemy. This is operationalized as Functional Area 40 - space operations officers requesting the achieved battlefield effects on behalf of their maneuver commanders at specific time windows. This may have been adequate during the Global War on Terrorism, where the threat had a nonexistent space capability and the timing of combat was more permissive. However, given current Russian and Chinese space capabilities, current maneuver commanders require a real-time connection to the space domain if they want to be able to both counter threat space capabilities and achieve offensive cross-domain freedom of maneuver simultaneously. This requires maneuver commanders to have a real-time flexible connection to the space domain.

Looking to the air domain for inspiration, the connection of cross-domain fire and maneuver is not a novel concept. For cross-domain fire and maneuver in the air domain, maneuver commanders are assigned an attached U.S. Air Force (USAF) joint terminal attack controller (JTAC). A JTAC directs the action of USAF aircraft on the battlefield to enable ground-based maneuver through close air support, rendering control in both the air and land domains. Essentially, JTACs give maneuver commanders real-time solutions to battlefield problems presented by a cross-domain discrepancy. Just as JTACs enable options for maneuver commanders in the air-land relationship, maneuver commanders should also have an attached space-based DEW specialist or JTAC equivalent that can provide space-

Figure 2 — Space-Based Directed Energy Weapons (Challenges to Security in Space, Defense Intelligence Agency)



A U.S. Air Force joint terminal attack controller enables freedom of maneuver in the air domain during an exercise in Hohenfels, Germany. Space Force JTACs can also be assigned to Army formations and provide the same freedom of maneuver in the space domain. (U.S. Army photo)

land solutions. This warfighter can be from the 1st Space Battalion or from the U.S. Space Force as it begins to absorb more of the SMDC workload. Regardless, the addition of a JTAC-like space enabler to maneuver commanders is critical to bridge the obvious gap between strategic space assets and the tactical level of warfighting.

Additionally, the role of a space enabler-JTAC equivalent would not just be relegated to only controlling and executing DEW space technical operations. By serving as the inherent link between the land and space domains, these enablers could also provide maneuver commanders with real-time space situational awareness for the entire space domain as it directly affects conditions on the ground. This would include real-time threat satellite and capability updates and refined friendly ISR and PNT windows.

Unlike space-based DEWs, land-based DEWs are ironically more complicated. Theoretically, land-based DEWs achieve the same effects through the same medium as space-based DEWs but require a kilowatt (kW) output strong enough to achieve the same effects at a much greater distance. This means land-based DEWs have to create a focused energy variant strong enough to penetrate the atmosphere and destroy an enemy satellite yet with a beam control that's small enough to not cause widespread collateral damage.[24] Current operational land-based DEWs only yield a 50 kW output, which is strong enough to neutralize only enemy artillery, let alone satellites. In 2022, the Army aims to have these lasers mounted on a platoon of four Strykers and implemented at the tactical level.[25] The U.S. Army aims for the next step to be fielding a 300 kW land-based DEW variant by 2024.[26] Even so, such an energy output would only be strong enough to at most destroy a cruise missile, let alone penetrate the atmosphere and affect enemy satellites.

Advanced simulations conducted by space physicists with the *Journal of Physics* have demonstrated that the wattage threshold to effectively neutralize satellites in LEO is 3 mega-watts (MW), 1,000 times the current U.S. fielding.[27] Yet the same study stated the U.S. Army currently has ground-based lasers with a ceiling of 10 MW.[28] Therefore, while the technology for the required energy output may be present, there are several technological leaps that must occur before maneuver commanders will have mobile anti-satellite land-based DEWs in their formations.

Luckily, the U.S. Missile Defense Agency has already commissioned the Ballistic Missile Defense System Laser Scaling Project to meet these inadequacies. The Laser Scaling Project aims to produce a smaller, lighter, and portable 10 MW laser.[29] However, project completion is still seven years away.[30] Therefore, the implementation of a portable 10 MW laser platform with the capability of serving as a land-based counter-satellite DEW could follow the same implementation protocol as the 50 kW Stryker-mounted anti-artillery DEWs that will reach the force by 2022.[31]

Kinetic Energy Weapons

KEWs are conceptually the easiest to understand and employ of counterspace systems. KEWs destroy enemy satellites without placing anything into orbit.[32] They accomplish this by delivering a kill vehicle to the enemy satellite via a rocket and/or missile launch that gives a kill vehicle enough velocity to penetrate the atmosphere and destroy the enemy satellite. KEWs typically consist of a fixed or mobile launch system, the atmosphere piercing missile, and the actual kill vehicle payload that destroys the satellite. Since this entire engagement happens outside of the atmosphere at incredibly high velocities for both the targeted satellite and the kill vehicle, the kill vehicle payload is quite small.[33] Yet the simplicity of implementing KEWs stops there. Albeit, the practice of using KEWs is tested and viable, there are two major logistical concerns when using KEWs to destroy satellites.

