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Space & Missile Defense Special Edition

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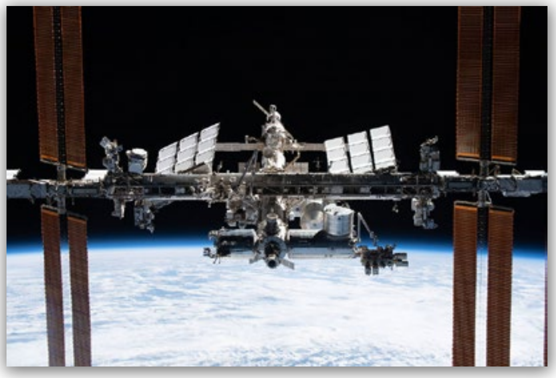

Cover photo: The International Space Station is observed from the SpaceX Crew Dragon Endeavour during a fly around of the orbiting lab that took place following its undocking from the Harmony module's space-facing port on 8 November 2021. The orbital complex was flying 263 miles above the Marshall Islands in the Pacific Ocean when this photograph was taken. (Photo courtesy of NASA)

Army University Press

Soldiers with the 17th Field Artillery Brigade fire three M142 HIMARS during a combined joint live-fire demonstration at Shoalwater Bay Training Area in Queensland, Australia, 22 July 2023. This demonstration launched Talisman Sabre, the largest bilateral military exercise between Australia and the United States, advancing a free and open Indo-Pacific by strengthening relationships and interoperability among key allies and enhancing their collective capabilities to respond to a wide array of potential security concerns. (Photo courtesy of the U.S. Army)

Foreword

Gen. Charles A. Flynn, U.S. Army

China's test of an antisatellite system in 2007 did more than shatter an aging weather satellite and launch debris throughout near space.[1] The display of this newfound capability awakened the world to the reality that space is now a warfighting domain. Long the topic of science fiction and the imaginations of many, conflicts in space were once thought to be hypothetical and far-fetched. Now, they are real. Nearly everyone relies on capabilities and services provided by satellites—from military applications, communications networks, financial transactions, and international commerce to personal use.

From a military standpoint, however, it is important to recognize the implications of space as a warfighting domain while keeping in mind that capabilities and services in space begin and end on the ground. For example, the internet access provided by Starlink in war-torn Ukraine has allowed its government to gain international support, its military to communicate on the battlefield, and its people to remain connected with each other and the outside world.[2] None of this would be possible without the terminal connecting the user to the assets in orbit.

Moreover, missiles have proven their utility since Germany employed the V-2 in World War II. The ease of use and ready availability of missile technology has seen the propagation of missile employment to all corners of the globe. In 2021, China tested a hypersonic missile that partially orbited the earth, reinforcing the rapid pace of change in the capabilities that advanced militaries can bring to bear for both deterrence purposes and, should conflict arise, for precision strike on targets at ever-increasing ranges.[3] More recently, on 7 October 2023, Hamas's all-out assault on southern Israel began with a rocket barrage numbering in the thousands of rounds.[4]

Missile defense has clearly become a fundamental necessity—and the need is growing rapidly for capabilities that counter the extended ranges, increasing volumes, and hypervelocities of modern missiles. Similarly, the next generation of unmanned systems and their novel application presents new dilemmas in the form of swarm technology, low signatures, and the like.

Two years of war in Ukraine and the conflict that erupted suddenly in Israel provide sober reminders that wars are violent, often longer than we expect, unpredictable, and very human. The last thing we need is another war, particularly in the theater where I have spent most of the last decade—the Indo-Pacific.

Our *National Defense Strategy* calls on the U.S. joint force to deter conflict—and, if necessary, be in a position to fight and win—through three pillars of integrated deterrence, campaigning, and building enduring advantage.[5] Deterrence is built upon the foundation of capability, posture, messaging, and will. Considering the changing character of war and the evolving nature of conventional threats, the Army's space and missile defense capabilities are essential to maintaining and strengthening the joint force's combat credibility, thus signaling U.S. resolve and presenting a credible deterrent to our adversaries.

Gen. Charles A. Flynn, U.S. Army, assumed duties as the commanding general of U.S. Army Pacific in June 2021. He previously served as the Army deputy chief of staff G-3/5/7 for operations, plans, and training; and as the commanding general of the 25th Infantry Division. Commissioned as an infantry officer in 1986, he has spent nearly four decades in uniform.

Discussions over capability typically involve advanced munitions, platforms, weapons systems, or other equipment. However, while those aspects are important, the design of formations that must integrate them with the joint force and employ them against a thinking, evolving adversary is arguably the most critical.

The Multi-Domain Task Force (MDTF) is the signature formation for the Army's "continuous transformation"—one of Army Chief of Staff Gen. Randy George's four focus areas—which offers critical space, air, and missile defense capabilities as part of a broader suite of means that synchronize the joint force's delivery of kinetic and nonkinetic effects.[6] When I was the Army deputy chief of staff for operations, plans, and training, the MDTF began as a way to explain what the Army was doing to operationalize our multidomain operations concept, now doctrine. However, it has since proven its value in ways we did not anticipate at the time.

By building the organization first, instead of fielding new technology to a legacy unit, the Army was able to learn and develop its tactics, techniques, and procedures to inform the full range of associated requirements in-stride, commonly referred to as DOTMLPF-P.[7] Consequently, the Army created an organization that has exercised, rehearsed, and "debugged" the new technologies for the joint force's immediate benefit upon fielding.

The MDTF is purpose-built to operate in periods of competition as well as conflict, so it must be positioned forward in theater—under the authorities of the combatant commander—to operate. When operating forward, the organization can see, sense, and understand the environment and will soon possess all the necessary pieces along the kill chain to find, fix, finish, and assess targets in any domain either through organic delivery or another joint shooter. So as mid-range capabilities are enhanced over time, employment of kinetic-effect munitions within the theater in the near future translates to increased credibility and thus a threat-deterrent effect.[8]

Ukraine has demonstrated that the U.S. capabilities work, even against new and advanced technologies. In May 2023, Ukrainian forces successfully

Gen. Charles Flynn, U.S. Army Pacific commanding general, visits Guam 26 July 2023. Flynn met with soldiers and the leadership of Echo Battery, 3rd Air Defense Artillery Regiment, Task Force Talon, to discuss the mission and the quality of life in Guam. (Photo courtesy of the U.S. Army)

employed a Patriot missile to down the Russian Kinzhal missile—a weapon President Vladimir Putin described as "invincible."[9] The air defense battalions are similarly fielding and employing advanced capabilities in the form of counter-unmanned aircraft systems, short-range air defense (SHORAD), including mobile-SHORAD and directed energy SHORAD, in addition to the combat-tested Avenger, Patriot, and Terminal High Altitude Area Defense (THAAD) systems.

While the MDTF is not the only formation to employ space, air, and missile defense capabilities, it offers a glimpse into the future of deterrence and warfighting for the joint force. Yet many of the Army's other space organizations along with legacy air and missile defense formations still form the backbone of an integrated air and missile defense network by providing command and control, multitier protection, and intelligence support to targeting. The 94th Army Air and Missile Defense Command is a theater-enabling command under the theater Army that offers lower, mid, and upper tier defense capabilities in forward locations in Korea and Japan, which are critical for allowing the United States to fulfill its treaty obligations. Furthermore, the air defenders in Guam—a U.S. territory and key power projection node—perform our most sacred mission of all, defense of the homeland.

As mentioned previously, leveraging the Army's capabilities across all domains, including space, fundamentally relies on posture. Areas that provide positional advantage are the reason that key terrain is in fact key. Therefore, the Army's basic purpose of seizing, holding, and defending key terrain has not lost its importance considering the ongoing changes in the character of war fueled by the prominence of data, artificial intelligence, and other information age technologies.

Meanwhile, dispersion causes targeting dilemmas for adversaries and multiplies advantages for friendly forces, because as George has said, land forces have the unique advantage of "hiding in the clutter."[10] This is especially important in the Indo-Pacific theater because China's antiaccess/area denial arsenal is designed primarily to defeat naval and air power, and secondly to disrupt and degrade space and cyber. It is not, however, designed to find, fix, and finish distributed, mobile, networked, lethal, and reloadable land forces.

Because space-based effects begin and end on the ground, it is worth considering the asymmetric advantages land forces provide not only to generate those effects, but perhaps more importantly, to also protect and defend the key nodes and critical capabilities—on key terrain—that make it possible for the rest of the joint force to do so. This, of course, involves implications not only for conventional deterrence but nuclear deterrence (e.g., early warning, targeting, communications) as well.

Nearly all the joint force's advanced platforms rely on the Army's space and missile defense capabilities, whether it's a ship operating at sea or an advanced aircraft beyond sight of land. I often refer to these capabilities, along with many others like theater logistics and command and control at echelon, as foundational capabilities that only the Army provides the joint force at depth and scale. And speaking of scale, the Army happens to be the biggest consumer of space capabilities.

The point here is the men and women who comprise the Army's space and missile defense—particularly in this new era of renewed interstate conflict and long-term strategic competition—provide some of the most critical capabilities to support, enable, and protect the joint force along with our allies and partners while performing the most consequential mission of all—defending the United States and protecting the American people. Renewing our collective appreciation for not only these critical capabilities but also the implications of space as a warfighting domain are essential to carry forward in training, campaigning, and future battlefields. ■

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The U.S. Army Space Vision

On 8 January 2024, the U.S. Army released its vision for greatly expanding its emphasis on developing the ways and means associated with exploitation of space to support multidomain operations.

This vision statement conveys to Army commanders, staffs, and other Army stakeholders the urgent need to invest more in development of space capabilities and formations to assert dominance in this domain over the capabilities possessed by existing or prospective adversaries of the United States and its allies.

The Cygnus cargo vessel deploys a U.S. Army joint capability technology demonstration satellite after its release from the International Space Station in June 2021. (Photo courtesy of NASA)

Army space professionals are tasked with leading the effort to increase understanding of space capabilities across the Army to include mentoring more rapid integration of these capabilities into all Army operations and activities. To accomplish this objective, greater training and education about the Army's space capabilities will be initiated together with greater practical incorporation of such capabilities in Army experiments and exercises to help shape the development of live, virtual, and constructive environments that replicate the complexity and uncertainty of the twenty-first century operational environment. These will focus on facilitating employment of Army-unique capabilities to interdict or disrupt our adversaries' use of space capabilities to help ensure Army forces gain and maintain the initiative in the event of either any peacetime confrontation or open conflict from positions of relative advantage.

By outlining Army roles and missions in and through the space domain, the vision will give leaders a better understanding of how they can leverage space capabilities to improve their ability to deploy, fight, and win our Nation's wars. The full statement is found at page 6 of this publication or online at https://www.smdc.army.mil/Portals/38/Documents/Army_Space_Vision_Supporting_MDO.pdf.

  

Army Space Vision Supporting Multidomain Operations

The Army will integrate friendly joint and coalition space capabilities and interdict adversary space capabilities in support of ground force commanders.

The Army's next fight will occur across multiple domains. Successful operations in and through the space domain will be critical to our success. Space has become more important as both enabler and dependency to our Warfighting. Commanders at all echelons have access to, rely on, and can be observed by the space-based assets of allies and competitors alike. Commanders must understand that space capabilities start and end on the ground and be fully aware of their importance in planning and operations. This means that understanding commercial, military, and scientific space platforms directly correlate to our ability to conceal and protect friendly ground forces across the entire battlespace, from home station to assembly areas, and from assembly areas to objectives. Simply put, we will be operating under constant surveillance and must invest in the knowledge and forces to counter threat space systems and enable our own space systems.

Army space professionals, at echelon, will lead the effort to increase understanding and integration of friendly joint and coalition space capabilities into our operations and activities while simultaneously interdicting the adversary's use of space based, and space enabled capabilities. To do this, highly trained Army Soldiers and Civilians must be organized, have the right resources, kit, authorities, and expertise to:

- **<u>Integrate</u> friendly joint, coalition, and commercial space capabilities in support of all Army Warfighting Functions to include positioning, navigation, and timing; deep sensing; beyond line-of-sight communications; force tracking; environmental monitoring; space domain awareness; and geospatial information.**

- **<u>Interdict</u> adversary space capabilities by delivering necessary fires and effects at echelon to protect friendly forces from observation and targeting by counter-satellite communications, counter-surveillance and reconnaissance, and navigation warfare operations.**

To fight at echelon in and through space means employing the next generation of tactical terminals to leverage multi-orbit satellite communications services and access space-enabled tactical intelligence, surveillance, and reconnaissance platforms to meet deep sensing requirements. By fusing the data from multiple space-based sensors, in coordination with the intelligence community, the Army can deliver targetable intelligence to enable long-range precision fires, movement and maneuver, and command and control. These space capabilities, layered with stratospheric, high-altitude balloons and long endurance, semi-autonomous fixed-wing aircraft, can provide redundant and complementary capabilities for the theater to increase resiliency of the U.S. and Allied space architecture in a denied, disrupted, intermittent and limited bandwidth environment. Mobile ground and aerial platforms demonstrate the potential to deliver space interdiction fires to deny adversary access to space capabilities, and disrupt their command and control, navigation, targeting and intelligence collection. Forward-postured Multidomain Task Forces, employing Army space interdiction forces alongside cyber operations and electronic warfare enablers, will disintegrate adversary anti-access and area-denial systems. Simultaneously, Theater Strike Effects Groups can synchronize and deliver Army space interdiction fires in support of theater targeting objectives.

Army space professionals are critical to Army Preparedness—to setting theaters, supporting deterrence, and enabling multidomain operations. Forward-stationed Army space organizations conduct continuous operational preparation of the environment during campaigning to help set conditions to defeat layered defenses and open contested theaters in crisis and conflict. These organizations build partnerships with close, highly capable allies to increase interoperability. Positioning Army space operators in theater with cyber and special operations forces allows for convergence, amplifying lethality and contributing to deterrence. Army space integration also supports and spans across all Army Branches and Warfighting Functions to build and navigate the multidomain common operating picture. For example, Army Signal integrates satellite communication services from the Department of Defense and external agencies to establish the networks vital to multidomain operations. The networked enterprise provides force tracking services to ensure joint and combined situational awareness, contributing to information advantage. Additionally, Army Intelligence leverages space-based assets to provide geospatial, signal, and all-source intelligence, enabling the Army and joint space interdiction fires necessary for multidomain operations.

Expeditionary, scalable, and mobile Army space formations, empowered by flexible command relationships at echelon, should move alongside and keep pace with ground combat formations to protect the force and enable the Army to deploy, fight and win decisively against any adversary.

Developing new space capabilities, organizations, and trained professional Soldiers to deliver effects for Army maneuver forces is critical to multidomain operations. Rapid proliferation and tactical application of competitor space capabilities will erode the advantages that ensure U.S. land dominance. To counter this challenge, current and future Army space integration and interdiction capabilities must enable multidomain operations for the Army.

Michael R. Weimer
Sergeant Major of the Army

Randy A. George
General, United States Army
Chief of Staff

Christine E. Wormuth
Secretary of the Army

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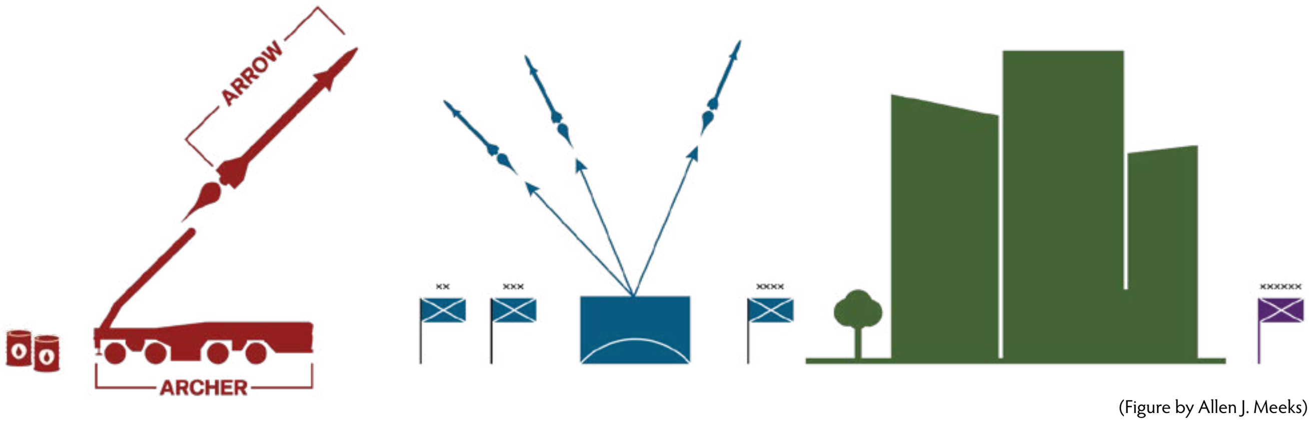
Lt. Gen. Daniel L. Karbler, then commanding general of U.S. Army Space and Missile Defense Command, delivers the keynote address 8 August 2023 during the 26th Space and Missile Defense Symposium at the Von Braun Center in Huntsville, Alabama. He focused on how the command ensures space remains a capability for the soldier, the Army, and the Nation. (Photo by Dottie White, U.S. Army)

Introduction

From Missile Defense to Missile Defeat

Lt. Gen. Daniel L. Karbler, U.S. Army, Retired

My Army story started in 1983, right in the middle of the "new" Cold War. As a plebe at West Point, I watched what happened in Beirut and Grenada in October of that year. After commissioning, I watched from Europe as the United States conducted Operation Just Cause into Panama



(Figure by Allen J. Meeks)

Figure 1. The Missile Dynamic in 1991—Defending against a Bow (Archer) and an Arrow (Tier 1 Supplier)

in 1989. Soon, it was my turn. In 1990, I deployed the recently fielded Patriot system to Tel Aviv as a first lieutenant during Operation Desert Storm.

The operating environment, in retrospect, was simple. The adversary was on their side, firing missiles, and we were on the other, shooting them down (see figure 1). We referred to enemy missile systems as "archers and arrows." Our goals were also simple: strike the "archers" first and intercept the "arrows" before they hit military capabilities and civilian populations.

Things have obviously changed, and I will leave some of that discussion for the articles in this publication. But I would posit that we are not thinking far enough, or deep enough, upstream against "archers and arrows," and we need to adapt our Army's thinking toward one of missile defeat.

Running thirty-six-plus years deep in air and missile defense, I consider Operation Desert Storm the first missile defense fight, and we learned a lot. However, let us consider also what has happened since 1990: the USSR collapsed; helicopters were employed in the dense urban areas of Somalia, Bosnia, Haiti, and Kosovo; drone and cyberattacks intensified throughout Afghanistan and Iraq; similar operations happened in Syria, Niger, and Ukraine; and the list continues.

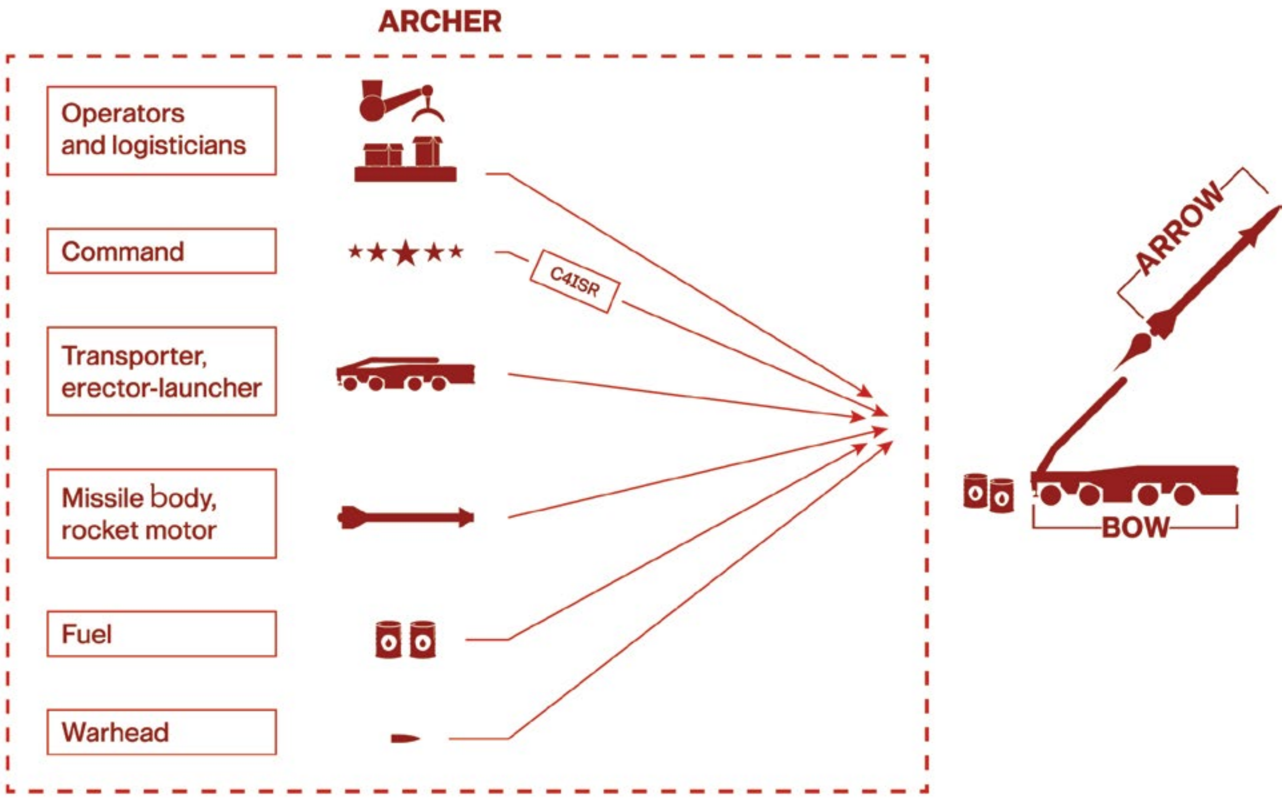
Accordingly, the question on everyone's mind is, What kind of war will we face in the future? Conversely, we might ask ourselves, What have we really learned from the past, where we faced threats that merely crossed two or three domains and from just one or two directions?

Don't get me wrong; I do not have all the answers. But I can tell you what I have learned, especially in command at the U.S. Army Space and Missile Defense Command (USASMDC): pay attention to complex unmanned systems and space warfare and to a future that portends directed energy, autonomous systems, machine learning, and distributed operations. And consider all this with lower barriers to entry than we have ever seen—with a continued normalization of use. With so many variables at play, it is hard to tell what emergent technology will be as promising as the radio and what will fizzle out—short-lived ideas that had no applications whatsoever.

So, against this backdrop of uncertainty, I contend *missiles*, especially in our current and forecasted security environment, will be at the forefront of the next war. Combined with unmanned aircraft systems, they are the *poor man's air force* and the culmination of what a state can do regarding hard power. As I testified to Congress last spring, "I have never seen adversary threat activity, be it in test or operationally, as great as I see it today."[1] In this, it is not that historian T. R. Fehrenbach was wrong about putting our service members into mud to win a war.[2] I see another missile defense fight emerging first.

But here is the rub: we do not have, and we will never have enough interceptors. Therefore, we must adjust our theories

Lt. Gen. Daniel L. Karbler, U.S. Army, retired, served as the U.S Army Space and Missile Defense Command commanding general and Joint Force Functional Component Command Integrated Missile Defense commander.



(Figure by Allen J. Meeks)

Figure 2. Basic Upstream (Tier 2 Supplier) Components of an Adversary Missile System

of victory to include *missile defeat* as a major principle—if not the first principle—of future wars, especially considering what we have seen take place in Ukraine.

Dr. Stephen Biddle, professor of international and public affairs at Columbia University, stated in regard to Ukraine, "Instead, as has often been the case in the past, the best path forward will involve incremental changes, not tectonic shifts."[3] While Biddle does not discuss these "incremental changes" and outcomes when fighting shoulder-to-shoulder with NATO or other allies and partners, he explains that "the most important adaptations are often not technological but operational and tactical. They involve changes in how armies use the tools at their disposal."[4]

It so happens the latest edition of our capstone doctrine, Field Manual (FM) 3-0, *Operations*, recognizes the speed at which conflict is shifting, stating that the "rapid advances in, and the proliferation of, air, space, and cyberspace capabilities with military applications are changing warfare," and that "space and cyberspace capabilities can provide commanders with options to defeat, destroy, disrupt, deny, or manipulate enemy networks, information, and decision making."[5]

What I would like to lay out here is not a new revolutionary theory or strategy. Rather, it is a simple idea of missile defeat being a premier mission for multidomain operations by our Army and for our Army. The reason for this is threefold: our Army has its unique missions, enables the joint force, and never fights alone.

The early twentieth-century air-power theorist Italian Gen. Giulio Douhet was prescient nearly two decades before World War II. He wrote that technological advances would change the way we all fought, stating, "For now *it is possible* [emphasis in original] to go far behind the fortified lines of defense without first breaking through them."[6] Obviously, this vision drove a lot of change in what militaries looked like in preparation and the execution of that war.

I think Douhet was right. He was ahead of his time, and even though he was thinking in bombs and bombers, his idea of "going far behind" applies against adversary missiles and unmanned aircraft systems in depth. This time around, for the next missile defense fight, we can—we must—apply Douhet's theory of "bypassing rather than breaching" to create nonkinetic effects across active campaigning, through crisis and into conflict, using all domains, and coming from all directions, including from way, way up.

An "arrow/archer" metaphor has often been used to explain missile launchers and interceptors. However, a new—and necessary—mental model for missile defeat may best be described as an arrow, bow, archer, and quiver.[7] This is an *evolutionary idea*. It is the natural progression of our strategic thinking considering our technology, the majority of which we already have, and the ever-increasing cost of inaction or passivity.

Let us begin with a simple breakdown of what makes a missile system work (see figure 2). There are, essentially, six components: the people that set up and operate the equipment (operators and logisticians), the command itself to fire, the delivery vehicle (e.g., transporter erector launcher, silo, aircraft, ship, submarine, launch pad), the rocket body and motor, the fuel to make it fly, and the warhead that explodes—in some cases as a weapon of mass destruction.

Generally, these components are dispersed throughout a given country, but in figure 2, we assume a system without geography (or other limitations). In the real world, you may not be able to prosecute the targets you should (that is the problem with models). As an additional aside, along the left-hand side of the figure, the "softer" targets are generally up top, accessible, and particularly vulnerable to nonkinetic effects (to include influence); whereas the components that make up the bottom left are the most vexing, deep, and difficult targets to prosecute in the world—by our adversaries' design!

This is not meant to be a targeting systems analysis; it is a base of understanding we can use together, as in mission command. And since we have that coursing through our Army veins, we can take a quick shortcut; much like the phrase "left-of-boom" that we used in Iraq and Afghanistan, we need to adopt a "left-of-launch" approach to missile defeat—and, by the way, designate a commander to lead a newly developed position of "missile defeat effects coordinator."

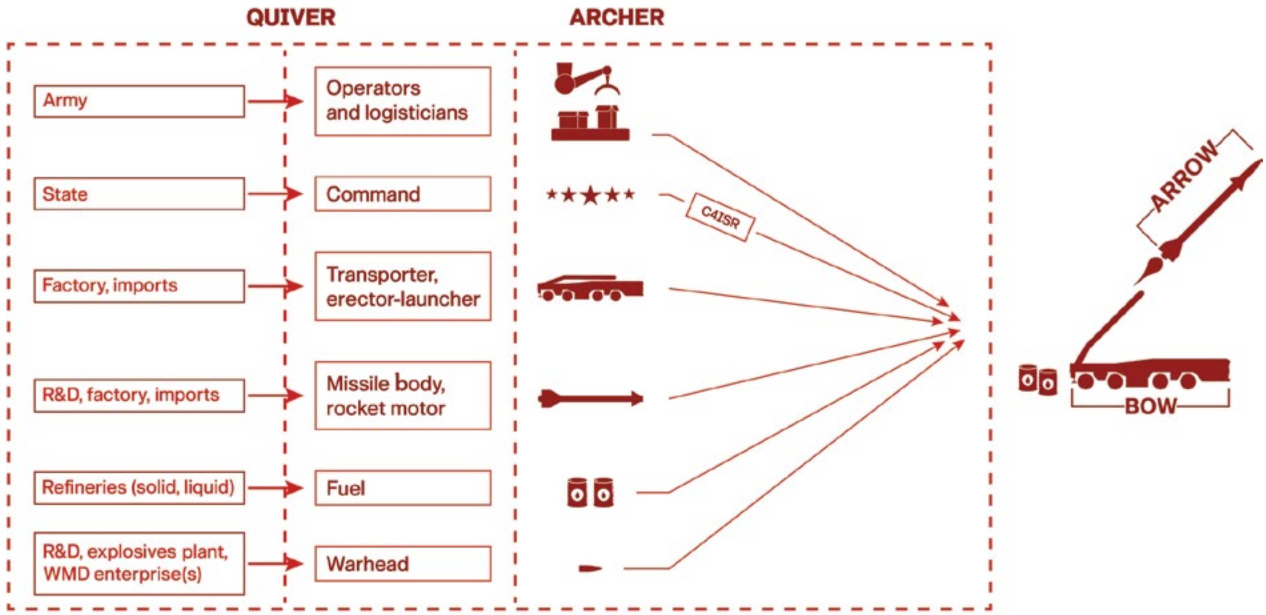
I need to pause here, before we go deeper, to make an important point: *missile defeat* must first be approached through the lens of the *art of command*. We should be thinking about who should be doing what, creating which effect, under their own given missions, functions, roles, responsibilities, and authorities.

Now, onto the quiver, the support system to the components laid out in the first upstream diagram (from figure 3). Here, we go even deeper into the supply chain in both senses of the word: upstream and underground—harder targets. Not many factories produce rockets, even in our own country. The fuel generally comes in one of two states of matter: solid (part of the rocket body) or liquid. The refineries are usually centralized, so the fuel can be distributed. Even then, the variant fuels are limited because of the cost. Finally, we get to the warhead—the pinnacle of current military science, from guidance system to release and timing mechanism—and that warhead may be developed in a lab or a reactor, manufactured, or refined.

I borrowed some of these ideas from the discipline of supply chain risk management because it seems timely. Across electronic enterprises, all over the world, we have great fragility in critical systems, from the optical to the magnetic. Post-COVID, it also seems our publics are keenly aware of how critical shortfalls can affect availability of goods, services and, in some cases, military capability. Hence, the use of the graphics in terms of tier 1, tier 2, and tier 3 suppliers—the next missile defense fight is a war of supply and the will to preserve or expend it. Every war is that way.

Now, I would like to pivot from the problem set of missile defeat to a solution set that USASMDC has been working on in partnership with the strong leadership and commitment of Lt. Gen. Jon Braga, U.S. Army Special Operations Command, and Lt. Gen. Maria Barrett, U.S. Army Cyber Command. Some of you have heard the three of us and our staffs talk about a modern "Triad" that offers options to Army and joint force commanders across active campaigning, crisis, and conflict should deterrence fail.

I assure you that the Triad is not just talk. We are experimenting and demonstrating our unique and complementary capabilities at least monthly and, in some cases, near our adversaries. In this way, Triad is a clever name for our collaborative efforts among the three commands. It also is an interesting choice of label because of how it affects our adversary's decision calculus.



(Figure by Allen J. Meeks)

Figure 3. Secondary Upstream (Tier 3 Supplier) Support to Missile System Components

In broad strokes, the traditional triad of nuclear-capable bombers, nuclear attack submarines, and nuclear intercontinental ballistic missiles has contributed to deterrence through the imposition of cost—the ability to threaten or hold at risk what the adversary values or requires to operate. So, for over seven decades, we've been maneuvering at the strategic level to communicate our intent with the traditional nuclear triad.

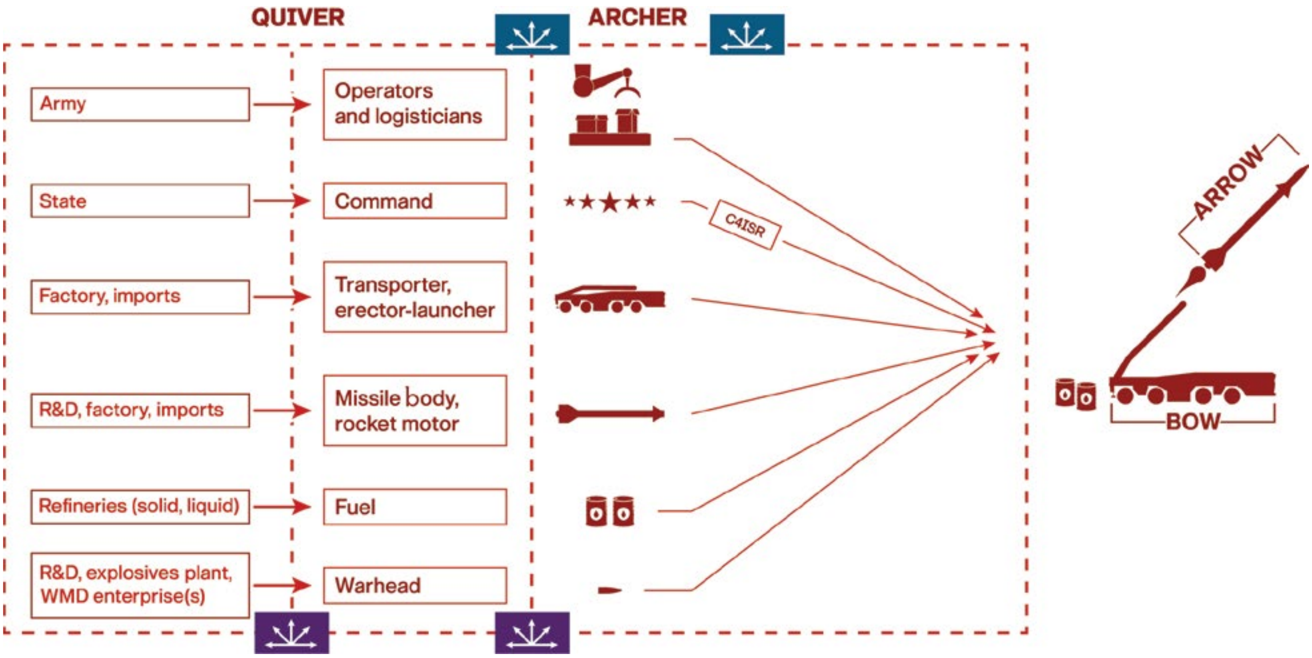
What we've seen in the current security environment, and will continue to see in the future, is the threat of selective use of nuclear weapons, which erodes the deterrent effect of massing them. Heaven forbid we have a limited nuclear exchange, but the immediate effects of heat, blast, pressure, and radiation won't be the worst part. It will immediately establish a "new normal" because the consequences of limited nuclear use have yet to be established. In other words, limited nuclear use can only beget more limited nuclear use.

As a soldier, the options to demonstrate resolve usually come down to which instrument the military can employ to threaten or impose cost without crossing a nuclear threshold from a nuclear power. As an air defender, I have only lately seen the idea of denying benefit in our national security documents. That is, the adversary attempted to strike us, but we blocked it, or they hit us where it didn't matter because we were dispersed and resilient.

There are two final points I would like to make in this imperfect crash course in strategic deterrence. It doesn't really work if you can only make empty threats, so credible communication is a pillar. In other words, your capabilities have to work, be proven to work, and be observed by the intended audience. But just as the imposition of cost has its mirror of denying benefit, credible communication also has a mirror: doubt. And so, the question becomes, how do I—and where can I—instill doubt?

Enter the Triad, in what I would consider our return on the USASMDC investment in this body of work for *missile defeat*. First, we must accept the premise that you may conduct offensive action at the tactical or operational level to maintain an overall strategic defense—in other words, there is great utility in a well-timed (or continuous) spoiling attack. Second, we must accept that the next missile defense fight will be a race for us to contain the fight in a single combatant commander's area of responsibility, while our enemies will be racing to expand the war horizontally and out of theater.

Therefore, the Triad is as much a call to action as it is a proof of concept—not only for convergence and broader multidomain operations and formations among three Army Service component commands but also as the test bed for future Army epochs, whether in 2030, 2040, or



(Figure by Allen J. Meeks)

Figure 4. The "Triad" Applied to Each or All Adversary Missile System Components

beyond. Because, when applied to missile defeat, unique applications of Triad cyber, special operations, and space capabilities can deceive, delay, degrade, deny, disrupt, and destroy myriad components of adversary missile systems across time and space to achieve a broader strategic defense (see figure 4).

Our capstone doctrine, FM 3-0, states, "Strategic leaders may task Army long-range fires, cyberspace, space, and other global capabilities to support attacking targets in the extended deep area to set conditions for friendly defensive operations."[8] But what has our Army done thus far to prepare for these strategic leaders' orders?

Assuming we are talking about combatant commanders, or joint force commanders, I would suggest that the multidomain operational graphics (as depicted in figure 4) provide some options against adversary missile systems; against that tier 1, tier 2, and tier 3 supplier; and against that arrow, bow, archer, and quiver. Within our Army, we essentially control the Triad among the three Army Service component commands. It is incumbent on us in this corner of the coming missile-defense or missile-defeat fight to continue to chip away at the "with what" and the "how" of conducting multidomain operations. We are not alone, as we continue to drive the Triad body of work, our joint partners are already forming in the Nexus community of interest, built with different capabilities and authorities (represented in purple at the bottom of figure 4).

At the risk of being too prescriptive on the "with what" or "how" we should conduct missile defeat using the Triad and multidomain approaches, I will wind this note down. How cyber, special operations, and space capabilities converge to deceive, delay, degrade, deny, disrupt, and destroy enemy missile systems in breadth and depth is up to you now. Ultimately, it is your Army, and we have an outstanding record of adapting to new wars, but we usually bleed while we are learning. Wouldn't it be great to see us adapt a little beforehand, at a low cost, and with outsized effect? And, we are merely doing as FM 3-0 instructs, "Operational headquarters conduct activities that physically and psychologically isolate enemy leaders from their formations and other sources of support."[9]

Stated another way, I believe that modest investments in time and money using Triad and missile defeat as organizing principles, ideas, and experiments will lead to a more survivable "first battle." But most of all, if we can do this forward in our adversaries' backyards and demonstrate forward that we have the will and capability to hang weights on or render ineffective their missile systems, we get a triple return on investment.

By modifying our approaches from missile defense to missile defeat, we get to make the most of what we have already and are not waiting on a sudden influx of resources, we get live practice with the most tactically and technically proficient forces in our Army, and above all, we deter our adversaries by denying the benefits of their desire to impose cost. And by doing so, we seed doubt in whether they can win the fight they might consider picking. ■

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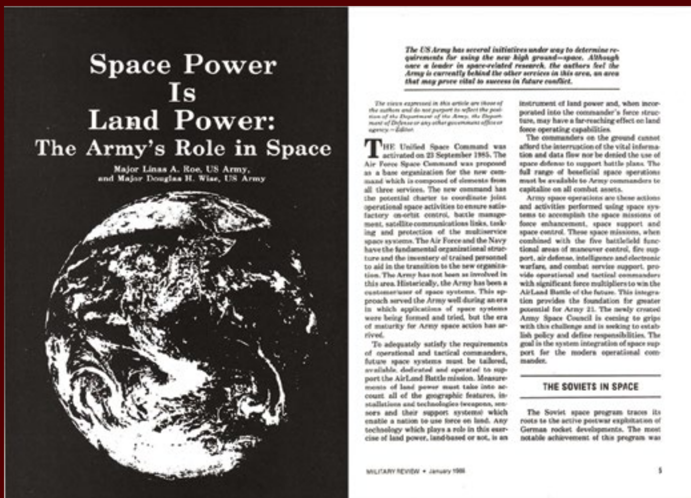

Originally published in January 1986

"Space Power Is Land Power: The Army's Role in Space"

Maj. Linas A. Roe, U.S. Army
Maj. Douglas H. Wise, U.S. Army

Long before the Army's focus on multidomain operations, the space domain was discussed in *Military Review*. The authors considered space systems to be critical even then for success in future combat operations. To read this article online, visit https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/January-February-2022/Roe-Wise-Space-Power-1986/.

"Visualizing the Synchronization of Space Systems in Operational Planning"

Maj. Jerry V. Drew II, U.S. Army

Gaining and maintaining a relative advantage in a multidomain environment will require the synchronization of tactical actions across all domains—including the acions of space systems—to achieve strategic ends. The author offers an explanation of space systems and provides a visualization tool that a staff might produce to achieve that synchronization. To read this article online, visit https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/Jan-Feb-2019/Drew-Space/.

January-February 2019

1st Battalion, 1st Air Defense Artillery, establishes a command-and-control center to coordinate missile defense operations against ballistic missile threats 16 July 2022 during Talisman Sabre 2022 in Australia. Exercise Talisman Sabre is conducted biennially and is the largest combined training event between the Australian Defence Force and the U.S. military. (Photo courtesy of the U.S. Army)

How Army Air Defense Underpins the Military Component of Integrated Deterrence

Maj. Gen. Brian W. Gibson, U.S. Army
Maj. Seth Gilleland, U.S. Army

In the introduction to his 2020 book *The Kill Chain: Defending America in the Future of High-Tech Warfare*, Christian Brose, a senior policy advisor to Sen. John McCain from 2009 to 2014, paints a realistic and concerning picture for U.S. forces operating in the Indo-Pacific. While discussing a possible conflict in the Indo-Pacific, he describes a scenario in which

> America's forward bases in places like Japan and Guam would be inundated with waves of precise ballistic and cruise missiles. The few defenses those bases have would quickly be overwhelmed by the sheer volume of weapons coming at them, with many leaking through. Those bases would have no defense against China's hypersonic weapons, which can maneuver unpredictably, fly at five times the speed of sound, and strike their targets within minutes of being launched. As all of these missiles slammed into US bases, they would destroy fighter jets and other aircraft on the ground before US pilots could even get them airborne. They would crater runways, blow up operations centers and fuel storage tanks, and render those US forward bases inoperable. If any aircraft did manage to escape the Chinese missiles, it would be forced to relocate to another base in the region, which itself would come under attack. It would look like a US evacuation.[1]

Many defense experts and government officials believe Brose's prediction could be accurate; peer and near-peer adversaries in the Indo-Pacific have embraced the antiaccess/area denial (A2/AD) strategies enabled by the type of precision strikes described in *The Kill Chain*.[2]

In response to this unprecedented threat evolution, President Joseph Biden's 2022 *National Defense Strategy* lays out a grand strategy of integrated deterrence based on a whole-of-government approach to deterring open conflict among great powers in the Indo-Pacific theater.[3] The concept of deterrence is not new—the idea of mutually assured destruction has been a part of U.S. military strategy and doctrine since the 1960s.[4] The *National Defense Strategy* expands the concept of deterrence beyond the use of nuclear weapons. Integrated deterrence entails working seamlessly across warfighting domains, theaters, the spectrum of conflict, all instruments of U.S. national power, and our network of alliances and partnerships. Tailored to specific circumstances, it applies a coordinated, multifaceted approach to reducing competitors' perceptions of the net benefits of aggression relative to restraint. Integrated deterrence is enabled by combat-credible forces prepared to fight as needed and win, and it is backstopped by a safe, secure, and effective nuclear deterrent. Although integrated deterrence is a whole-of-government approach, the Army plays a specific and crucial role within the military aspect of the framework in the Indo-Pacific theater—ground-based air defense.

Army air defense forces will play an integral role in any conflict in the Indo-Pacific. With most of its forces stationed in the continental United States, the joint force will flow forces into theater at the onset of crisis or conflict in support of the combatant commander. In a theater where all adversaries have employed extensive A2/AD networks, Army air defense forces are critically required to persistently protect U.S. force flow and the infrastructure it relies on. This also is not a new concept—the Army has provided ground-based air defense enabling the joint force dating back to World War II. As threats evolved throughout the decades, Army air defense forces have undergone several modernization efforts.

Maj. Gen. Brian W. Gibson, U.S. Army, commands the 94th Army Air and Missile Defense Command responsible for strategically deploying combat-ready forces and theater-level air and missile defense integration in support of the joint force. Gibson's decorated career spanned the globe with notable air and missile defense contributions to U.S. Central Command, U.S. European Command, and most recently, the Indo-Pacific area of operation.

Maj. Seth Gilleland, U.S. Army, is the force management officer for the 94th Army Air and Missile Defense Command. He has worked on the Enhanced Integrated Air and Missile Defense (IAMD) System on Guam initiative as well as with several stakeholders across U.S. Indo-Pacific Command to develop posture initiatives for other high priority IAMD requirements, and he has advocated with the Joint Staff and Missile Defense Agency to improve the Terminal High Altitude Area Defense system capabilities.

To continue providing critical protection against the proliferated modern threats the joint force faces today, Army air defense is undergoing yet another modernization initiative known as Army Integrated Air and Missile Defense (AIAMD), the most significant and sweeping modernization effort yet.

The first step of the AIAMD concept aims to integrate engagement operations centers, Sentinel air surveillance radars, and Patriot missile system radars and launchers across an integrated fire control network. The engagement operations centers provide the operating environment for soldiers to monitor and direct sensor employment and the engagement of air and missile threats. Central to AIAMD is the Integrated Battle Command System, which will enable the Army to integrate current and future air and missile defense (AMD) sensors and weapons into a common integrated fire control capability within a distributed "plug-and-fight" network architecture. As AIAMD implementation moves forward and evolves, the integration of current and future AMD technologies into an integrated fire control system provided by AIAMD will enable the U.S. Army to have a more comprehensive situational understanding of air threats. This single air picture will allow for more effective coordination between different AMD systems, resulting in increased defended area—critical in an operational environment as large as the Indo-Pacific. Furthermore, by integrating different AMD systems into a single networked architecture, AIAMD reduces support costs while providing enhanced training opportunities for soldiers. This plug-and-fight architecture allows for modular components to be easily added or removed from the system as needed.[5]

Modernizing Army air defense forces has additional benefits. While air defenders conduct the "protection" warfighting function in joint doctrine, these same forces execute the "fires" warfighting function in Army doctrine alongside their field artillery counterparts. This nuance is an important distinction, as Army air defense units contribute to and even conduct offensive fires as they deliver lethal and nonlethal effects on targets. AIAMD will enhance the role air defense units play in the fires warfighting function by providing air defenders with unprecedented amounts of data from the operational environment via network-enabled sensor fusion. This increased situational understanding will enable execution of a broad range of missions in the fires warfighting function, from defensive counterair operations that detect, identify, intercept, and destroy adversary air threats, to the provision of time-sensitive targeting data enabling left-of-launch operations, thus reducing the threats that air defenders ultimately face. The reciprocal relationship between the offense and the defense, central to the idea of the fires warfighting function, is highlighted by air defense's support to the Air Force's Agile Combat Employment strategy.[6] Designed to mitigate the risk inherent to operating inside a modern A2/AD environment, the Air Force will operate from a series of "hubs" and "spokes" in a dispersed manner, ensuring flexibility and survivability in the Indo-Pacific theater. Army air defense forces will provide robust protection of Agile Combat Employment's main operating hubs, ensuring continued operations in the highly contested environments anticipated in the Indo-Pacific theater. Army air defense's contributions to deliberate and dynamic targeting, combined with direct offensive and defensive fires, again highlights the Army's value to the joint force.

Modernization is not the only line of effort Army air defense units are pursuing to contribute to the strategy of integrated deterrence. If conflict unfolds in the Indo-Pacific, our adversary will likely operate with the advantage of interior lines as they employ a deliberate defense.[7] Modernization alone is not sufficient to mitigate the challenges the joint force will face. The geographical reality of the Indo-Pacific theater dictates that combat-credible forces be postured forward in theater to enable integrated deterrence. Again, the goal of integrated deterrence is to prevent conflict from occurring, not win once it starts. Accomplishing that goal cannot be done by continental U.S.-based forces that will arrive once crisis has already happened. Gen. Charles Flynn, the U.S. Army Pacific commander, reaffirmed this in a recent article:

> Having forces forward in the region is important for the Army not just because of the work done with allies and partners, but also the ability to understand the environment and conditions that they must operate in. … Providing a persistent presence forward in the region is part of that posture equation. We do have to have those forces forward, we have to be there to understand the

environment and the conditions that we're operating in.[8]

As Flynn stated, the Army must posture its air and missile defense units forward to enable the building of relationships with key allies and partners in the region. The current strategy of stationing Army air defense units to flow into theater with the units they are supposed to protect and enable is not viable in this region and against peer and near-peer adversaries. Forward-postured Army air defense units to work side by side with our allies and partners is the key to ensuring deterrence holds in the region and ultimately ensures a free and open Indo-Pacific that benefits all.

The Army Air and Missile Defense Command (AAMDC) in the Indo-Pacific, the 94th AAMDC, has demonstrated the powerful potential of combining forward-postured Army air defense forces with modernized integrated air and missile defense (IAMD) capabilities. Through a series of joint exercise and experimentation initiatives in theater such as Valiant Shield, Northern Edge, Balikatan, and Talisman Sabre, the 94th AAMDC has demonstrated how Army air defense forces can employ and experiment with modernized capabilities forward-postured alongside our allies and partners to contribute to integrated deterrence. Over the last two years, the 94th AAMDC has deployed AMD forces west of the international dateline, integrated them into the theater's IAMD architecture, and conducted a series of joint and combined live fires with the joint force and our allies in the Philippines and Australia. This is in addition to the daily contributions to integrated deterrence made by consistent combined and bilateral AMD operations with our allies in Japan and the Republic of Korea. Improving the posture of Army air defense units in the Indo-Pacific theater will only increase the effectiveness of the contributions made toward integrated deterrence, and if deterrence fails, the warfighting capability and capacity of the regions IAMD architecture.

Ultimately, integrated deterrence is a strategy aiming to prevent conflict from occurring in an era of renewed great-power competition. The U.S. Army's air defense forces are uniquely postured to contribute to the military's efforts as the foundation of that strategy. Employing those forces with the right capability requires decisive action and investment now. While forward-posturing modernized Army air defense forces now, ahead of conflict, will be costly, failure to do so will lead to a failure of deterrence. In a theater and time as consequential as the Indo-Pacific is now, the cost of conflict in terms of money and lives would dwarf the investment required to sustain deterrence. ■

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The wreckage of a Russian SU-35 fighter shot down by the Ukrainian Air Force burns on the ground in the Kharkiv region circa 3 April 2022. Ukrainian forces captured the Russian pilot despite attempts by Russia to recover him by helicopter rescue. (Photo courtesy of the Ukrainian Ministry of Defence)

The Russia-Ukraine Conflict Laboratory

Observations Informing IAMD

Col. Todd A. Schmidt, PhD, U.S. Army

The Russia-Ukraine war is, in many ways, an open laboratory providing insights into what war and large-scale, multidomain combat operations may look like in the decades ahead. Allies and adversaries are studying the conflict closely, observing how new technologies are being militarized and used to gain advantage. Countless papers, studies, and articles will continue to be written as the Russia-Ukraine conflict continues to rage. This article focuses broadly on six areas, warfighting functions, through the specific lens of integrated air and missile defense (IAMD) as well as through the wider lens of large-scale, multi-domain combat operations.[1]

I outline observations that will, hopefully, inform lessons that endure scrutiny in relationship to the current conflict as well as in relationship to the future operational environment. This operational environment is composed of multiple domains that include air, land, sea, space, and cyberspace. Each domain can be seen through multiple dimensions—physical, human, and information.[2] The overall intent of this article is to provide a catalyst for discussion and debate about our collective ability to enhance the defense of the United States and its allies and partners in the way ahead.

Scene Setter

Consider the following battlefield exchange in the Russia-Ukraine war that occurs over a twenty-four-hour period. It includes a wave of Shahed-136 attack unmanned aircraft, Killjoy nuclear-capable hypersonic missiles, Kh-101 air-launched cruise missiles, supersonic Kaliber cruise missiles, Iskander ballistic missiles, reconnaissance drones, Lancet loitering munitions, and barrages of conventional artillery and missiles. The attacks occur deep in friendly territory, targeting civilians, critical infrastructure, and urban government centers. In addition to these munitions, the adversary launches simultaneous cyberspace attacks and psychological operations that disrupt electrical grids, jam cellular networks, and replace internet and telecommunications capabilities with adversary-controlled services.

In response, friendly forces return limited counterfires, targeting enemy command-and-control (C2) nodes easily identifiable by their unique formations, equipment, and electronic signature. These C2 nodes remain static for long periods, unable to operate effectively on the move. They are unmasked and fully transparent to friendly intelligence, surveillance, and reconnaissance (ISR) capabilities. This makes the enemy's logistics exceptionally vulnerable to attack. Leadership is easily targeted and pays an existential price of attrition. The momentum of enemy attack forces is halted as dispersed, well-masked friendly forces rapidly return counterbattery fire and mimic enemy tactics.

This real-world vignette provides a relatively recent example of how aerial weapon systems converging with attack capabilities in multiple domains can overwhelm an opponent's defenses and ability to C2 forces in the field and on the front lines. It also demonstrates what U.S. Army authors have described as "The Graveyard of Command Posts."[3] Nearly 20 percent of Russian casualties are seasoned, experienced, highly trained officers.[4] This population of leaders is paying an incredible price. As of the drafting of this article, over 1,500 and counting have paid with their lives through the "relentless assault on command and control" posts through systematic attacks "at scale and across all tactical echelons."[5] Attacks on both sides have severely degraded the ability to mobilize, deploy, and conduct centralized planning and coordination, slowed momentum of operations, and prevented the ability to leverage any success or gains on the battlefield.

Command and Control

In a recent unclassified briefing, Lt. Gen. Chris Donahue, 18th Airborne Corps commanding general, shared lessons learned from his headquarters' recent deployment to Europe. Challenges Donahue outlined related to the speed and velocity of available data in relation to the speed and velocity of modern conflict—both are advancing very rapidly. Intuitively, the military that can leverage data the fastest, at speed and echelon, will have strategic, operational, and tactical advantages. Organizations that can quickly integrate data into planning, adapt operations on the ground, and persist through grueling conflict will win (much like the lessons learned by Joint Special Operations Command in Iraq and Afghanistan).

For allies and partners, this means that the passing and sharing of data is imperative. We know we can "pass data," but "sharing data" remains a hurdle. It is a strategic national policy puzzle that must be solved during

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The Army Integrated Fires Mission Command and soldiers of the 3rd Battalion, 43rd Air Defense Artillery Regiment, conduct a missile flight test with the Integrated Air and Missile Defense Battle Command System at White Sands Missile Range, New Mexico, on 17 November 2022. The test was deemed a success. (Photo by Darrell Ames, Program Executive Office Missiles and Space)

relative peace, not in the midst of high-intensity conflict. These problems can be investigated for potential policy solutions in events like those hosted by Nimble Titan.[6] With an alignment of national policies between allies and partners, the hurdles to information sharing and integration of platforms can be overcome. As of today, however, the United States and its allies and partners are significantly challenged to provide C2 in a combined-joint fight, and the first solutions must be solved by common national policies that address this challenge in a multilateral context.

Secondly, a 2022 report from the Royal United Services Institute for Defense and Security Studies in the United Kingdom describes observations from British and NATO militaries related to events in Ukraine. One of the many takeaways is that the modern battlefield is increasingly transparent: "There is no sanctuary in modern warfare."[7] Static systems will be relentlessly attacked. This raises the question, How expeditionary and mobile are some strategic and operational IAMD systems and C2 nodes in our current inventory? Our most capable defeat mechanisms are also our least mobile. Dispersion of highly mobile capabilities is imperative to survivability. The ability to maneuver under surveillance and fire is critical. Redundant, agile, rapidly deployable capabilities are essential to minimizing vulnerability to enemy detection and targeting.

Indeed, persistent identification, surveillance, and targeting of systems is a fundamental component of "systems warfare," a key adversarial strategy.[8] Systems warfare is identifying and isolating or destroying critical subsystems and components to degrade or destroy an opponent's overall system and capability.[9] This dynamic concept requires offensive measures to attack an opponent's system and defensive or countermeasures to protect against attack. To minimize risks, ensuring seamless connectivity across threat detection platforms (terrestrial and space), C2, and IAMD systems is crucial. This raises an additional question: What are our current capabilities to swarm satellites in the space domain and defeat adversarial swarming capabilities? These capabilities and integration must be real-time and effective because the timeline between the launch of a threat and impact is extremely short.

An example of system warfare is the defense of command posts and IAMD C2 at each echelon. For the United States and its allies, command posts, particularly in the IAMD fight, are exceptionally vulnerable to attack—an easy target for our adversaries because of the magnitude of multispectrum electromagnetic transmissions, generators, vehicles, personnel, and other logistical support requirements. Western command posts are no longer a sanctuary, having become less mobile and less survivable in the context of modern large-scale, multidomain combat operations.[10]

Likewise, tactical and operational units must decentralize operations and C2, empowering leaders at every level to exercise disciplined initiative as C2 nodes are heavily targeted to destroy, disintegrate, isolate, dislocate, and disrupt operations.

Future command posts must have a smaller, less detectable signature. C2 nodes must be more resilient, mobile, and agile. These C2 nodes and electromagnetic signatures must also be easily masked. Deception capabilities should allow for blending allied military signatures into the "white noise" of populated urban centers. However, this capability must be developed in accordance with the rules of land warfare.

Finally, future combined-joint doctrine needs to direct C2 nodes and leaders to be less reliant on the physical dimension and far more capable of leveraging the human and information dimensions through artificial intelligence (AI), augmented and virtual reality, and analysis of large amounts of data. This translates into C2 nodes that may partially exist in a virtual construct, aggregating and integrating functions, processes, and capabilities without depending on the physical (and targetable) construct of people, equipment, and the support capabilities required to sustain them.[11]

Fires and Maneuver

To support fires and maneuver, from an IAMD perspective, offensive and defensive unmanned aircraft systems (UAS) and counter-UAS capabilities must be fielded at echelon. While UASs will have an exceptionally critical role in future conflicts, they will also be subject to exceptionally low survivability rates. Multinational, jointly developed IAMD systems using interoperable, off-the-shelf solutions offer flexible and scalable ways for nations to strengthen IAMD in an efficient and cost-effective way.

It is imperative that the United States and allies possess fires capabilities and technologies that provide both precision and volume. Epic "artillery duels" and requisite air and missile defense "umbrellas" across an expansive and deep battlespace will be a requirement and attribute of future war. This requires inexpensive, high-capacity multinational industrial manufacturing capabilities that allow for stockpiling of these critical, revolutionary systems that provide for ISR, target acquisition, and fire control; can be designed as a munition; and support nearly all warfighting functions with developing capabilities in logistics and resupply.

Second, we must continue to develop and train to utilize systems and subsystems that ensure an "any sensor, best shooter" capability, particularly for IAMD. Combined-joint training events, at the Army Corps level, must be expanded to rehearse and exercise targeting and airspace management procedures in an exceptionally fluid and contested environment. Various weapon platforms such as UASs, fighter jets, ground-based systems, maritime air defense assets, information technology systems, and satellites will be utilized to establish defense synergies and layer interconnected and overlapped spheres. The aim of alliance IAMD policy and strategy must be to challenge and complicate adversary efforts to overcome these friendly defenses.

IAMD must be able to respond promptly to an array of threats at multiple ranges and altitudes. These capabilities must be designed to prevent successful adversary attacks and to prevent friendly IAMD systems from being overwhelmed, whether through technical or quantitative superiority.[12] More importantly, but not fully addressed in the scope of this article, will be the component of leadership.

Third, as we have observed, Russia has dedicated immense resources to targeting and destroying Ukrainian IAMD systems because of their exceptional success in shooting down Russian aircraft and munitions. The success of Ukrainian air defenses has been a strategically and internationally embarrassing and politically damaging coup. The lesson for the United States and allies is that dispersion and protection of IAMD assets, without losing C2 capability, is imperative.

To improve the survivability of friendly forces, allied IAMD concepts and capabilities must be hardened and operationalize basic principles such as speed, mobility, protection, defense-in-depth, and overlapping fires. Because adversaries will engage in the full spectrum of conflict across all dimensions and domains, allied capabilities may be disrupted and degraded before the outbreak of kinetic conflict. National will and resilience will be challenged before the first military units or service members deploy from their home stations; before any first shots may be fired.

NATO's IAMD mission, as outlined in the 2021 Brussels Summit communiqué, describes an all-encompassing strategy that aims to counter IAMD threats from all strategic directions through a 360-degree approach.[13] However, only a limited number of capabilities have been allocated to this mission thus far. Introducing a long-range system like THAAD (Terminal High Altitude Area Defense) or Arrow 3 would not only expand alliance capacity but also broaden the range of capabilities, conveying a strong deterrent message. This, of course, necessitates a delicate balance among political, strategic, military, industrial, and economic considerations.[14] Similar policies must be implemented in the Pacific theater.

Intelligence

Clear from observations of the Russia-Ukraine war, IAMD operations occur in all domains. Likewise, IAMD systems will be contested by peer competitors, kinetically targeted and attacked from the ground, air, sea, space, and cyberspace. Increasingly, IAMD systems and personnel will also be targeted through the electromagnetic spectrum and the information and human (or cognitive) dimensions as conflict and capabilities evolve and improve.

Intelligence related to and informing IAMD operations must help leaders understand the operational environment at echelon. As previously noted, we must assume we are under constant, persistent observation and targeting. We must have the capability to operate at the smallest element possible, enabled by resilient C2 systems and networks, including information and data sharing.

Information and data sharing is a key strategic, operational, and tactical enabler and asset. It is not a "zero-sum" asset that is lost when given to an ally. Therefore, the willingness to exchange information and data is a prerequisite for effective IAMD. Moreover, in contrast to sharing and common procurement of weapon systems to partners, IAMD information and data sharing does not impede the capacity of assets but, by contrast, enables partners. There is no loss of information and data but, rather, increased leverage of this critical component across an IAMD system. These imperatives can force multiple dilemmas on our adversaries while providing allies with decision dominance.

To achieve superiority, as previously mentioned, training events and exercises must combined-joint in nature and increasingly incorporate AI to aid in rapid decision-making, target acquisition, and engagement processes. Current and future alliance considerations will also need to address the development and incorporation of virtual reality or augmented reality capabilities into multidomain operations and IAMD.

Intelligence will be further enabled through the convergence of multiple technologies and capabilities. This convergence is intended to create revolutionary, multidomain, interoperable, and seamlessly integrated effects within allied air and missile defense against a peer or near-peer adversary. The U.S. military defines convergence in its new military operations doctrine (Field Manual 3-0, *Operations*) as a spectrum of outcomes that can be created by an orchestrated, simultaneous employment of capabilities across multiple domains against a combination of key targets.[15] Convergence creates effects against an adversary's formations, systems, processes, and key individuals and publics across time, space, and geography.[16]

For allies, multinational convergence of technologies and weapon systems and multifaceted approaches can offer flexible and scalable options that create unforeseen outcomes wherein the sum of the advantages and effects is far greater than any individual technology, capability, or system. The intent is to disrupt an adversary and create multiple, simultaneous dilemmas for an enemy combatant while creating exploitable opportunities for friendly forces. This increases freedom of action, allows for consolidation and expansion of gains, and results in favorable outcomes for friendly forces.

To manifest the principles and reality of convergence, particularly in intelligence and IAMD, Pacific allies should expand observation and participation in Project Convergence and the upcoming 2024 Capstone Event 4 in the United States. While previous capstone events have incorporated cruise missile threats, the 2024 Capstone 4 event will, for the first time, incorporate ballistic missile threats. The intent will be to use combined-joint exercises such as Pacific Pathways to test new capabilities and attempt to understand and solve persistent information sharing, data transfer, and platform integration challenges that have plagued previous events.[17]

As previously noted, allies must enact common policies that promote integration and interoperability as a critical component of modernization. Too often, national caveats and policies prevent combined-joint interoperability. In the future, combined-joint operations

U.S. Army Futures Command's Artificial Intelligence Integration Center tests an Inspired Flight 3 artificial intelligence drone 27 October 2022 during Project Convergence 2022 at Fort Irwin, California. Project Convergence 22 experimentation incorporated technologies and concepts from all services and from multinational partners, including in the areas of autonomy, augmented reality, tactical communications, advanced manufacturing, unmanned aircraft, and long-range fires. (Photo by Spc. Lessitte Canales, U.S. Army)

must be well-rehearsed, if not routine. To achieve the potential revolutionary capabilities enabled by the convergence of technologies, multinational acquisition, integration, and interoperability with allies cannot be an afterthought. Peer competitors and adversaries will persistently challenge the alliance across all domains, searching for and exploiting identifiable gaps, seams, and weaknesses to fracture and disintegrate friendly coalitions. The alliance should aspire to compel the enemy to fight the alliance's preferred fight. Likewise, it must avoid being dragged into fighting the preferred fight of the enemy.

Protection and Sustainment

Another observation of the Russia-Ukraine conflict is the unrelenting contest between adversaries in multidomain operations. This contest will challenge historical norms and past theories of war and victory. It will target civilian populations in the information and cognitive domains in ways that the current Russia-Ukraine war hints but, in total, remains unforeseen. Future contests will require opponents to fight their way to the fight, meaning military targets will be engaged before deployment. This will challenge national will, damage national infrastructure, and stress national mobilization.

Allied countries must accept that they are under constant and persistent surveillance. There will be nowhere to hide from enemy targeting. Militaries will be targeted across every domain, at home or abroad, as will their families and friends, through capabilities that include developing capabilities in AI, cyber, drones, robotics, augmented reality, hypersonic vehicles, and space-borne systems. The law of land warfare, as we may know it, must remain relevant to these changes.

From a more specific IAMD perspective, using a UAS enabled by AI is revolutionizing warfare. UASs are a game changer. Small, inexpensive, and increasingly lethal, this AI-enabled capability will only become more challenging. Allied IAMD efforts must focus on and expand detection capabilities and countermeasures to defend against UASs, particularly in the electromagnetic spectrum. Critical to this effort will be terrestrial, sensors-based platforms, space-based satellite imagery, and human-enabled crowdsourced intelligence. Additionally, allies must ensure that they maintain capability and advantage in other low-cost measures such as tactical air defense, deception capabilities, and shroud technology.

responsive doctrine enabled by common national policies. Finally, allies must have the right capability and capacity to confront and defeat potential competitors and opponents.

Policy. When crisis or conflict develop, barriers to allied integration are often quickly overcome. However, in the future combined-joint operational environment, where the velocity of war is exponentially increased,

> “Archaic, costly, and overly political, protective, and bureaucratic processes and decision-making frameworks are self-defeating encumbrances.”

waiting for conflict to occur and delaying the removal of barriers and hurdles to allied integration and interoperability will have catastrophic consequences. National information and data-sharing disclosure policies must reflect current and future realities.

Archaic, costly, and overly political, protective, and bureaucratic processes and decision-making frameworks are self-defeating encumbrances. Allies can no longer afford disjointedness that can feed irrelevance and, at worst, massive destruction and tragic casualties. Information and data sharing, and interoperability in periods of crisis and high-intensity conflict require highly responsive policy and decision-making processes backed by common, shared procurement vision; shared resource commitment; and operationalization by military power and forces that are indoctrinated, trained, and conditioned for combined-joint coalition action.

Specifically, national policies among allies must incentivize collaborative efforts and align to ensure and enable real convergence potential at scale and echelon. Investment consortiums in research, development, and testing of the defense applications of AI, “big data,” cyber capabilities, augmented reality, drones, robots, hypersonic vehicles, and space capabilities must take on a “whole of alliance” priority and approach. Likewise, national and allied investments in human capital and force structure must reflect and be commensurate with capability development. Events like Nimble Titan are a great catalyst to achieving these aspirations.[18]

Sustainment of IAMD platforms in large-scale, multidomain combat operations will be critical, particularly in the Pacific region. Logistical planning assumptions need to be frequently assessed. Stockpiling munitions with long lead times for production is a key consideration. Ammunition and equipment need to be reevaluated based on the requirements of the future operational environment, taking into consideration cost, size, mobility, lethality, survivability, and sustainability. Finally, allies will not have the convenience of choosing when and where it will fight. It must be prepared to engage in exceptionally contested, expeditionary environments with no interior lines and exacerbated long, vulnerable exterior lines.

A Way Ahead

As stated in the introduction, there are countless observations being gathered from the Russia-Ukraine war. Potential future adversaries are observing and noting these same lessons, particularly in the Pacific theater. At the most basic level, allies must preserve the capability and freedom to maneuver at scale and echelon, and be prepared to overcome massing or swarming efforts, particularly in the IAMD fight. Opponents should be assumed to have massive inventories of threat capabilities that will be choreographed and deployed across every domain and dimension of war. With this premise, it is imperative that allies have the right policies in place. Allies must develop and train on common,

Doctrine and training. A key observation of the current Russia-Ukraine conflict is that professional Western-style militaries that are highly trained, educated, experienced, proficient, competent, and well-equipped can defeat opposing, less professional military forces, even if vastly outnumbered. In contrast, when U.S.-NATO forces are advising and assisting foreign militaries, it is imperative to consider that Western-style doctrine and training may not be optimal with partners that do share similar military institutional culture and learning style. This was a key finding in a recent public briefing by the U.S. Army Air Defense Artillery School at the 2023 Association of the United States Army (AUSA) Annual Conference in Washington, D.C. In other words, as U.S. alliances and partnerships expand, how we train and fight must be adaptable and considerate of foreign military culture, knowledge, learning, and professional development, particularly as the United States seeks to expand its network of allies and partners in the Pacific.

For historic U.S. allies and partners in the Pacific, however, there should be a clear intention to create fully interoperable, theater-wide air and missile defense systems through common acquisition programs. To achieve this objective, more than common policy and proportional investment are required. Policy and investment must be reflected in common doctrine and training. Pacific allied forces, whether forward stationed or regionally aligned, must be well-versed and practiced in common doctrine and training, especially if there are doctrinal differences at the national or military service levels.

Observations from the Russia-Ukraine war demonstrate the profound importance of combined-joint operations, mobility and logistics, dispersion of forces, and redundant C2 capabilities at scale and echelon—all under protection of a well-integrated, interoperable, allied-empowered IAMD umbrella. Likewise, doctrine and training must be responsive to these fast-changing dynamics of current and future

The Northrup Grumman and Shield AI V-BAT is one of five project agreement holders for the Future Tactical Unmanned Aircraft System (FTUAS) Increment 2 rapid prototyping effort. The FTUAS is the Army's premier vertical take off and landing unmanned aircraft modernization effort. Shield AI and Sentient modified the V-BAT with AI imagery to detect and classify machine-invisible targets on the move. (Photo courtesy of Shield AI) operations. If a target can be found, it can be degraded or killed.

Lastly, urban centers, rear areas of operation, and C2 nodes will be under persistent targeting and attack in an effort to disrupt operations, undermine civilian spirit and will, and destroy the ability to conduct integrated, combined-arms warfare. Opponents will be in persistent information warfare. Cyber and telecommunications capabilities will be targeted, taken hostage, or mimicked and ghosted to disrupt communications. Cyber and information will also be used to contest the cognitive domain, creating and achieving psychological effects and advantages, and deceiving adversary leaders, formations, and publics. Doctrine, training, and capability development in IAMD operations must take these asymmetric threats into account.

Capability and capacity. From an IAMD perspective, achieving air supremacy or superiority will not be fully achievable. At best, friendly forces must field a combination of capabilities that ensure enemy forces and capabilities are insufficient to prejudice friendly operations.[19] Active air and missile defense capabilities must be able to defend against and withstand pulse attacks, hypersonics, and swarms (from both UASs and satellites), and effectively engage in counter-UAS fights. Friendly forces must reinforce passive measures that reduce heat, electromagnetic, and optical signatures by emphasizing concealment, camouflage, obscuration, and deception, whether through conventional tactics and techniques or future "hider" capabilities such as shroud technology.

Many, if not most, IAMD capabilities come with high price tags due to the cost of research, development, and testing. However, the military-industrial complex should adopt a novel approach to capability development that necessarily emphasizes affordability. This will be incredibly challenging in a free market, capitalist system, but it is achievable with the appropriate incentives and capability development strategies. However, if allied forces and formation are to be prepared to face the massive inventories of low-cost capabilities being developed by our adversaries, we should not depend on defeating $100 drones with $1 million munitions.

Conclusion

Imagine the dynamic principle of convergence applied to IAMD in the context of the Pacific theater. The challenges can seem to be insurmountable. With the rapid evolution of adversary capabilities competing with allied aspirations of decision dominance, maintaining relevant policy has fallen behind, leaving easily exploitable gaps and seams in national policies and across multidomain environments. This requires a top-down, alliance-wide directed effort that aligns information and data-sharing policies with allied integration priorities. Allies must ensure that formal agreements, interactions, shared systems, and capabilities are not overly encumbered or unnecessarily stymied by archaic policies and processes from a bygone era.

To succeed, allies must be more persistent and serious about improving information and data sharing, common weapons system acquisition policy, integration of national systems, and interoperability in training and operations, whether in peacetime, crisis, or conflict. Information and data-sharing barriers that prevent or overly constrain allied integration come in all shapes and sizes. Granted, there are legitimate concerns related to the classification and protection of sensitive information and data. It is imperative, however, that the puzzle of policies that prevent information and data sharing be navigable if not fully solved.

Allied efforts must facilitate integrating a broad range of air and missile defense systems. Furthermore, policy must address and ensure alignment of allied military doctrine, operations, training, logistics, and more. Failure to remove barriers now to allied integration in the current and future operational environment will prove to be disastrous and expensive and cannot wait until new conflict erupts to be addressed. The United States must be a central leader and partner in this effort.

In conclusion, the observations and recommendations presented in this article can revolutionize how Pacific allied militaries operate and wage war, particularly in the IAMD domain. To succeed, however, requires a common vision of procurement, integration, and interoperability of joint services and capabilities, as well as combined, allied services and capabilities. There is still a long way to go in achieving these goals and objectives. The Russia-Ukraine war signals that large-scale, multidomain combat operations remain a distinct and ever-present threat from a disruptive adversary. This should be a reminder, catalyst, and accelerant for action. ■

DISCLAIMER: *The information and opinions expressed in this article are unclassified, found in open-source media, and do not reflect the policies or opinions of the government or military institutions of the author's parent nation and organizations.*

Notes

1. Field Manual (FM) 3-0, *Operations* (Washington, DC: U.S. Government Publishing Office, 2022), 2-1. Warfighting functions are composed of command and control, movement and maneuver, fires, intelligence, protection, and sustainment. "Multidomain operations are the combined arms employment of [combined and joint capabilities] to create and exploit advantages that achieve objectives, defeat enemy forces, and consolidate gains [within each domain]" (ibid., 3-1).

2. Ibid., 1-18, 1-21–1-23. A domain is "a physically defined portion of an operational environment requiring a unique set of warfighting capabilities and skills." Dimensions span across or through these domains. Other domains may include the cognitive domain and the electromagnetic domain.

3. Milford Beagle, Jason C. Slider, and Matthew R. Arrol, "The Graveyard of Command Posts: What Chornobaivka Should Teach Us about Command and Control in Large-Scale Combat Operations," *Military Review* Online Exclusive, 28 March 2023, https://www.armyupress.army.mil/journals/military-review/online-exclusive/2023-ole/the-graveyard-of-command-posts/.

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5. Ibid.

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7. Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022* (London: Royal United Services Institute, 30 November 2022), 2, https://rusi.org/explore-our-research/publications/special-resources/preliminary-lessons-conventional-warfighting-russias-invasion-ukraine-february-july-2022.

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11. Beagle, Slider, and Arrol, "Graveyard of Command Posts."

12. Sven Arnold and Torben Arnold, "Germany's Fragile Leadership Role in European Air Defence: The Need for Adjustments at All Levels of the European Sky Shield Initiative," SWP Comment No. 6 (Berlin: German Institute for International and Security Affairs [SWP], February 2023), https://www.swp-berlin.org/publikation/germanys-fragile-leadership-role-in-european-air-defence.

13. "Brussels Summit Communiqué: Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Brussels 14 June 2021," NATO press release no. 086, last updated 1 July 2022, https://www.nato.int/cps/en/natohq/news_185000.htm.

14. Arnold and Arnold, "Germany's Fragile Leadership Role."

15. FM 3-0, *Operations*, 3-3.

16. Ibid.

17. Ashley Roque, "Project Convergence Events Set for Spring 2024, with Ballistic Missile Defense Addition," Breaking Defense, 29 March 2023, https://breakingdefense.com/2023/03/project-convergence-capstone-event-set-for-spring-2024-with-ballistic-missile-defense-addition/.

18. James Dickinson, "Protect, Defense, Exploit: Air and Missile Defense Evolves for Multidomain Operations," Army.mil, 21 June 2019, https://www.ausa.org/articles/protect-defend-exploit-air-and-missile-defense-evolves-multidomain-operations.

19. Joint Doctrine Publication 0-30, *UK Air and Space Power*, 2nd ed. (Swindon, UK: Development, Concepts and Doctrine Centre, UK Ministry of Defence 2017), https://assets.publishing.service.gov.uk/media/5a8238bd40f0b62305b9320c/doctrine_uk_air_space_power_jdp_0_30.pdf.

Bayraktars and Grenade-Dropping Quadcopters

How Ukraine and Nagorno-Karabakh Highlight Present Air and Missile Defense Shortcomings and the Necessity of Unmanned Aircraft Systems

Capt. Josef "Polo" Danczuk, New York Army National Guard

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The onboard camera of a Russian Lancet one-way attack unmanned aircraft targets a Ukrainian SA-8 "Gecko" air defense system in April 2023, seconds before the aircraft struck and destroyed the vehicle. (Screenshot from Funker530)

The Turkish-made Bayraktar TB-2 armed with lightweight, laser-guided bombs, shown here on 2 November 2014, carried out successful attacks by Azerbaijan against Armenian and Artsakh forces in 2020 and by Ukraine against Russian targets in the early stages of that conflict. (Photo by Bayhaluk via Wikimedia Commons)

The increased use of unmanned aircraft systems (UAS) in modern war is no surprise. Modern drones provide outstanding aerial capabilities at all echelons, from a frontline infantry soldier using a small, commercial quadcopter to surveil enemy positions, to large UAS equipped with advanced precision munitions and the ability to operate beyond line of sight from its operator. Necessarily, armed groups seek to counter their adversaries' UAS capabilities by destroying, disabling, or negating them and their effects on the battlefield.

While we can look to almost any conflict fought in the last decade for important lessons on the use and countering of UAS, two of the most recent conflicts provide numerous examples of how modern militaries are fighting the UAS fight. The 2020 Nagorno-Karabakh war between Armenia and Azerbaijan saw widespread use of UAS but also the weaponization of information about that use. The ongoing war in Ukraine reinforces many observations from Nagorno-Karabakh, but it also shows how modern warriors not only would prefer to have, but inherently require, UAS at the lowest echelons. Russian's full-scale invasion of Ukraine reveals how small UAS (sUAS), sometimes purchased commercially or even donated through crowdfunding campaigns, can provide an offensive capability against a larger, technologically capable adversary.

The numerous lessons could likely fill an entire journal, so this article focuses on four lessons. First, we saw the effective use of one specific UAS platform in both conflicts: the Turkish-produced Bayraktar TB-2. The TB-2 flew into popular war songs and crowdfunding campaigns as the world watched clip after clip of TB-2s effortlessly destroying enemy air defenses, tanks, command posts, and supply convoys.[1] With its lethal effects on the battlefield, the TB-2 and similar UAS will undoubtedly be ubiquitous in future conflicts. Second, all sides of the conflicts have used UAS in information operations. The abilities of UAS on the battlefield have captured the public mind, and government information outlets have capitalized on that by publishing video feeds from their UAS or sharing statistics and footage of their forces destroying an enemy's UAS.

Third, more specifically in Ukraine, military forces have acquired drones outside their military procurement channels to equip frontline forces with sUAS to execute the tactical fight, often with strategic effects.

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Ukrainian soldiers watch drone feeds from an underground command center in Bakhmut, Donetsk region, Ukraine, 25 December 2022. The Ukrainian government minister in charge of technology says his country has bought some 1,400 drones, mostly for reconnaissance, and is now developing air-to-air combat drones that can attack the drones Russia is using against Ukrainians. (Photo by Libkos, Associated Press)

While not a new tactic in war, Ukrainian and Russian forces alike have made widespread use of modifying commercial sUAS to drop munitions on enemy forces, providing their forces with an accurate, immediately correctable offensive weapon. Fourth, despite the widespread use and success of UAS, both conflicts reveal how present air defense systems and tactics currently fail to provide adequate counter-UAS (C-UAS) defense against these threats.

These lessons reveal critical shortcomings in the United States' C-UAS—specifically C-sUAS—capabilities, as well as the lack of organic tactical sUAS capabilities, training, and fielding for use by our forces. Future conflicts, regardless of the adversary, will inevitably require U.S. forces and our allies to protect against enemy UAS. As the conflicts show, any viable C-UAS program requires widespread air defense and force protection capabilities at all echelons, not just one short-range air defense (SHORAD) battalion per Army division that rarely, if ever, train together. It will require novel C-sUAS capabilities and tactics in addition to traditional SHORAD and C-UAS defense. And, just as important as negating an adversary's UAS is providing the benefits of such UAS to friendly forces at all echelons and for all types of units.

Bayraktars in Nagorno-Karabakh and Ukraine

For decades, the United States and other technologically advanced militaries were the only ones with the technical expertise and money to put unmanned aircraft in the sky. However, as both military-designed and commercial drones become cheaper, more plentiful, and easier to operate, they will continue to proliferate to militaries and armed groups around the world, bringing their deadly capabilities with them.[2]

Take the Azeri's Bayraktar TB-2s. When Azerbaijan launched its offensive against Armenian and Artsakh forces in 2020, it made effective use of the TB-2s. It destroyed Armenian air defenses, tanks, battle positions, and much more, thereby enabling ground forces to maneuver effectively against Armenian forces and rapidly advance through the territory of Nagorno-Karabakh.[3] Armored assets in fortified battle positions with cover and concealment as well as air defense systems actively searching for air tracks were not safe from

A Ukrainian serviceman attaches a hand grenade to a drone to use in an attack against Russian targets near Bakhmut in the Donbas region of Ukraine on 15 March 2023. (Photo by Aris Messinis, Agence France-Presse)

Azeri TB-2s.[4] Yet, Azerbaijan had only just acquired the TB-2 a few months prior to the war. The government announced the acquisition in June 2020 and were employing them on the battlefield by November 2020.[5] Similarly, Ukraine received its first TB-2s in July 2021 and used them for its first kinetic strike in the Donbas region against militants of the Donetsk People's Republic on 26 October, just three months later.[6] Ukraine's acquisition and use of such an advanced UAS was a potential impetus, or at least a purported one, for Russian President Vladimir Putin's decision to begin building up forces along the Ukrainian border before the full-scale invasion on 24 February 2022.[7]

Both Azerbaijan and Ukraine were able to acquire, field, and employ the TB-2 in just a few months. While both militaries are relatively modern and well-equipped, they are not what the United States would typically consider near-peer or a comparable conventional adversary. This shows how easily modern militaries can acquire, train on, and effectively deploy a UAS comparable to the TB-2's capabilities. While such systems are surely not impervious to current air defenses, video feeds from both conflicts show a startling ability to fly directly above enemy air defenses unthreatened, targeting and destroying them instead.

UAS like the TB-2, which are larger and require more logistical and communications support to operate, are classified as Group 4 or 5 UAS.[8] They often provide an organic kinetic strike capability in addition to reconnaissance, intelligence, surveillance, and target acquisition (RISTA). As a result of real-time information sharing, these UAS can also perform immediate battle damage assessment (BDA) and provide data for prompt correction of artillery or other fires on a target, as Azerbaijan and Ukraine have done.[9]

The proliferation of Group 4 and 5 UAS will give many militaries and armed groups the abilities that Ukraine and Azerbaijan employed to great effect. The TB-2 has already seen use in various African states, and worldwide sales show no signs of slowing down.[10] United States and allied ground forces and their leaders should expect any adversary to effectively employ such UAS against them. Even if a potential adversary does not possess such UAS now, Ukraine and Azerbaijan's rapid acquisition and deployment of the TB-2 demonstrate that any modern military can, and likely will, acquire Group 4 and 5 UAS and use them

A video feed from a Ukrainian TB-2 shows it guiding a missile onto a Russian Buk M-3 air defense system outside Kyiv on 28 February 2022. The missile struck and destroyed the Buk system. (Screenshot courtesy of the Ministry of Defence of Ukraine via Twitter)

to great effect, often sidestepping current air defense platforms. Such UAS may even soon become a C-UAS weapon in its own right.[11]

UAS in the Information Fight

As critical as the TB-2 and other UAS were to the parties of both conflicts on the battlefield, they were also a major factor in the information wars. Government media outlets shared drone feed footage of their UAS striking or surveilling enemy forces. In the face of such public fascination with the purported successful employment of UAS, the opposite side would often attempt to discredit such reports, usually by sharing footage or reports of shooting down UAS. Both conflicts clearly show how important UAS have become in the information domain, as the public perceives successful UAS use as crucial to battlefield success.