First, due to the destruction of the satellite being entirely contingent upon timing and positioning of the kill vehicle, the physical destruction of the satellite from such a highly energetic interaction causes a large amount of orbital space debris. These orbital debris particles can take on trajectories of their own, where the resultant vector can damage friendly satellites or even create entire fields where planned orbits are no longer feasible. These unpredictable second-order effects make actual KEW implementation to destroy satellites the least preferred method.[34] In 2007, China deliberately destroyed a Chinese LEO weather satellite with a ground-based KEW as a proof of concept. The resultant orbital debris from the damaged satellite actually struck a Russian satellite in 2013.[35] It is not public information if the satellite was permanently damaged. This unpredictability of trackable space debris from KEWs leaves most states opting for different space-control solutions.

Secondly, KEWs require very specific launch considerations. Atmospheric and meteorological conditions that substantially effect rocket trajectory can prevent the launch of a KEW. Certain KEWs require robust launch sites with mission command nodes similar to non-violent rocket operations. Mobile KEWs still require open areas with a flat and uniform surface to serve as a viable launch pad. Despite these logistical constraints, ground-based KEWs were the first and remain the most common form of counterspace measures by both friendly and adversarial forces. Furthermore, the transformation from states that can already launch satellites to developing KEWs is a minimal leap. Accordingly, the threat analysis for KEWs is substantially more robust and involved than for DEWs.

The People's Liberation Army (PLA) in China not only already has operational KEWs, but they have already initiated integration and training with ground forces.[36] Current Chinese ground-based KEW capabilities can only range ISR and PNT LEO satellites. Yet, it is estimated that the PLA is currently pursuing the development of mobile ground-based KEWs that can target satellites ranging to a geosynchronous orbit. Geosynchronous satellites are responsible for intercontinental ballistic missile warning and detection. Therefore, China is only years away from being able to destroy U.S. capabilities at detecting a nuclear missile while in flight. This cross-domain capability provides not just freedom of maneuver on the ground but can also offer an unconventional strategic advantage.

Additionally, Russia is developing a mobile KEW that can destroy LEO satellites. Russia completed the eighth field test of the PL-Nudol anti-satellite missile — a ground-transportable, mobile KEW that can easily integrate with ground maneuver formations.[37] While not at the geosynchronous altitude capability like its Chinese counterpart, the incredible mobility of the PL-Nudol enables easier integration with maneuver forces and gives Russian maneuver commanders a viable space control measure on the battlefield.[38]

Russia and China are not the only threats with ground-based KEWs. Iran successfully launched an LEO satellite in 2009. With only minor weaponizations to its launch vehicles required, Iran is well within reach of a ground-based KEW.[39] Additionally, North Korea has successfully launched both a ballistic missile and a space vehicle. When coupled, North Korea is only a minor step behind in the development of a ground-based KEW.[40]

Despite increased threat production of ground-based KEWs, the orbital debris caused by KEWs creates operational variables in the space domain that outweigh the cross-domain freedom of maneuver that their successful destruction of satellites provides. Therefore, enabling cross-domain fire and maneuver should emphasize the prevention of enemy use of ground-based KEWs, not the implementation of them by friendly forces. Luckily, these systems and programs are already in practice.

The Ground-Based Midcourse Defense (GMD) Program is responsible for the development and implementation of anti-ballistic counter missiles designed to intercept enemy intercontinental ballistic missiles (ICBMs) while in mid-flight. The U.S. currently fields 44 of these interceptors with 40 located at Fort Greely, AK, and four located at Vandenberg, CA. At the height of their trajectory, ICBMs leave the Earth's atmosphere. Therefore, the initial thrust velocity between ICBMs and ground-based KEWs are similar enough to potentially intercept enemy KEWs prior to their leaving the atmosphere and causing orbital debris issues.