In Nagorno-Karabakh, Azerbaijan published numerous clips of its TB-2 feeds and its Israeli-made Harpy drones, which are one-way loitering attack UAS that fly into their targets to destroy them.[12] These clips showed the destruction of Armenian vehicles, artillery, troop positions, and more. Azeri government outlets shared these clips on social media sites like Twitter directly on the official ministry of defense page for the world to access and view. Third-party sites like Funker530, a combat footage website, and other social media users and platforms reshared these clips, increasing worldwide viewership.[13] Fascination with the Azeri's use of UAS presented an image that the Azeri military was highly successful and effective on the battlefield. The government's goal was clearly to paint a picture of battlefield success to ensure domestic support and international awe at the military's effectiveness.

The Armenian government sought to counter this information, especially as the forces of their military and that of their ally, Artsakh, lost territory during the conflict. As domestic turbulence grew in light of Armenia's losses, the government published its own footage showing an air defense intercept and destruction of an Azeri UAS, a modified AN-2 Colt. Armenia shared this footage on its Twitter page as well, likely hoping for high viewability just as Azerbaijan was able to garner with its drone footage.[14] Government accounts also tweeted photos purporting to show debris from Azeri TB-2s after being shot down.

While Azerbaijan's injection of UAS footage dwarfed Armenia's C-UAS information operations, it was still an interesting development. That Armenia felt the need to respond to the effects of Azerbaijan's drone information operations illustrates how important and effective they can be. The 2020 Nagorno-Karabakh conflict ushered in a new technique of state-sponsored UAS-related information operations that Russia and Ukraine have exploited.

Ukraine's government outlets also quickly published TB-2 recordings on official government channels such as the messaging application Telegram. They included strikes on the Russian backed-up convoy outside Kyiv, thwarting Russia's attempt to topple the capital.[15] These clips have also featured in Ukraine's recent counteroffensives such as showing the destruction of air defenses and boats on the strategically and symbolically important key terrain of Zmiinyi (Snake) Island, which forced Russia to withdraw on 30 June 2022.[16] Just like in Nagorno-Karabakh, third-party sites republished these clips, increasing viewership and global fascination. The TB-2 became so famous that Ukrainian fighters wrote songs and shared videos of them dancing along.[17]

And just as Armenia sought to counter this information effect, Russia shared stories of shooting down TB-2s. They even went so far as to stage a fake air defense kill of a TB-2, all to appear to be successfully countering Ukraine's UAS employment.[18] Ukrainian government sites have also touted their own C-UAS capabilities, sharing videos of shooting down Russian UAS, posing with downed UAS, and sharing destroyed UAS counts in their daily briefings.[19] While all sides oftentimes inflate such counts and reports in a conflict, the fact that they are so central and oft-reported reveals how important the conflict parties view them in their information operations.

In future conflicts, the United States should expect that the success of UAS and C-UAS employment, whether real or purported, will be an increasingly important aspect of information operations. Successful UAS employment is therefore significant not only for the effects they bring to the tactical battlefield but also on mobile devices and social media platforms.

> In future conflicts, the United States should expect that the success of UAS [unmanned aircraft systems] and C-UAS [counter UAS] employment, whether real or purported, will be an increasingly important aspect of information operations.

The public is increasingly fascinated with unmanned operations in conflict and associate UAS/C-UAS success with success in the overall war effort. This will apply to information consumers domestically, in allied nations, in a potential adversary's nation, and worldwide.[20] Finally, as unmanned ground and naval vehicles become increasingly capable and autonomous, there is little reason not to expect those platforms to impact the information domain as armed groups and state militaries begin employing them in combat.

Group 1–3 sUAS in Ukraine

While the Nagorno-Karabakh conflict lasted six weeks, the full-scale Russian invasion of Ukraine has continued for a year and a half. Further, the war in Ukraine has resulted in mass mobilization within Ukraine, resulting in hastily organized units such as the Territorial Defense Force and the Ukrainian International Legion for foreign volunteers.[21] As the war continued, both the newly organized units and firmly established units began employing smaller, cheaper, Group 1–3 sUAS extensively.

Ukrainian forces (and, to a lesser extent, at least in Western media, Russian forces) have purchased or received donations of commercial drones for their use. While not as large, capable, or long-range as standard military designed UAS, these drones can still provide an essential RISTA and BDA capability. Frontline personnel, such as at the platoon or squad level, can employ their own UAS rather than relying on UAS held as intelligence assets at the battalion-or-above level. This permits them and their leaders to see the battlefield in real time, make immediate adjustments, and better avoid ambushes or prepared enemy positions.[22]

Video footage from Ukraine also shows that Ukrainian forces modified such Group 1–3 sUAS to carry and drop munitions—often antitank rounds, grenades, or mortar rounds—onto enemy positions, vehicles, and personnel.[23] This is far from the first time we have seen commercial drones fitted to carry and drop such munitions; in Syria, militant groups like the Islamic State pioneered this technique as early as 2015.[24] However, Ukrainian forces appear to use them in large numbers and outside of formal military acquisition and development channels. Their effectiveness can be seen plainly in the published video footage. Furthermore, Ukraine has acquired purpose-built munitions-dropping sUAS. A Taiwanese-based producer, DronesVision, sent eight hundred purpose-built munitions-dropping UAS to Ukraine via Poland. The Revolver 860 system can carry eight 60 mm mortars to drop directly onto targets below.[25]

Whether purely commercial sUAS conducting surveillance, jerry-rigged commercial drones carrying whatever munitions available, or purpose-built munitions-dropping sUAS, the United States must expect to face an ever-increasing quantity and variety of Group 1–3 sUAS on today's battlefield, no matter the adversary.[26] Ukraine's rapid acquisition, proliferation, and employment of commercial sUAS shows that any potential adversary can exploit current technology similarly. Taiwan's Revolver 860 UAS is an example of one of the first, but certainly not the last, of a small munitions carrying UAS.

These Group 1–3 sUAS have such a low radar cross-section that they can avoid detection by most modern U.S. Army air and missile defense (AMD) radars and are usually too small to counter with current U.S. Army SHORAD systems like the FIM-92 Stinger missile, whether fired in a Man-Portable Air Defense System (MANPADS) configuration or from the legacy Avenger or new Maneuver-SHORAD (M-SHORAD) platforms. While the United States has developed and acquired a litany of C-sUAS systems (e.g., Fixed Site-Low, Slow, Small Unmanned Aerial Vehicle Integrated Defeat System [FS-LIDS]; Mobile Low, Vehicle Integrated Defense System [M-LIDS]; and Mobile Air Defense Integrated System [MADIS]), they are not currently fielded to trained personnel across the force, especially our maneuver forces, in sufficient numbers to counter this exponentially growing threat. There is also an immediate need for highly mobile C-sUAS systems to accompany friendly forces that must remain agile to avoid detection and targeting by those same sUAS and other enemy collection techniques. If Ukraine and Russia are rushing "drone busters" to their forces, why aren't we?

"sUAS [small UAS] have such a low radar cross-section that they can avoid detection by most modern U.S. Army air and missile defense radars and are usually too small to counter with current U.S. Army SHORAD [short-range air defense] systems."

Providing Friendly sUAS Capabilities in the Tactical Fight

The lessons of Ukraine and Nagorno-Karabakh are not limited to C-UAS. They also reveal the necessity of all tactical units having a sUAS RISTA capability. In Ukraine, sUAS have become so essential to the battlefield that Ukrainian forces have sent sUAS on sUAS-recovery missions behind enemy lines—a drone rescuing a drone.[27] Maneuver platoons can employ sUAS to surveil an objective before occupying, conducting movement, or attacking. RISTA/BDA sUAS are clearly essential for correcting indirect fire of all types, whether used by forward observers or any front-line soldier.

sUAS benefits should not be limited to maneuver units only, however. The ability for real-time,

A Ukrainian soldier controls a drone as its camera shows Russian troop positions during heavy fighting at the front line in Severodonetsk, Luhansk region, Ukraine, 8 June 2022. (Photo by Oleksandr Ratushniak, Associated Press)

on-demand aerial reconnaissance or surveillance is essential for all units. For example, a battery—whether air defense or field artillery—conducting a Reconnaissance, Selection, and Occupation of Position performs a ground reconnaissance of a potential new site and the routes there.[28] A sUAS would allow them to add a real-time air reconnaissance capability, protecting the ground element until they have surveilled the site and route. Any unit—logistics, medical, engineer, etc.—conducting a road march or occupying a new position can use a Group 1–3 sUAS to conduct an air reconnaissance of the route ahead of them, doing so even as they move. A sUAS RISTA capability at echelons lower than brigade combat teams will also reduce the number of priority intelligence requirements submitted to higher headquarters, thereby freeing up brigade-and-above intelligence assets.

Equipping units with Group 1–3 sUAS—ideally government-developed but, if necessary, commercial off-the-shelf as Ukraine has done—will also benefit the defense of fixed sites from ground attack. This includes command posts at all echelons, forward arming and refueling points, tactical assembly areas, communications relay sites, and many more. sUAS can monitor the site perimeter, entry control points, and routes in and out of the area with a live feed direct to the element tasked with site security or the local command post.

Of course, the internal proliferation of sUAS would necessitate training in discretion; if I fly a small quadcopter over the brigade command post twenty-four hours a day, it will be quite easy for an enemy force to determine where we are and target us, both visually and based on electromagnetic emissions. But the benefits of having the capability of a sUAS for monitoring relatively fixed sites and conducting reconnaissance of new sites and routes, employed with proper discretion, far outweigh the risks, especially since the adversary is very likely to be using comparable sUAS to try to find our positions anyway. If Ukraine and Russia are rushing Group 1–3 sUAS to their forces, why aren't we?

Current AMD and C-sUAS Shortcomings

Both Nagorno-Karabakh and Ukraine show the inability of current AMD systems to defend friendly forces against new UAS like the Bayraktar TB-2 and

Group 1–3 commercial sUAS adapted for military use. A number of videos released by both Azerbaijan and Ukraine during their respective conflicts show the TB-2 striking Soviet-era AMD platforms, still in use by a number of countries—including NATO countries—like the SA-8 "Gecko" or the Buk M-1/2 (SA-17 "Grizzly"), and others.[29] Russia also recently shared video of a Lancet one-way attack UAS striking and destroying an American-made Avenger system.[30] Ukraine and Russia's use of commercial Group 1–3 sUAS demonstrates the requirement for a vast expansion in C-sUAS coverage, and combatants there have scrambled to rapidly equip their forces with C-sUAS weapons.[31] Even if current AMD platforms could adequately intercept such sUAS (which they cannot), their high quantity, cheapness, ease of use, and proliferation among tactical-level units means modern militaries need a C-sUAS capability interspersed throughout their forces. From a warfighting function perspective, this is both a fires and a protection issue.[32]

What does this mean for air defense and protection against sUAS? First, there is little doubt that modern militaries will require more air defense. As Group 4 and 5 UAS like the TB-2 increase in quantity and capability, militaries will need more C-UAS AMD systems to deny those systems airspace and, ideally, intercept and destroy them. AMD and the fires warfighting function, including incorporating nonlethal fires via electronic warfare capabilities, are best suited to counter Group 4 and 5 UAS. Indeed, Russia has reportedly vastly improved its ability to counter Ukraine's TB-2s, incorporating electronic warfare capabilities alongside traditional air defense systems to relegate the TB-2s to reconnaissance duties safely away from potential intercept.[33]

Second, there is also an urgent need for a robust C-sUAS capability that can detect, identify, respond to (including engagement), and report the enemy sUAS, with the aim of negating the effects of the enemy's sUAS.[34] The current radars and weapon systems that most militaries, including the United States, rely upon were designed and maintained with a counter-aircraft mission, adept at detecting and destroying fighters, bombers, and helicopters, not small, slow UAS. While the United States and other modern militaries possess capable C-sUAS systems such as M-LIDS and various "drone buster" guns, these systems must be available organically—not as a just-before-deployment attachment or fielding—for maneuver and support units alike. Just as all units can receive and deploy with antiarmor systems like the AT-4, or formerly deployed to Iraq and Afghanistan with counter-improvised explosive device systems, all units require a short-range C-sUAS capability to at least defend against Group 1–3.[35] Most importantly, they need this capability *now*. The next fight, whoever it is against, will see widespread use of sUAS by our adversary.

Third, units must train with UAS, including Group 1–3, in mind. Tactics thought to be left to the history books—air guards, react-to-air attack, using small arms to fire at aircraft—need to return and adapt to the C-UAS fight.[36] Even if units cannot train with an air defense unit directly, trainers can provide their opposing forces with sUAS to conduct RISTA operations against the training audience. They can even rig them to drop foam Nerf footballs or tennis balls to mimic current battlefield tactics. And while these changes will come at a financial cost, they cannot exist solely at combat training centers.[37] Adversary UAS need to be incorporated into regular field training exercises, combined live-fire exercises, command post exercises, convoy training, small-unit training, and more.

The question quickly arises: How best to address these shortcomings? There are a variety of options available to policymakers and planners. The Army's current approach to counter armored threats provides a possible framework with multiple options. Ground forces could field C-sUAS weapons systems directly to lower-echelon units, just as we currently do with AT-4s and did for counter-improvised explosive devices in Iraq and Afghanistan. After Russia's illegal annexation of Crimea and support for separatists in eastern Ukraine in 2014, the Army began the Additional Skill Identifier A5 program, training infantry soldiers on the Stinger platform. One option is to expand this program or make such training standard, just like AT-4s, or supplement the current Additional Skill Identifier A5 program with additional C-UAS training and equipment.

There is also an option to add a separate SHORAD/C-sUAS element to units organically. This would prevent haggling over command and support relationships and reduce demand for AMD/C-sUAS resources when, as is the current doctrine, U.S. SHORAD battalions are "potentially" distributed to Army divisions, not organically a part of the maneuver units.[38] An element organic to maneuver units could be a new type of SHORAD battery, minimally reliant on integration with other air defense sensors and shooters, in each brigade combat team, perhaps within the brigade engineer battalion. This battery might consist of a platoon of sensors, a C-sUAS platoon with electronic warfare weapons systems to counter Group 1–3, and a typical SHORAD platoon with weapons like the Stinger missile in MANPADS configuration to counter aircraft and Group 4 and 5 UAS.

Or, again looking to the example of antiarmor capabilities within maneuver units, every maneuver battalion could include a platoon within the battalion headquarters and headquarters company or weapons company dedicated to C-UAS, perhaps with two squads for C-sUAS and one squad of traditional SHORAD. After many decades of risk-averse air defense, the increased risk of decentralized air defense shooters is necessary in this emerging world of UAS. The Army could look to how Air Force tactical air control parties, embedded in Army maneuver forces, receive a tactical air picture as inspiration for how to integrate the necessary SHORAD/C-UAS capabilities in maneuver forces into the joint AMD fight. Whether this hypothetical C-UAS element resides organically at the battalion, brigade, or division level, with or without a C-UAS weapons system fielded directly to frontline personnel, or a mix of all of these, the key takeaway is that maneuver units need C-UAS organically and in adequate numbers to defend their battlespace independent of external support. Better minds can determine the precise form of the solution—the *immediate* need, however, is all too apparent.

Whatever the solutions, a few principles are evident, principles that the Joint Counter-Small Unmanned Aircraft Systems Office may consider in their strategies, particularly when updating the Department of Defense C-sUAS strategy that has not been updated since January 2021 despite the stream of lessons from Nagorno-Karabakh and Ukraine.[39] As mentioned, we need more air defense force protection assets, better equipped for C-UAS and specifically C-sUAS, dispersed to the lowest level, organic to maneuver and nonmaneuver units alike, and with more integrated and accountable training. The large-scale drone fight is already here; our ground forces need the equipment, knowledge, and training to counter and survive it.

Conclusion

The wars of Nagorno-Karabakh and Ukraine show us the present and the future of UAS warfare. Whether it is the employment of Group 4 and 5 UAS like the TB-2 Bayraktar or ingeniously adapting and rigging commercial off-the-shelf sUAS for RISTA and offensive capabilities, the wars show that any potential adversary, and the United States itself, can and should rapidly acquire and employ such UAS. These drones have reshaped the battlefield, reshaped the information fight, and obviated or revealed gaps in older air defense systems. It has ushered in new urgency to a latent shortcoming in the U.S. Army and Department of Defense-wide—its C-UAS capability.[40]

Just as the United States and allied ground forces should seek to distribute the benefits of small RISTA UAS to all units at low-level echelons, they must also rapidly add, improve, and integrate C-UAS force protection capabilities with all units down to the tactical-unit level. Failure to do so before the next conflict, whomever it may be against, will lead to public embarrassment in the information domain, tactical losses of materiel and personnel, and lost opportunities in the offense. Domination of the skies will not just depend on advanced fifth-generation aircraft—it will require the Group 1–3 quadcopters and C-sUAS weapons we are seeing proven on the battlefield every day in Nagorno-Karabakh and Ukraine. ■

Special thanks to Capt. Nathan "Coastal" Jackson for his insightful thoughts and observations.

Notes

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Syrians, Chechens; and Crimean Tatars – Bayraktar], Instagram video, 28 February 2022, accessed 27 April 2023, https://www.instagram.com/tv/CaiTrp_DMX5/?igshid=YmMyMTA2M2Y=.

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9. Ibid., para. 1-9.

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12. A note on citations to clips of drone footage. First, many of the clips depict war footage, at times graphically, so viewer discretion is advised. Second, the citations in this article are merely to provide a reference to one or two examples of each development discussed in this piece. Anyone can simply search on the internet for "Ukraine grenade-dropping drone," or any similar search, and find hundreds of related videos, which further substantiates the points made in this article. As one of many examples, see an Azeri Ministry of Defense tweet with TB-2 feed footage: Azerbaijan Ministry of Defense (@wwwmodgovaz), "#Azerbaijan Army destroyed #OPs of armed forces of #Armenia located in Azerbaijan territory," Twitter, 9 October 2020, 12:40 a.m., accessed 27 April 2023, https://twitter.com/wwwmodgovaz/status/1314440465920528385.

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Sea fleet on May 9 this year will be held near Snake Island - at the bottom of the sea." Twitter, 7 May 2022, 7:15 a.m., accessed 27 April 2023, https://twitter.com/DefenceU/status/1522897994701549573?s=20&t=uFJUQ_7q7RF2DgnwSTmp_A; Antonia Colibășanu et al., *The Strategic Importance of Snake Island* (Washington, DC: Center for European Policy Analysis, 27 September 2022), accessed 27 April 2023, https://cepa.org/comprehensive-reports/the-strategic-importance-of-snake-island/.

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18. David Axe, "The Russians Got Caught Faking a TB-2 Drone Shoot-Down," *Forbes* (website), 28 April 2022, accessed 27 April 2023, https://www.forbes.com/sites/davidaxe/2022/04/28/the-russians-got-caught-faking-a-tb-2-drone-shoot-down/.

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Michel Assouline, secretary general of the Association Aéronautique et Astronautique de France (3AF), presents at the fifteenth 3AF Integrated Air and Missile Defense Conference held 13–15 June 2023 in Porto, Portugal. (Photo courtesy of 3AF)

A Collective Overview of IAMD through the Fifteenth 3AF International Conference on Integrated Air and Missile Defense

Lt. Col. Emmanuel Delorme, French Air Force, Retired
Yannick Devouassoux
Luc Dini

Every two years, the integrated air and missile defense (IAMD) community gathers for the Association Aéronautique et Astronautique de France (3AF) International Conference on IAMD (3AF IAMD Conference) to discuss the status of the air and missile defense field from a political, military, and industrial perspective. The latest conference was held 13–15 June 2023 in Porto, Portugal, with 250 participants from seventeen countries. It was a special occasion since the conference reached its twentieth anniversary, making it an excellent opportunity to reflect on IAMD evolution.

A Brief History of IAMD, Seen through the Various Conference Sessions

The first "International Conference on Missile Defense: Challenges in Europe," held in 2003 in Arcachon near Bordeaux, France, was based on a shared analysis that a nongovernmental forum to discuss technical aspects of ballistic missile defense (BMD) was missing in Europe. Participating in the analysis were the the French Armament Procurement Agency (DGA—Direction Générale pour l'Armement); 3AF, the French Aeronautics and Astronautics Association; and ArianeGroup (formerly EADS Launch Vehicles), the only European maker of ballistic missiles. At the time, BMD was mostly a matter for nuclear powers and NATO was just beginning to assess its feasibility of theater BMD, a technical feasibility supported by contracts with industry.

This first conference was successful with strong support from U.S. and Israeli industries. The first day was dedicated to speeches by high-level government representatives to set the political/military context. The following days were filled with technical sessions to discuss the key issues related to BMD feasibility, including threat analysis, detection, tracking and discrimination, interception, and command and control (C2). This agenda continues to be maintained over the years.

On the European side, support grew with the active participation of Thales (France, Netherlands), ThalesRaytheonSystems (a joint venture between the Thales Group and Raytheon), European missile systems leader MBDA, and other European companies, including Bae (United Kingdom) and IABG mbH (Germany). The joint venture extended

Lt. Col. Emmanuel Delorme, French Air Force, retired, was appointed missile defense advisor to the director of strategic affairs from 2010 to 2013. He holds an aeronautical engineer diploma from the French Air Force Academy, and a master's degree at Sciences Po. He was certified as a fighter pilot in 1999, became a transport pilot in 2000, and went through a scholarship at the War College in 2010. In 2020, he retired to join MBDA as business management manager. He is a cochair of the 3AF (Association Aéronautique et Astronautique de France) Integrated Air and Missile Defence Conference.

Yannick Devouassoux has cochaired the 3AF Integrated Air and Missile Defence Conference since 2011. He was ArianeGroup's director for missile defense and space security programs from 2011 to 2021. Prior to this position, he was involved in numerous missile defense and space projects as guidance and navigation engineer, system engineer, and project manager. He holds an MS in aerospace engineering from the Georgia Institute of Technology and from Institut Supérieur de l'Aéronautique et de l'Espace, Toulouse, France; and an MS in physics and electronics from the École Polytechnique, Paris.

Luc Dini graduated as an engineer in aeronautics, and he is skilled in radars, hyperfrequence, missiles, and space. He is the former auditor of the 44th Defense Economy National Session of French Institute for Defense and Security, and of the Economic Intelligence Session. He has been a member of the Multinational BMD Conference IPC since 2006. Dini is a former military engineer. He has been the manager of development R&T program for penaids and ballistic missiles phenomenology and testing. He has been the director of IAMD and Product Line of Theater Defense since 2016. He has been chairing a NATO NIAG study on standards of IAMD multisensors fire control clusters of systems networking since 2017.

(*Left to right*) Emmanuel Delorme, Luc Dini, and Yannick Devouassoux, the three cochairs of the 3AF Integrated Air and Missile Defense Conference, preside at the fifteenth conference held in June 2023 in Porto, Portugal. (Photo courtesy of 3AF)

with companies from other nations like Aselsan, a Turkish defense corporation (as a participant in 2013 and sponsor in 2017); and laboratories from South Korea. This conference has always been chaired by industry—first by ArianeGroup, then cochaired with Thales in 2008, and then MBDA joined in 2017 as a third cochair—showing a turn in the emphasis on missile defense in Europe by main European industry groups and the convergence between the starting point of BMD to counter ballistic missiles and the air defense to counter air breathing threat including cruise missiles. It is to be noted that the coordination with the U.S. Missile Defense Agency-led BMD Multinational Conference is active as chairmen of the 3AF Conference sit at its International Program Committee.

With the involvement of NATO, the conference gained enough momentum to warrant its annual periodicity. The conference provided a modest contribution to the following turning points. In 2006, NATO developed an Active Layered Theatre Ballistic Missile Defence (ALTBMD) program to protect troops from ballistic missiles. In 2008, with the conference being held in Prague, there was an agreement between the United States and the Czech Republic to deploy a third ground-based interceptor site in Europe to better protect the United States against ballistic missile attacks from Iran. In 2009, the Obama administration changed course and decided that a European-phased adaptive approach, based on SM-3 interceptor sites in Poland and Romania and a forward-based radar in Türkiye, was a better solution given the technical and political situation at the time.[1] The European-phased adaptive approach was proposed as a U.S. contribution to NATO defense. After more feasibility studies of territorial missile defense, NATO decided to expand the ALTBMD program in 2010 to protect its territory and population.[2]

The first demonstration of ALTBMD intermediate capacity occurred in a 2010 test with NATO AirC2 and Air Command and Control System TMD prototypes. The program was renamed NATO

Ballistic Missile Defence. Of course, these evolutions in Europe met strong opposition from Russia from the very beginning. Official Russian representatives were invited to voice Russia's position on day one of each conference; however, Russia was no longer invited after the invasion of Crimea in 2014. Meanwhile, rockets rained on Israel, and Iran developed a ballistic arsenal, prompting the country's fast development of a layered missile defense.[3]

In addition, the 3AF IAMD Conference steering committee took several initiatives in the period of negotiations about cooperation on missile defense among NATO, the Russian council, and the United States:

- Russia was invited to participate in the 2008 3AF Missile Defense Conference in Prague when Lt. Gen. Trey Obering, then director of the U.S. Missile Defense Agency, signed the agreement regarding cooperation on BMD radar with the Czech prime minister. This participation showed an open mind from U.S. and European industries into possible cooperation under the umbrella of official discussions. Russia continued to be invited at the Lisbon (2010), San Sebastian (2011), Paris (2012), and finally Bucharest (2013) 3AF conferences, when Russian participation then stopped because of the situation in Crimea.
- Despite this history, this period was useful for analyzing and comparing the perception of missile defense roles on both sides.
- In parallel, 3AF sent European industry representatives to the NATO missile defense exhibition, which took place during the NATO summit in Chicago in 2012, to emphasize contributions of European Union industry to the missile defense effort and to complement the strong effort from the United States. Among the topics was multisensor networking, later discussed again among 3AF representatives who were, at that time, invited by the Atlantic Council in 2013 to an exchange of views in Washington, D.C. The topic was still on the agenda of the 2014 3AF Missile Defense Conference in Mainz, Germany, where members of U.S. and European industries drafted a white paper to propose a study to NATO NIAG.[4] This study started within the frame of a NATO Industry Advisory Group (NIAG) in 2017 on multisensor clusters; thirty-three companies and seventeen countries participated.

These are milestones of initiatives taken throughout the conference that take advantage of the presence of industry and government representatives to explore cooperation and solutions versus the history stream of missile defense and emerging threats.

Over two decades, conflicts emerged that either confirmed or reoriented the focus of the community. Short-range ballistic missiles were heavily used in Syria in 2014 and then by the Houthis against Saudi Arabia in 2015, with close to one thousand missiles fired.[5] Missile defenses proved efficient during these events twenty years after a sketchy record in the First Gulf War in 1991, strengthening the usefulness of BMD.

Another trend came under the spotlight with the attack on a Saudi refinery by drones in 2019 and with the Nagorno-Karabakh conflict. If ballistic missiles have become the "aviation of the poor," drones have become the "cruise missiles of the poor."[6]

This was well perceived by NATO, which moved from BMD to IAMD in 2014, and as a consequence led to the transformation of the 3AF Missile Defense conference from 2003 into the IAMD conference in 2017 (in Stockholm). This shift from BMD to IAMD has the command and control role at its core: essential for the Air Defense and Air Operations with the development of ACCS by NATO, it is paramount for the Theater Missile Defense and the territorial Missile Defense in Europe and therefore for the integration of these two capabilities.

After decades of development, hypersonic missiles are now coming of age and are employed in the war in Ukraine along with other air and missile threats. Defense is now faced with a vast spectrum of threats, from cheap, slow, low-flying, and low-radar-cross-section (RCS) drones to very hard-to-develop, ultrafast intercontinental ballistic missiles and hypersonic gliders. As the availability and efficiency of traditional air defenses increases, these two ends of the spectrum are initially favored by the offensive side to either saturate or penetrate defenses.

This is why the IAMD conference opened the themes of threat and defense to cover the entire spectrum from counter rocket artillery and mortar up to space, including space surveillance and antisatellite.

Current and Possible Future Trends

The fifteenth IAMD conference provided an invaluable insight into current political, military, and technical issues concerning participating countries through the numerous interventions from government officials, academics, and technical experts. A contextualized summary of the rich and diverse discussions held during the conference is provided.

Political and military context. Recent conflicts have confirmed the necessity of IAMD. Defense budgets are increasing worldwide, and IAMD is always in the portfolio of capabilities to procure and/or develop for reasons proper for each country. One or several of the following reasons apply:

- While nuclear deterrence remains at the core of nuclear countries and NATO defense, IAMD changes the calculus from an adversary, as it increases the required scale of attack to reach its objectives and therefore increases for the adversary the risk of reaching a possible nuclear threshold. As an example, the Russian aggression toward Ukraine shows once again that nuclear deterrence still holds: NATO countries are not targeted by Russia despite the tremendous help provided to Ukraine, and NATO weapons delivered to Ukraine are not to be used against Russian territory.
- IAMD provides antiaccess capability; while air defenses hold, airborne platforms necessary for heavy bombing campaigns are banned from the sky. They are, therefore, an attractive capability for countries faced by an extensive air force. Recent Russian air defense systems S-300 and S-400 export successes can be viewed in that light.[7]
- IAMD counters area denial weapons such as precision-strike missiles (cruise and maneuvering ballistic missiles), an imperative for anyone with an expeditionary force. Maritime missile defense proceeds from that logic.
- IAMD protects key economic infrastructures such as power plants, refineries, and decision centers, all necessary to pursue any war effort, and it protects population centers to preserve morale.
- IAMD is a facilitator of military integration; the more systems cooperate through exchange of information, the more capability they have and the more efficient they are. IAMD, therefore, helps cement alliances and is a tool of influence.
- IAMD is a very challenging mission that requires technological and operational innovation, pulling industry toward excellence. Excellence spreads in the industry and is key for export, which makes IAMD capabilities more affordable for its developers.

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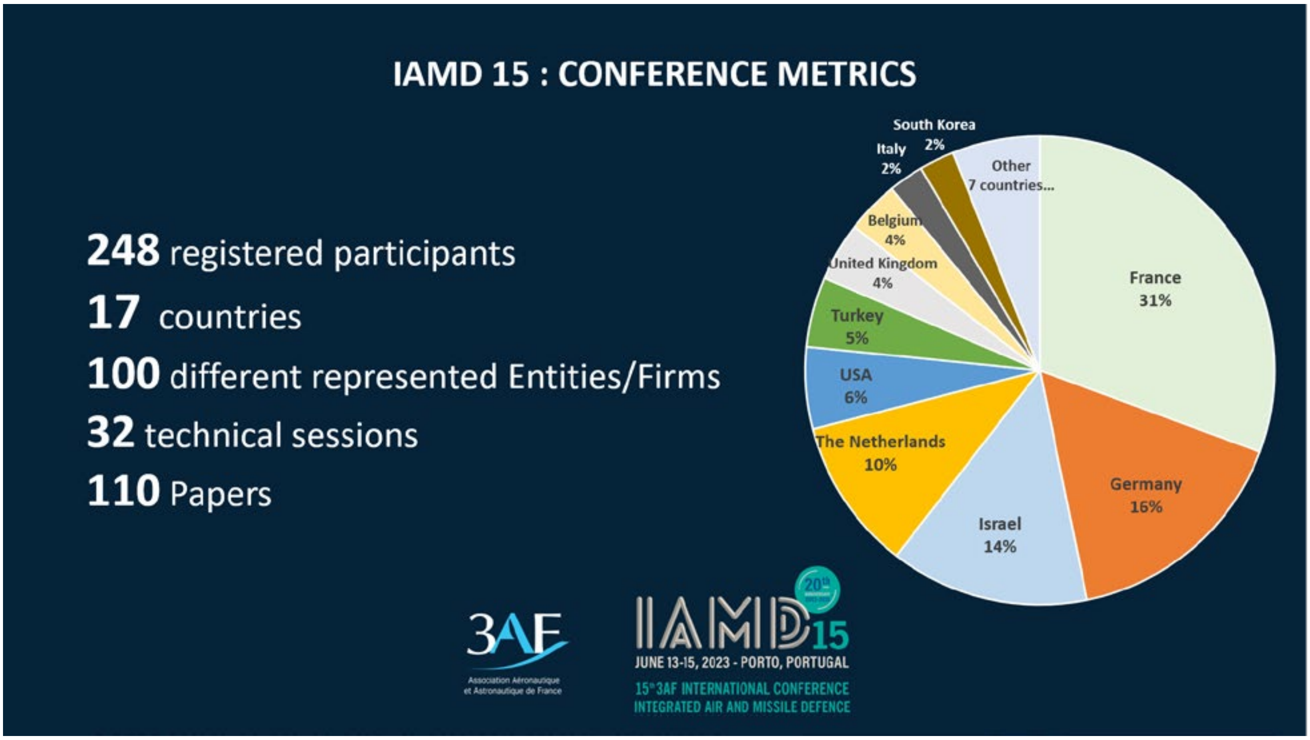
IAMD is one of the pillars of NATO defense strategy. The capability, based on the interoperability of national systems, is progressively deployed. Newcomers Sweden and Finland will provide additional capability to the alliance.

In the last three years, several European countries committed to expanding their existing capabilities through the development or the acquisition of new assets. Space-based early warning and interception systems able to detect or defend against hypersonic missiles are studied in the frame of the Permanent Structured Cooperation project called Timely Warning and Interception with Space-based TheatER (or TWISTER), which is coordinated by France with Finland, Germany, Italy, the Netherlands, and Spain.[8] This political will is supported by the European Defence Fund, which granted one project to study the feasibility of a space-based theater missile defense early warning system and two projects for the concept phase of an interceptor against high-end threats, including hypersonic



Conference metrics for the fifteenth 3AF Integrated Air and Missile Defense Conference. (Photo courtesy of 3AF)

ones.[9] Germany signed a nonbinding agreement with fourteen countries around the European Sky Shield Initiative, a missile defense architecture built around the American Patriot, the German Iris-T, and the Israeli Arrow 3 missile defense systems. The United Kingdom has planned the deployment of an enhanced missile defense radar system by the end of the decade. France and Italy launched the SAMP/T NG (surface-to-air medium-range/land-based new generation) program (development and production), which is an upgrade to the SAMP/T air defense system currently deployed in Ukraine. The SAMP/T NG program has notably new active electronically scanned array (AESA) radars (with same AESA technology used for French and Italian frigates), a new engagement module, and an enhanced Aster missile, thus providing not only an enhanced capacity but also a strong growth potential. In parallel, NL developed new AESA multimission SMART-L radars, deployed for the Air Force long-range capacity. For naval application, NL took part in Exercise Formidable Shield demonstration campaigns of naval IAMD, together with other navies' part of MTBM—Maritime Theater Ballistic Missile forum.[10] Finally, France, Germany, Italy, and the Netherlands are cofunding one of the European Defence Fund-granted projects, the Hypersonic Defense Interceptor Study (HYDIS), led by MBDA for the concept phase for a new interceptor against high-end threats.

Israel, under the constant threat of rockets and missiles, is thickening its layered defense architecture with the addition of the David's Sling defense system and is developing the Arrow 4 to succeed to the Arrow 2. Rafael has partnered with Raytheon to produce the combat-proven Iron Dome in the United States.[11]

South Korea is developing indigenous systems to protect itself against North Korea, which is regularly increasing and testing its missile arsenal.[12] Japan continues its long-standing cooperation with the United States to do the same.

The United States is improving the full spectrum of its capabilities, developing new systems to deal with hypersonic threats, and reinforcing alliances to keep its two strategic competitors, Russia and China, in check. Of note are the developments of its next-generation interceptor to replace the ground-based interceptor and of the glide phase interceptor to deal with hypersonic gliders. The national defense architecture extends into space to allow 24/7 global detection and tracking of missile threats, including hypersonic missiles. To do this, constellations of satellites are launched in low earth orbit to detect launchers (custody layer), detect launches (early warning), track missiles during their flight (tracking layer), and exchange data with low latency (transport layer).

In reaction to the increasing value of space functions, space warfighting means are under development, testing, and fielding, including spy satellites, kinetic and nonkinetic antisatellite weapons, electronic warfare, and cyber capabilities to jam, incapacitate, or even take control of space assets.

The lower end of the threat spectrum is an increasing concern, as drones are now not only the missiles of the poor but also the new improvised explosive devices. In that respect, security issues join military issues and cheaper and effective solutions against these threats are under development.

Fifteenth IAMD Conference

The technical aspects of the previously mentioned threats and defense means were discussed during the conference and are further developed hereinafter.

Threat evolution. As new missile systems appear on the world stage, they are analyzed by the intelligence community and retro-engineered by technical experts to estimate their performances, assess the involved technologies and their limitations, position the country on the scale of missile expertise, and estimate operational constraints and concepts of operations. The conference dedicates a half day to such analyses by prominent experts in the field. On the menu this year, a Russian ICBM, a North Korean ballistic missile with a hypersonic glider, air-launched ballistic missiles (ALBMs), antiship threats, and the use of cruise missiles in conflicts.

"The conference dedicates a half day to such analyses by prominent experts in the field. On the menu this year, a Russian ICBM, a North Korean ballistic missile with a hypersonic glider, air launched ballistic missiles (ALBMs), antiship threats, and the use of cruise missiles in conflicts."

The Russian and North Korean cases were retro-engineered in an effort to confirm official statements and performances of missiles after recent tests. The ALBMs presentation was a retrospective on the developments of such systems, back under the spotlight with the use of an air-launched Iskander by Russia in Ukraine. There were many developments in the past, but the concept fell out of fashion when they were replaced by cheaper and more compact cruise missiles. The improvement of missile defenses is the reason why ALBMs are now more relevant as they are harder to intercept than subsonic missiles. Since the Falklands War, the antiship missiles are recognized by a wide audience as a key element of maritime supremacy.[13] A presentation provided an overview of such systems. Finally, a synthesis on the use of cruise missiles in recent conflicts was made—a family that includes drones (unmanned, self-propelled, self-guided)—to conclude that their threat was until recently underestimated compared to the ballistic missiles.

Defense architectures. Defense architectures need to adapt to the threat evolution in performance, volume, and concepts of use. As new offensive systems emerge, they do not necessarily replace the old ones, so the threat spectrum to handle at the same time is widening. As with everything else in society, the pace of fight is increasing. This is a real challenge for defense architectures. Under a well-coordinated attack, multiple defense systems need to cooperate seamlessly and in real time in order to be efficient. Defense architectures are textbook system of systems, a collection of independently developed weapon systems coordinated by C2 functions designed for "countering advanced threats with advanced integration," as one of the presenters said. So concepts of networking, interoperability, modularity, open architectures, layered architectures, and scalability were discussed at length. To keep costs down, adaptation of existing defense systems and of concepts of operation should be considered as well. Each conflict provides lessons to be learned in that area; the war in Ukraine is no exception and was discussed in many speeches.

Modeling and simulation. The complexity of modern IAMD cannot be handled without appropriate tools. Modeling and simulation are key components of the toolbox. Through the simulation of defense architectures, we can do the following:

- Progressively refine concepts of operations by playing them out, observing the outcomes, and looping back to adapt the concepts.
- Predict and evaluate performances.
- Define requirements for future systems.
- Communicate effectively with stakeholders and in particular decision-makers.
- Train military personnel.

Architecture simulation capabilities expand to integrate new threats, especially hypersonic systems, new defense systems, and the space battlefield. Even if computing power is largely available, questions of model fidelity are always present; the level of detail required depends on users' needs.

As threats evolve, so does the way we need to evaluate architecture performance. For example, while the concept of defended area is relatively straightforward to understand and implement when considering attacks by purely ballistic missiles, the concept is much more complex to implement in the case of attacks by ballistic missiles with hypersonic gliders. One of the presentations included definition and visualization of a defended area in that case.

Of course, the traditional role of simulation in assessing and verifying a defense design remains and was discussed at the conference, mainly around the simulation of hypersonic gliders and hypersonic cruise missiles. The physics involved in flight are complex and depend on atmospheric conditions and material properties, so model validation is key. As all engineers well know, the quality of simulation depends on input data. Having validated data on materials, and models validated through flight tests, is mandatory to predict trajectories with accuracy.

Another area where simulation is heavily used is the prediction of threat signatures, radar or infrared, in all phases of flight. This is the major input to assess the detection and discrimination functions, and good fidelity is needed to evaluate architecture performance with confidence. Here again the physics are complex, the input data is hard to obtain, and real measurements are required to validate models. There are very few people able to discuss this secretive topic closely linked to intelligence.

Interceptors and weapon systems. As we previously discussed, there are now several weapon systems and interceptors on the market, some of which were presented in greater detail at the conference, including SAMP/T (current and NG versions), Principal Anti-Air Missile System and Sea Viper with the Aster missile developed by MBDA, and the Iris-T.

New concepts were discussed as well, such as concepts to intercept hypersonic weapons. This is a difficult problem, because the interceptor is the last element of a chain that needs to work perfectly in hopes of neutralizing such a fast and maneuverable threat.

Finally, exchanges about detailed technical issues such as control algorithms and propulsion systems were held. These topics are closely linked; an interceptor needs to outmaneuver its target. It requires a very reactive and flexible control system to do so. As the intercept altitude gets higher, aerodynamic control surfaces become inefficient and a specific propulsive system is required. Solid propellant is usually (but not always) used, as it is easier to store and to handle. Various concepts of such systems were presented.

Directed energy weapons. For decades, lasers have been researched as potential game changers because in theory, they provide a low cost, unlimited magazine solution with the speed of light effect. Lasers were supposed to reverse the cost equation in favor of the defender; the munitions of traditional kinetic missile defense systems are much more expensive than their targets. But real life is tough for lasers. Their range and power on a target depend greatly on weather conditions. Their effect on a target strongly depends on target material, which can potentially lead to huge power requirements and technical hurdles, and they need to stay on target for some time before the target is neutralized—no fire and forget here. The potential for collateral damage is high with high-powered lasers as well, because the eye-blinding threshold is low and therefore the hazardous range is well beyond the target.

However, technical progress has allowed the development of systems or concepts that are operationally relevant. Short-range lasers have demonstrated their usefulness in dry areas against "soft targets" such as unmanned aerial vehicles (UAVs) and rockets, artillery, and mortars. Laser systems to neutralize earth observation satellites are fielded.

The conference addressed the antidrone and more futuristic antihypersonic missiles applications, as well as the impact of atmospheric turbulence on laser performance.

Sensors and sensor networks. Sensors allow detection, discrimination, and tracking of missiles. In rough terms, the earlier the detection, the better; and the more sensors in different wavelengths, the better for discrimination. Of course, there is a cost consideration.

Different radar technologies and sensors and their capabilities were presented by Thales, Hensoldt, Weibel, Elta, the Naval Group, Aselsan, DRS Rada Technologies, and Leonardo. The main results of studies by the NIAG to multiply sensor effectiveness by high-rate information exchange and coordination were shown, including a presentation from the NATO Allied Command Transformation sponsor of NIAG SG217, then 260. Space-based infrared sensors were discussed as well by Airbus and OHB (a German company specializing in space systems). Such sensors can provide early detection and tracking of high-energy/high-velocity missiles. Very few countries have such a capability, and there is currently a European project called Odin's Eye, funded by the European defense fund, designed to assess feasibility under the TWISTER umbrella.

The use of AI in sensor processing is also undergoing study, in particular for classification. But as we saw before, signatures are hard to obtain, whereas a large dataset is available in most civil applications. There are therefore pitfalls to avoid that were pointed out in this technical session.

Command and control. C2 is the glue that makes the architecture work. The C2 provides planning services supported by simulation capabilities, builds the operational picture, and leads execution. It assigns tasks to sensors and weapon systems and ensures that rules of engagement are respected. It provides communication between all entities. It has to be resilient against attacks, both kinetic and nonkinetic, such as cyberattacks.

The C2 has to handle the complexity of IAMD and help decision-making by providing relevant data at the right time. This is an area where artificial intelligence could be used in the future. Human interface is key to achieve performance objectives. Notions and solutions for collaborative and netcentric engagement, mission optimization, and dynamic target weapon assignment were addressed.

C-RAM, C-UAS. As low-tech threats are proliferating, low-cost answers need to be found. Besides directed energy solutions presented before, other solutions based on mature technologies were presented, such as radar detection, jamming (UAV), and/or interception by kinetic means. For UAVs in civilian areas, other technologies are studied; where a swarm of drones is very unlikely, a capture can be envisioned and detection can be done by LiDAR with no impact on the electromagnetic environment.

Testing and demonstration. Testing is the truth of the field and is mandatory to update simulation models, qualify systems, train operators, and verify operational capability. It was addressed at different levels at the conference:

- at the subsystem level, with the proposal of a hypersonic glider test-bed to evaluate sensors, materials, and algorithms in relevant conditions;
- at the weapon-system level, with the presentation of the NATO missile firing installation in Greece; and
- at the architecture level using the NATO integrated test-bed that is able to connect the NATO C2 and the various national contributions.

Demonstrations have a larger scale and are used to evaluate interoperability, to rehearse coordination, and to send messages to potential adversaries. Exercise Formidable Shield at sea was described, involving more than twenty ships of thirteen countries and with multiple live fires to intercept missiles.[14]

Conclusion

IAMD is a dynamic field. Missiles (here in the generic sense, including drones) are under development and acquired globally at both ends of the technology spectrum because they provide high operational benefits for low risk of loss of human life for the attacker. Missile varieties complicate the calculus of the defender and generate high defensive costs. Conflicts in the last two decades demonstrated the usefulness of missiles but also the efficiency of air and missile defenses that have become mandatory to preserve operational capability before a counterattack.

IAMD is one of the most technically challenging tasks in defense. It needs to be supported by a highly trained workforce in industry, in procurement agencies, and in the armed forces. The 3AF International Conference on Integrated Air and Missile Defense provides a unique forum to gather this community, discusses the many IAMD challenges, and embarks the future generation in this field. The fifteenth conference was a great success, with more than 110 papers submitted, around 250 participants from seventeen countries, and more than one hundred companies represented. This article provided a quick summary of the discussions held during the conference and covered all technical fields of IAMD. We hope it will raise interest in the discourse on IAMD and encourage participation in the next conference in two years. ■

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9. The possibility for member states to engage—on a voluntary basis—in permanent structured cooperation in the area of security and defense was introduced by article 42(6) of the Lisbon Treaty on European Union that states, "Those Member States whose military capabilities fulfil higher criteria and which have made more binding commitments to one another in this area with a view to the most demanding missions shall establish permanent structured cooperation within the Union framework." Consolidated Version of the Treaty on European Union, art. 42(6), 26 October 2012, 2012 O.J. (C 326) 39.

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Glossary

3AF: Association Aéronautique et Astronautique de France (French Association for Aeronautic and Space)
AESA: Active electronically scanned array
ALBM: Air-launched ballistic missiles
ALTBMD: Active Layered Theatre Ballistic Missile Defence
BMD: Ballistic missile defense
C2: Command and control
C-RAM: Counter rocket, artillery, and mortar
C-UAS: Counter unmanned aircraft system
IAMD: Integrated air and missile defense
NIAG: NATO Industry Advisory Group
TWISTER: Timely Warning and Interception with Space-based TheatER
UAV: Unmanned aerial vehicle

Rear Adm. Larry Watkins, deputy commander of the U.S. 3rd Fleet, greets Korean military members participating in an integrated air and missile defense (IAMD) seminar during Rim of the Pacific (RIMPAC) 2022. Militaries from twenty-six nations participated in RIMPAC from June 29 to 2 August 2022 in and around the Hawaiian Islands and Southern California. The world's largest international maritime exercise, RIMPAC is one of many exercises that foster security cooperation between allied and partner nations in the Indo-Pacific region. (Photo by Mass Communications Specialist 3rd Class Demitrius J. Williams, U.S. Navy)

Integrated Air and Missile Defense Security Cooperation in the Indo-Pacific

Col. Lynn Savage, U.S. Air Force
Capt. Pat Connelly, U.S. Navy Reserve, Retired

When Russia attacked Ukraine in February 2022, the invasion caught the best military minds in the Western world by surprise and convinced nearly everyone that it would result in a swift capture and defeat of Kyiv.[1] Russia had an overwhelming number of soldiers and significant advantages in armor, airpower capability, and by any metric used to measure past wars, the unequivocal ability to succeed swiftly. Yet quick victory eluded Russia, and while the outcome is still to be resolved, it can be said the metrics used to measure the likelihood of success before the conflict began will not be the same factors that determine the victor.

In the Pacific, military planners observe the activities in Ukraine with great interest, drawing parallels to potential Chinese aggression in the region. Given China's ever-increasing long-range strike capability and its escalating provocative rhetoric and bellicose expansionist activity toward multiple sovereign neighbors, U.S. Indo-Pacific Command (INDOPACOM) has been developing strategies in the region to counter the growing threat. One aspect of the Ukraine conflict that was anticipated is the ability of air and missile attacks (and the defense of these systems) to shape the outcome of today's wars. Hundreds of Russian missile strikes and the extensive damage they inflicted on Ukraine's infrastructure quickly resulted in the United States supplying Ukraine with over $29 billion in aid, mostly for air and missile defense.[2] While Western support to back Ukraine in defending itself helped turn the tide of Russia's advancement, having the integrated air and missile defense (IAMD) capability in place from the beginning would have saved lives and protected Ukraine assets.

Col. Lynn Savage, U.S. Air Force, is a command pilot and the director of the Pacific Integrated Air and Missile Defense (IAMD) Center (PIC) on Hickam Air Force Base, Hawaii. He attended the U.S. Army Command and General Staff College in Fort Leavenworth, Kansas, and the Naval Warfare College in Newport, Rhode Island. He has held a variety of F-16 tours and staff assignments, including in the Republic of Korea, Alaska, Italy, Germany, South Carolina, Utah, and Hawaii. His PIC team works directly with allies and partners in the region to share U.S. IAMD doctrine; tactics, techniques, and procedures; and lessons learned.

Capt. Pat "Pellet" Connelly, U.S. Navy Reserve, retired, served for thirty years in the active Navy and the Reserve. He is a graduate of the U.S. Navy Fighter Weapons School (TOPGUN) with over 2,900 flight hours in the F-14 Tomcat and has extensive operational level expertise in airpower planning and execution in Europe, Asia, and the Middle East. He is a founding member of the Pacific IAMD Center (PIC) and has led PIC development in the nine years since the PIC was created.

Examining similar scenarios potentially playing out in the Indo-Pacific, the United States has been working with regional partners to consider options in defending themselves against the increasing China menace. Many of the same systems the United States provided to Ukraine have been in place to protect Pacific allies for years. Complicating regional matters, North Korea's rapid progression with advanced ballistic missile ability threatens Japan, the Republic of Korea (ROK), and the United States itself, prompting INDOPACOM to ramp up its IAMD portfolio with a program that began nearly a decade ago. Recognizing the importance of conducting regional missile defense, INDOPACOM tasked Pacific Air Forces to stand up the Pacific Integrated Air and Missile Defense Center (PIC) in 2014. The vision that guides the organization is to defend the region from the full range of advanced air and missile threats—with ability to seamlessly integrate with high-end allies.[3] To accomplish the vision, the PIC's mission is to enhance INDOPACOM theater, joint, and coalition and multinational IAMD capability by providing IAMD academics and education, and promoting IAMD integration among components, critical allies and like-minded partners based on priorities outlined in OPLANS, Theater Cooperation Plan, and the INDOPACOM Campaign Plan.[4] A joint team of eight retired and active-duty military professionals comprise the PIC, engaging in IAMD security cooperation efforts in support of the 94th Army Air and Missile Defense Command (AAMDC) and advancing development of regional IAMD defenses to deter future conflicts. Maj. Gen. Brian Gibson, former commanding general of the 94th AAMDC, noted, "China and North Korea fired the greatest number of (test) missiles last year, so certainly the environment is different than a few short years ago. Our responsibility is to be ready."[5] Readiness includes a multinational partnership of like-minded nations to collaborate in developing a strong regional IAMD design to deter potential adversaries. While the U.S. military is considered a global power, it alone cannot defend assets and simultaneously protect allies and partners against air and missile attacks in the vast Indo-Pacific region.

As INDOPACOM scrutinizes similarities among combat in Ukraine, Saudia Arabian missile strikes, and rising tensions in the Pacific, stark differences emerge among the European theater, the Middle East, and the Indo-Pacific region. Both Saudi Arabia and Ukraine are keenly aware of the enemy's missile capabilities along their borders and require little coordination or reliance on neighboring countries to establish effective defense. Indo-Pacific geopolitics are not as straightforward as the circumstances in Riyadh and Kyiv, where defenders focus their attention along a defined threat axis. In the Pacific, where the majority of nations are surrounded on most sides by water, adversary submarine ballistic missile, surface cruise missile, and air-launched cruise missile capabilities necessitate the requirement to conduct 360-degree coverage. Antagonists can launch missile strikes from all points on the compass, and threats can emerge from enemy territory, fly vast distances over open ocean, and trespass through allied sovereign airspace as warheads target another nation. The PIC recognizes the growing capability of potential adversaries and, using INDOPACOM's *IAMD Vision 2028* as a guide, continues to find avenues and means to highlight and address this challenging regional concern.[6]

A primary aspect of the PIC's mission to promote multinational defense design is providing academics and education on IAMD fundamentals as outlined in Joint Publication 3-01, *Countering Air and Missile Threats*, and Army Field Manual 3-01, *U.S. Air and Missile Defense Operations*, to allies and partners.[7] Academics lay the foundation for a future coalition in which members understand and speak IAMD with a baseline understanding and common vernacular. The PIC's initial partner engagement in 2015 consisted of a defense design workshop with IAMD personnel from Japan, the ROK, and the United States. Patterned after the well-established international IAMD wargame Nimble Titan, Japanese and Korean service members cemented the importance and value of the PIC's first multination event: the Multilateral Table-Top Experiment (MTTX). The first two years of the MTTX involved Japanese and ROK IAMD planners collaborating in a fictional geographic scenario to develop a combined defense design to defeat a regional rival. Participants discovered an appreciation of IAMD information sharing that led to changes increasing decision space for leadership in making informed choices on ballistic missile defense. Unfortunately, in 2017, a cooling of the political relationship between Japan and Korea caused the ROK to disengage with the PIC in multilateral IAMD collaboration for the next five years, but a new regional IAMD partner emerged with Australia in 2016.

> The Missile Defense Agency Modeling and Simulation Team captures essential decisions from the participants and builds scenarios to illustrate the outcomes and validity of their designs. Resulting lessons learned feed development of future trilateral IAMD engagements.

Australia initially took a bilateral, systematic, pragmatic approach to PIC engagement. After the first year and multiple one-on-one PIC sessions to gain the academic background necessary to develop IAMD acumen, Australia joined Japan to establish a follow-on to the MTTX: the Multilateral IAMD eXperiment (MIX). Over the last seven years, the MIX has grown in complexity and content, achieving secret classification and a real-world geometry laydown that infinitely enhances value for all partners. Throughout the defense design process, the three nations experiment with defense postures, preplanned responses, command-and-control authority, and bilateral and multilateral cooperation. The Missile Defense Agency Modeling and Simulation Team captures essential decisions from the participants and builds scenarios to illustrate the outcomes and validity of their designs. Resulting lessons learned feed development of future trilateral IAMD engagements. Most recently, Australia, Japan, and the United States experimented in the MIX with regional designs where command and control is shared among the partners. Policy challenges revealed by exercising combined command and control are highlighted, shared, and discussed in other venues such as Nimble Titan and the Trilateral Missile Defense Forum, as operational-level issues discovered at the MIX often must be solved at a higher policy level.

The U.S. Coast Guard cutter *Assateague* provides security for a Sea-Based X-Band Radar ship as it enters Pearl Harbor, Hawaii, 21 December 2005. (Photo by Petty Officer 3rd Class Michael De Nyse, U.S. Coast Guard)

With the continuing success of the MIX, the PIC relaunched the MTTX in 2022. While the MIX is a "university-level" defense design experiment, MTTX 2022 established a "community college" entry-level program that included IAMD representatives from eight Pacific nations. The week-long experiment incorporated three days of PIC-led IAMD academics and one day during which nations shared their IAMD capabilities and socialized and discussed their concerns openly with all participants. A highlight of the week was a day dedicated to a defense design workshop. The eight nations divided into two teams and developed a defense design for a federation of nations against a common antagonist. The teams observed how their defense design fared against multiple air and missile attacks from the regional adversary, and with their newfound insight, adjusted their design to mitigate future attacks. The five-day event was interwoven with professional development events to include a tour of the Sea-Based X Band Radar and a visit to the 613th Air & Space Operations Center. During his opening comments at the MTTX, Gibson highlighted that in his thirty-plus-year military career, he had never seen so many militaries come together at one time to collaborate on IAMD. MTTX participants echoed the value of the opportunity to meet IAMD experts from other nations, describing the MTTX as the first time they discussed their issues with several neighboring countries. Leveraging the surprising achievement of the MTTX, the PIC introduced an innovative addition to its Academic and Partner Engagement lines of effort by creating quarterly multinational educational activities, with one recent major event—the Japanese Annual Shooting Practice (ASP) at McGregor Range in New Mexico in September 2023.[8]

The 2023 ASP was not the first time the PIC hosted other nations to attend Japanese Patriot maneuvering and live firing, but it encompassed the largest number of observing countries to date. The PIC supported the 2021 ASP, inviting the Philippine Air Force, and the activity was a major success due to the Japanese and Philippine airmen's engagement and exchange of contacts for further collaboration. This year, Japan was very generous in allowing the PIC to invite nine countries throughout the region to observe its Patriot live-fire event. During the live-fire event, nations witnessed the Japanese command and control, saw firsthand "shoot and scoot" tactics, and experienced the teamwork and esprit de corps of the Japanese Air Self-Defense Forces (JASDF). Prior to the live-fire event, the PIC provided multiday IAMD academic and collaboration events to educate participants on IAMD concepts, highlighting specific actions and techniques that were then observed during the live fire.

From its modest establishment in 2014, the PIC has expanded participation in its academics and partner engagement from two to thirteen Indo-Pacific nations, many located within what is known as the First Island Chain.[9] Academics provided by the PIC run the gamut of multiday courses delivered from Pacific Air Forces Headquarters to virtual three-hour subject-focused presentations. Multiday courses are taught by a combination of PIC contractors and instructors from the Joint Ballistic Missile Defense Training & Educational Center. Topics included in the multiday courses include regional threat briefs, deliberate planning, crisis action planning and employment, regional and sector area air defense commander classes, joint IAMD classes, and the joint IAMD instruction. Specific IAMD multiweek instruction is provided to the ROK Air Force and the ROK Navy.

Shorter courses provided by the PIC include a quarterly Intro to IAMD seminar describing the fundamentals of IAMD to include the four operational elements of IAMD; the Joint Theater Air and Missile Defense Board; critical and defended asset prioritization; and the criticality, vulnerability and threat assessment process. Quarterly virtual academics presented online are routinely attended by over 150 ally and partner participants across the Indo-Pacific and include topics such as passive defense, cyber in IAMD, counter-unmanned aircraft system operations, and hypersonic missiles. Once baseline IAMD understanding is established, the PIC progresses to experimenting with the nations on defense design.

Going forward, the PIC will continue bilateral engagements when required and multinational activities where able. INDOPACOM set up and established the PIC, and the 94th AAMDC directs the PIC's security cooperation efforts, but the PIC primary customers are the countries in the region. If a nation requests PIC secrecy due to regional geosensitivity, the PIC maintains anonymity with engagement. The PIC never publishes or shares information about any partner unless first garnering approval to impart details to neighboring countries. Some nations exercise caution with publicity and interaction; others are more open with their PIC exchanges. It is not uncommon for visiting dignitaries to request a PIC presentation on capabilities, and the PIC team always accommodates. Often during foreign visits, the PIC receives higher-level guidance on a nation's desires for PIC assistance toward their IAMD development. PIC professionals are graciously supportive, believing with shared IAMD understanding, operational improvements occur on the battlefield, and a synergistic effect on the region's ability to defend itself is realized.

The PIC continues close collaboration with the most capable partners in the region (Japan and Australia) with the MIX, with the prospect of observations and lessons learned by MIX participants sharing with developing IAMD countries at the MTTX. MIX members are expected to become MTTX mentors with Australian and Japanese IAMD professionals taking the lead. MTTX participants will work together to develop a complete regional defense design. Their plan will be experimental and include IAMD capabilities of eight regional nations, making it a holistic Indo-Pacific IAMD plan. During the design process, MTTX participants will observe how shared early warning increases decision time, examine how layered defenses increase effectiveness, view how practiced preplanned responses increase probability of success, and discover additional significant IAMD revelations. Most importantly, IAMD professionals from eight regional colleagues will work side by side, with shared IAMD vernacular, and depart at the conclusion with calling cards of like-minded military members to contact and cooperate with for years to come.

The PIC forges ahead, expanding the INDOPACOM IAMD portfolio with current partners and the goal of adding nations to the MIX and MTTX. Bringing onboard new IAMD partners is not only a strategic message promoting regional cooperation; it also allows for operational collaboration to synergize advantages of multilateral integration and interoperability. In a future MIX scenario, Australian and Japanese operators may consider sharing early warning information and discuss and collaborate on interceptor deconfliction, with a Korean ship launching interceptors against missiles targeting a Philippine asset. Decisions they make can be incorporated in the simulation tool and played back with the outcomes delivered to their respective nations to visually demonstrate to leadership the advantages of establishing a regional, shared defense design. As the situation in Ukraine continues to unfold, real-world IAMD lessons learned inform INDOPACOM strategists, planners, and policymakers as well as the nations in the region with a candid and fundamental military axiom: *You may not win a war by having effective IAMD capability, but you can certainly lose a conflict if you don't.* ■

Notes

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Test engineers prepare the Lonestar Tactical Space Support Vehicle for employment at the Leidos Dynetics facility clean room in Huntsville, Alabama. Launched 1 July 2022, the Army's Lonestar satellite was designed to provide space-based situational awareness directly into the hands of the tactical warfighter. (Photo by Gary Gee, courtesy of Leidos Dynetics)

Army Space Policy

Past, Present, and Future

Maj. S. Lacey Dean, DLP, U.S. Army

Since launching America's first satellite in 1958, the U.S. Army has played a pivotal role in the Nation's space operations. This involvement necessitated the development of an Army space policy the following year. The policy provided purpose and guidance for the Army's nascent space operations and space-based systems with the goal of optimizing its effectiveness in land warfare. As the use of the space domain evolves, so too must this policy. In this context, examining the past, present, and future of the Army space policy not only reflects the critical role the Army has played in space operations but also reveals the importance of continually updating and improving the Army space policy. An effective space policy articulates purpose and goals, is adaptable to change, and provides direction for strategic decisions.

Given the central role of the Army space policy in shaping its space operations, it is helpful to understand the broader role of how policy helps guide actions. Defining policy can be challenging, as there is no universally agreed-upon definition. However, a loose consensus exists that suits a meaningful discussion: a policy is a statement in any form, given by the government or an organization with authority, declaring its intentions to address a problem. Issued as a law, regulation, ruling, or decision depending on the level at which it is codified, the policy may also include instances where the governing body deliberately refrains from action.[1] Policies often represent overarching goals, guiding principles, or specific actions to achieve objectives, with definitions sometimes tailored for specific purposes by some person or agency with the appropriate authority.[2]

Maj. S. Lacey Dean, DLP, U.S. Army, is a space operations officer and the 8th Space Company commander in the U.S. Army Reserve. In her civilian capacity, she serves as the deputy division chief for policy and doctrine at the U.S. Space Command (USSPACECOM). She holds a doctorate in law and policy from Northeastern University, Boston, where she focused her research on space debris policies, and she is a graduate of the Command and General Staff College, Fort Leavenworth, Kansas. Dean has served in Terminal High Altitude Area Defense batteries in the 32nd Army Air and Missile Defense Command, in the 100th Missile Defense Brigade, and as the doctrine branch chief at USSPACECOM.

Past Policy

1940s and 1950s. The origins of the Army space policy date back to 1945, the end of World War II. By this time, the Army had accumulated battle-tested experience in aerial intelligence, signals intelligence, global communication ground stations, air defense early warning, and rocket propulsion development.[3] The Army's Signal Corps worked for decades to develop mobile communication devices and signal intelligence capabilities. Concurrently, Army ordnance worked on long-range rockets and liquid and solid propellants. Then, in 1945, three initiatives converged that set the path for Army missile and signal capabilities: the Army's prior research under ordnance; California Institute of Technology, which was the contract vehicle for the partnership with the Jet Propulsion Laboratory; and Project Paperclip's employment of German rocket experts, including Wernher von Braun.[4]

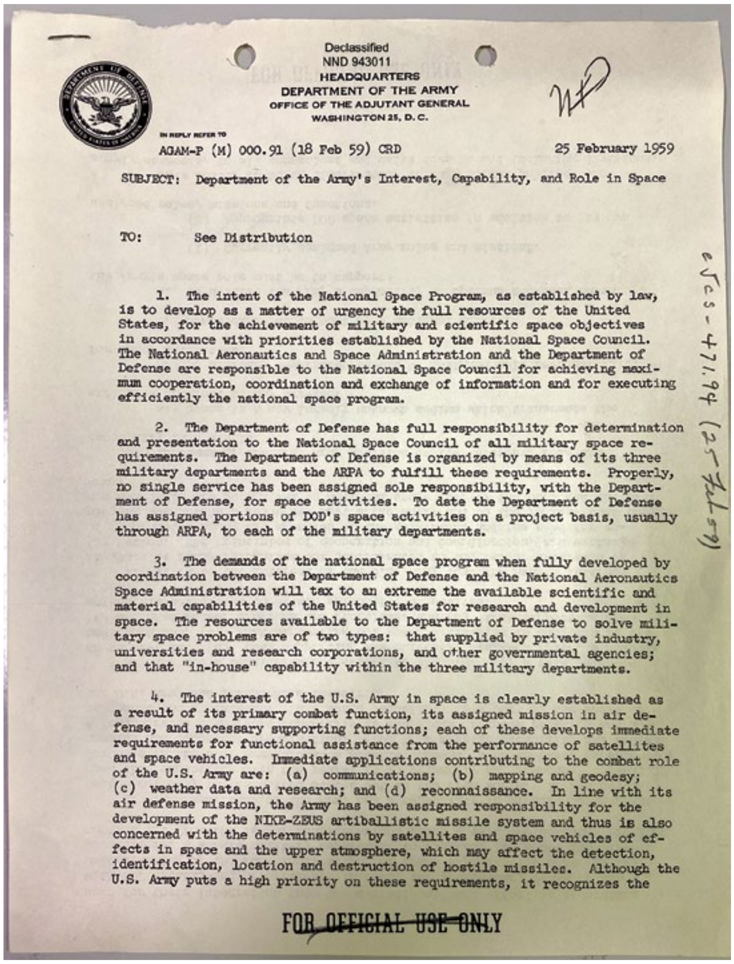
The Army Air Forces commander, Gen. Henry "Hap" Arnold, sought to ensure the U.S. military was well-equipped with the most advanced weapons and technologies for the next war.[5] In addition to missile and signal advancements, another technological concept discussed was an intelligence-gathering system that could "circle the earth" and prevent another scenario like Pearl Harbor.[6] To this end, Arnold recommended to the secretary of war the establishment of Project RAND, an independent consultant group tasked with conducting operations research, researching prospective weapon developments, and providing advice on emerging technologies, including an intelligence earth-circling capability.[7]

Arnold appointed Maj. Gen. Curtis LeMay as the first deputy chief of air staff for research and development to oversee Project RAND. In 1945–46, the Army Air Force competed with the Navy for prospective congressional research funds for "earth-circling" systems. When the Army and Air Force split in 1947, Arnold and LeMay had well-established strongholds on the reasoning for space research funds to go to the Air Force. Then, "in January 1948, General Vandenberg, Vice Chief of Staff of the US Air Force, signed a Statement of Policy for a Satellite Vehicle."[8] This policy announced that the Air Force was "the Service dealing primarily with air weapons—especially strategic—has logical responsibility for the Satellite."[9]

During the split, the Army received the primary responsibility of land operations and air defense and either ignored or did not receive Vandenberg's memo.[10] Braun and his team believed space and missiles were intrinsically linked. In 1954, Braun and Frederick Durant III, president of the International Astronautical Federation, met at the Office of Naval Research to discuss "developing a satellite program using already existing rocket components."[11] After multiple meetings, Braun submitted a secret report to the Army titled *A Minimum Satellite Vehicle: Based on Components*

Available from Missile Developments of the Army Ordnance Corps.[12] The Army agreed to this joint venture, contingent on the program not detracting from its assigned air defense mission and subsequent missile development program. Over the next few years, some of the worst interservice infighting occurred among the military services, as each raced to develop the first satellite and launch capabilities.

On 31 January 1958, the U.S. Army launched the first satellite, Explorer I, and with it followed the first Army space policy.[13] Despite being first in space, the Army was concerned it would lose its pertinence. One year after launching Explorer 1, the Army published its space policy, "Department of the Army's Interest, Capability, and Role in Space," on 25 February 1959.[14] Here, the Army stated its position on space: "Space is a new largely unknown medium which transcends the exclusive interest of any service … No military department should be assigned sole responsibility for space activities."[15] The Army would (albeit a little too late) reiterate this position in hearings with the Senate and the House of Representatives as Congress grappled with the best way to dole out space responsibilities and funds.



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WASHINGTON 25, D. C.

WP

IN REPLY REFER TO
AGAM-P (M) 000.91 (18 Feb 59) CRD 25 February 1959

SUBJECT: Department of the Army's Interest, Capability, and Role in Space

TO: See Distribution

eJCS-471.94 (25 Feb 59)

1. The intent of the National Space Program, as established by law, is to develop as a matter of urgency the full resources of the United States, for the achievement of military and scientific space objectives in accordance with priorities established by the National Space Council. The National Aeronautics and Space Administration and the Department of Defense are responsible to the National Space Council for achieving maximum cooperation, coordination and exchange of information and for executing efficiently the national space program.

2. The Department of Defense has full responsibility for determination and presentation to the National Space Council of all military space requirements. The Department of Defense is organized by means of its three military departments and the ARPA to fulfill these requirements. Properly, no single service has been assigned sole responsibility, with the Department of Defense, for space activities. To date the Department of Defense has assigned portions of DOD's space activities on a project basis, usually through ARPA, to each of the military departments.

3. The demands of the national space program when fully developed by coordination between the Department of Defense and the National Aeronautics Space Administration will tax to an extreme the available scientific and material capabilities of the United States for research and development in space. The resources available to the Department of Defense to solve military space problems are of two types: that supplied by private industry, universities and research corporations, and other governmental agencies; and that "in-house" capability within the three military departments.

4. The interest of the U.S. Army in space is clearly established as a result of its primary combat function, its assigned mission in air defense, and necessary supporting functions; each of these develops immediate requirements for functional assistance from the performance of satellites and space vehicles. Immediate applications contributing to the combat role of the U.S. Army are: (a) communications; (b) mapping and geodesy; (c) weather data and research; and (d) reconnaissance. In line with its air defense mission, the Army has been assigned responsibility for the development of the NIKE-ZEUS artiballistic missile system and thus is also concerned with the determinations by satellites and space vehicles of effects in space and the upper atmosphere, which may affect the detection, identification, location and destruction of hostile missiles. Although the U.S. Army puts a high priority on these requirements, it recognizes the

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"Department of the Army's Interest, Capability, and Role in Space," published in 1959. To read the complete memorandum, see the appendix.

The Army's new policy was very clear on what it perceived as its interest and role in space activities:

> The interest of the U.S. Army in space is clearly established as a result of its primary function, its assigned mission in air defense, and necessary supporting functions; each of these develops immediate requirements for functional assistance from the performance of satellites and space vehicles. […] [T]he U.S. Army's role in space [is] threefold: (a) that supporting its currently assigned roles, missions, and functions, (b) that supporting DoD space activities in addition to its own assigned roles, missions and functions, and (c) that supporting NASA scientific activities to attain scientific objectives.[16]

The intense interservice fighting and political shifts surrounding space initiatives continued. Despite the Army repeatedly stressing the importance of space-based capabilities in support of land combat and air defense, it ultimately had to relinquish most of its fledgling space programs.

In 1959 and 1961, Secretary of Defense Robert McNamara reshuffled space responsibilities. Responsibilities were split between the newly created National Aeronautics and Space Administration (NASA), Advanced Research Projects Agency, and the Air Force, leaving the Army with very little. This loss left the Army without a clear and centralized focus for its space initiatives. Without focus, there was no perceived overarching need for a comprehensive policy to guide its remaining efforts. The absence of such a policy left the Army without a defined purpose or clear framework for its remaining space initiatives. This led to disjointed efforts and a common belief that the Army had little to no role in space for several decades.

1960s and 1970s. During the 1960s and 1970s, the U.S. Army played a crucial but largely unacknowledged role in the Nation's space efforts. While NASA held the public's attention with its journey to the moon, the Army's contributions to space activities included satellite communications systems, ground terminals, imagery payloads, space surveillance, ballistic missiles, and ballistic missile defense systems, geodesy and mapping (Army Mapping Agency), and space infrastructure building (Corps of Engineers at Johnson and Kennedy Space Centers). Unfortunately, most of this went unnoticed by the American population and other governmental agencies.

In 1961, when McNamara directed the Army to transfer most of its space-related programs to either the Air Force or NASA and its Jet Propulsion Laboratory, the Army managed to retain a few programs. The remaining programs under Army control included the Advent communication satellite system, the Pershing missile system, and the Nike-Zeus antiballistic missile system, including the Zeus acquisition radar. These programs would be a cornerstone for the Army to rebuild its internal space interest, knowledge, and expertise. Select personnel in the Army embraced the 1961 Department of Defense (DOD) Directive 5160.32, *Reconnaissance, Mapping and Geodetic Programs*, as it slowly and disjointedly reconstructed a space portfolio. The directive stated, "Each military department and Department of Defense agency is authorized to conduct preliminary research to develop new ways of using space technology to perform its assigned function."[17] This directive only allowed for preliminary research on how space-based effects could benefit land warfare. Once the program was past the initial stages, the Army had to turn it over to the Air Force.

Throughout the 1960s, the Army was recognized primarily as a user of space-based capabilities but rarely for its research and capability development contributions. In addition to Advent, some of its efforts included work on programs such as Corona, Argon, Mudflap, and the Hexagon mapping camera.[18] Most of the Army's space-related work was classified during this time, which prevented dialog between agencies or recognition outside specific projects.

Despite the Army's contributions, it consistently faced challenges when collaborating with other organizations, sometimes even within the same organization, such as the National Reconnaissance Office (NRO). The NRO was responsible for several mapping projects, and the Army contributed to several of these initiatives. Yet, in 1966, when the Army requested to join the NRO's Manned Orbiting Laboratory space initiative, it was initially denied.[19]

In September 1969, the task group released *The Post-Apollo Space Program: Directions for the Future* report to Nixon. NASA was encouraged to pursue 'robotic and human space programs.'

The NRO, mainly comprised of Air Force and Central Intelligence Agency personnel, flatly told the Army everything it was requesting to be a part of was "in the area of NRO responsibility."[20] The Army obtained clearance for the NRO's Manned Orbiting Laboratory team to learn about their work on high-resolution satellite photography systems, which was a separate NRO program. After learning about the Army's work, the NRO requested an Army officer join its test operations division or mission planning division.[21] Decades would pass before these and other contributions saw the light of day, long after projects were declassified.

Shortly after assuming office in 1969, President Richard Nixon established the Space Task Group to recommend "post-Apollo space goals and programs" for the military and NASA.[22] Less than a year later, in September 1969, the task group released *The Post-Apollo Space Program: Directions for the Future* report to Nixon. NASA was encouraged to pursue "robotic and human space programs."[23] The military did not receive the same encouragement. The report stated that the "DoD will embark on new military space programs only when they can clearly show that particular mission functions can be achieved in a more cost-effective way than by using more conventional methods."[24] This same year, DOD Directive 5160.32 was modified to add the following:

> Military Department proposals for space development programs will require specific OSD [Office of the Secretary of Defense] approval based on DCP and DSARC policies. DCPs for space communications, navigation, unique surveillance (i.e., ocean or battlefield), meteorology, defense/offense, mapping, charting, geodesy, and major technology programs will designate the Military Department or DOD agency responsible for the execution of the program.[25]

The Defense Systems Acquisition Review Council would use the development concept papers (DCP) as a guide to approve the initiation of new programs. The DCP outlined a program's characteristics, objectives, plans, and performance targets.[26] This recommendation and new directive fueled select Army personnel to embark on new space initiatives. In small, isolated, and disconnected groups, the Army conducted (mainly classified) research into unique battlefield surveillance, communication, navigation, mapping, and geodesy satellites.

Unfortunately, the Army continued not to have any unifying space policy. The Vietnam War had consumed most of the Army's resources and attention. Even without a formal policy, the Army's modest and predominantly classified contributions to space-based capabilities continued to be significant. As the United States transitioned into the 1980s, the Army's disjointed approach to space-related projects limited its potential and resulted in missed opportunities. This would soon change in the coming years, but at the end of the 1970s, the Army's involvement with space-based initiatives was limited, disconnected, and mostly concealed.

1980s. The 1980s brought U.S. space initiatives back to the forefront: NASA launched the first space shuttle in April 1981, and President Ronald Reagan delivered a robust national space policy (National Security Decision Directive 42) on 4 July 1982. In this new national policy, Reagan stated,

> The United States will conduct those activities in space that are necessary to national defense. The military space program shall support such functions as command and control, communications, navigation, environmental monitoring, warning, tactical intelligence, targeting, ocean and battlefield surveillance, and force application (including an aggressive research and development program which supports these functions). In addition, military space programs shall contribute to the satisfaction of national intelligence requirements.[27]

One month later, the Army published its new AirLand Battle doctrine.

“Gen. John Wickham, chief of staff of the Army, would say, ‘Space assets and related technologies provide unique means to accomplish critical tasks in support of AirLand Battle Doctrine.’”

AirLand Battle placed a greater emphasis on collaboration between land and air forces. In a few years, Gen. John Wickham, chief of staff of the Army, would say, "Space assets and related technologies provide unique means to accomplish critical tasks in support of AirLand Battle Doctrine."[28] However, in 1983, the Army still needed to figure out its purpose in space. This began with the creation of the Army Space General Officer Working Group. The working group's goal was to provide guidance for Army space-related initiatives and detail the land-based problems that space-based assets could help solve.

The Army Space General Officer Working Group met regularly, but after a year, there was no forward movement. By 1984, the "Army was the only service which had not established a strong central staff organization to manage its space activities."[29] The Army's space initiatives were still as disjointed and fractured as they were through the 1960s and 1970s. Additionally, "Army participation in joint space matters was [still] halting and poorly coordinated."[30] By 1985, action was needed. To help push action, the Army deputy chief of staff for planning launched the Army Space Initiative Study (ASIS) that May. The ASIS would become a significant milestone for the Army, determining its role in space.

The ASIS was tasked to compile an inventory of all Army "space activities" and to "develop a blueprint for future Army involvement and investment in space through the first quarter of the 21st century."[31] At the onset, the ASIS realized the Army lacked a definition for "space activities."[32] A definition was required because "the Army was dealing with space systems and did not realize it."[33] With that, the group defined space activities as the "research, procurement or operation of any system that directly interfaces with or relies upon a space-based segment."[34]

ASIS's report included several notable findings and insights. The study found that, as of the preceding year, "the Army is executing nearly $1,820 million and has 5,235 people involved in space activities."[35] ASIS found personnel conducting space activities in four categories: "staff planning; research and development; evaluation and training; and operations."[36] The amount of space-related work the Army was doing was more extensive than any singular department or person realized.

Concurrently, the Army Space General Officer Working Group published an Army space policy on 4 June 1985. Some key elements of this policy included the following: (1) the Army will "exploit space activities that contribute to the successful execution of Army missions," (2) the Army must build a "pool of experts" and take the initiative to participate in national and joint programs that would contribute to fulfilling Army requirements, and (3) doctrine must capitalize on developing space capabilities.[37]

The following December, ASIS unveiled its conclusions along with the Army Master Space Plan. The plan utilized the new Army space policy as its guidelines. The plan opened with, "perceptions that space is the sole domain of the Air Force and NASA are changing," and "the Army is by no means a newcomer to space activities."[38] The Army once again had a unifying policy, a purpose, and was back in the space game.

1990s. The 1990s brought what reporters and historians would call the "first space war." Operation Desert Storm showcased the unprecedented integration of space-based navigation technology in a major land campaign. Global Positioning System (GPS) allowed allied forces to move across the featureless terrain of the desert, while early warning satellites offered crucial minutes for defensive measures. "The satellite communications network established during Desert Shield reflected considerable system flexibility and cooperation among the military, civil, and commercial space sectors."[39] This conflict revealed the Army's purpose with space-based capabilities, highlighting its crucial role in the joint utilization of these capabilities for land warfare.

Although the Army had been a member of the GPS joint development planning team since 1973, it wasn't until Operation Desert Storm that most soldiers and Army civilians had the opportunity to understand how space contributed to AirLand combat operations, as stated in the 1985 Army space policy.[40] This policy emphasized the need for the Army to "exploit space activities that contribute to the successful execution of Army missions." Desert Storm solidified the vital role of space-based technologies in modern land warfare and underscored the importance of continued innovation, adaptation, and relevancy by the U.S. Army. With a new understanding of the possibilities, the Army would publish an updated space policy.

The Army also realized it needed to redefine where space activities took place. In 1985 the ASIS group determined that the Army regarded space differently than the Air Force and Navy. To the Army, "Space operations are a logical extension of the battlefield."[41] The Army had seen this during Desert Storm. On the other hand, the Air Force and Navy took the stance that space activities took place where the space system was located—above the Karman line. The updated 1994 *Army Space Policy* addressed this. "The Army will consider space to include those regions from, through, or in which space or space-surrogate systems operate."[42] In the coming years, the rest of the DOD would come to use "from, through, or in" or a similar variation to encompass where space activities took place.[43]

The 1994 *Army Space Policy* was only one paragraph long, but it contained language that would set the trajectory for Army space initiatives and personnel for the next twenty-five years. It maintained the 1985 language about exploiting space activities that "contribute to the successful execution of Army missions," growing the Army space expertise, and embedding space applications in doctrine and training.[44] It also included the following:

> Employment of space products that meet land warfighter requirements will provide a force multiplier essential to our power projection force. Information technology which enables success on the battlefield relies heavily on space solutions. Beyond affecting future space systems design and developmental initiatives, the Army, in joint and combined operations, will organize and train Army forces using space capabilities and products to make them more responsive, flexible, interoperable, survivable, and sustainable.[45]

This language in the 1994 *Army Space Policy* was highly reminiscent of Gen. Lyman Lemnitzer's summation of the 1959 policy given to the House of Representatives Committee on Science and Astronautics in February 1960:

> The Army's role and interests in space are initially directed toward the application of space to modern terrestrial warfare and, more specifically, to its application in the accomplishment of the Army's principal assigned missions in this environment. These principal missions are threefold: (1) to provide and support forces for land combat; (2) to provide and support forces for air and missile defense; and (3) to provide a number of related services, not only for the Army, but in support of the other armed services as well.[46]

The difference was now, in 1994, others were finally beginning to see what the Army had seen thirty-five years prior. What happens in space is inextricably connected to what is happening on the ground, in the air, and on the seas.

Present Policies

2000s. Through the 1980s and 1990s, the Army space policy was broad and nonprescriptive. The primary and shared purpose of each of the previous policies was to assert that the Army would utilize space activities that contributed to mission accomplishment and the systems that enabled it. That changed in the 2003 *Army Space Policy*. The policy became prescriptive, leaving little ambiguity and calling out the specific capabilities the Army would advocate for and pursue. The last time the Army space policy called on types of capabilities was in 1959.