While conceptually feasible, there are outstanding requirements prior to the conversion of GMD interceptors from ICBM interceptors to KEW interceptors. Technologically, these interceptors would need to be modified to be able to track and intercept KEW trajectories and be able to do so at a faster rate than they currently track ICBM trajectories. Furthermore, a study by the Center for Arms Control and Non-Proliferation determined that the effectiveness of the current fielded interceptors is limited.[41]

Assuming these technological barriers are solved, anti-KEW interception is still retained at the grand-strategic, state level. The implementation of KEW interceptors to enable ground-based tactical maneuver would need to see a paradigm shift in the level of approval for the deployment of an anti-KEW interceptor. Yet again, there is a tactical precedent of cross-domain condition setting by tactical maneuver commanders.

A Ground-based Interceptor is launched from Vandenberg Air Force Base, CA, on 25 March 2019 in the first-ever salvo engagement test of a threat-representative intercontinental ballistic missiles target. (Photo courtesy of U.S. Missile Defense Agency)

Ground force tactical commanders lead suppression of enemy air defense (SEAD) prior to the infiltration of a ground force by airborne or rotary assault. The ground force tactical commander has the required autonomy for the implementation of SEAD assets to ensure that friendly forces will have superiority in the air domain, enabling their infiltration. The physical assets conducting SEAD are not necessarily collocated with the maneuver commander, but the autonomy to use them in order to set conditions is still given to the tactical level. Therefore, the implementation of anti-KEW interceptors at the tactical level can serve a similar purpose, but in the space domain. Suppression of enemy space weapons (SESW) will need to become another condition to set on the battlefield. In the world of MDO, tactical commanders will need this authority in the event enemy forces launch KEWs during a tactical fight to suppress with an interceptor. Retaining anti-KEW interceptors at the highest level would only prevent the tactical commanders on the ground that need the cross-domain fire and maneuver from being able to directly affect their battle space in real time. GMD and SMDC can retain the physical assets at their level and own the launching procedures. However, giving the tactical maneuver command launch authority in the event it is to counter an enemy's KEWs enables tactical freedom of maneuver in MDO.

Conclusion

On the modern battlefield, MDO calls for tactical maneuver commanders to affect all domains of war to create the requisite cross-domain fire and maneuver for their forces. While this has yielded a paradigm shift in the air and cyber domains by giving maneuver commanders more influence, the space domain remains a strategic domain where tactical maneuver commanders have no control. Space-based assets provide ground forces with geolocation, navigation, target identification, and many other services. Yet the offensive mechanisms in the space domain that preserve these satellites — or deny enemy forces the same capabilities — are retained exclusively at the strategic level by SMDC. The reallocation of DEWs and KEWs to the tactical level presents the solution for tactical maneuver commanders to exercise control over the space domain and enable cross-domain fire and maneuver at the ground level.

An immediate solution is to give control and deconfliction of DEWs to a JTAC-like space enabler. This would give maneuver commanders a tangible connection to the space domain where directed energy satellite-on-satellite combat that effects ground maneuver takes place. Long term, the integration of a ground-based DEWs into maneuver formations at the tactical level would give a more timely effect. While the U.S. is only a few years from this capability, Russia and China are already working on the development and tactical integration of ground-based DEWs.

KEWs may be the traditional and preferred form of exercising offensive space control. However, the destruction of an enemy satellite by a KEW creates orbital debris that can dramatically affect the entire space domain. Additionally, with the launching of a KEW being a state-level detectable action, it's not feasible to give physical control of ground-based KEWs to tactical maneuver commanders. However, similar to the current doctrine of tactical commanders owning SEAD prior to airborne and air assaults, tactical maneuver commanders need operational yet contingent control of re-designed anti-ballistic missile interceptors to suppress and destroy enemy counterspace capabilities prior to large-scale operations.

While the nature of war does not change, the character of war does. The prevalence of MDO and increased threat abilities have seen a new importance of giving multi-domain influence to the tactical level. The space domain is the most critical, overlooked, and next in line for this same paradigm shift.

Notes

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[9] Ibid, i.
[10] Ibid, i.
[11] Ibid, i.
[12] Ibid, B-1.
[13] Ibid, B-2 and C-9.
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