In 1959, with three U.S. Army satellites in orbit, the capabilities called out were as follows: communications, mapping and geodesy, weather data and research, and reconnaissance, "all in line with the Army's air defense mission."[47] The air defense mission included the responsibility for antiballistic missiles and a means to detect and track "hostile missiles."[48] These capabilities were explicitly connected to the purpose, and the policy identified the problem that these capabilities intended to solve. In contrast, the 2003 *Space Policy* language was too prolix, obscuring any intended purpose and making it difficult to understand:

> Responsive, dynamic space-based intelligence, surveillance, and reconnaissance sensors networked with land, sea, air, and soldier sensors; Seamlessly integrated, dynamic bandwidth, satellite communications (SATCOM) on the move; Responsive, tactically relevant Space Control capabilities synchronized and integrated with Land, Sea, Air and Information Operations; Assured, accurate, real-time missile warning and tracking distributed direct to affected forces and battle command systems; Precise, redundant, jam-resistant: position, velocity, navigation, and timing services; Advanced sensors for timely, tailorable weather, terrain, and environment.[49]

This language was not only prescriptive but also crossed over into requirements. Returning to the agreed-upon definition of policy, "Policies often represent overarching goals, guiding principles, or specific actions to achieve objectives, with definitions sometimes tailored for specific purposes."[50] The question becomes, what is this policy's goal, principle, objective, or purpose? Three possibilities exist embedded in this policy:

> The Army must promote a federated and distributed information network of sensors and communication devices among Commercial, Military, and National Space-Based Capabilities as part of the Global Information Grid. A seamless space-to-soldier continuum

1st Space Brigade's Chief Warrant Officer 2 Robert Wyman, Cpl. Terrence Shatswell, and Staff Sgt. Robert Harris rehearse crew drills 24 April 2023 in preparation for a 75th Ranger Regiment raid during the U.S. Army Special Operations Command's Capabilities Exercise held 23–27 April 2023 at Fort Liberty, North Carolina. (Photo courtesy of the U.S. Army Space and Missile Defense Command)

> of sensors, networks, and information is the signature characteristic of well-integrated Space and Land Force and Joint Operations; Achievement of these space capabilities will dramatically change how Army and Joint forces collect, exploit, and distribute information; In the 21st Century we must fully exploit the high ground of Space to empower adaptive leaders and soldiers with the ability to see first, understand first, act first, and finish decisively.[51]

Of these possible choices for a "goal, principle, objective, or purpose," none explain why the policy requires listing out narrowly defined capabilities.

The objective in 1959 was to use space to support currently assigned roles and missions. The objective shifted in 1985 toward exploiting space activities that contributed to the Army mission. Similarly, the 1995 policy aimed to "enhance operational support to warfighters and contribute to the successful execution of Army missions."[52] These previous policies were clear. These previous policies provided a clear purpose for unifying efforts toward exploiting space capabilities to support the Army mission, aiming to improve land warfighting abilities. However, the 2003 *Space Policy* failed to provide the same clear and unifying purpose as its predecessors. Rather than explicitly stating the policy goal, the language was rambling and lacked focus. The absence of clear and concise policy guidance would begin to hinder the Army's potential, repeating the same past mistake.

Six years later, the Army published a new Army space policy. This time, instead of releasing a standalone policy, the policy would be published as a chapter in the 2009 Army Regulation (AR) 900-1, *Department of the Army Space Policy*. This construct provided a concise method for delivering the policy and the framework for executing the policy. While the goal and objectives were easy to identify, their meaning and focus remained unclear. The goal was "enable the land force to conduct the full range of military operations now and in the future."[53] There were four objectives, with the first one returning to its previous simplicity. "Maximize the effectiveness of current space capabilities in support of operational and tactical land warfighting needs."[54] In the coming years, the policy's lack of clarity and focus would hinder Congress and the DOD's understanding of the Army's role in space.

Unfortunately, the 2009 policy also maintained the prescriptive nature of the 2003 policy. Inside the policy, there were initially four "broad space-related objectives."[55] Within that list was a sublist with ten capabilities listed as what the Army would "pursue and advocate." Then there was another additional sublist labeled "To achieve the Army's space responsibilities, the Army will …" This second sublist detailed eight paths to achieving the responsibility of "actively participating in defining space-related capability needs that ensure the necessary force structure and systems are developed and acquired to enable the land force to conduct the full range of military operations now and in the future."[56]

There is a place for connecting systems and implementation methods. However, by including too many detailed capabilities and implementation methods within the same chapter as the policy, the Army failed to articulate the purpose of its space program clearly. A better approach would have been to separate the various sections into distinct chapters, allowing for a clearer understanding of the problem the policy intended to solve. As it stood, a soldier not connected to space operations would have struggled to understand the policy's purpose beyond the vague statements of "enabling the land force to conduct military operations" and "participating in defining space-related capabilities." This lack of clarity ultimately limited the policy's effectiveness in guiding the Army's space program.

2010s. Space technological advancements and commercial participation increased drastically during the 2010s. At the beginning of the decade, fewer than a thousand satellites were in orbit. By 2020, that number would increase to over three thousand, with companies able to launch over a hundred at a time. The Army's structure for the employment and support of space capabilities also grew, and an updated AR 900-1, *Army Space Policy*, was published in 2017.

Like its predecessors, the 2017 *Army Space Policy* is overly verbose and lacks clarity and conciseness. For a person outside of the space community, it is difficult to understand the main points. Moreover, the policy contains nebulous statements that are open to interpretation. Additionally, the purpose, the reason for Army to have space, changes from the previous policies. The overarching purpose for the Army to have space responsibilities in the 2017 *Army Space Policy* is to "integrate space capabilities across the force, provide needed space capabilities and support, and develop capabilities needed to provide space effects in support of Army requirements."[57]

This subtle shift from supporting the Army mission to addressing Army requirements is small but significant. It detracts from the primary objective of using space capabilities to support the overall mission and instead focuses on meeting specific requirements. This change results in a less cohesive and effective space policy, ultimately hampering the Army's ability to leverage space capabilities in support of its missions.

At a time when space-based requirements, systems, and programs are moving from the Army to the U.S. Space Force, it is prudent to focus on what is more important. As the Army evolves, its requirements for space-based capabilities will change. However, the fundamental reason the Army needs space will remain the same as it was sixty-four years ago.

Future Policy

In 1988, "the Army Space Agency became Army Space (ARSPACE) and in August 1992, ARSPACE became a subordinate command of the U.S. Army Space and Strategic Defense Command, a predecessor of the U.S. Army Space and Missile Defense Command."[58] In 1997, the Army then established its Space and Missile Defense Command with the mission to provide the Army perspective in planning for DOD space support to land forces and strategic defense operations. No policy in the twenty-first century directly states that part of the purpose, goal, or objective of the Army space policy is to support the Army's mission with strategic defense operations, such as missile defense. These ideas could be inferred, and those who work in the Army space community might know what it means. However, a good policy should not require someone to assume the intent, and folklore does not turn something into policy.

The Army needs a space policy that speaks to the purpose of space for the Army, provides an objective, and allows us flexibility to grow as the space environment changes. Every soldier should know why the Army employs space-based capabilities and effects in the same way that every soldier knows why we use tanks. The Army space policy should clearly articulate why we exploit space-based capabilities to support land warfare and the Army's space role in multidomain operations. This support ranges from Assured-Positioning, Navigation, and Timing used by a brigade combat team, to global missile defense, and precision targeting in a multidomain formation. These are elements any soldier could articulate. Any soldier would understand how these space-based effects better enable land warfare.

In the 1950s, many skeptics outside the Air Force posed a legitimate question: What was a military service defined by ground warfare doing with a space program?[59] This question has reverberated throughout the decades and is once again at the forefront of discussions with the establishment of the Space Force. As we witness the dawn of the next era in space exploration, new space-based capabilities, and how our Nation conducts warfare, it is imperative that the Army learns from the past and concentrates on its core competencies to ensure a cohesive and efficient Army space policy that capitalizes on the unique strengths of its service. ■

Notes

1. Thomas A. Birkland defines policy as "a statement by government of what it intends to do, such as a law, regulation, ruling, decision, order, or a combination of these. The lack of such statements may also be an implicit statement of a policy not to do something." Thomas A. Birkland, *An Introduction to the Policy Process: Theories, Concepts, and Models of Public Policy Making*, 5th ed. (New York: Routledge, 2020), 6, 249. He further defines the policy codification levels on pages 249–50. The top four levels of policy and where each is codified are as follows: (1) constitutional (federal or state constitution), (2) statutory (U.S. Code, Statutes at Large), (3) regulatory (Federal Register, Code of Federal Regulation), and (4) formal record of standard operating procedure (operating procedures, operating manuals). The U.S. Army and its internal policies fall under this fourth level of policy.

2. Richard Wilson, "Policy Analysis as Policy Advice," in *The Oxford Handbook of Public Policy*, ed. Michael Moran, Martin Rein, and Robert E. Goodwin (New York: Oxford University Press, 2008), 153.

3. Eddie Mitchell, *Apogee, Perigee, and Recovery: Chronology of Army Exploitation of Space* (Santa Monica, CA: RAND Corporation, 1991), 53.

4. Ibid., 44.

5. H. H. Arnold, *Third Report of the Commanding General of the Army Air Forces to the Secretary of War, November 12, 1945* (Washington, DC: U.S. Government Printing Office [GPO], 1945), 68.

6. R. Cargill Hall, "Essay: 'Origins of U.S. Space Policy: Eisenhower, Open Skies, and Freedom of Space,'" in *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program Volume I: Organizing for Exploration*, ed. John M. Logsdon et al. (Washington, DC: NASA History Office, 1995), 213; Delbert R. Terrill Jr., *The Air Force Role in Developing International Outer Space Law* (Maxwell Air Force Base, AL: Air University Press), ix.

7. Terrill, *The Air Force Role*.

8. Dwayne Day, "Invitation to Struggle: The History of Civilian-Military Relations in Space," in *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program Volume II*, ed. John M. Logsdon et al. (Washington, DC: NASA History Office, 1996), 236.

9. Ibid.

10. Mitchell, *Apogee, Perigee, and Recovery*, 39; Day, "Invitation to Struggle," 238. The Army had no responsibility to acknowledge or act upon the policy memo put forth by the vice chief of staff of the Air Force. These actions did, however, lay the foundation for the Army creating its unique service conception of how space should operate.

11. Day, "Invitation to Struggle."

12. Ibid.

13. *Investigation of Governmental Organization for Space Activities: Hearings Before the Subcomm. on Governmental Organization for Space Activities of the Comm. on Aeronautical and Space Sciences*, 86th Cong., 1st sess. (14 April 1959), 227–45.

14. Office of the Adjutant General, Headquarters, Department of the Army, Department of the Army's Interest, Capability, and Role in Space, 25 February 1959 (Department of the Army's Interest, Capability, and Role in Space); box 34, "471.94 (1959)"; General Twining, 1957–1960 (Twining, 1957–1960); Records of the U.S. Joint Chiefs of Staff, Chairman's File, Record Group 218 (RG 218); National Archives at College Park, College Park, MD (NACP). This reference was provided by Logsdon et al., *Exploring the Unknown*, 2:255–56.

15. Ibid.

16. Ibid.

17. Department of Defense (DOD) Directive 5160.32, *Development of Space Systems* (Washington, DC: U.S. DOD, 6 March 1961), https://www.nro.gov/Portals/65/documents/foia/declass/WS117L_Records/215.PDF.

18. Kevin C. Ruffner, ed., *Corona: America's First Satellite Program* (Washington, DC: Center for the Study of Intelligence, 1995); Guy F. Welch, "Hexagon (KH-9) Mapping Camera Program and Evolution" (presentation, Chantilly, VA, December 1982); Sharon Watkins Lang, "With Project MUDFLAP, NIKE-ZEUS Demonstrates ASAT Capability" (unpublished white paper, June 2022).

19. "The Manned Orbiting Laboratory (MOL) was a joint project of the U.S. Air Force (USAF) and the National Reconnaissance Office (NRO) to obtain high-resolution photographic

imagery of America's 1960s Cold War adversaries." John Uri, "50 Years Ago: NASA Benefits from Manned Orbiting Laboratory Cancellation," NASA, 10 June 2019, https://www.nasa.gov/feature/50-years-ago-nasa-benefits-from-mol-cancellation.

20. Alexander H. Flax, memorandum to Assistant Secretary of the Army, Research and Development, "Manned Orbiting Laboratory," 23 February 1966.

21. Alexander H. Flax, memorandum to Assistant Secretary of the Army, Research and Development, "Manned Orbiting Laboratory," 6 April 1966.

22. John M. Logsdon, "Lessons from the Past: Why the U.S. Decided Not to Explore After Going to the Moon," Space Policy Institute, 23 April 2023, https://spi.elliott.gwu.edu/files/2018/11/Logsdon-Lessons-from-the-Past-Why-the-U.S.-Decided-Not-to-Explore-After-Going-to-the-Moon-1vcit1f.pdf.

23. John Uri, "50 Years Ago: After Apollo, What? Space Task Group Report to President Nixon," NASA, 18 September 2019, https://www.nasa.gov/feature/50-years-ago-after-apollo-what-space-task-group-report-to-president-nixon.

24. Paul B. Stares, *The Militarization of Space, U.S. Policy, 1945–1948* (Ithaca, NY: Cornell University Press, 1985), 27; "USAF Facts and Figures," *Air Force Magazine* 70, no. 5 (May 1987), 159.

25. DOD Directive 5160.32, *Development of Space Systems* (Washington, DC: U.S. DOD, 8 September 1970).

26. J. Ronald Fox, *Defense Acquisition Reform, 1960–2009: An Elusive Goal* (Washington, DC: U.S. GPO, 2011), 49, https://history.defense.gov/Portals/70/Documents/acquisition_pub/CMH_Pub_51-3-1.pdf.

27. National Security Decision Directive 42, *National Space Policy* (Washington, DC: The White House, 4 July 1982), https://www.reaganlibrary.gov/public/archives/reference/scanned-nsdds/nsdd42.pdf.

28. U.S. Army Space Agency, *Army Space Master Plan* (Redstone Arsenal, AL: U.S. Army Space Agency, April 1987), 3.

29. Mitchell, *Apogee, Perigee, and Recovery*, 100.

30. Ibid.

31. Ibid.; John R. Wood, "The Army and Space: Historical Perspectives on Future Prospects" (master's thesis, U.S. Army Command and General Staff College, 1986), 89, https://apps.dtic.mil/sti/tr/pdf/ADB105345.pdf. Page numbers refer to the PDF and not the report.

32. Wood, "Army and Space," 80.

33. Ibid., 128. Wood's thesis contains the Army Space Initiative Study's complete findings and report. In the report, footnotes 26 and 27 can be found on page 1-1, para. 3.

34. Ibid.

35. Ibid., 129.

36. Ibid.

37. Ibid., 96.

38. U.S. Army Space Agency, *Army Space Master Plan*, 16.

39. David Spires, *Beyond Horizons: A Half Century of Air Force Space Leadership* (Washington, DC: U.S. GPO, 1998), 248.

40. "In April 1973 Deputy Secretary of Defense William P. Clements issued a memorandum creating the Defense Navigation Satellite Development Plan, a joint Army, Navy, Marine Corps, and Air Force program." Richard D. Easton and Eric F. Frazier, *GPS Declassified: From Smart Bombs to Smartphones* (Lincoln, NE: Potomac Books, 2013), 63.

41. Wood, "Army and Space," 104.

42. Togo D. West Jr., *Army Space Policy* (Washington, DC: U.S. Department of the Army, July 1994).

43. "While space is a physical location, operations are executed and interpreted through virtual stimuli. Ultimately, space systems are tools that extend the ability of an individual or group to perform tasks in, from, and through the space domain." In 2020, the newest U.S. military branch, the U.S. Space Force, would use this exact phrasing as part of its foundational doctrine, Space Capstone Publication, *Spacepower* (Peterson Space Force Base, CO: U.S. Space Force, June 2020), 8, https://www.spaceforce.mil/Portals/1/Space%20Capstone%20Publication_10%20Aug%202020.pdf.

44. West, *Army Space Policy*.

45. Ibid.

46. Space, Missiles, and the Nation, H.R. Rep. No. 2092, at 34 (1960).

47. Sarah A. Loff, "Explorer 1 Overview," NASA, 18 March 2015, https://www.nasa.gov/history/explorer-1-overview/. Explorer I launched on 31 January 1958, Explorer III on 26 March 1958, and Explorer IV on 26 July 1958.

48. Department of the Army's Interest, Capability, and Role in Space; box 34, "471.94 (1959)"; Twining, 1957–1960; RG 218; NACP.

49. Eric K. Shinseki and Thomas E. White, *The Army Space Policy* (Washington, DC: U.S. Department of the Army, April 2003), 1–2.

50. Wilson, "Policy Analysis as Policy Advice," 153.

51. Shinseki and White, *Army Space Policy*, 1–3.

52. West, *Army Space Policy*.

53. Army Regulation (AR) 900-1, *Department of the Army Space Policy* (Washington, DC: U.S. GPO, 23 January 2009).

54. Ibid.

55. Ibid.

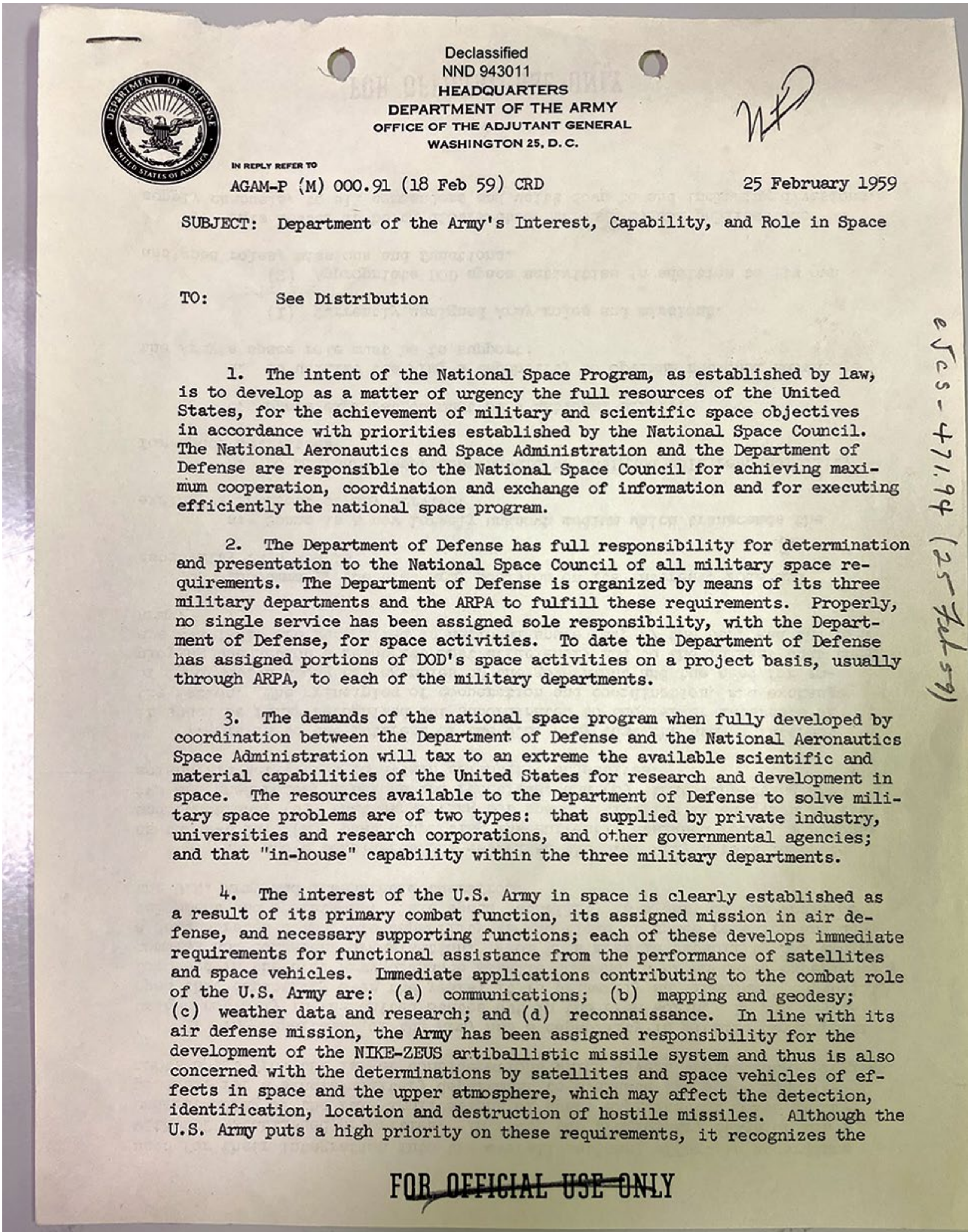
56. Ibid.

57. AR 900-1, *Department of the Army Space Policy* (Washington, DC: U.S. Government Publishing Office, 21 April 2017).

58. James Walker, Lewis Bernstein, and Sharon Lang, *Seize the High Ground: The Army in Space and Missile Defense* (Redstone Arsenal, AL: U.S. Army Space and Missile Defense Command, 2003), 144.

59. Michael J. Neufeld, "The End of the Army Space Program: Interservice Rivalry and the Transfer of the von Braun Group to NASA, 1958–1959," *Journal of Military History* 69, no. 3 (July 2005): 740–41, https://doi.org/10.1353/jmh.2005.0178.

Appendix. "Department of the Army's Interest, Capability, and Role in Space"



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HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE ADJUTANT GENERAL
WASHINGTON 25, D. C.

IN REPLY REFER TO
AGAM-P (M) 000.91 (18 Feb 59) CRD

25 February 1959

SUBJECT: Department of the Army's Interest, Capability, and Role in Space

TO: See Distribution

eJCS-471.94 (25 Feb 59)

1. The intent of the National Space Program, as established by law, is to develop as a matter of urgency the full resources of the United States, for the achievement of military and scientific space objectives in accordance with priorities established by the National Space Council. The National Aeronautics and Space Administration and the Department of Defense are responsible to the National Space Council for achieving maximum cooperation, coordination and exchange of information and for executing efficiently the national space program.

2. The Department of Defense has full responsibility for determination and presentation to the National Space Council of all military space requirements. The Department of Defense is organized by means of its three military departments and the ARPA to fulfill these requirements. Properly, no single service has been assigned sole responsibility, with the Department of Defense, for space activities. To date the Department of Defense has assigned portions of DOD's space activities on a project basis, usually through ARPA, to each of the military departments.

3. The demands of the national space program when fully developed by coordination between the Department of Defense and the National Aeronautics Space Administration will tax to an extreme the available scientific and material capabilities of the United States for research and development in space. The resources available to the Department of Defense to solve military space problems are of two types: that supplied by private industry, universities and research corporations, and other governmental agencies; and that "in-house" capability within the three military departments.

4. The interest of the U.S. Army in space is clearly established as a result of its primary combat function, its assigned mission in air defense, and necessary supporting functions; each of these develops immediate requirements for functional assistance from the performance of satellites and space vehicles. Immediate applications contributing to the combat role of the U.S. Army are: (a) communications; (b) mapping and geodesy; (c) weather data and research; and (d) reconnaissance. In line with its air defense mission, the Army has been assigned responsibility for the development of the NIKE-ZEUS antiballistic missile system and thus is also concerned with the determinations by satellites and space vehicles of effects in space and the upper atmosphere, which may affect the detection, identification, location and destruction of hostile missiles. Although the U.S. Army puts a high priority on these requirements, it recognizes the

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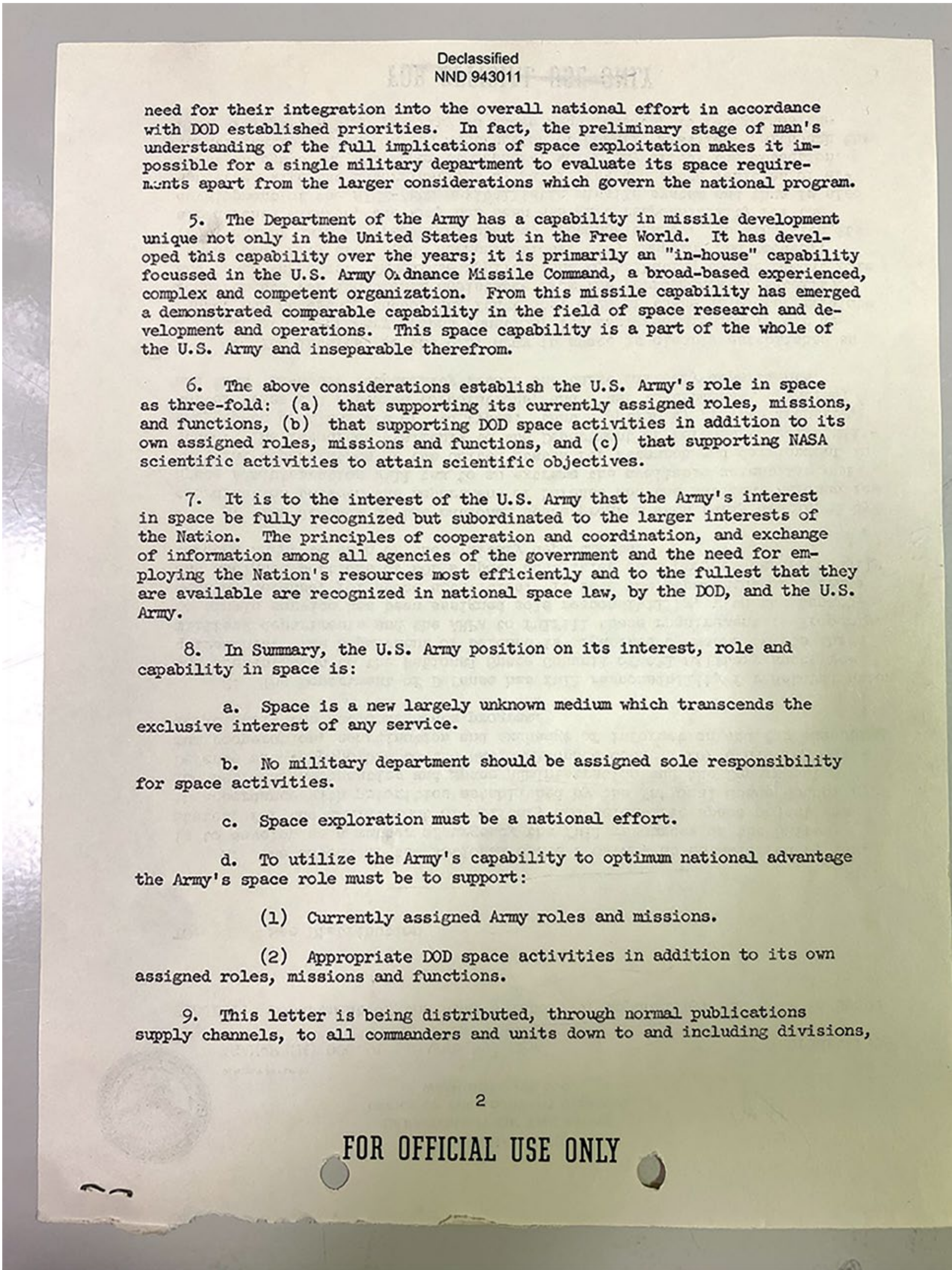

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need for their integration into the overall national effort in accordance with DOD established priorities. In fact, the preliminary stage of man's understanding of the full implications of space exploitation makes it impossible for a single military department to evaluate its space requirements apart from the larger considerations which govern the national program.

5. The Department of the Army has a capability in missile development unique not only in the United States but in the Free World. It has developed this capability over the years; it is primarily an "in-house" capability focussed in the U.S. Army Ordnance Missile Command, a broad-based experienced, complex and competent organization. From this missile capability has emerged a demonstrated comparable capability in the field of space research and development and operations. This space capability is a part of the whole of the U.S. Army and inseparable therefrom.

6. The above considerations establish the U.S. Army's role in space as three-fold: (a) that supporting its currently assigned roles, missions, and functions, (b) that supporting DOD space activities in addition to its own assigned roles, missions and functions, and (c) that supporting NASA scientific activities to attain scientific objectives.

7. It is to the interest of the U.S. Army that the Army's interest in space be fully recognized but subordinated to the larger interests of the Nation. The principles of cooperation and coordination, and exchange of information among all agencies of the government and the need for employing the Nation's resources most efficiently and to the fullest that they are available are recognized in national space law, by the DOD, and the U.S. Army.

8. In Summary, the U.S. Army position on its interest, role and capability in space is:

a. Space is a new largely unknown medium which transcends the exclusive interest of any service.

b. No military department should be assigned sole responsibility for space activities.

c. Space exploration must be a national effort.

d. To utilize the Army's capability to optimum national advantage the Army's space role must be to support:

(1) Currently assigned Army roles and missions.

(2) Appropriate DOD space activities in addition to its own assigned roles, missions and functions.

9. This letter is being distributed, through normal publications supply channels, to all commanders and units down to and including divisions,

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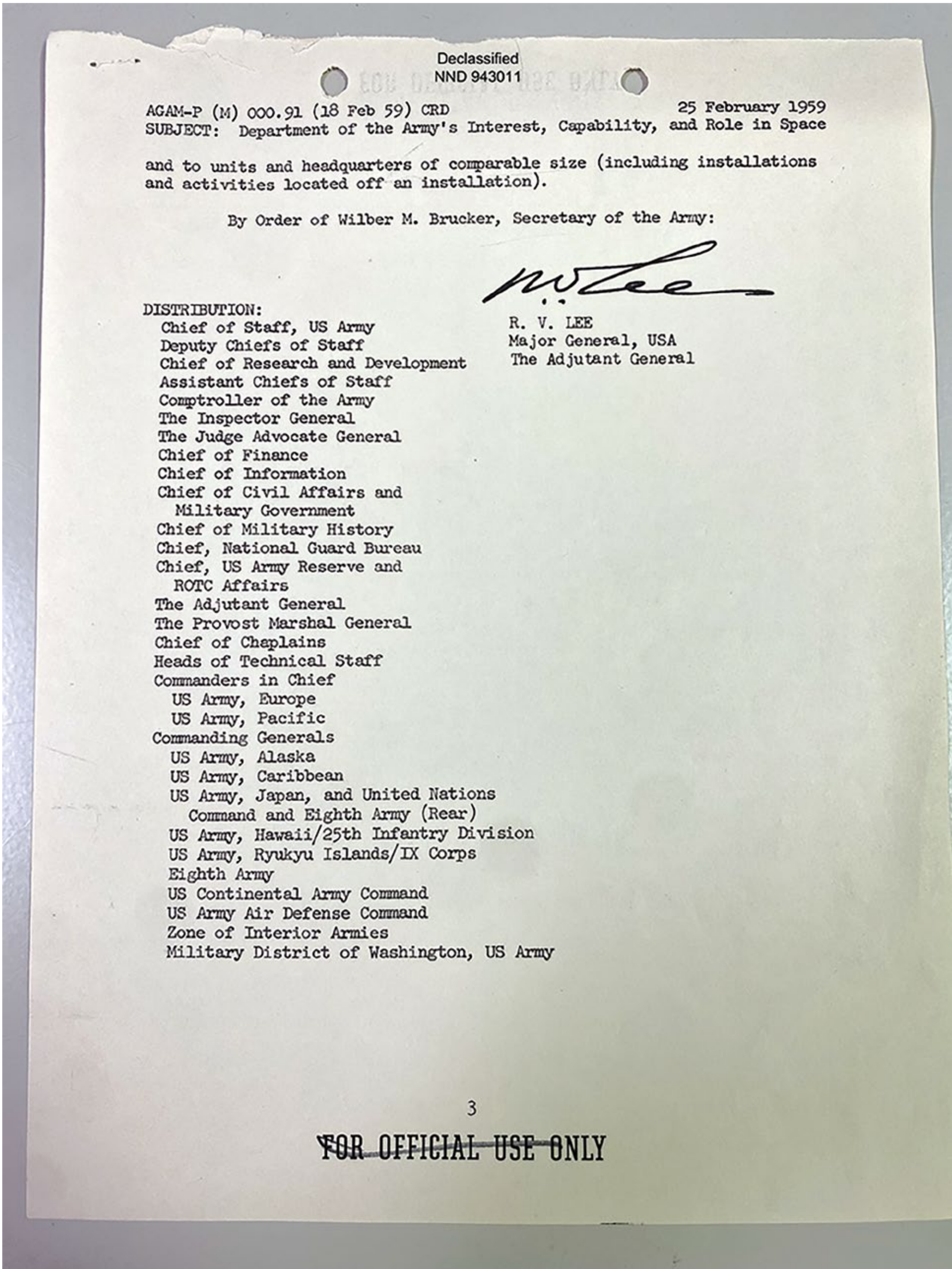

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AGAM-P (M) 000.91 (18 Feb 59) CRD 25 February 1959
SUBJECT: Department of the Army's Interest, Capability, and Role in Space

and to units and headquarters of comparable size (including installations and activities located off an installation).

By Order of Wilber M. Brucker, Secretary of the Army:

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The Army's Current Multidomain Inflection Point and Potential Lessons from the Early Space Race

Lt. Col. Jerry V. Drew II, U.S. Army

When the Bumper 8 rocket team arrived to its Florida launch site in July 1950, the site was a desert wasteland filled with deer, alligators, mosquitos, scorpions, and raccoons that "got into the instrumentation."[1] The security detail, comprised of 3rd Infantry Division soldiers from Fort Benning (now Fort Moore), Georgia, regularly went to sleep knowing that by morning, their tent would be full of rattlesnakes trying to keep warm.[2] To further add to the difficulties, the on-loan Army Signal Corps team from Fort Monmouth, New Jersey, found the radio signals of "taxi cabs from Houston interfering with [the] command destruct systems."[3] Despite the difficulties of the conditions, however, the Bumper program had exceeded the available range of the vast White Sands Proving Ground (WSPG), leaving the Army little choice but to look toward the Eastern Seaboard to launch its future rockets.

As the first rocket launch from the Florida coast, Bumper 8 marked an inflection point in rocket development for the United States and the Army. It represented the culmination of a fruitful collaboration between two early rocket development efforts—an American-led effort by the Jet Propulsion Laboratory (JPL) and a German effort the U.S. government transplanted to the American southwest after World War II.[4] As a program, Bumper had successfully demonstrated the Nation's first multistage rocket, a hypergolic second stage at extreme altitude, and the feasibility of postlaunch communication relay through the Caribbean islands—all essential developments for the Space Age.[5] Furthermore, from Bumper's lessons emerged the Jupiter-C that launched JPL's Explorer I satellite in 1958, the Mercury Redstone rocket that launched Alan Shepard in 1961, and the Saturn V rockets that launched the Apollo missions to the moon. Yet at the peak of its prowess in the military's early space efforts, new strategic realities required the Army to divest its space operations expertise, forcing it into an ancillary role in the Nation's space efforts.

The Army faces a similar situation today. Following a period of conflict, the Army once again seeks an organic, long-range fire capability that is likely to put the service at loggerheads with the U.S. Air Force. Once again, at unprecedented capacity, the mandates of policy and strategy require the Army to transfer some of its most significant space equities—this time to the U.S. Space Force. Although the future is not certain, a possible

A jet-assisted airplane successfully takes off during a test circa August 1941. The airplane on the ground is attempting to take off without rocket assistance. (Photo courtesy of the Jet Propulsion Laboratory)

future sees the Army stripped of its most significant space missions, returning to a focus on ground combat against nation-state threats. As the Army's space capability once again diminishes, a historical perspective can inform the decisions of the institution as it navigates the uncertainty of a multidomain future—one that mandates near-term divestiture for the efficacy of the joint force and for the good of the Army's core mission.

The Beginning of the Jet Propulsion Laboratory

The combination of technologies that produced Bumper and its successor boosters was not foreseeable in 1936 when the California Institute of Technology (CALTECH) established a small organization for rocket research under the patronage of renowned aeronautics expert Dr. Theodore von Karmen.[6] The new organization, led by Frank Malina, was little more than a handful of students and rocket enthusiasts. Named the GALCIT (Guggenheim Aeronautical Laboratory) Rocket Research Project at CALTECH, Malina set a goal of building a rocket that could reach one hundred thousand feet to study the upper atmosphere.[7] Considering that Dr. Robert Goddard, the father of American rocketry, did not reach altitudes of nine thousand feet until 1941, GALCIT's goal was decidedly ambitious.[8]

In 1939, with the Second World War already engulfing Europe, GALCIT temporarily abandoned its scientific goals to support the Army Air Corps' development of small rockets for jet-assisted takeoff (JATO).[9] The JATO rockets allowed an aircraft to more quickly reach takeoff speeds and solved three of the most significant problems of solid rocket development: how to achieve a controlled burn (vice an explosion), how to manufacture shelf-stable substrates (so rockets would not explode after being in storage), and how to pour liquid ingredients into molds to create solid rocket motors (vice molded or extruded solid motors).[10] These technologies proved foundational to every solid rocket system that followed, including the spin stabilization apparatus on Bumper, the upper stages of Jupiter-C, and the Army's Pershing missile.

While solid motor development provided the nascent JPL with its first successes, solid and liquid rocket development continued throughout the war on both sides of the Atlantic. In 1943, the first British intelligence reports of German missiles found their way to the desk of Karman. If they were to be believed, despite JPL's efforts, the United States was woefully behind the Germans in developing liquid-propellant missiles.[11] Army Ordnance accepted JPL's funding proposal for longer-range missile research to counter the threat. Although the air and naval arms of the service continued to maintain their ties with JPL, from 1944 until its annexation by the National Aeronautics and Space Administration (NASA) in 1958, Army Ordnance bore responsibility for JPL's facilities and equipment, and provided the majority of its funding.[12] At the end of the summer of 1944, however, American forces were pushing through France, and JPL produced preliminary designs of its next evolution of rockets: Private A, the WAC Corporal, and the Corporal E.[13]

The first Private flew at Leach Spring, Camp Irwin (now Fort Irwin), California, on 1 December 1944.[14] Although little more than four JATOs welded to a rocket body with fins, at eight feet tall, Private A was the first of its kind in the United States.[15] At a total weight of around five hundred pounds, it had flown just over one mile (5,400 feet) with a sixty-pound payload.[16] In contrast to the solid propellant of Private, the WAC Corporal and the Corporal used hypergolic propellant, meaning the fuel and oxidizer—kept separately in their tanks within the rocket body—combusted when mixed.[17] The programs also advanced the ground operations procedures necessary to track and receive in-flight data in addition to the propulsion research. Like the Private, the engineers viewed WAC Corporal and the Corporal as existing for research and development purposes, but the Army was anxious for practical weapons systems.[18] While the JPL team built the necessary testing infrastructure for its powerful liquid-propellant engines at the Army Air Force's Muroc facilities (today's Edwards Air Force Base), a second operation involving both the Army and JPL was already underway to capture German missile technology.[19]

German Scientists, German Technology

On 11 April 1945, 104th Infantry Division soldiers liberated Nordhausen, a concentration camp filled with enslaved people who labored in the Schutzstaffel's underground missile construction facility.[20] It was just what Army Ordnance Technical Intelligence in Paris hoped to find.[21] The Army believed it could leverage the new technology to affect the still-raging war in the Pacific, but due to the unconditional surrender of the Japanese the following September, no German rockets ever found their way to that theater.[22] On the same day U.S. troops entered Nordhausen, the second version of Private, Private F, flew at Hueco Range, Fort Bliss, Texas.[23] The Private F, based on the same solid-propellant motor as Private A, was primarily an experiment using fins to stabilize the rocket for extended flight. Significantly, Private F demonstrated that a winged missile required a guidance system to ensure stable flight.[24]

Two days after the liberation of

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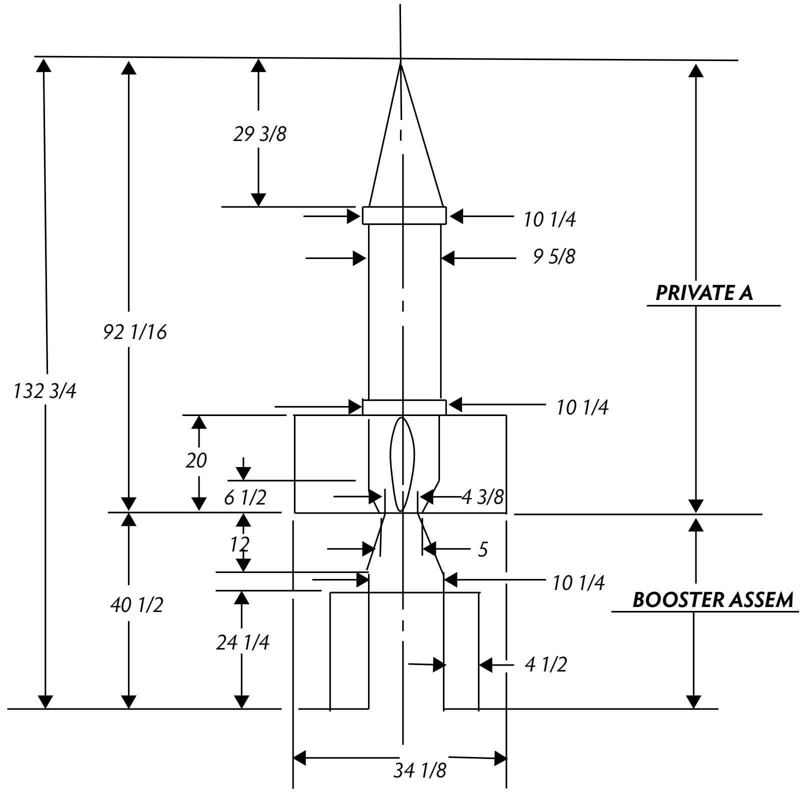
Nordhausen, elements of the 1st Infantry Division discovered the Hermann Göring Aeronautical Research Center at Völkenrode with its highly advanced aeronautics facilities.[25] Fortunately for the Americans, a team of German rocket scientists led by Dr. Wernher von Braun—the very people who had developed many of the plans and models found at Völkenrode—were looking for a new patron. On the morning of 2 May 1945, Braun's younger brother Magnus, the group's most capable English speaker, surrendered to Pfc. Fred P. Schneikert of Sheboygan, Wisconsin, on the group's behalf.[26] Following the success of Ordnance's Special Mission V-2, more than 360 metric tons of German missile parts began their journey to New Mexico. To accommodate their expanding missile efforts, Army Ordnance established a facility at Wallops Island, Virginia, for air-to-air missile and sounding rocket testing (the inaugural launch on 27 June 1945) and a larger facility at WSPG near Las Cruces, New Mexico.



Schematic of a Private A rocket with booster. Measurements are in inches. (Graphic courtesy of James W. Bragg, *Development of the Corporal: The Embryo of the Army Missile Program*, vol. 1 [1961])

On 11 August 1945, JPL exhibited two German missiles. Although uncertain about the missiles' capabilities, the group estimated that the first ran on liquid oxygen and alcohol, producing about three thousand pounds of thrust, while the second possibly ran on hydrogen peroxide.[27] At three thousand pounds, the estimated thrust output was double the amount produced by JPL's most powerful vehicle, the WAC Corporal. In September, however, the hypergolic fuel propelled the WAC for forty-five seconds, achieving an American altitude record of forty-three and a half miles, finally achieving the original goal of one hundred thousand feet set by the original GALCIT team nearly a decade before.[28] The Army's hopes for even greater performance than the WAC Corporal rested with the Corporal E, a more powerful member of the Corporal family with a twenty thousand-pound thrust motor (double the power of the original Corporal), which promised greater range and larger payload capacity.[29]

In addition to significant progress on the Corporal E, autumn 1945 also saw the arrival of the German engineers in the American southwest. Braun arrived at Fort Bliss on 8 October 1945 with a lone Army escort, and three additional groups of Germans joined him throughout the winter.[30] By the end of January 1946, the same month that the War Department began canceling its wartime contracts, Project Hermes, Army Ordnance's efforts to reconstruct and improve the V-2s, was in full swing. General Electric served as the prime contractor, and despite three hundred rail cars full of German rocket parts and more than one hundred German experts headquartered at Fort Bliss, Ordnance could only manage to assemble two complete V-2s in the beginning.[31]

With the promise of a large number of forthcoming V-2s, the Rocket Development Branch of Army Ordnance established the V-2 Upper Atmospheric Research Panel, which included representatives from all services, the Army Air Forces, the Army Signal Corps, the Naval Research Laboratory, numerous civilian

Frank Malina, director of CALTECH's Jet Propulsion Laboratory, stands beside a WAC Corporal rocket in 1945. (Photo courtesy of the Keck Institute for Space Studies)

research institutions, and General Electric.[32] One of the significant contributors to the V-2 experimentation program was Dr. James Van Allen of the University of Iowa, who oversaw the radiation detection payloads for the Explorer satellite program a decade later.[33]

Like the V-2 experimentation program, the WAC Corporal payloads performed upper atmospheric radiation experiments, took photographs, and collected atmospheric data. The Army Signal Corps, which often supported the WSPG test launches with communications and weather balloon activities, was a key beneficiary of the WAC Corporal's meteorological instruments.[34] These payloads did not achieve orbit, but they served as stepping stones toward achieving the technology necessary for future satellites, and at the end of 1947, such sounding rocket technology was "expected to give the United States a dominant position in upper atmospheric research."[35]

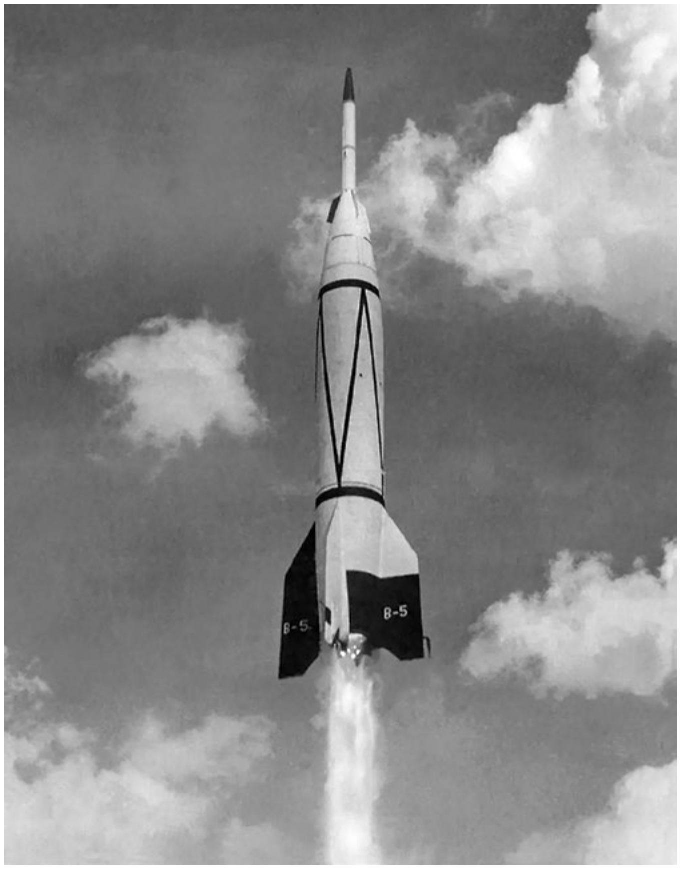
Unfortunately, the V-2 design was still imperfect and had "considerable problems" from the time of its initial employment that had never been entirely resolved by the Germans or in testing at WSPG.[36] Among the V-2's problems were aerodynamic instability and a lack of quality control in parts manufacturing that contributed to 50 percent failure rates during testing.[37] Despite these challenges—contributing factors to some of the Bumper program's failures—Bumper remained a significant technological achievement. It was the Army's first missile to involve staging and the first to combine American missiles with German ones—a modified V-2 as the first stage and a modified WAC Corporal as the second stage.[38] The modified WAC Corporal, known as a Bumper WAC, included attached spin-stabilization rockets that caused the upper stage to spin during flight, thereby stabilizing its trajectory.[39] These spin-stabilization rockets consisted of solid motors with a direct lineage stemming from the original JATO and Private experiments.[40] While work with Corporal and Bumper progressed at WSPG, Army Ordnance looked to two deactivated facilities still on the Army's wartime books to use in their development of larger liquid-propellant missiles. The Ordnance Research and Development Division Suboffice of Rockets at Fort Bliss took over the Huntsville Arsenal, and the nearby Redstone Arsenal became the Ordnance Guided Missile Center in November 1948.[41]

Long-Range Fires and Satellites

With the repurposing of the Alabama arsenals, the Army and its rocketeers intended to develop missiles of unprecedented range. From an institutional perspective, the Army's ballistic missile development programs were a significant part of its strategy for Cold War relevancy and fit within larger defense establishment notions of waging future wars through the air.[42] The Army's 1949 version of Field Manual 100-5, *Operations*, envisioned nuclear artillery at higher echelons to disrupt enemy forces before they came into contact with the friendly main body, which still held conventional artillery to affect the closer fight.[43] With Corporal missiles progressing toward fielding, the Bumper program remained essential to both long-range missile development and the future role of the Army in the atomic era. The success of the Bumper 8 flight in July 1950 signaled both a significant advance toward the dual goals of long-range firepower and a true space-launch vehicle.

The latest evolution of Project Hermes' C1 variant, rechristened as the "Redstone" rocket on 8 April 1952, took advantage of the lessons learned from Bumper and resolved the instability and quality control issues that had plagued the V-2 and its successors.[44] Although a single-stage missile, the Redstone was capable of greater range than the Corporal E, and when employed in tandem, the pair promised a defense-in-depth capability for the tactical Army. For the Nation, however, the Redstone played a much more significant role. Following the launch of the Soviet Union's two Sputnik satellites in late 1957, public concern about falling behind the Communists in the new space race soon grew into paranoia.[45] The failure of the U.S. Navy's Vanguard program to launch a satellite increased national anxiety to the point that President Dwight Eisenhower transferred the responsibility for the initial launch from Vanguard to the Army.[46] On 28 January 1958, a modified Redstone, the Jupiter-C, carried America's first satellite, JPL's Explorer I, into orbit.

Over the twenty years preceding the launch of Explorer I, the Army had overseen the development of—among other variants—the Corporal short-range ballistic missile, the Redstone medium-range ballistic missile, and the Jupiter intermediate-range ballistic missile. Vital to those efforts were the JPL and German rocketeers who eventually formed the Army Ballistic Missile Agency (ABMA). Under the dynamic political environment of the new Space Age, however, these two organizations did not remain under the Army's control.



A V-2 launches from White Sands Proving Ground as part of Project Hermes. (Photo courtesy of L. D. White, *Project Hermes V-2 Missile Program*, Final Report [Schenectady, NY: General Electric, 1952], via the Smithsonian Libraries)

Although CALTECH continued to administer JPL, control of the laboratory officially transferred from the Army to the newly formed NASA on 1 December 1958.[47] Unlike the fairly immediate transfer of JPL, the ABMA remained in Army control for nearly two years after the creation of NASA. Following the successes of Redstone and Jupiter, ABMA continued with Saturn, its super-booster program. The Army had no use for such a vehicle within its service responsibilities, but NASA continued Saturn's sponsorship.[48] While Saturn matured, Project Mercury began in October 1958 and required the ABMA to provide NASA with ten Redstones and three Jupiters in support of the new manned spaceflight program.[49] In the subsequent acquisition of ABMA, NASA gained more than five thousand employees to support its mission of putting an astronaut

Maj. Gen. John B. Medaris (*seated at center*), commanding general of the Army Ballistic Missile Agency, and Dr. Wernher von Braun (*second from right*) gaze at Explorer I in this undated photo. (Photo courtesy of the U.S. Army Aviation and Missile Life Cycle Management Command)

into space.[50] In the spring of 1961, Mercury-Redstone missiles launched Alan Shepherd and Virgil "Gus" Grissom, the first and second Americans into space.[51]

No longer under the employ of an army for the first time since the age of nineteen, Braun and his team continued developing the Saturn program, which eventually produced the Saturn V, the missile that put Americans on the moon. Without the JPL and ABMA, the Army no longer possessed the organizational structure to continue its satellite and missile development roles in the same capacity. As an institution, however, its various components (e.g., the Army Corps of Engineers, the Army Signal Corps, and the Army Ordnance Corps) remained essential to U.S. activity in space and missile development throughout the Cold War.

Where Do We Go Now?

The Army's successes in the early days of the Cold War space race offer two significant parallels to the Army's current evolution of multidomain operations and provide insight into a possible future: its quest for long-range fires and its divestiture of space capabilities on behalf of the greater good. If the current attitudes of the service toward space, the interservice competition over long-range fires, and the growth of competing bureaucracies are indicators, the Army will once again lose its quest to contribute significantly to the joint force's space and missile efforts.

Unfortunately for the future of Army space, the institution's current attitudes toward space compare well to the attitudes of the service at the dawn of the Space Age. Much like the Army of the 1950s and 1960s, the contemporary Army knows that space capabilities are essential to the future of ground combat, but the service is having difficulty articulating how these capabilities should be employed and the reason that those capabilities need to belong to the ground component. As in the late 1950s, a small group is advocating for the Army's space equities, but space operations continue to be ancillary to the Army's core mission as a ground combat force.

Following a period of protracted, disquieting conflict and the subsequent specter of reduced defense budgets, the Army of the late 1950s sought to transform itself into an organization more capable of facing the envisioned strategic environment. To remain relevant on the extended battlefield against a nuclear-capable adversary, the Army of the early Cold War sought to develop various new organizations and material solutions including organic, long-range fires. This operating concept stood at loggerheads with the U.S. Air Force's vision of warfare, which required aircraft to strike deep inside of enemy territory. A very similar situation is occurring today with the discussions over extended range and hypersonic munitions, and as in the 1950s, both service identities and service budgets are threatened.[52]

In another historical parallel, the Army is once again transferring significant space equities to a new space organization. Rather than NASA, however, the beneficiary this time is the U.S. Space Force, which of course belongs to the Department of the Air Force. As of this writing, Space Force is absorbing Army space operations missions as NASA did in the wake of Sputnik. In the summer of 2022, the Army's satellite communications management mission under the 1st Satellite Operations Brigade transferred to the Space Force (along with 502 billets).[53] At the beginning of fiscal year 2024, the direct-downlink satellite-based missile warning mission (the Joint Tactical Ground Station, or JTAGS) transferred to the Space Force, taking approximately another hundred billets with it.[54] With these two transfers, the Army has divested its two continuous, near-global, space operations missions and the only successfully fielded program of record in the Army space portfolio, the JTAGS system. Some force structure and equipment remain, but for the U.S. Army Space and Missile Defense Command, a three-star command that consisted of a mere 2,800 people at the creation of the Space Force, one must ask what the future of Army space is.[55]

The Army has found itself at another inflection point regarding space. The ultimate paradox may be that the Army at large (meaning the preponderance of soldiers in the service), does not understand space operations, but the Space Force does not understand combat. Some combination of the two cultures is necessary to forge a joint force that is not only space-capable but also has aspirations for space-dominance in advance of the next conflict. The Department of the Air Force, meanwhile, seems unlikely to abandon its traditional position as the provider of long-range fires and satellites—even though it culturally balks at the ground-support mission—and will likely end up in the most advantageous position.

How these dynamics will unfold are anyone's guess. Still, the historical case of this article reveals an instance where the Army was the institutional loser in both space and long-range fires, but through that loss, it regained focus on its core competency of ground combat. The whole of the U.S. government was postured to advance more effectively the goals of national policy in the face of a significant Communist threat. A similar outcome may occur this time unless the Army can convincingly articulate why space and missiles are uniquely Army missions and then successfully field those capabilities as part of a truly multidomain force. ■

The Redstone family of missiles are displayed on 12 June 2017 in Huntsville, Alabama. *Left to right:* Mercury Redstone, Jupiter-A, Saturn IB (*background*), Juno II (*foreground*), a tactical Redstone variant, Jupiter-C. (Photo courtesy of author)

Much of this article has been adapted from a portion of the author's master's degree thesis: Jerry V. Drew II, "First in Space: The Army's Role in U.S. Space Efforts, 1938–1958" (master's thesis, U.S. Army Command and General Staff College, 2017), https://apps.dtic.mil/sti/pdfs/AD1038666.pdf. The author would like to extend a special thanks to Tom Gray, Dr. John Curatola, and Dr. Sean Kalic for their original assistance in the project. Kalic additionally reviewed the advised manuscript prior to publication.

Notes

1. Hermann Bank, "Bumper 8, 50th Anniversary of the First Launch on Cape Canaveral, Group Oral History, Kennedy Space Center, Held on July 24, 2000," 24 July 2000, 27, JPL 232, Group Oral History-Kennedy Space Center, Jet Propulsion Laboratory Archives (hereinafter cited as "Bumper 8," 24 July 2000, JPL Archives).

2. Ibid., 28.

3. Dick Jones, "Bumper 8," 24 July 2000, 21, JPL Archives.

4. Amy S. Teitel, *Breaking the Chains of Gravity: The Story of Spaceflight before NASA* (New York: Bloomsbury, 2016), 196–97.

5. Paul H. Satterfield and David S. Akens, *Army Ordnance Satellite Program* (Redstone Arsenal, AL: Army Ordnance Corps, 1958), 44; Jones, "Bumper 8," 10–12.

6. Franklin O'Donnell, ed., *JPL 101* (Pasadena: California Institute of Technology, 2002), 4.

7. P. Thomas Carroll, "Historical Origins of the Sergeant Missile Power Plant," August 1972, 4, folder 13, Walt Powell Collection, Articles by Other than Powell, JPL Archives.

8. Ray A. Williamson and Roger D. Launius, "Rocketry and the Origins of Space Flight," in *To Reach the High Frontier: A History of U.S. Launch Vehicles*, ed. Dennis R. Jenkins and Launius (Lexington: University Press of Kentucky, 2002), 36.

9. "Chronological Survey of Rocket Development at the Jet Propulsion Laboratory-California Institute of Technology," n.d., JPL 119, folder 6, Historical File Organization 1945 to 1970, JPL Archives.

10. Carroll, "Historical Origins," 6, 8; J. Frank Malina, "Origins and First Decade of the Jet Propulsion Laboratory," in *The History of Rocket Technology*, ed. Eugene M. Emme (Detroit: Wayne State University Press, 1964), 57.

11. Carroll, "Historical Origins," 10–11.

12. James B. Medaris, *Countdown for Decision* (New York: G. P. Putnam's Sons, 1960), 234; Historical File Organizational Charts 1945-1970, n.d., JPL 119, folder 6, JPL Archives. The organization charts depict a formal liaison structure between the Army and the Jet Propulsion Laboratory (JPL) during this period. Following the war, the liaison structure expanded to include elements of Army Ordnance, Army Air Forces Materiel Command, the Navy Bureau of Ordnance, Army Ground Forces, and the Army Signal Corps.

13. "Chronological Survey."

14. Carroll, "Historical Origins," 12.

15. "Organized Research in Jet Propulsion," n.d., JPL 64, folder 16, Walt Powell Collection, JPL Archives.

16. James W. Bragg, *Development of the Corporal: The Embryo of the Army Missile Program*, Historical Monograph No. 4, vol. 1 (Redstone Arsenal, AL: Army Ballistic Missile Agency, 1961), 35.

17. Not surprisingly, fuel/oxidizer combinations varied throughout testing and development. The variation in fuels derives from two sources: (1) Minutes of JPL-1 Conference, 10 September 1945, 5, JPL 64, folder 8, Walt Powell Collection, JPL Archives; and (2) "Organized Research in Jet Propulsion," 19. Bragg, *Development of the Corporal*, xv, xvii. While eliminating the need for an ignition system and thereby simplifying the engine design, the fueling process required extreme care. The hazards of this process, however, did not preclude the approval of the Corporal as the first U.S. atomic missile in December 1950 or the activation of three Corporal battalions in March 1952—the Nation's first ballistic missile units.

18. William Pickering, "Bumper 8," 24 July 2000, 17, JPL Archives. Pickering later recalled that the JPL engineers viewed Corporal E as a research and development vehicle, but the Army was anxious to field it as a weapon, which it did in 1954.

19. "The ORDCIT Test Station Muroc Army Air Base," n.d., JPL 64, folder 6, Walt Powell Collection, JPL Archives.

20. Annie Jacobsen, *Operation Paperclip: The Secret Intelligence Program that Brought Nazi Scientists to America* (New York: Little, Brown, 2014), 46–47.

21. William E. Burroughs, *This New Ocean: The Story of the First Space Age* (New York: Modern Library, 1999), 111.

22. Jacobsen, *Operation Paperclip*, 90.

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The Russian navy frigate *Admiral Gorshkov* fires a Zircon antiship hypersonic cruise missile in the Barents Sea 23 May 2018. (Screenshot from YouTube video)

Hypersonic Capabilities

A Journey from Almighty Threat to Intelligible Risk

Lt. Col. Andreas Schmidt, German Air Force

According to a lot of open-source publications found in the internet and emphasized by Russian President Vladimir Putin on 4 January 2023, hypersonic capabilities are a force to be reckoned with or even a "game changer" when applied to the stability of the overall international security situation.[1] Although hypersonic capabilities are not new, and related technology has been researched since the 1930s, it was almost a century from the first wind tunnel tests of the German "Silbervogel" project to a fielded hypersonic weapon system like Russia's "Avangard" (claimed operational in December 2019).[2] Within NATO, hypersonic capabilities are considered an emerging and disruptive technology, which emphasizes hypersonic capabilities' evolving nature. This brought the Joint Air Power Competence Centre (JAPCC), NATO's first and largest center of excellence, into play since it is the mission of a team of multinational experts to provide key decision-makers with effective solutions to air and space power challenges.[3] JAPCC sees itself as NATO's catalyst for improving and transforming joint air and space power, delivering practical solutions through independent thought and analysis.

JAPCC's subject-matter experts are leading and augmenting NATO and national studies concerning hypersonic capabilities. JAPCC has been supporting the journey from hypersonics as an almost magical "silver bullet" to a threat that can be analyzed with a manageable threat/risk calculus. That does not mean hypersonics do not change the game we have to play into something unwinnable, but it means we can play the game to begin with. The following discussion highlights the path of understanding hypersonics and presents a possible way ahead from defensive and offensive perspectives.

Lt. Col. Andreas Schmidt joined the German Air Force in 1993. After attending officer's school, he studied computer science at the German Armed Forces University in Munich. Since 1998, he has built an extensive background in ground-based air defense, particularly the Patriot weapon system. He started as a tactical control officer and subsequently held positions as reconnaissance officer, battery executive officer, and battery commander in various Patriot units. Furthermore, he had two nonconsecutive assignments in Fort Bliss, Texas. In between, he had an assignment as the A3C in the former Air Force Division. Currently, he is the integrated air and missile defense/surface-based air and missile defense/ballistic missile defense subject-matter expert at the Joint Air Power Competence Centre.

What Are Hypersonic Threats?

By its nomenclature, every threat that moves faster than hypersonic speeds somewhere on its flight path could be considered a hypersonic threat, including most ballistic missiles in their midcourse phase. John D. Anderson, currently the curator for aerodynamics at the National Air and Space Museum, identified five distinguishing characteristics of hypersonic flight: thin shock layers, entropy layers, viscous-inviscid interactions, high-temperature effects and extreme heat transfer, and low-density flows.[4] If two or more of these criteria occur at the same time, we consider it hypersonic flight, which generally happens at speeds beyond Mach 5 within the atmosphere. Hence, Mach 5 is not an arbitrary threshold between "supersonic" and "hypersonic," but it is based on physical phenomena that have demands on the flying object, sufficiently distinguishing it from slower threats.

In 2020, NATO's Science and Technology Organization Specialist Team 008 (ST008) for Applied Vehicle Technology (AVT) defined a hypersonic vehicle as "flying within the atmosphere for major parts of their non-ballistic trajectory, reaching a velocity of at least five times the speed of sound."[5] Here, hypersonic vehicles were subcategorized into the well-known hypersonic glide vehicle (HGV) and hypersonic cruise missile (HCM). Additionally, the third group of hybrid threats, also called aero ballistic missiles, was defined as representing a weapon between a ballistic missile and an HGV, with characteristics of both. Regardless of whether hypersonic threats are described from a physical or a capability perspective, from a military standpoint, generally, only three aspects matter:

- How survivable is the effector?
- How fast can the effect be delivered?
- Which kind of effect can be delivered?

The better the understanding of hypersonic capabilities, the easier it will be to develop realistic risk calculus. One crucial fact that studying hypersonic threats over the past five years has shown is that we have evolved our understanding and have identified numerous criteria that still require a lot of attention, so the journey needs to continue.

Finally, it should be mentioned that the size of the available hypersonic stockpile is also essential for how and when hypersonic weapons might be employed, but this will not be analyzed in this article.

What Are the Benefits of Having Hypersonic Weapons?

With significant budgetary constraints, no nation will develop and procure new systems when the military benefit does not justify the overall cost. So, fielded hypersonic missiles are either the replacement of an obsolete capability or a dedicated development to create a previously unavailable effect. In the early years of missile development, new systems promised to affect hitherto unreachable targets with little warning

The U.S. Army fires a Patriot missile in a 31 March 2019 test. The Patriot missile system is a ground-based, mobile missile defense interceptor deployed by the United States to detect, track, and engage unmanned aerial vehicles, cruise missiles, and short-range and tactical ballistic missiles. (Photo courtesy of U.S. Army Security Command)

times and without endangering the otherwise needed aircrews. Classic examples are ballistic missiles (BM) and cruise missiles (CM).

As the name suggests, the first BM had a simple ballistic flight path, where the main available variables were burnout time and launch angle. Also, gyroscope-based guidance and control systems achieved minor flight path corrections. For example, the accuracy of the German V2 was very limited with a circular error probable (defined as the radius in which 50 percent of the shots land in) of 4.5 km, which does not qualify for any purpose other than terror. In the mid-1980s, the Pershing II medium-range ballistic missile was the first ballistic missile with a truly maneuverable reentry vehicle (MaRV).[6] Here, the nonballistic flight path after reentering the atmosphere had two benefits. It allowed the internal guidance sensors more time to acquire the intended target, and it increased survivability against defensive systems.

Consequently, the accuracy and precision could be improved (Pershing II's circular error probable was 30 m), achieving the intended effect with a smaller payload. Lower circular error probable also allowed the use of ballistic missiles as means of deterrence by denial. Modern ballistic missiles with active guidance sensors promise to hit moving targets to a certain extent. With sufficiently current reconnaissance data, ballistic missiles may be even used against time-sensitive targets.

The first cruise missile built was the German V1 in 1939. At the end of World War II, both German systems (V1 and V2) had a comparable circular error probable, but the V1 was considered the more successful weapon. The speed of effect delivery was relatively unimportant for the pulsejet powered V1. But even with a much lower level of survivability, about 80 percent compared to 100 percent of the V2, it was considered the more effective weapon based on cost and ease of production.[7] Modern cruise missiles are faster and have very small circular error probable, which makes them a formidable choice for deliberate planning, deterrence by denial, and time-sensitive targeting.

Hypersonic weapons promise to combine benefits of fast effect delivery and high survivability against modern air and missile defense (AMD) systems. In the past, Putin announced three "invincible" weapon systems that fall into our defined category of hypersonic weapons. Russian videos displayed this superior technology in animated clips and created a lot of hype. Since then, we have learned enough to separate fact from fiction because even emerging threats need to adhere to the laws of physics.

Survivability, Speed, and Range of Hypersonic Threats

Military planners want effectors in their arsenal that have an increased chance of survivability and effect delivery. This reduces the number of systems needed per desired effect compared to more vulnerable legacy systems. To achieve this, hypersonic missiles need to minimize the available battlespace of opposing defensive systems and then minimize the effectiveness of the defensive system in that battlespace. Looking at all currently available AMD systems, hypersonic threats attempt that. HGVs and HCMs have their glide/cruise phase at altitudes between 20 km and 60 km, putting them at the upper fringes of the endo-atmospheric battlespaces of most existing AMD systems. This makes existing interceptors susceptible to the threat system's maneuverability, especially when having a large speed delta between a hypersonic vehicle and an interceptor. Hypersonic threats have (outside of the boost phase of HGVs) no intersection with exo-atmospheric BMD systems, making them unsuitable for a potential hypersonic AMD system. However, due to the small number of friendly hypersonic missile systems (or adequate representations), existing AMD systems have yet to be tested and verified for defensive capabilities. As of May 2023, Ukraine forces reported to have intercepted multiple Russian Kinzhal missiles with U.S. Patriot AMD systems.[8] This might be the first indication of such capabilities against a real hypersonic threat. However, the Kinzhal is an aero-ballistic missile with hypersonic threat features but is not a fully mature hypersonic system. So, the defensive capabilities of Patriot might be akin to the already-known Russian Iskander-M missile system, which has similarities to Kinzhal.

Further analysis will show the implications of this intercept. In general, it is currently more likely that hypersonic threats can be intercepted in their terminal phase, where defensive systems have existing battlespaces against ballistic missiles. Interestingly, HGVs can have two kinds of flight paths. As the name suggests, the glide vehicle can either glide on the upper atmosphere or use a phugoid trajectory, following a wave-like path. The latter complicates the calculation of the terminal phase initiation and heightens the chance of wasted interceptors.

Maneuverability is one factor that increases survivability for all three threat categories of hypersonic weapons. However, every maneuver comes at a cost in either range, speed, or altitude. Maneuver reduces the overall range and potentially increase the risk of interception in the remaining flight path. It is currently unclear whether hypersonic threats can reactively maneuver, which would require onboard sensors and potentially external communications. Preplanned maneuvers require much less energy and, therefore, have a less detrimental effect on the mission. Reactive maneuvers need further analysis of how early an evasive maneuver must be initiated to be effective without hampering the threat's mission, if possible. The quality of reactive maneuvers will define the requirements for real-time surveillance as well.

As for the effect delivery time, we must identify the speed throughout the flight path. Faster effect delivery times speed up the kill chain and make some formerly unreachable targets viable. HGVs have a depressed ballistic boost phase and an unpowered glide phase (or phugoid trajectory) after reentry, which can extend to intercontinental ranges, depending on the booster and glide capability of the HGV, with speeds up to Mach 20. For sufficient accuracy, the vehicle likely slows below Mach 5 in the terminal phase. The terminal phase of an HGV and HCM will be somewhere between a gradual descent, which would allow for better target acquisition but would allow for more interceptor battlespace, or a relatively abrupt steep descent, which is technically far more complex and, if feasible, very hard to defend.

For HCMs, the vehicle gets boosted to an altitude between 20 km and 40 km when the motor (e.g., Ramjet, Scramjet, or Sodramjet) is powering the cruise and beginning the terminal phases. During the actively propelled phase, the speed is dependent on the actual motor. Ramjet engines could propel an HCM not far beyond Mach 6. Scramjet engines have been tested up to Mach 10 but speeds up to Mach 15 are anticipated. China announced a successful test of a Sodramjet engine with a speed of Mach 16.[9] One of the results of the AVT-359 study was that hypersonic motors are susceptible to disruption during strong maneuvers.[10] Hence, although the HCM can maneuver, it needs to be within the limits of the engine. This adds to the issue discovered in ST008 that the physical structure of HCMs and HCMs and HGVs may not allow for maneuvers well beyond 10 G, resulting in turning radii of 120 km at Mach 10 and 480 km at Mach 20.[11] So, erratic maneuvers cannot be expected. In the terminal phase, HCMs will likely slow down to speeds below Mach 5 due to drag but also because hypersonic motors will probably stop working in a denser atmosphere.

Hybrid threats follow a quasi-ballistic (or aero-ballistic) trajectory, elongated by created lift. Their maximal speed (like those of HGVs) is defined by what the rocket motor can produce at burnout. This is not a new concept. As written above, the Pershing II was the first missile with a MaRV, creating some qualities of hypersonic threats comparable to HGVs, which moved out of focus over the past three decades within the BMD community. However, numerous current systems can be found to employ MaRVs, including Russian Iskander-M, Iranian Soleimani, North Korean KN-23, Chinese Dong Feng 21/26, and U.S. long-range hypersonic weapons. Within this group, the Russian Kinzhal and the Chinese CM-401 are two outliers. Both systems are air-launched BMs, where the actual missile launch point is far more flexible than surface-based systems. Also, the air-launched BMs have an initial launch altitude and speed, positively affecting range and overall speed. Interestingly, and even after several years of international research, the Kinzhal, having similar dimensions and features as the ground-launched Iskander-M and launched from a MiG-31, is supposed to have a range of 2,000 km compared to the Iskander's range of approximately 500 km. Sometimes in the same articles, the Kinzhal is described to have a range of 3,000 km when launched from SU-22M3

A self-propelled launcher 9P78-1 OTRK 9K720 Iskander-M with a 9M723K5 missile. The short-range ballistic missiles can reach hypersonic speeds of 2,100 to 2,600 meters per second. (Photo by Vitaly Kuzmin via Wikimedia Commons) bomber aircraft, which is slower and has a lower max flight ceiling than the MiG-31. A logical explanation is that the Kinzhal's range includes the operational range of the launch vehicle, which is supported by calculations made in the AVT-359 study, estimating the range increase of an air-launched Iskander variant under perfect conditions will not exceed 150 percent compared to the land-based variant. So far (based on open-source research), aero-ballistic missiles have been the only threats with hypersonic qualities seen in operational use, and their overall numbers seem to be constantly increasing (e.g., RUS Kinzhal, IRN Soleimani, PRK KN23, USA LRHW, etc). This preference for aero-ballistic missiles is likely based on the existing good understanding of BM and the availability of advanced BM technology compared to the new technological fields of HGVs and HCMs. Also, since they are much cheaper to produce than HGVs or HCMs, aero-ballistic missiles can be available in much higher numbers and with a much faster production rate. So, the potential lack of survivability compared to HGVs or HCMs can be compensated by statistics of larger numbers, similar to the V1 and V2 analogy.

Effect Delivery

Understanding how fast and reliable hypersonic weapons can deliver kinetic effects is already quite important, but for operational targeteers, it is even more important to know which kind of effects can be produced. Otherwise, these new expensive tools cannot be smartly used for planning.

The ST008 study calculated that HGVs with strategic range (e.g., Russian Avangard) and HCMs (1,000 km range) could house an effector weighing up to 500 kg.[12] These warheads can be either conventional or nuclear. Conventional warheads will often be used for time-sensitive or precision targeting. A 500 kg high-explosive warhead has a very limited surface effect (above ground explosion) with crater sizes below 20 m in diameter and less than 5 m in depth (not considering shrapnel or pressure wave damages).[13]

Initially, it was thought that hypersonic vehicles would have sufficient kinetic energy at impact to destroy any target. This seems plausible on paper since a 2.5 t HGV impacting at Mach 20 could deliver the same amount of energy as the first nuclear bomb dropped in 1945. However, the HGV will slow down due to drag in the atmosphere. Simulations for the AVT-359 study showed that an HGV could impact somewhere around Mach 7. This would still leave a kinetic energy comparable with approximately 1.5 kt TNT at impact but with a debatable accuracy. ST008 assessed that hypersonic weapons must slow down below Mach 5 to have sufficient accuracy, leaving an equivalent of only 800 kg TNT, less than a 2,000 lb bomb. How deep can it penetrate? Are such effectors limited to surface effects? Following Newton's approximation for impact depths, the max penetration is about the length of the impactor times the fraction of the impactor density divided by the density of the target material.[14] Even specially designed "bunker busters" like the World War II Disney bomb or a more modern GBU-28 have only a penetration depth of about 5 m in reinforced concrete. These bombs, however, have high-density penetration aids to allow this. The GBU-28 casing weighs about 1.8 t, approximately four times more than the assumed HGV/HCM payload of 500 kg. Hence, it can be considered that the penetration capabilities of HGVs and HCMs are significantly less than those of dedicated bunker busters. However, some penetration capabilities will be available, and possibly enhanced through modern tandem charge mechanisms like some cruise missiles (e.g., U.S. Tomahawk Block Vb).[15] Discussions with experts in the AVT-359 study pointed out that impacting with hypersonic speeds and fusing at a particular point in time is technically very complex and might run into limitations.

"ST008 [NATO's Science and Technology Organization Specialist Team 008] assessed that hypersonic weapons must slow down below Mach 5 to have sufficient accuracy, leaving an equivalent of only 800 kg TNT, less than a 2,000 lb bomb."

Aero-ballistic missiles' effects are equal to known BM systems. Historically, they are mainly used for surface effects with relatively low penetration capabilities. However, this knowledge helps targeteers plan these effects since they are well defined in damage and precision.

Deterrence and Protection Considerations

A common understanding of certain concepts like threat, cost, risk, and deterrence is required to support the subsequent arguments. The threat is the combination of capability and the intent to use it. Cost is the negative impact such capability has on our strategic objectives. This can have many metrics like monetary cost, human lives lost, or even the effect on the political/societal will to continue a confrontation. Risk is the chance that a threat will inflict such costs. The goal is to nullify or at least minimize the overall risk for one's nation or alliance. This can be either done through deterrence or by applying military instruments of power. Deterrence is defined as making a competitor refrain from a particular action based on the predicted cost of this action under specific circumstances. Deterrence occurs both during preconflict and within conflict; restoring deterrence is critical to prevent conflict escalation. Deterrence's primary purpose is to prevent conflict by pointing out its futility. But deterrence still plays an essential role in case it initially fails by emphasizing the futility of continuing. Deterrence relies on strategic messaging about threatened/predicted outcomes and can help end conflicts earlier. Also, the terms "winning" and "losing" must be defined. Winning happens when one side can maintain sufficient strategic goals to continue a conflict and the competitor cannot. Losing is the opposite, when one side must stop the confrontation due to a catastrophic impact on its strategic goals. However, the transition between the two is gradual, and absolutes are not likely.

In our case, the first step is to negate the possession of hypersonic capabilities themselves by deterring a competitor from developing or procuring them. Nonproliferation architectures like the missile technology control regime already exist for regular missiles and other uncrewed systems.[16] It should be feasible to extend such constructs to cover hypersonic capabilities. However, even the missile technology control regime is not a legally binding treaty but an informal political understanding amongst states to limit such proliferations. This gets even more complicated since much modern military technology is dual use with civilian applications. So, nations might be less willing to restrict their global economic influence, even more so for evolving capabilities like hypersonics, which are crucial for any serious national research environment in industry or education to stay competitive. Assuming that the technical availability of hypersonic means over time is hardly preventable, other deterrence goals must be implemented. With a focus on military instruments of power, we must distinguish between means of denial and punishment. Here, deterrence by denial either denies the employment of these weapons prior to launch or negates all their effects afterward with active or passive defense means. An optimized mix of offensive and defensive means must be found to maximize the effectiveness of deterrence by denial. However, since perfect denial is implausible, the remaining risk of such threats must be deterred by means of punishment. Hypersonic weapons can also play an essential role in executing both pillars of deterrence (denial and punishment), which makes friendly possession desirable.[17]

For the weaker nation in a nonpeer confrontation, hypersonic weapons can be used as means of denial to prevent the opponent from winning in a specific time frame or as a tool for massive punishment as a last resort. The stronger nation in such a competition supports the strategic message of a swift victory, which contributes to deterrence. In times of conflict, hypersonic weapons help to negate adverse capabilities for defense and deterrence and, therefore, end the conflict faster. In a great-power confrontation, hypersonic weapons will likely act operationally or tactically as mission enablers or multipliers by taking out key elements of the adverse military posture. Although this could also be achieved by saturation with less capable means, the psychological effect of *Wunderwaffen* (wonder weapons) for deterrence and friendly assurance must be taken seriously.[18] Therefore, the desire to have hypersonic weapons is there for all competitors.

What can be done to defend against hypersonic weapons? We must look at gaps in the observe, orient, decide, and act loop to enable a defensive structure to intercept hypersonic missiles. Here, we concentrate on observe and act but significant changes in the command-and-control process in between also need to be addressed.

First, the incoming threat needs to be detected and tracked; otherwise, the rest of any kill chain cannot be executed. Consequentially, capability development must start here. Since none of our fielded sensors was developed with this threat in mind, we need to identify which sensors can be adapted and where longer-term gaps might be present. Due to their relatively low flight paths, sensor gaps in the glide/cruise phase are expected, placing the initial emphasis on terminal defense. The physical limitations of hypersonic maneuverability indicate that modern BMD-capable sensor networks should be able to handle hypersonic threats in point defense. However, the impact on the remaining mission set must be researched. Future concepts of space-based infrared satellite networks (e.g., U.S. National Defense Space Architecture) combined with surface-based sensors might close this gap and support a midcourse defense.[19] Since modern sensors are software-defined in their capabilities, it is crucial to have the best possible understanding of the threat to optimize the sensor's search-and-tracking algorithms. This necessitates continuous research on threat development and sufficient information sharing among allies. Only this will allow for adequate defensive requirements, efficient and effective system design, and appropriate defensive employment. Insufficient information sharing could also hamper trust in nondomestic alliance capabilities.

As described above, hypersonic weapons are designed to follow a flight path that minimizes intersection with known defensive battlespaces. All viable intercept points are endo-atmospheric, which excludes any mere exo-atmospheric interceptor like the U.S. SM-3, GBI, or the Israeli Arrow 3. As for endo-atmospheric capabilities, such as THAAD, Patriot, SM-6, or Arrow-2, we must determine the probability of an intercept and how software/hardware changes or an amended firing doctrine could potentially maximize this. The concept of intercepting maneuverable BMs should be familiar to missile defense system designers since MaRV has been a reality for decades. We need the best possible understanding of a threat to optimize the functional requirements for interceptor development. The capability will likely grow from mere point defense to limited area defense. A large area or even territorial defense can only be created by employing a defensive curtain around the area, which may be very cost intensive. However, the industry has already shown creative mitigation options like using air-launched interceptors with fewer capabilities but much more flexible battlespace.

A depiction of a Space-Based Infrared System (SBIRS) satellite. The SBIRS is designed to support missile early warning, missile defense, and intelligence collection. (Image courtesy of the U.S. Space Force)

Assuming an interceptor can reach an intercept point, it is vital to identify the most promising form of intercept. A direct hit will likely be 100 percent effective but requires sufficient resilience against maneuvers, making the capability more expensive. Hitting a hypersonic target with very small objects might be sufficient since hypersonic shock effects could allow appropriate damage for ablation to do the rest. Fragmentation warheads are particularly useful as they inflate the impact zone, compensating for insufficient maneuverability in the intercept endgame. This effect is likely factual for a perpendicular impact of a fragment, but effectiveness decreases with shallower impact angles. Differences between glide/cruise and terminal phases must also be identified since the hypersonic vehicle will have slowed down significantly in the latter phase.

Another idea of impacting hypersonic threats is by affecting their guidance and control system. Hypersonic flight depends on stable guidance and control. Even small unforeseen environmental changes could cause compensable and catastrophic effects. So, the idea of sufficiently changing a volume of air by bringing out small particles was conceived and should be further analyzed for practicality and implications on the airspace for friendly use.[20] Another way of potentially affecting guidance and control is electronic warfare. In the AVT-359 study, specialists identify which kind of electronic warfare might be practical to achieve such an effect.

Also, lasers or other direct energy weapons are often mentioned as the ultimate interceptor against hypersonic threats. However, hypersonic vehicles are designed to sustain extremely high temperatures to survive hypersonic flight in the atmosphere. The additional energy necessary to have the needed effect on the vehicle structure is exceptionally high. Calculations have shown that only some options for terminal defense over short distances seem currently feasible. This could be a future option for self-defense of high-value assets, especially for those with an unlimited power supply such as nuclear-powered U.S. aircraft carriers. Longer-range intercepts are unlikely in the future due to a lack of sufficient energy projection for having the necessary effect on the target.

As a word of caution, it is imperative not to look at the hypersonic threat in isolation. It is a threat that imposes significant risk, but other threats may be of equal or higher importance when seen in context. Given a likely long-term, high-cost commitment to counter hypersonic threats in a highly budget-constrained environment, it is of utmost importance to make sound decisions on where and how to spend the budget to maximize the stabilizing effect on the security environment or to have an advantage on the battlefield over time. Overly rash decisions for investment to counter hypersonic means might amplify capability gaps in other vital areas, such as counter-unmanned aircraft systems, cyber, or space capabilities. Polemically, one could raise the theory that competitors communicate higher interest in hypersonic weapons to force competing nations into investing resources in own hypersonic or counterhypersonic capabilities, making limited funds unavailable for other critical tasks.

Conclusion and Recommendation

The journey of understanding hypersonic weapons is far from over. Still, over the past few years, through national and NATO studies and research, the fear of a new Wunderwaffe has decreased through furthering our understanding of such enabling technologies. The Mach 20+ "at will" maneuvering weapons have become demystified by analysis of their current and foreseeable capabilities, likely availability, and actual use in conflict. Hypersonic weapons are not the "game changer" competitors want us to believe, but they are dangerous new pieces on the board that need attention. Our initial focus should be on enabling the defense of critical military elements or strategic targets with point defense capabilities. The evolution of current systems should be feasible within the midterm horizon. Also, the required additional sensor network can be used for other military purposes. A credible area defense will remain extremely expensive and resource intensive for the foreseeable future. In parallel, the use of prelaunch offensive means, including the necessary deep sense capabilities and command-and-control networks, must be advanced and deterrence by punishment credibly strengthened. NATO and its nations must ensure that the development of any defensive capability can grow with evolving hypersonic threats. If the procurement process does not provide sufficient flexibility to cover the uncertainty of evolving capabilities (red and blue), it will be behind the power curve in no time.

Lastly, it is critical that these threats not be considered in isolation. Effects can be created in numerous ways within a multidomain environment in an orchestrated fashion. Hence, the perfect hypersonic defense might be nullified by a cheap drone, a sniper, or a fighter aircraft. Military advisors to the procurement process must be honest about the overall risk a threat poses on a timeline to ensure the best mix of capabilities is available to maximize deterrent or fighting postures. ■

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Soldiers with the 1st Multi-Domain Effects Battalion (1st MDEB) train on the 1st Lt. John R. Fox Multi-Domain Operations Non-Kinetic Range Complex at Fort Huachuca, Arizona, 13 February 2023. The 1st MDEB demonstrated a wide array of nonkinetic effects during this training event, highlighting the event's significance as a milestone on the 1st MDEB's path to become fully operationally capable. (Photo by Sgt. 1st Class Henrique De Holleben, U.S. Army)

Multi-Domain Effects Battalion

Space Integration and Effects in Multidomain Operations

Lt. Col. Joe Mroszczyk, U.S. Army

In a fight with China as the pacing threat, understanding and then leveraging friendly and adversary dependencies on space systems will drive a relative advantage. As the biggest user of space systems, the U.S. Army must be prepared to effectively mitigate risks from dependencies on space while seizing the initiative to exploit adversary use. China has clearly invested in and demonstrated a systems approach to threaten others' ability to leverage space, and the U.S. Space Force (USSF) was established in 2019 to focus on capabilities needed in the space domain as a result.[1] Despite maturing USSF capabilities to organize, train, and equip guardians for operations and defense of capabilities in the space domain, the Army fights and wins the Nation's wars by dominating in and from the land. Fighting from the land does not prevent the Army's use of space or remove responsibility for sensing and engaging threat capabilities in all other domains. The Army's primary formation for sensing and engaging across warfighting domains is the multi-domain task force (MDTF). The MDTF has been designed as a joint force enabler, competing forward inside threatened areas to enable a position of relative advantage across all warfighting domains. The MDTF includes new long-range fires capabilities and nonkinetic assets in a first-of-its-kind formation. While understandable focus and emphasis is placed on the kinetic long-range fires' capabilities, those are not always the most impactful enablers for the joint force. Emphasis on MDTF long-range precision fires (LRPF) from rockets or hypersonic missiles to hold targets at risk on the land or sea requires a deeper understanding of how space enables their success.

Lt. Col. Joe Mroszczyk, U.S. Army, commands the 1st Multi-Domain Effects Battalion in the 1st Multi-Domain Task Force at Joint Base Lewis-McChord. A former artillery officer, he transitioned to Functional Area 40, space operations officer, in 2012. He holds a BS in computer science engineering from the U.S. Military Academy and an MS in space studies from American Military University. He also attended training with industry at Johns Hopkins University Applied Physics Laboratory. Mroszczyk has served in a variety of command and staff assignments in the artillery and in space operations, and he deployed twice to Iraq in support of Operation Iraqi Freedom, and to Afghanistan in support of Operation Enduring Freedom.

Sensor-to-shooter for most LRPF will include space-based or space-enabled sensors providing target acquisition, identification, and custody. As a cornerstone of the 1st MDTF, the 1st Multi-Domain Effects Battalion (MDEB) provides the "secret sauce" for LRPF through both sensing and converged effects delivery. The primary purpose of the MDEB is to provide all-domain, long-range sensing and nonkinetic effects delivery. Each company within the MDEB leverages space capabilities to sense and support delivery of kinetic and nonkinetic effects in all domains. The formation is capable of such feats because MDEB soldiers lead the joint force as subject-matter experts for multidomain operations (MDO), providing the key to disintegrating antiaccess/area denial (A2/AD) systems and building interior lines. The Army must continue to invest in the formation of experts and address three persistent technology challenges related to space and high altitude. For rapid and successful disintegration and penetration of A2/AD systems, the MDEB requires (1) a fielded high-altitude family of systems with payload flexibility, (2) a nonkinetic planning and technical firing solution for Joint All-Domain Command and Control, and (3) survivable/maneuverable systems for electromagnetic reconnaissance and satellite communications (SATCOM) on the move.

Background

Space capabilities have provided the Army an asymmetric advantage in achieving the mission since Operation Desert Storm three decades ago. As the bar to entry for the use of space has lowered, adversaries have increased investments to lessen the advantage. Despite recent press about the importance of space with the USSF and U.S. Space Command stand-up, limited exposure and understanding of the Army's use of space persists. Unfortunately, the public (and by extension most soldiers) have limited exposure or education on Army space capabilities that are viewed as overly technical or too classified to discuss. In fact, the Army is the largest user of space capabilities in the Department of Defense (DOD) and has grown expertise in the space career field over the last twenty-five years. Army space professionals have been largely distributed through Army and other DOD organizations to support the integration of space capabilities. Advances in threat capabilities and plans to impact our use of space have driven senior leaders to consider necessary Army structure changes.

In 2012, the joint staff formally designated space as a warfighting domain along with the cyber, air, land, and maritime domains in the *Joint Operational Access Concept* (*JOAC*).[2] This concept first defined the terms *antiaccess* and *area denial* and combined them into *A2/AD*, describing an adversary *systems warfare* concept to target technological aspects of U.S. force projection capabilities in depth. The *JOAC* called for greater integration of space and cyber capabilities at lower echelons, recognizing peer adversaries' systems also leverage space capabilities in depth providing opportunities for exploitation.

In 2016, Adm. Harry B. Harris, then combatant commander of the U.S. Indo-Pacific Command, said, "A Combatant Commander must be able to create effects from any single domain to targets in every domain in order to fight tonight and win."[3] He clarified in the same speech, "That means the Army's got to be able to *sink ships*, neutralize satellites, *shoot down missiles*, and *hack or jam the enemy's ability to command and control* its forces."[4] Neutralizing satellites fits generally within the doctrinal language of space control or what is known as negating the adversary's use of a space system (ground, space, or link) while protecting our own.[5] On the protection side of the coin, the Army has focused on improving use of space systems with additional efforts identifying space vulnerabilities and mitigating those risks for Army formations since the 1990s. The Army space training strategy has improved training and education across the service, with an expansion to include considerations for high-altitude platforms and payloads. In the last few years, the Army established a cross-functional team under Army Futures Command to improve the Army's ability to leverage space and high-altitude capabilities.

The Army's answer to the *JOAC* and Harris's charge came in 2017 with the experiment to create a nonkinetic combined arms battalion. The experimental formation began integrating intelligence, information, cyber, electromagnetic warfare, and space capabilities (I2CEWS) under an existing fires command structure at Joint Base Lewis-McChord in Washington state. The 1st MDTF was recognized as a joint-force-enabling capability and moved under U.S. Army Pacific Command for improved command and control at the theater level. Due to the success of the rapid experimentation and realized benefits provided, the Army further adapted the I2CEWS name to appropriately capture its function as the multi-domain effects battalion.

In the MDEB and across the 1st MDTF, soldiers leverage work in each of the space mission areas: SATCOM; intelligence, surveillance, and reconnaissance (ISR); position, navigation, and timing (PNT); environmental monitoring; space situational awareness; and space control. As global competitors and adversaries have increased investments in the use of SATCOM, ISR, and PNT, opportunities to negate those systems to achieve a relative advantage are expanding faster than the capacity of the Army to engage.[6] In recognition of the threat outlined in the *JOAC* and by the intelligence community, the Army published Training and Doctrine Command Pamphlet 525-3-1, *The U.S. Army in Multi-Domain Operations*, in 2018 for outlining several required space capabilities that have manifested in the MDEB full design structure.[7]

Since the 2018 concept was published, the 1st MDTF has continuously evolved and experimented with capabilities to advance the application of MDO. In a personally published white paper, Chief of Staff of the Army Gen. James McConville designated the MDTF as the lead for multidomain experimentation to advance the Army's ability to conduct MDO.[8] 1st MDTF has experimented with technologies as well as organizational structures and pulled from each of the subordinate battalions to create agile fighting elements known as multidomain cells (MDCs). These cells may be comprised of any combination of kinetic or nonkinetic capabilities from the long-range fires battalion, MDEB, indirect fire protection capability battalion, or task force support battalion. This evolution continues as the 1st MDTF competes forward in the first island chain throughout the year, exercising with allies and partners in competition. As the Army continues to invest in MDTFs, Secretary Christine Wormuth highlighted the importance of these alliances, suggesting potential forward stationing of MDTF assets in

Soldiers train on emerging electronic warfare capabilities 29 August 2019 during Cyber Blitz 19 at Joint Base McGuire-Dix-Lakehurst, New Jersey. Co-led by the U.S. Army Combat Capabilities Development Command's C5ISR Center and the U.S. Army Training and Doctrine Command's Cyber Center of Excellence, the Cyber Blitz exercise informed the Army on how to perform evolving cyber electromagnetic activities across the full spectrum of operations. Cyber Blitz 19 was executed in conjunction with U.S. Army Pacific's Orient Shield Exercise in Japan, marking the first time that the Army combined field based experimentation with an Army Service component command tier 1 exercise. The experimental exercise pairing gave more than thirty organizations from across the Army, Navy, and Air Force, along with the Japan Ground Self-Defense Force, a realistic first look at how the intelligence, information cyber, electronic warfare, and space (I2CEWS) formation could fight and win as part of a multidomain task force. (Photo by Edric Thompson, U.S. Army Combat Capabilities Development Command)

Japan.[9] She said this as the Army continues to stand up additional MDTFs. 2nd MDTF was established in Germany while 3rd MDTF recently stood up under U.S. Army Pacific Command in Hawaii.[10] MDEB capabilities, enabled by space, remain the centerpiece for each of the MDTFs established.

Multi-Domain Effects Battalion—Space Integration

The MDEB includes six unique companies designed to enable a complementary and combined arms approach to sensing and delivery of effects. Though the signal and military intelligence companies may be viewed as support formations, each company includes space-enabled capabilities and supports all-domain deep sensing and delivery of effects for the joint task force. The success of the MDEB is enabled through a family of systems approach to distribute sensors and effectors throughout the joint area of operations from the land, in and through all warfighting domains. For success throughout the competition continuum MDEB must be viewed as a combined arms battalion requiring cross-domain maneuver to close with and engage the enemy.

Perhaps most obvious of the space enabled, the signal company executes the SATCOM mission and leverages the timing provided by the Global Positioning System (GPS) constellation to ensure the MDTF and supported joint task force can communicate with disaggregated and decentralized subordinate elements. The company will provide support through both line of sight and SATCOM while ensuring the communications security aspects required to leverage encrypted PNT from GPS are properly utilized. Signal soldiers will be adding to all-domain sensing through increased awareness of the electromagnetic spectrum (EMS) as they conduct general electromagnetic reconnaissance. The signal company is a critical element to enable distributed operations for the MDTF's small and agile MDCs. The signal company ties the MDC's ability to sense and provide target-quality information to the rest of the MDTF and out to the joint force as it seeks to penetrate and exploit the A2/AD network of systems.

The MDEB military intelligence company (MICO) provides multiple functions to support overall target development and intel support to space while also leveraging space capabilities in support of the broader MDTF intel mission. The MICO informs the Army's development of the TITAN (Tactical Intelligence Targeting Access Node) program of record through daily operation of the TITAN preprototype (TPP) system and leveraging live space-based information forward in theater. The TPP is a key capability, enabling timely target acquisition and custody. MICO soldiers understand and feed the data from long-range sensors through the TPP to targeting and engagement systems as part of convergence packages. They also provide the soldiers conducting analysis and intel support to targeting using National Reconnaissance Office overhead systems and other commercial space-based ISR capabilities. The open-source intelligence section also has access to commercially available space-based information to support addressing intelligence requirements that can be more rapidly shared with partners and increase overall situational awareness. The MICO's ability to leverage the TPP for direct access to commercial space-based imagery has greatly improved 1st MDTF's ability to share and collaborate with partners through Operation Pathways.

The extended range sensing and effects (ERSE) company provides the land/sea, airborne, and high-altitude layers of the MDEB's all-domain sensing and effects delivery. High altitude specifically refers to the area of the stratosphere above normal air operations between sixty thousand and one hundred thousand feet above ground level. The Army has been the DOD proponent for high-altitude operations for decades, working with industry to advance technology to a point where it has only recently gained traction for military use. As the Army's only current force structure designed for high altitude, the high-altitude platoon within the ERSE company has two sections to support the launch, recovery, and operations of high-altitude balloons with payload flexibility to support various functions. Envisioned payloads/missions include electromagnetic warfare (EW) (including navigation warfare [NAVWAR]), communications extension, and various types of ISR to provide organic coverage and dynamic augmentation persistently with the space layer. The EW platoon within the ERSE company will support the NAVWAR space mission area along with additional electromagnetic reconnaissance and attack. The unmanned aircraft (UA) platoon will provide similar functions to the high-altitude platoon through persistent and long endurance UA platforms with various payloads. Unlike traditional UA, ERSE's concept of employment seeks to leverage automation for pilots to fly squadrons of UA from a single control station supported through resilient mesh-networked systems. In addition to extending a mesh communications architecture to support target acquisition and custody, the ERSE family of systems will also support assured PNT, marrying the

"The Army has been the DOD proponent for high-altitude operations for decades, working with industry to advance technology to a point where it has only recently gained traction for military use."

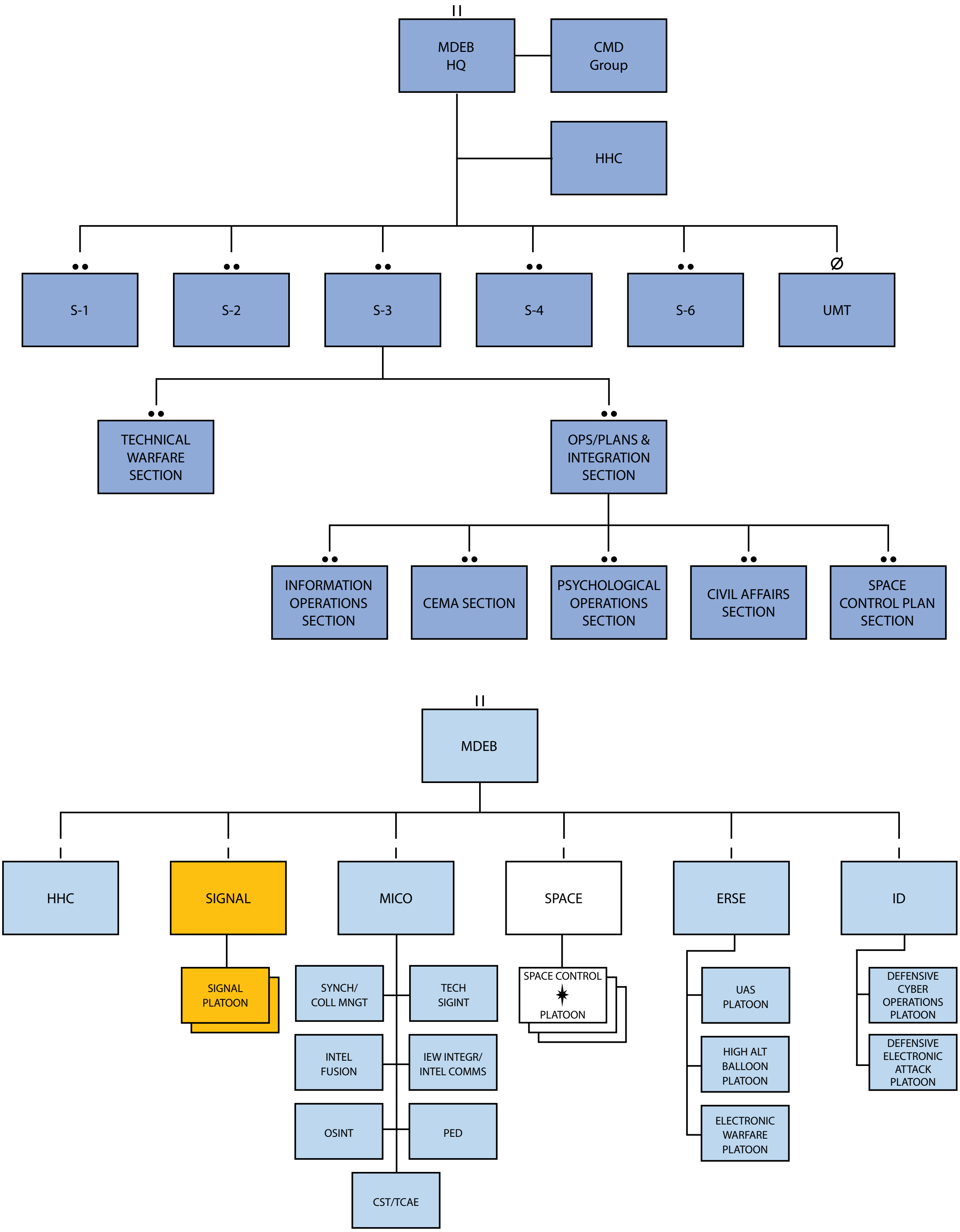
space, high altitude, and UA systems for improved network coverage and resilience.

The information dominance (ID) company is primarily protection-focused to provide defensive cyberspace operations and defensive electromagnetic attack (DEA). Defensive cyberspace operations are accomplished through its mission elements performing the role of cyber protection teams on behalf of the joint task force; this unique command relationship places mission elements outside of the U.S. Cyber Command and enables prioritization of joint task force critical cyber terrain. The ID company's DEA platoon will work along with its sister indirect fire protection capability battalion to protect joint task force critical assets from threats and preserve freedom of maneuver to maintain a relative position of advantage for the MDTF. The DEA platoon will have EW assets like the tactical layer system, echelons above brigade to support the NAVWAR space mission by identifying threats to PNT in the EMS while training to effect adversary PNT-enabled systems. While defensive cyberspace operations soldiers will defend cyber key terrain across Army systems, cyber analysts within the ID company will work with space planners to identify any space-related critical assets and support their protection as well.

The MDEB's space control company is the only Army space formation not assigned to U.S. Space Command and provides three platoons to conduct focused electromagnetic reconnaissance and support delivery of space effects for the U.S. Indo-Pacific Command. The space control company will conduct cross-domain maneuvers; emplacing and displacing from position area to position area in the land domain for survivability and operational access while conducting electromagnetic reconnaissance through the space and cyber domains. The space control platoons will provide beyond-line-of-sight sensors from the land and are another key component to the unique nature of the MDEB's family of systems approach. As SATCOM modernizes to provide reduced spotbeams and frequency reuse, space platoons will require the ability to operate in multiple locations to conduct electromagnetic reconnaissance on adversary communications. The company's ability to monitor, detect, and characterize electromagnetic interference will support indications and warnings of adversary attacks in the EMS while enabling mitigation of threat impacts to friendly SATCOM. The need to maneuver for access and survivability will drive unique coordination measures with battlespace owners and require flexible and smaller form factor technology for SATCOM on-the-move to enable rapid emplacement and displacement in crisis or conflict.

In the headquarters and headquarters company, the space control plans section in the S-3 (operations) shop (shown in the figure) is the principal means to plan employment of space control capabilities within the battalion structure. The space control plans section will analyze friendly and adversary use of space capabilities like SATCOM and plan optimal position areas for the platoons. Coordination with battlespace owners will likely occur within the plans section to free the company and platoons to focus on force protection, and maneuver as they conduct their missions. The section will also coordinate with the MDTF space control planning team on necessary effects coordination measures and allocate targets to platoons based on location and operational or system status as necessary. The MDTF space control planning team will support the necessary command and control, including coordination measures with adjacent or higher space control elements across the joint force through the theater space coordinating authority. When the demand for capacity grows beyond organic assets, the MDTF space control planning team will work through the targeting process to request joint assets for support.

Currently the integration of planning with space as part of nonkinetic capabilities is challenged without a system for holistic target systems analysis and planning for nonkinetic firing assets. Like planning systems for kinetic fires assets, MDEB sensors and nonkinetic effects platforms require planners to assess available combat power and allocate assets to targets. Planning considerations for maneuver and environmental factors like traditional fires requirements for accurate predictive fire (including weather) must be accounted for in a tactical firing solution for nonkinetics. As the Army and joint force work through Joint All-Domain Command and Control, development of a nonkinetic planning system that enables nonkinetic sensor-to-shooter collaboration must be a priority.



(Figure by author, adapted from the U.S. Army Cyber Center of Excellence, *MDEB Overview*; abbreviation key on next page)

Figure. Multi-Domain Effects Battalion Organizational Chart

Expanding the Army's Delivery of Space Effects

Until recently, the Army Space and Missile Defense Command was the only Army formation enabling delivery of space effects for the joint force. This includes a recent shift in organizational structure within the 1st Space Brigade changing from a focus on Army space support teams to space control planning teams within the 1st Space Battalion. In addition to what the Space and Missile Defense Command provides, each MDTF staff will include space control planners to create the layering and convergence of effects outlined in the Army's latest operational field manual, Field Manual 3-0, *Operations*.[11] The MDEB is the principal formation for the joint force to deliver nonkinetic effects converging to defeat adversary A2/AD systems. Increased capacity of space control planners and delivery assets is critical to offset any perceived numerical advantage with reach to address interior lines adversaries may seek to use for an effective A2/AD system. With proper placement and intelligence support, space control companies will have an outsized impact in understanding and defeating adversary A2/AD systems.

It is essential to understand how adversary A2/AD systems integrate space capabilities for their sensor-to-shooter kill chain—extending reach. China and Russia have expanded investments and launches of space-based ISR satellites and continue to improve their architectures for distribution of the data to find and target U.S. and allied forces. As the United States has invested in GPS-guided capabilities using PNT systems, adversary systems are commonly built with the capability to use expanding Beidou PNT and U.S. commercially available GPS technology. To project command and control of forces over the vast distances in the Pacific, China has also developed robust SATCOM capabilities connecting geographically disbursed forces back to each other and the mainland. The MDEB was designed to train, understand, and enable the disintegration of these systems.

CEMA	Cyber-electromagnetic activities
CMD	Command
CTE	Cyber threat emulation
ERSE	Extended range sensing and effects
ID	Information dominance
IEW	Intelligence and electronic warfare
MDEB	Multi-domain effects battalion
MICO	Military intelligence company
OSINT	Open-source intelligence
PED	Processing, exploitation, and dissemination
SIGINT	Signals intelligence
TCAE	Technical control and analysis element
UAS	Unmanned aircraft system
UMT	Unit ministry team

Multi-Domain Effects Battalion Organizational Chart Key

Future of Army Space and the Multi-Domain Effects Battalion

All of this will be underpinned through the Army's soldiers who understand the benefits and risks associated with the use of space systems. Continued education and training of "joint smart" space professionals and "space smart" joint professionals on how to integrate the MDEB's space capabilities into joint plans must be emphasized under the JADC2 umbrella. The Army requires continued increases in capacity for planning and coordinating the convergence of space effects from joint and Army assets. The Army currently maintains a professional cadre of soldiers and civilians who are trained in the basics of space with officers designated as functional area experts spread throughout the Army. While currently under discussion with Army senior leaders, a space career field or branch like the infantry, armor, cyber, and others to manage enlisted and officer personnel through a career has not been established. Efforts to create a space operations branch within the Army to include enlisted and warrant officer personnel will ensure planners and operators have the necessary depth and talent on the team.

Innovative approaches to training through live, virtual, and constructed environments must be enabled through a consistent ability to manage space talent to reduce risks in execution. The MDEB will continue to lead the Army through multidomain experimentation with space and high-altitude capabilities enabled through its people. The MDTFs will continue building realistic all-domain training environments and working through innovative ways to test and improve the integration of space capabilities and effects with the other portions of the MDTF.

The asymmetric advantage provided by the MDEB is not from the space control company alone, but rather having it integrated with the other elements to provide a combined arms approach to nonkinetic and all-domain warfare. As the formation advances with training, fielding, and integration of an all-domain family of systems including nonkinetic planning and tactical firing capabilities to tie it all together, A2/AD disintegration and penetration will be more rapid and successful. To continuously deliver these effects and survive the early stages of crisis or conflict, the MDEB must have capabilities built to support distributed MDCs capable of rapid emplacement and displacement with the ability to conduct SATCOM on the move, launch and recover tailorable high-altitude systems, and tie it all together with a nonkinetic planning and tactical firing system. As the MDTF continues to demonstrate utility to joint force commanders, space integration and effects within the MDEB and MDTFs will remain a key to success. ■

Notes

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Staff Sgt. Yamil Ramirez-Lopez, a weapons operator with the 49th Missile Defense Battalion, Alaska Army National Guard, works in the Fire Direction Center at Fort Greely, Alaska, during Global Lightning 21, 8–12 March 2021. Members of U.S. Army Space and Missile Defense Command and Joint Functional Component Command for Integrated Missile Defense supported the U.S. Strategic Command and U.S. Space Command during the annual battle staff exercise designed to train Department of Defense forces and assess joint operational readiness across mission areas. (Photo by Staff Sgt. Zach Sheely, U.S. Army)

Modernizing Army Space

The Need for Enlisted Space Soldiers

Master Sgt. Kacee W. Love, U.S. Army

Functional Area (FA) 40 officers are the Army's subject-matter experts (SME) on movement and maneuver in and through the space domain and its use to provide timely, relevant, and feasible options to commanders and staffs for targeting, fires, collection, operations, and sustainment of the force. Space operations officers are augmented by enlisted manpower borrowed from other Army branches.

Army space-related activities are comprised of two categories: space operations and space-enabled operations. "Army space operations, duties, and responsibilities are centered on eight codified joint space capabilities: space situational awareness, PNT [position, navigation, and timing], space control, SATCOM [satellite communications], satellite operations, missile warning, environmental monitoring, and space-based intelligence, surveillance, and reconnaissance."[1] These are tasks in which soldiers actively use space-based capabilities to perform operations. Space-enabled operations "are combined, derived, or second order tasks and actions enabled by space capabilities."[2] The Army's Space and Missile Defense School has two requirements regarding these categories: conduct "qualification training and leader development for the Army's global space operations" and "educate soldiers and develop Army leaders in space capabilities and operations."[3] The Army's institution of space has changed over the last twenty years. The Army is developing high-altitude platforms, space control capabilities, and navigation warfare technology. With these changes comes a foundational revolution to the way the Army implements space personnel. FA40s and borrowed military manpower are not enough to achieve success in the multidomain conflicts of 2030 and beyond. The Army requires a robust cadre of space professionals to perform space operations and guarantee success of space-enabled operations.

History

The Army's mission is "to deploy, fight, and win our nation's wars by providing ready, prompt, and sustained land dominance" as part of the joint force of all U.S. military.[4] The Army is comprised of twenty-four branches and corps and supplemented by twelve FAs.[5] An FA is "a grouping of officers by technical specialty or skills" other than an arm, service, or branch "that usually requires special education, training, and experience."[6] The Army established FA40 in May 1998, with the first eleven FA40 officers selected in May 1999.[7] The formation of FA40 happened in a very different world than the one in which we currently live. In the beginning, the role of an FA40 included bringing awareness of Global Positioning System capabilities and ensuring Army commanders understood satellite communications and the effects of space and terrestrial weather on tactical systems, as the concept was new for Army leaders. Now, twenty years later, the role of an Army space soldier has grown from merely awareness to implementation of our own Army space systems, and with that change came the requirement for enlisted soldiers to man those systems. Enlisted soldiers have performed space operation missions and utilized space capabilities since the late 1980s when the U.S. Army Space Command (ARSPACE) was established as a field operating agency of the Army deputy chief of staff for operations and served as the Army component command to U.S. Space Command.[8]

The relevance of the capabilities provided from and through the space domain was first demonstrated during Operation Desert Storm. Members of ARSPACE, including enlisted soldiers, provided Global Positioning System and other space-enabled devices and capabilities that helped the United States maintain tactical advantage over enemy forces.

After the conflict, ARSPACE became a subordinate command of the U.S. Army Space and Strategic Defense Command (now the U.S. Army Space and Missile Defense Command [USASMDC]). ARSPACE continued to add capabilities to its portfolio, including military satellite communications, Army space support teams (ARSST), early missile warning with the Joint Tactical Ground Station (JTAGS), space control, and the ground-based midcourse defense weapon system with associated radars.[9] Added to ARSPACE's organizational design were the 1st Satellite Control Battalion (later predesignated the 53rd Signal Battalion), the 1st Space Brigade, a space

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battalion in the Army Reserves and National Guard; and the 100th Missile Defense Brigade, consisting of a missile defense battalion and five AN/TPY-2 (Army-Navy Transportable Radar Surveillance) forward-based radar batteries. As a result of President George W. Bush signing change two of the 2002 Unified Command Plan, USASMDC became the Army Service component command to U.S. Strategic Command and ARSPACE was redesignated as Army Forces Strategic Command, as the full command became known as the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command.[10]

The number of enlisted soldiers performing space operations missions has continued to rise along with an increased number of Army space operations organizations and missions. Enlisted soldiers from air defense, engineering, military intelligence, and signal contribute to successful mission accomplishment and integration of space throughout the Army.

As a result of Officer Personnel Management System XXI in 1997, the Army realized the growing operational reliance on space and established the space operations officer FA (FA40).[11] However, the Army did not establish a corresponding enlisted space career management field (CMF) or a space warrant officer career field. The principal issues with these two missing pieces are the training requirements and lack of ability to build experience since warrant officers and enlisted soldiers only spend one or two tours in space operations positions before rotating back to their basic branch, often never returning to space operations. These issues have resurfaced multiple times over the years.

During the conduct of the Space Force Management Analysis (FORMAL) in the early 2000s, the Army G-1 (Personnel) directed that USASMDC conduct a study examining the training of and operations performed by Army enlisted space forces to determine the "optimal mix of MOS [military occupational specialty], ASI [additional skill identifier], and SQI [special qualification identifier] for the enlisted forces documented in the Space TOEs [tables of organization and equipment]."[12] From 2002 to 2004, an L-3 Communications Holdings team conducted an *Army Space Enlisted Force Study* and focused on enlisted soldiers performing the satellite control, ARSST, and JTAGS missions.[13] In addition to SME conferences, interviews, site visits, and job analysis surveys conducted by the study team, the U.S. Army Human Resources Command (HRC) established personnel development skill identifiers (PDSI) for each mission area: PDSI C6B (Theater Missile Warning–JTAGS), PDSI C7C (ARSST), and PDSI C8C (satellite control) to help with data collection in Army personnel databases.[14]

The study team found issues with the training and management of enlisted space soldiers, specifically those soldiers performing the ARSST and JTAGS mission, and recommended the establishment of a space MOS or an ASI for each mission area, JTAGS and space operations. L-3 recommended solutions to HRC to better identify, track, and manage JTAGS- and ARRST-trained-and-qualified enlisted soldiers.[15] In the long term, no space MOS was created, and only the ASI Q4 (JTAGS operator) was established.

The next effort, the Army space cadre FORMAL, was conducted in four phases from 2004 to 2005 and resulted in two categories of space cadre, space professional and space enabler. The space professional category included only FA40s, and the space enabler category included all other non-FA40 Army space operations personnel, including enlisted soldiers performing space operations missions and utilizing space capabilities. Although the L-3 team briefed the results of the *Army Space Enlisted Force Study* to the members of the Army space cadre FORMAL, the implementation plan, signed by the Army G-3/5/7 in 2008, stipulated that life-cycle management and assignment functions remain with personnel proponents and the HRC. Furthermore, the implementation plan stated that space operations-related training, other than positional qualification training, is not mandatory.[16]

The Army Space Personnel Development Office (ASPDO) conducted the Army Space Cadre Assessment from 2012 to 2014. Advocated by the USASMDC commanding general, one of the recommendations was to eliminate the two space cadre categories and simplify the Army space cadre definition.[17] Initial drafts of the assessment indicated that a study needed to be completed to determine if a space CMF and a space warrant officer career field were needed; however, later drafts and the final version did not address them. To reinforce the importance of space-related professional development training, ASPDO also recommended ASI 3Y (Army Space Cadre) be converted to a billet and personnel ASI. This change would allow

Space and Missile Defense School students (*from left*) Spc. Philip Sechow, Pfc. Jarod Milliman, Spc. David Sheek, and Sgt. Elizabeth Hughes, all from 1st Space Battalion, 1st Space Brigade, continue critical training in Colorado Springs, Colorado, in May 2020 during the COVID-19 pandemic. (Photo by Dottie K. White, U.S. Army)

warrant officer and enlisted soldier Army space cadre positions to utilize Army training funds for attendance at the Army Space Cadre Basic Course rather than organizational funds. ASPDO submitted a military occupational classification structure (MOCS) proposal for approval, but Army G-1 did not support the conversion of the ASI.[18] Subsequently, only the name and criteria for award of the ASI were changed.

USASMDC senior leadership decided to go forward with a request to establish a space CMF in 2018, and ASPDO developed the MOCS proposal for submission. USASMDC conducted two rounds of internal coordination toward the end of the year, and ASPDO forwarded the MOCS proposal to the four affected personnel proponents in April 2019. The last concurrence was received in October 2019. Meanwhile, a space-imbalanced issue was identified for one of the proposed MOSs, and an internal determination was made to move forward with a single MOS. The momentum for an Army space branch slowed with the development of the U.S. Space Force. However, in 2022, the Army space branch initiative emerged once more to create a modular approach to a space branch by focusing on the largest obstacle first. In March 2023, the USASMDC commandant determined the enlisted space soldier as the number one priority to create and maintain lethality and superiority in the space domain.

Problem

Army space has been altered in many ways during the last twenty years. The Army focused on modernizing its weapon systems and capabilities by fielding JTAGS detachments, Mobile Integrated Ground Suite companies, and space control planning teams. It now needs to modernize its implementation of soldiers. Soldiers serving in space positions within the Army come from numerous career paths, including the engineering, air defense, signal, and intelligence branches. Soldiers serve a single tour within their space mission area before rotating back to their basic branch. This creates a problem where expertise is built through a three-year process before being lost as soldiers return to their basic branches. There are currently no master-gunner-level experts within Army space due to the small amount of time they spend within a mission area. There are no processes to assess talent and performance to place successful NCOs into assignments with more span of influence. The small number of soldiers who do elect to spend more than one tour within Army space do so while risking a detriment to their career, as their professional development models do not account for positions within space as career enhancing.[19] The space domain's relevance is established in the Army's new operations doctrine:

> Proliferation of advanced space technology provides access to space-enabled technologies

> to a global audience. Some adversaries have their own space capabilities, while commercially available systems allow almost universal access to some level of space-enabled capability with military applications. … Army forces rely on space-based capabilities to enable each warfighting function and effectively conduct operations. Commanders and staffs require an understanding of space capabilities and their effects and the ability to coordinate activities between involved agencies and organizations. Commanders cannot assume that U.S. forces will have unconstrained use of space-based capabilities, including data communications. Therefore, Army forces must be prepared to operate under the conditions of a denied, degraded, and disrupted space domain.[20]

Weapon systems and battlefield effects utilizing the space domain will not be totally realized in warfare until a sustainable source of expertise is shaped. Many soldiers who find themselves working within a mission area in Army space desire to carry on with the field. When opportunities are unavailable, soldiers take other chances to extend their duration within space-based mission areas. Evidence of this phenomenon is seen with the ongoing exodus of soldiers to the U.S. Space Force along with the 53rd Signal Battalion's satellite communications mission and the recent transition of 1st Space Brigade's JTAGS missile warning mission.[21] The soldiers transferring to the Space Force, along with these mission areas, are at least partly soldiers who could be retained if the opportunities existed within the Army. From the exit survey and interviews I conducted with soldiers who choose to transition to the Space Force, soldiers tend to exit the Army to remain with their preferred space mission areas by working civilian roles within the operational and institutional training units comprising the space enterprise.

Position

While the U.S. Space Force is focused on strategic-level warfare, warfighters at the tactical level require space support and effects. This is not unlike the development of the Army's aviation branch. In the wake of the U.S. Air Force's birth in 1947 from the Army Air Corps, the Army retained the requirement for organic aviation support to Army-specific operations. Similarly, organic space operations are required to support the multidomain operations of the Army in 2030 and beyond. Col. Pete Atkinson, the space division chief of the Army Strategic Operations Directorate, emphasizes this point:

> Army space professionals share two unique qualities. First, they understand the Army and large-scale ground maneuver. Second, they understand the space domain and how space-based capabilities affect the Army, and they can enable Multidomain operations … The Space Force establishment highlights the need for more space forces and capabilities in all services, not fewer. Army space must define its unique service culture centered around its Army space professionals, who leverage and integrate space capabilities.[22]

In defining its service culture, the Army must cultivate a cohort of enlisted space professionals capable of implementing space capabilities at echelon. It must empower that cohort to share their knowledge with future generations of space professionals. Finally, the Army must guarantee career progression for those who dedicate themselves to the space domain. Failing to perform any of these pillars will lead to a less professional Army space contingent that is unable to maintain its best weapon, its people.

Solution

The Army needs to establish three pillars to modernize Army space enlisted cohort. First, soldiers performing within Army space mission areas must garner professional credit for their successful assignments by awarding them with career progression. Second, the Army must establish broadening assignments within Army space similar to those within basic branches. Last, the Army has an obligation to deviate from the status quo of using Army space enlisted soldiers as borrowed military manpower. The creation of an enlisted space operator MOS is vital to the Army's success in future eras of competition.

Leaders within the operational branches of the Army charged with the completion of space mission areas must establish key developmental positions within the current Army space population branches. Key developmental billets allow soldiers to earn points toward progressing throughout their career; these positions are normally outlined in the Department of the Army Pamphlet (DA Pam) 600-25, *U.S. Army Noncommissioned Officer Professional Development Guide*.[23] The branch-specific variant of DA Pam 600-25 outlines the knowledge, skills, and behaviors necessary for soldiers within that CMF to be successful. An example from the air defense supplement reads,

Master space badge (Photo courtesy of the U.S. Army Space and Missile Defense Command)

> Sergeants should be the tactical and technical NCO that executes training for individuals, crews, and small teams; should work toward becoming a Subject Matter Expert (SME) of ADA Doctrine and their systems' capabilities and limitations; develop a keen understanding of Troop Leading Procedures and Army Programs that are available to Soldiers. Sergeants should manage their team's participation in the Army Maintenance Program. They should begin attaining a knowledge of planning, preparing, executing, and assessing individual and crew training.[24]

Knowledge, skills, and behaviors are not developed for Army space soldiers due to the prevalence of these residing with basic branches. The career progression plans within DA Pam 600-25 also outline the duty positions that are required to progress to subsequent ranks.[25] For example, the DA Pam 600-25 signal supplement outlines the required assignments required for a favorable look during promotion. For example, satellite communication systems operator-maintainer staff sergeants should utilize the following models to be prepared for promotion to sergeants first class:

- **Institutional training.** Senior Leader Course and Battle Staff NCO Course. Successful graduation with honors from these courses may be a significant promotion factor.
- **Operational assignments.** NCOs should focus on continued development and refinement of their skills with assignments that develop leadership skills, hone technical expertise, and lay a foundation of tactical knowledge during this phase of their career. NCOs should seek positions to gain leadership experience such as SATCOM system supervisor, SATCOM operations NCO, circuit control supervisor, SATCOM maintenance supervisor, Military Strategic and Tactical Relay team chief, and platoon sergeant at every opportunity. Likewise, NCOs should seek positions that broaden the force such as drill sergeant, recruiter, instructor, developer, or Advanced Leader Course small group leader while avoiding consecutive assignments outside of their MOS.
- **Special assignments.** Drill sergeant, platoon sergeant, White House Communications Agency, Advanced Leader Course small group leader, instructor/writer, security forces advisory brigade, and detailed recruiter.[26]

The first step to creating a professional enlisted space cohort is codifying the developmental positions within the space domain as "career enhancing" via DA Pam 600-25 edits. Each proponent involved in space mission areas would need to update their supplement to allow for credit toward promotion while also prioritizing follow-on assignments within Army space to better utilize expertise developed in those positions.

To elaborate on the follow-on assignments, the Army needs to establish codified key developmental leadership positions within Army space. Titles like platoon sergeant, first sergeant, and command sergeant

Table. Space MOS Using Billets Performing Space Mission Areas

	Army Space Requirement	Percentage of Branch Population Affected
Air Defense	250 personnel	7.8%
Signal	121 personnel	3.6%
Military Intelligence	54 personnel	.6%

(Table by author)

major resonate with members of the promotions board. Many Army space manning documents utilize nonstandard Army vernacular for duty positions; notably, a FBM (forward-based mode radar) operations sergeant describes what is, in practicality, a detachment sergeant, or systems evaluator instead of the known term, "master gunner." Army space soldiers are boarded for promotion alongside their basic branch peers, while branch sergeants major acting as members for proceedings do not understand what these positions entail. This falls into an overarching objective to normalize Army space. The normalization process includes everything from duty positions to the space lexicon. Army space effects must be translated to warfighting terminology to enable division commanders to apply them as warfighting effects. Similarly, Army space duty positions should reflect their common Army verbiage to prevent confusion when implementing both effects and manpower. In addition to recoding current Army space billets, there is a need to grow the Army space institutional and support elements. The Army Space and Missile Defense School hosts twenty-two courses. When the JTAGS mission area transitions to Space Force, the remaining twenty-one courses will not have a single enlisted instructor position to sculpt the initial qualification training of Army Space 2030 and beyond. The Army must add military instructors throughout the Space and Missile Defense School to reinject expertise at the institutional level. Division, corps, and combatant command staffs currently have no enlisted personnel to plan and employ layered space effects on the battlefield. Creating an enlisted space military occupational specialty would enable precision implementation of Army space assets, capabilities, and effects at various echelons to produce additional kinetic and nonkinetic pathways to success.

Based on a 2023 analysis from the Army Space Personnel Development Office, creating a space MOS (internally called 40D) using the billets currently performing space mission areas would require 425 active-duty billets (see the table).[27]

If FA40D were established using a grade structure of E5–E9, the MOS would allow initial-term soldiers to switch to a new career path, allowing a degree of control within their professional progression and positively affecting retention numbers. This transition would allow for more Army retention of personnel interested in space domain mission areas by following the functional area format of selecting applicants from a wide talent pool (in this case any MOS could apply) to take their existing skillset and shape their expertise toward the space domain. Under this plan, artillery soldiers could take their skills with targeting and specialize into space by assisting with the future development of space control capabilities. Soldiers could merge their intelligence knowledge with space-based reconnaissance or surveillance. FA40D would act as an evolution to enlisted career progression, allowing soldiers to not simply move into a new career field, but instead merge spheres of knowledge enabling new ways of problem-solving.

Conclusion

The Army is delivering the force of 2030 and designing the force for 2040. Multidomain operations are the playbook by which our Nation will overcome all states along the competition continuum. The personnel carrying out those plays are the enlisted members conducting space operations. To fully empower those soldiers, the Army must redefine the manpower utilization of Army space. Senior Army leaders must ensure soldiers performing within Army space mission areas garner professional credit for their assignments. The Army must emphasize the institutional avenue of Army space by establishing broadening assignments in line with basic branches. The Army has an obligation to the enlisted space soldiers to stop using them as borrowed military manpower. The culmination of evolution within the Army space human dimension is the creation of an enlisted space operator MOS. FA40D would be an Army-trained SME in all levels of completion through the lens of the space domain.

Land, maritime, and air operations need to be nested with space effects while countering enemy space capabilities able to halt or slow progress on those operations. Just as Army land component units utilize enlisted expertise in each warfighting function, they also need enlisted personnel specialized in delivering domain applications to the fight. In doing so, the U.S. Army must adapt a professional enlisted space cohort in the form of a space operations sergeant to use basic branch mission awareness coupled with Army space implications to revolutionize the battlefield of 2030 and beyond. ■

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An Army Space Training Division (ASTD) training specialist sets up training aids overwatching a helicopter landing zone planned for 2nd Infantry Brigade Combat Team, 25th Infantry Division. ASTD initiated integration of contested space environment effects into the exportable combat training center rotation circa 2021 on Oahu, Hawaii, with the Joint Pacific Multinational Readiness Center. (Photo courtesy of the U.S. Army Space and Missile Defense School)

Operational Space Training across the Total Army

Justin B. Miranda

Think about your most recent deployment supporting a real-world operation or a rotation at one of the Army's maneuver combat training centers (MCTC). You were able to communicate with your adjacent and subordinate organizations beyond line-of-sight and had unfettered access to the Global Positioning System (GPS), the joint operations center, and/or tactical operations center (TOC). You received and viewed live video feeds from unmanned aircraft systems, and your unit maximized the use of intelligence-gathering capabilities and monitored real-time maneuver of friendly forces. During combat operations, the commander, key leaders, and staff had real-time battlespace awareness; monitored and tracked individual warfighters and vehicles; and synchronized and coordinated operations with foreign military partners. Units supported movement and maneuver with accurate and effective fire support, and logistical resupply requests were sent to higher headquarters located at a forward operating base for resupply to your distant outpost, camp, or battle position at the forward line of troops.

Now imagine your satellite communications (SATCOM) degrades and your subordinate units do not receive your orders or mission graphics for upcoming operations. The battle captain attempts to call other joint operations centers and TOCs via a Secure Voice over Internet Protocol phone but cannot connect, and the battle noncommissioned officer transitions to a vehicle-mounted Joint Battlefield Command–Platform but still cannot send or receive messages. The commander starts to lose visibility of friendly unit icons as they transition into a "stale" status, and the radiotelephone operator no longer has contact with adjacent units, headquarters, or foreign military partners. The forward observers GPS receiver is providing inaccurate positioning and navigation data and the fires support officer cannot execute fire missions due to the low quality of the information they are receiving from the forward observers. The S-4 (brigade logistics staff officer) reports that the logistical resupply convoy is diverted from the main supply route to the alternate supply route and is in contact with enemy forces. The brigade staff references standard operating procedures (SOP) and battle drills; however, staff primaries failed to codify or plan for this type of contingency. The brigade TOC resorts to frequency modulation radio communication to rebuild the common operating picture but is met with static and denied line-of-sight communications.

Does this sound like a future battlefield with unrealistic complications and problem sets? The reality is these effects, and their potential impacts are part of today's modern battlefield. You can expect adversaries to present this operational environment to challenge our formations and operations across the five domains. The joint force can no longer only consider the domain they fight in because modern warfare is a confluence of all domains. Plans and subsequent operations must maximize capabilities, effects, and impacts to establish a harmonious relationship among all domains. The joint force must clearly understand how its functions interconnect and how the space domain enables, and is critical to, multidomain operations (MDO).

MDO is "the combined arms employment of joint and Army capabilities to create and exploit relative advantages that achieve objectives, defeat enemy forces, and consolidate gains on behalf of joint force commanders."[1] MDO combines land, maritime, and air and embraces cyberspace and space while integrating electromagnetic warfare and the electromagnetic spectrum (EMS). For decades, the Army efficiently used the EMS to employ cyberspace and space capabilities to help troops move farther, faster, and with heightened precision, even when operating beyond line of sight. The Army's reliance on these capabilities

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provides our adversaries with ample opportunity to exploit linkages and segments within the Army's overall architecture. Adversaries have the capability to contest equipment, systems, and operations on a level not seen over the last twenty plus years of counterinsurgency (COIN) operations.

What is the critical significance of the space domain to the Army, and how does space impact warfighters on the ground? The average Army formation has thousands of space-enabled and space-dependent systems and equipment to enable each warfighting function. As highlighted in the "not-so-hypothetical" scenario previously described, "Adversaries will attempt to disrupt or deny U.S. Forces' use of space-enabled capabilities, including [GPS] receivers; satellite communication radios and communications suites; fires systems; and intelligence, surveillance, and reconnaissance systems. Commanders must implement denied, degraded, and disrupted space operational environment (D3SOE) as the expected operating environment."[2] The Army must also consider the hundreds of thousands of warfighters that depend on space for logistical resupply, accurate and timely indirect fires, medical evacuation, and precise locations of U.S. and foreign military partners. It not only affects combat forces on a more extensive scale, but it also affects the millions of people worldwide who rely on the space domain to enable critical commercial, civil, and economic infrastructure, from transportation and energy to commerce and financial transactions. As a military, there is an inherent responsibility to preserve, safeguard, and mitigate risk to the space domain, space-based assets, and space-enabled capabilities. The 2022 *National Security Strategy* addresses the need for maintaining space domain accessibility for all to provide tangible benefits and for the security and prosperity of people around the world.[3] The lack of access to the space domain and its enabling and enhancing capabilities results in greater risk to operations and an advantage to the force denying access.

How does the Army train for a D3SOE? "The D3SOE is the composite of the conditions, circumstances, and influences which affect the employment of space effects and capabilities … examples include signal jamming, signal spoofing, physically or virtually disabling or destroying space assets such as ground control stations and satellites and disabling or deceiving user equipment."[4] What do these adversarial capabilities mean for the Army? The Army has modernized into a force of space reliance, enabled to execute and synchronize complex operations plans, missions, and functions around the globe. Peer and near-peer adversaries have observed and developed counterspace capabilities to negate technological advantages and create opportunities when fighting in a large-scale combat operation (LSCO) environment. When preparing for the "fight tonight," Army leaders, staffs, and soldiers need to understand, train for, and adapt to D3SOE conditions to maintain operational tempo, lethality, and superiority to shape and contribute to the success of MDO.

How is the Army tackling this space domain problem set? On 1 March 2023, Lt. Gen. Daniel Karbler, U.S. Army Space and Missile Defense Command (SMDC) commanding general, signed the 2023 *Army Space Training Strategy* (*ASTS*). For context, the first *ASTS* was signed in November 2013, initiating space training across the Total Army. Several distinguishing factors and updates exist after a decade of training and preparing the force. After a decade of this training and awareness campaign, SMDC and the U.S. Army Space Training Division (ASTD) are working on enhancing and standardizing space training operations and optimizing space utilization in the Total Army's training and preparedness.

Over the past ten years, the Army was primarily concerned with its adversaries' ability to deny, degrade, and disrupt its space-enabled capabilities.[5] Today, the Army is planning for a future organic capability to plan for, integrate, and employ space capabilities and effects, enabling convergence in support of MDO during LSCO.[6] How can space-based capabilities help mitigate the uncertainty brought on by the fog of war and create opportunities/advantages to enable and enhance the Army's ability to seize the initiative over the adversary? The Army must shift its mindset and focus from COIN to MDO. The Army must continue training and conditioning its formations and warfighters to maintain lethality, speed, and precision even when facing an adversary who can deny access to space-enabled and space-based capabilities.

A second significant adjustment in the 2023 *ASTS* is Karbler's outreach for endorsement and advocacy with the deputy chief of staff for Headquarters, Department of the Army G-3/5/7; the U.S. Army

An Army Space Training Division training specialist instructs an infantry platoon from 1st Stryker Brigade Combat Team, 4th Infantry Division, on recognizing, reacting, and reporting electromagnetic interference during their rotation at the National Training Center, Fort Irwin, California. (Photo courtesy of the U.S. Army Space and Missile Defense School)

Forces Command deputy commanding general; and the U.S. Army Training and Doctrine Command (TRADOC) deputy commanding general. Leaders must understand how space enables their formations and the space capabilities and effects available to them at echelon. This collaborative effort represents a unified front when prioritizing the space domain in Army training, capability development, readiness, and modernization.

The ASTD is working to prepare the Army for a D3SOE and educate it on our space capabilities and effects, which is a critical component of MDO. ASTD consists of four branches, a Combined Arms Center (CAC)/Army University liaison officer, and an operations and effects team that comprehensively trains, educates, and prepares leaders, staff, and warfighters across the Army's training and education enterprise. To date, ASTD has trained more than fifty thousand warfighters across the Army's ten centers of excellence, more than twenty-five thousand warfighters at the U.S. Army Command and General Staff College (CGSC), and more than fifteen thousand warfighters across more than 150 corps/divisions/brigades. ASTD also continues integrating Army space equities across Army and joint doctrine; influencing training aids, devices, simulators, and simulations development; and informing Army strategy and capability development and acquisition.

Operations and Effects Team

In fiscal year 2023, the ASTD formed an operations and effects team to manage, research, and standardize current and emerging effects to expose and increase the force's ability to recognize, react, mitigate, report, and operate in and through a D3SOE. The team synchronizes ASTD training, administrative, and operational efforts to include informing the Army Lessons Learned Program. The team ensures ASTD trainers and instructors are armed with the appropriate resources and track coordination for training missions at home station, the MCTCs, and the Mission Command Training Program (MCTP). The team's major effort is

An Army Space Training Division training specialist oversees a soldier from the 11th Armored Cavalry Regiment (Opposing Force) as the soldier sets up a training aid during a rotation at the National Training Center, Fort Irwin, California, to help train the rotational unit on conducting operations under contested space domain conditions. (Photo courtesy of the U.S. Army Space and Missile Defense School)

coordinating and requesting live GPS and SATCOM denial effects to expose and train warfighters in the operational environment they will experience during LSCO. As of June 2023, ASTD requested, coordinated, and facilitated over fifty effects-driven events across the ultra-high frequency band to prepare Army units for a D3SOE. Finally, the team is responsible for ensuring training aids, devices, simulators, and simulations are fully mission capable and available, and whether future training aids are necessary to increase the level of training they are providing for the Army.

Foundational Space Education Branch

The Foundational Space Education Branch (FSEB) integrates a space-focused curriculum across the ten Army centers of excellence's professional, functional, and specialty training and education courses. Specifically, the FSEB provides subject-matter experts (SME) to educate and train soldiers to operate in and through a D3SOE, driven by the TRADOC Common Core Task #39—Conducting Operations in a Degraded Space Environment. This is the first touchpoint of many where soldiers will learn about a D3SOE. The team recently took on responsibility for integrating a space-focused MDO curriculum into the Battalion/Brigade Pre-Command Course. The FSEB is expanding its educational opportunities by improving its online and virtual repository and integrating distance learning options.

SMDC Liaison Officer to CAC/Army University

SMDC's liaison officer to CAC/Army University focuses on integrating space into CGSC courses, which includes providing a space elective in which CGSC students can earn the additional skill identifier of 3Y (Space Enabler). They also support numerous joint courses with space education such as the Joint Targeting Staff Course and the Joint Operational Fires and Effects Course. The liaison officer, a key duty position, directly influences field-grade officers on the space domain, its capabilities, and its effects across the other domains and warfighting functions.

Home Station Training Branch

When soldiers arrive to their duty stations, they can expect to receive more in-depth training on operating in a D3SOE. The Home Station Training (HST) Branch provides operational space training across the Total Army focused on D3SOE for brigade combat teams and space capabilities and effects in support of MDO for division and corps. Training packages are flexible and tailored to unit requirements and resource constraints to maximize training opportunities. HST trainers provide tactical-level training on space fundamentals; SATCOM; the EMS; positioning, navigation, and timing (PNT); space-based intelligence, surveillance, and reconnaissance; and planning considerations and electromagnetic interference mitigation. They also provide classified briefings regarding adversaries' capabilities and training specific to a military occupational specialty; for example, signal and intelligence. Additionally, HST trainers are prepared to facilitate a live GPS denial range, giving units the ability to experience it in a controlled learning environment, observing the effects on their equipment, systems, and architecture to inform their SOPs and battle drills. Finally, and most importantly, HST personnel are experts at integrating live D3SOE effects into a field training exercise, preferably after classroom and range training and before their MCTC rotation and/or operational deployment. The ASTD facilitates live effects and provides coaching and training to assist and enable Army units to adapt, sustain, and prepare for operations in a D3SOE. In the future, the HST will play a pivotal role in expanding informational training efforts to educate and train warfighters on how to capitalize on and converge space-based effects and mission areas, creating an advantage over the adversary and seizing the initiative in MDO and LSCO.

Maneuver Combat Training Center Branch

The MCTC Branch is responsible for supporting the space operations officer at the MCTCs with the planning and execution of live space effects. They send trainers and SMEs to most MCTC rotations in CONUS and OCONUS to support D3SOE scenarios, replicate opposing-force threats, reinforce HST learning experiences, and coach the unit through D3SOE conditions. Currently, MCTC trainers provide support at the National Training Center at Fort Irwin, California; the Joint Readiness Training Center at Fort Johnson, Louisiana; the Joint Multinational Readiness Center at Hohenfels, Germany; and the Joint Pacific Multinational Readiness Center in Hawaii and Alaska. Support is also provided to the Army National Guard's Exportable Combat Training Capabilities upon request. In recent years, MCTC initiated support to Exercise Sage Eagle for special operations forces to validate subordinate units through premission training requirements. The MCTC is integrated into scenario development efforts to ensure rotational training units are exposed to a D3SOE provided by training aids and devices that contest space-enabled equipment and systems. During rotations, MCTC trainers serve as SMEs to observe, coach, and train leaders, the staff, and warfighters to plan for, recognize, react, and report in a D3SOE. They also provide knowledge and expertise for Army units to understand, plan for, and capitalize on space-based capabilities and effects.

Mission Command Training Program

The MCTP provides training support to corps, division, and Army Service component command commanders and staff. This training includes support to operations plans and operations order development, mission command training, and SME support during Warfighter exercises (WFX). The team provides tailorable training during MCTP preexercise academic sessions as requested by the operations groups. They are prepared to cover critical topics and concepts such as space in MDO, D3SOE, red and blue space capabilities and effects, and space-focused lessons learned and trends. Army space operations officers (Functional Area [FA] 40A) are assigned to the MCTP at Fort Leavenworth, Kansas, to promote, strategize, and advance the integration of the space domain into Army WFX. In coordination and collaboration with the MCTP FA40s, the MCTP provides three types of support to WFX: the SME team—responsible for observing, coaching, and training the staff to integrate space across all warfighting functions; the exercise control group—responsible for all white cell space domain functions; and the world class space opposing forces space SME—responsible for presenting adversary space capabilities and effects to the training audience. The FA40As are focused on the proficiency and integration of corps and division space support elements.

How does an Army corps and/or division encounter and adapt to a contested space domain and D3SOE? Currently, the MCTP's exercise control group manually produces products, reports, events, and/or anomalies for the staff to plan, react to, and sustain operations. The MCTP effectively raises awareness and understanding of space's crucial role in military operations. Their expert trainers share their knowledge and actively contribute to the FSEB's efforts to comprehensively prepare senior Army leaders and staff for present and future warfare challenges. As a result, the battlefield is optimally prepared for all warfighters to plan and execute their missions with strict adherence to the fundamental nine principles of war: objective, offensive, mass, economy of force, maneuver, unity of command, security, surprise, and simplicity.[7] The Army's Next Generation Constructive Synthetic Training Environment is scheduled to replace the Warfighter simulation and is expected to automate space effects in the WFX simulation. The Next Generation Constructive Synthetic Training Environment initial capability document is currently under development, and the ASTD is involved to provide an operational perspective on what those effects should manifest as in the simulation. This will provide a more realistic operational environment that integrates the space domain, space-based capabilities, and adversary counterspace capabilities and impacts to Army space operations, MDO, and LSCO.

To recap, the ASTD comprehensively integrates across Army institutions, functions, and collective training to educate/train and prepare warfighters across the Total Army to capitalize on the space domain. Conversely, there has and continues to be a major line of effort to prepare forces to continue planning and operations when our adversaries negate or deny the plethora of space-enabled capabilities. The ASTD is comprised of professionals and experts to field an operations and effects team, FSEB, CAC liaison officer billet, HST, MCTC, and MCTP.

The ASTD supports training in varying capacities and venues to prepare warfighters at several echelons. But they are not the only space resource available. There are numerous professionals within each formation to answer questions, assist in integrating D3SOE into plans and operations, or coach and teach how the space domain can enhance operations overall. The Army has over six hundred space operations officers across Active and Reserve Components, with field artillery brigades and Special Forces groups as the lowest echelons for FA40A duty assignments. They are the gateway to understanding and employing the ultimate high ground and supporting MDO. All FA40s serve in one of the Army's primary branches until they are promoted to the rank of captain or greater and are then selected to transfer to the functional area. Their expertise and operational experience can be leveraged to inform planning and operations.

Without ASTD help, units can tackle operational and tactical challenges by focusing on three essential practices: building proficiency, conducting rehearsals, and enforcing discipline. These methods are cost-effective and only require time for the Total Army to prepare and plan for potential scenarios where we may lose access to all systems, functions, and capabilities that have been readily available to us in the last twenty plus years of COIN.

Proficiency

Proficiency requires expertise in two key areas. The first is a thorough knowledge of the equipment and systems used by various Army organizations in different formations and configurations, such as brigade combat teams, functional brigades, and special operations forces. Understanding how the equipment should function under normal and abnormal conditions is crucial, enabling us to identify operator errors, maintenance issues, or electromagnetic interference. Not distinguishing between these factors may lead to missed opportunities for targeting and delays in implementing measures for force protection. Electromagnetic attacks are a potential threat to operational tempo, command and control, and friendly forces that must be treated seriously on the battlefield.

Second, proficiency requires understanding the role and importance of space in Army operations. The Army must educate the force on the vulnerabilities of space-enabled equipment as they can be easily exploited. Prioritizing potential electromagnetic interference

An Army Space Training Division training specialist monitors a training aid and observes air assault and rotary wing operations during an undated special operations training exercise. Aviators and special operations forces recognize the critical significance of training under electromagnetic interference conditions as they increase their demand for this type of training environment and conditions. (Photo courtesy of the U.S. Army Space and Missile Defense School)

(EMI) as a threat versus a maintenance issue is paramount to success in large-scale operations. Ensuring battle drills, SOPs and tactics, techniques, and procedures are in place, practiced, and understood down to the lowest level will maximize the Army's use of space to enable and enhance plans and operations.

Rehearsals

"Winging it" and "figuring it out on the fly" does not work in the Army's favor. Live GPS and SATCOM denial and/or EMI are not required to exercise legitimate communications or PNT primary, alternate, contingency, and emergency plans. There are obvious gaps in readiness between units that arrive at an exercise or MCTC rotation without any D3SOE battle drills or SOPs and units that arrive with basic plans, drills, and SOPs that have been rehearsed at home station. When it comes to jamming, EMI, and counterspace effects, it is unnecessary to have anything elaborate or complex. But units must have legitimate drills and SOPs that guide them and are rehearsed enough for units to recognize, react, and report through the chain of command with some level of muscle memory. Rehearsals for jamming and interference are especially vital since the effects, indicators, and responses are less intuitive than Battle Drill 1: React to Direct Fire Contact. It takes rehearsals and repetition to build competency and confidence to maintain planning and operations when units are forced to employ all means of command and control (digital and analog) in nonpermissive environments.

Discipline

Leaders, staff, and warfighters must be disciplined at all echelons to reinforce proficiency and rehearsals. There must be discipline in proficiently operating all systems organic to Army units; the discipline must work through difficult and complex problem sets regardless of how well-integrated conditions are within the Army's warrior skills tasks and collective mission essential task list. Preparing for contested space, cyber, and electromagnetic warfare requires the discipline and initiative to go the extra mile during training to test and stress equipment, systems, operators, SOPs, architecture, and the unit's ability to operate in and through a contested EMS. As an Army, we must remain disciplined in balancing mass, economy of force, unity of command, and simplicity to be fully prepared to experience a loss of communications and PNT due to the current capabilities our adversaries possess. It is within each warfighter's influence and decision-making to change the precedence and improve the balance of space reliance versus space enhancement. Warfighters must avoid persistence and overuse of all digital systems all the time (e.g., emissions control). However, there is still great utility and opportunity in maximizing space-enabled capabilities to maintain operational tempo while creating complex problem sets to mitigate vulnerability to our peers and near-pear adversaries.

Success hinges on the Army's ability to fully understand how space contributes to the Army operation, MDO, and LSCO. Rather than expecting access to all capabilities, we must be willing to train and operate in uncomfortable situations. Operating in and through a D3SOE must be the overarching training objective, and commanders must challenge their formations to complete their mission-essential tasks in this operational environment. The Army cannot assume that its adversaries will not take advantage of the EMS. Chinese military leaders believe they must achieve EMS dominance and deny its adversaries use of the EMS to seize and maintain the initiative in a conflict.[8] We must assess our understanding of space's role in combat and our ability to adapt to any challenges that may arise. With a firm grasp of MDO and a willingness to adapt, we can overcome space-related obstacles and emerge victorious. ■

Notes

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3. The White House, "Overview of Our Strategic Approach," in *National Security Strategy* (Washington, DC: The White House, 12 October 2022), 12.
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Reframing the Special Operations Forces-Cyber-Space Triad

Special Operations' Contributions to Space Warfare

Maj. Brian Hamel, U.S. Army

SOF has a culture of decentralized combat operations with a focus in the human domain.

—Col. Mark Orwat

Humans are always in the loop of spacepower.

—Dr. Bleddyn Bowen

In November 2021, the commander of the U.S. Army Special Operations Command, Lt. Gen. Jonathan Braga, articulated a new deterrence framework to his staff.[1] This emergent framework included the space, cyberspace, and special operations communities having symbiotic relationships to converge effects throughout the competition continuum. As a homage to the nuclear Triad (intercontinental ballistic missiles, submarine-launched ballistic missiles, and strategic bombers), this "special operations forces (SOF)-cyberspace-space Triad" provides policymakers additional options to campaign against our adversaries. While the Triad has made substantial headway, no existing literature delineates the nexus of the SOF-space relationship. Joint Publication 3-14, *Space Operations*, and Field Manual 3-14, *Army Space Operations*, are both quick to point out that SOF receives effects from space, but only a few student theses and authors tangentially describe how SOF can create effects in the space domain.[2] In this study, the author elucidates the SOF-space segment of the Triad and recommends that the joint SOF enterprise conduct preparation of the environment, special reconnaissance, and military information support operations to set the conditions to influence, deceive, or degrade adversarial terrestrial-based, space-enabling infrastructure.

Unfortunately, SOF has not clearly defined how it can generate effects in the space domain. Failure to prescriptively delineate effects ensures that our adversaries will continue to hold positions of relative advantage and predisposes any efforts to failure due to their inability to be accurately measured and war-gamed prior to execution. This sharply increases risk to force and risk to mission. Current unclassified literature explains that SOF receives effects from the space domain through services such as satellite communications; positioning, navigation, and timing; and intelligence, surveillance, and reconnaissance. This article expounds on how SOF core activities, normally conducted during irregular warfare (IW), can create effects in the space domain to advance concepts within the Triad and provide flexible response options to counter the People's Liberation Army Strategic Support Force, which was created in 2015.[3]

How Can SOF Contribute?

Space warfare should not be synonymous with orbital warfare, or warfare that only takes place in the space segment (see the figure). The preponderance of space warfare relies on terrestrial infrastructure (ground segment), and more importantly, the human beings making decisions on how to manipulate that infrastructure and employ those capabilities. In that vein, the decision-making calculus, biases, and heuristics of our adversaries are as important as the on-orbit capability that they control. While U.S. Space Command manages the space segment portfolio against adversaries of the United States, there is ample opportunity for the joint SOF enterprise to examine how they can contribute to degrading the terrestrial-based, space-enabling infrastructure (SEI) of our adversaries.

U.S. Army Special Operations Command distinctive unit insignia (Image courtesy of the U.S. Army via Wikimedia Commons)

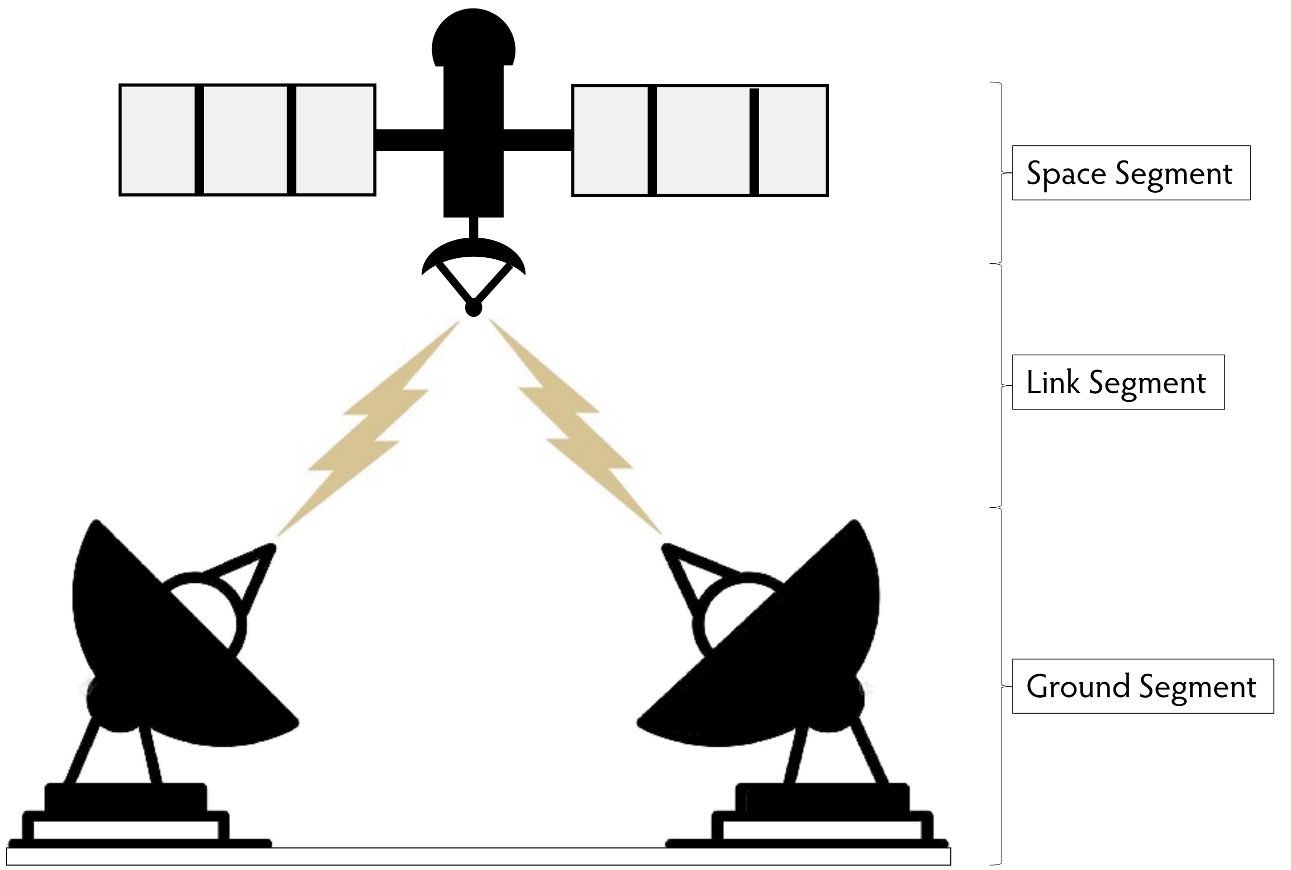
What does SEI encompass? The closest related term is critical infrastructure, but that definition varies throughout publications within the Department of Defense and the civilian community, neither of which come close to accurately explaining the intricacies of SEI. In lieu of no practical definition for SEI, the author proposes an amalgamation of tangentially related definitions to encapsulate the changes of the contemporary operational environment. Therefore, SEI is the

> systems, physical facilities, services, support personnel, staff, and essential services necessary to support operations, activities, and investments, to, from, and through space. This includes but is not limited to the activities conducted on the electromagnetic spectrum, launch facilities, ground control stations, celestial lines of communication, spaceports, computer hardware, software, and the cyber infrastructure that enables these operations, activities and investments. 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.[4]

While a broad definition could dissuade some, the intent is to showcase as many vulnerabilities as possible as the adversary and type of the terrestrial infrastructure will change based off the geographic area of responsibility. As an example, a People's Republic of China space situational awareness site in South America may not have the same vulnerabilities as a Russian electronic warfare platform in Ukraine.

Modified Methodology and Results

This article uses the same case study as the thesis from which it was derived. The thesis describes the Espacio Lejano ground station in Neuquén, Argentina, one of several ground stations that the People's Republic of China uses to transmit information for assets over the Southern Hemisphere. Understanding that the Chinese Communist Party is responsible for all national-level operations, activities, and investments (OAI) has led many in the region, and in Washington, D.C., to suspect that this ground station is dual use.[5] Espacio Lejano is run by China Satellite Launch and Tracking Control, a subentity of the People's Liberation Army Strategic Support Force, and currently boasts a primary antenna of 35 m and a secondary antenna of 13.5 m.[6] Recent assessments indicate that the larger antenna has been broadcasting data in the S and X band for sending data, and in the Ka band for receiving data.[7] Transmission of classified information typically occurs on the X and Ka bands, which is why there is



(Figure by author)

Figure. Different Segments of the Space Domain

scrutiny regarding the site's dual use. Scholars assess that the site at Espacio Lejano contributes to China's space situational awareness network and supports interplanetary spacecraft missions as part of China's Deep Space Network.[8] As is the case at other regional ground stations, China has also come under criticism for spying on other governments while it conducts its own space operations.[9] The repercussions of this could potentially back China into a corner and may force it to engage with one of the few sympathetic regional partners it has left, Venezuela.[10] This could limit the efficacy of China's OAIs by geographically constraining operations that typically require broad geographic dispersion to be effective.

Using this case study as a backdrop for the analysis, the author also standardized definitions for degradation measures. In this article, the word "degrade" is a sliding scale of potential effects as noted in table 1.[11]

With degrade now understood and SEI defined, the case study offers an opportunity to examine the realm of the possible SOF core activities that could be conducted against this ground site. It does not evaluate the efficacy of the actions, the risk, attribution, or second- and third-order effects. Through the lens of analytic generalization, table 2 was compiled to evaluate the outcome of SOF core activities juxtaposed against an adversary's SEI with an annotation of D, I, or N, for whether that core activity could directly (D), indirectly (I), or not degrade (N) the adversary's SEI. For the sake of brevity, not every core task will be explained. Please note that the definition for each SOF core activity as it is used in this article can be found in Joint Publication (JP) 3-05, *Special Operations*.

SOF Direct Effects against the Ground Segment

Direct action. Direct action (DA) would primarily be aimed at disrupting, denying, degrading, or destroying adversarial SEI. This could be conducted through raids, electronic warfare, sabotage from human

Table 1. Space Negation Measures

Deceive	Measures designed to mislead an adversary by manipulation, distortion, or falsification of evidence or information into a system, to induce the adversary to react in a manner prejudicial to their interests.
Disrupt	Measures designed to temporarily impair an adversary's use or access of a system for a period, usually without physical damage to the affected system.
Deny	Measures designed to temporarily eliminate and adversary's use, access, or operation of a system for a period, usually without physical damage to the affected system.
Degrade	Measures designed to permanently impair (either partially or totally) the adversary's use of a system, usually with some physical damage to the affected system.
Destroy	Measures designed to permanently eliminate the adversary's use of a system, usually with physical damage to the affected system.

(Table from Joint Publication 3-14, *Space Operations*)

intelligence-enabled operations on site, or against the domiciles of the employees. Furthermore, DA could also be targeted to disrupt the essential services at the ground site or the essential services in proximity to the ground site that enable it (electricity, sewage, water). Prominent authors such as Dr. Bleddyn Bowen have called for killing the scientists or nefarious experts of a particular initiative (e.g., a small team of scientists working on a chemical weapons program).[12] This line of thinking could extend to the families of these experts to create an effect so that an operator does not arrive to work on time, or a situation so undesirable is created that the services provided by this ground station are disrupted.[13] A parallel concept taken from the Air War Plans Division 1 paper, DA could also be taken against economic nodes that are enabling this ground station or against the supply lines that facilitate its services.[14] Finally, all these DA-related actions could be done unilaterally, through a proxy force, or with a unified action partner.

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Military information support operations. Military information support operations (MISO) would be conducted by the psychological operations (PSYOP) community to influence two primary groups, nested under the space negation effect of deceiving.[15] The first target audience is people who can directly impact operations because they work onsite. Examples include supply or support personnel, satellite operators, or those filling a leadership role. The second target audience is family members of the employees or operators who live in the surrounding area and can indirectly impact the ground site. A complementary activity that MISO personnel could conduct includes a targeted military deception (MILDEC) campaign, to include tactical deception. While MILDEC is not an activity exclusive to the MISO community, the principles of deception best align with the MISO community. Effects from MISO and MILDEC could affect the ground, link, or space segment (see the figure).

Related to the ground segment, MISO or MILDEC could foment enough discord within target audiences or select individuals that desired effects could range from employees leaving doors unlocked, conducting simple sabotage, deserting their posts, tainting fuel supplies, or adversely affecting local or regional politics, to police brutality against the families of workers. In the link segment, MISO efforts could influence either of the two

Table 2. Results of Joint SOF Core Activities against Adversarial Space-Enabling Infrastructure

SOF Core Activities	Effect on Space-Enabling Infrastructure
Civil Affairs Operations (CAO)	I
Countering Weapons of Mass Destruction (CWMD)	N
Counterinsurgency (COIN)	N
Counterterrorism (CT)	N
Direct Action (DA)	D
Foreign Humanitarian Assistance (FHA)	I
Foreign Internal Defense (FID)	I
Hostage Rescue and Recovery (HRR)	N
Military Information Support Operations (MISO)	D
Security Force Assistance (SFA)	I
Special Reconnaissance (SR)	I
Such other activities as may be specified by the President or the Secretary of Defense (OA)	N
Unconventional Warfare (UW)	D
(D – direct effect, I – indirect effect, N – no effect)	

(Table from Joint Publication 3-14, *Space Operations*)

target audiences to degrade or disrupt essential services to that ground station, or they could use electronic warfare platforms to inhibit the link segment from functioning correctly. Finally, influence efforts in the space segment could manifest as the onsite operators or employees maneuvering a satellite when there was no need to, thereby depleting the finite amount of propellant. While admittedly a very specific list of actions, these same types of effects can be created by other capabilities within the joint SOF formation, which remain outside the scope of this article. This is not an exhaustive list, and SOF operators should be encouraged to think of ways to impose cost on our adversary.

In the joint community, MISO is one of nearly a dozen information operations capabilities. Information operations capabilities integrate with the staff, and nest effects to support targeting and the maneuver formations. In the joint world, these information operations capabilities can include public affairs, MILDEC, electronic warfare, computer network operations and civil-military operations.[16] Within the Army, the PSYOP community under U.S. Army Special Operations Command best supports this role of MISO in IW and is most apt to conduct these types of OAIs.

Unconventional warfare. Noting the definition for unconventional warfare from JP 3-05, *Special Operations*, a large part of related subtasks focus on coercing or disrupting the host-nation government, not always overthrowing it.[17] Predicated on the fact that the indigenous or surrogate capabilities are developed, the PSYOP or information operations element inside of the resistance could refine their OAIs to coerce specific target audiences or decision-makers. Concurrently, the guerilla force, or the "underground," could focus on disrupting, denying, degrading, or destroying the requisite human network and physical infrastructure for the ground station to operate. Many of the parameters discussed in direct action, military information support operations, and special reconnaissance can be applied to this core activity.

SOF Indirect Effects against the Ground Segment

Special reconnaissance. Special reconnaissance (SR), as defined by JP 3-05, *Special Operations*, is "reconnaissance and surveillance actions conducted as a special operation in hostile, denied, or diplomatically and/or politically sensitive environments to collect or verify information of strategic or operational significance, employing military capabilities not normally found in conventional forces."[18] In light of that definition, SR could be conducted through signals intelligence, human intelligence, or SOF, and could be amplified by collaborating with interagency equities (e.g., National Security Agency, National Reconnaissance Office, Central Intelligence Agency) to facilitate any of the five space negation measures indirectly. SR should also include SOF-enabled cyber reconnaissance to map the digital infrastructure, find vulnerabilities, and gain access to other parts of the network. Both human intelligence and SOF-enabled cyber could be OAIs that serve two direct and indirect purposes. As an example, human intelligence can be used to conduct reconnaissance, but it can also be used in a different capacity to facilitate a direct degradation measure. This could manifest itself as a human cutout passing a mensurated grid to an operator or cutting the electricity to a building.[19] Another example of SR that transitioned to a cyberattack having direct degradation impacts was the Stuxnet attack against Iran.[20]

SR could be used to map the interior of the physical infrastructure to include doors, windows, access codes, and patterns of life for those working at this facility. As mentioned in the DA section, SR can extend beyond the employees, site operators, and leadership at the ground site, and can encompass family members and other personnel in vicinity of the ground site that could indirectly impact operations. As some of our adversary's space operations become automated through artificial intelligence and machine learning, SR can map potential vectors for data poisoning. If the data poisoning were then to occur, its effects could span from disrupt to destroy.

Civil affairs operations. Given the rise of the civil and commercial space sector, civil affairs operations can be integrated to engage and evaluate the capabilities of civilian networks that work at these adversarial terrestrial space sites. Subsequent civil affairs operations can be tailored toward civil knowledge integration and civil network development and engagement, highlighting key links and nodes in the environment. Information from these reports could enable all five of the space negation measures. Paramount to this endeavor is standardization of data collation, and quality network engagement. Network engagement is "the interactions with friendly, neutral, and threat networks, conducted continuously and simultaneously at the tactical, operational, and strategic levels, to help achieve the commander's objectives within an operational area."[21] Network engagement "utilizes the three activities of supporting, influencing, and neutralizing to achieve the commander's desired end state."[22] If this paradigm of network engagement is actively managed across civil affairs formations, then the data will be more standardized, which means more holistic analysis can be conducted.

Foreign internal defense and security force assistance. Reviewing the funding streams that Gen. Richard Clarke and Gen. Bryan Fenton highlighted in their posture statements to Congress, there is an argument that building capacity with our unified action partners could indirectly disrupt or deny the service that the Espacio Lejano ground station provides.[23] While this approach would take years to come to fruition, there is a case to be made that the U.S. military would garner extra attention from host-nation senior military leaders if training and developing host-nation capabilities with SOF, security force assistance brigades, and the National Guard's State Partnership Program were overwhelmingly successful. Senior military officials in South America, much like the United States, brief and advise politicians. As such, the senior military leaders of the host-nation country may convince the diplomats not to renew the country's land contracts with the People's Republic of China due to overwhelming support for the United States as the partner of choice. Out of all the proposed OAIs, this one would require the most synchronization between the elements of national power and is encapsulated in the strategic-level aperture of SEI.

Conclusions

Given the U.S. Special Operations Command's global disposition and concentration on an IW approach to campaigning, SOF is the most well-postured equity to provide direct and indirect effects against adversarial SEI. This emerging concentration requires an understanding of space infrastructure as critical infrastructure and would contribute to the Department of Defense maintaining a position of relative advantage against the adversaries of the United States in the space domain. While SOF will always be innovative in its approach to solving complex problems, history is replete with examples that can provide planners and operators a foundational understanding for grappling with a complex issue such as space warfare.

While DA provides the most damaging effects against adversarial SEI, this is not the recommended course of action. A nuanced approach, accounting for attribution and risk, points toward SR and MISO as preferred OAIs to conduct against our adversaries to stay below the level of armed conflict. This is imperative so our adversaries do not disproportionally retaliate. While currently not a joint SOF core activity, preparation of the environment needs to be added to the list of recommended OAIs as well. The previous version of JP 3-05, *Special Operations*, defined preparation of the environment as "an umbrella term for operations and activities conducted by selectively trained special operations forces to develop an environment for potential future special operations."[24] Leveraging preparation of the environment efforts to conduct future OAIs against adversarial SEI will be paramount to maintaining positions of relative advantage.

SOF must execute SR in conjunction with the interagency to bring to bear national-level capabilities and to facilitate a comprehensive and enduring approach. The consolidation of collection efforts should focus on network mapping to include the physical and cyber infrastructure, dossiers on the employees at these sites, the surrounding essential services that supports the SEI site, and the essential services that support employees when they are at their domicile.

The global integration of SEI also introduces more vulnerabilities against the adversary. Much like concepts from the Air War Plans Division 1 document, niche components that allow these ground stations to function may only be produced by a select number of factories in an adversary's domestic industry or the domestic industries of their partners. Therefore, if the few factories that made these components were degraded, then repercussions may extend globally to adversely affect an adversary's SEI. Predicated on gaining access to the network, cyber forces will have a large part to play against adversarial SEI. The cyber community will need to map the digital infrastructure to find vulnerabilities and potentially cause physical repercussions. Finally, the conduct of these OAIs is predicated upon funding, appropriate authorities and permissions, requisite training infrastructure, and tailored military education. This will enable our tactical formations to articulate requirements at an intelligible level to experts and prosecute intended effects. The capacity to hold adversarial SEI at risk will be a key marker in how irregular warfare contributes to integrated deterrence. Effectively implementing the Triad gives policymakers offensive options across the competition continuum and ensures that the United States remains in a position of relative advantage in the space domain.

Recommendations

The author proposes the following recommendations by precedence to better posture the United States to compete against our adversaries:

- The Joint Staff should adopt the definition for space-enabling infrastructure proposed in this article as well as incorporate celestial lines of communication into the professional lexicon.
- Given the emphasis from senior space leaders and prominent authors on the role of the cognitive dimension in space warfare, greater collaboration is needed between SOF PSYOP and the specific space equities focused on altering adversary decision-making to create greater shared understanding regarding MILDEC and MISO operations.
- Synchronize IW campaigning efforts among the Central Intelligence Agency, National Security Agency, National Space Intelligence Center, and the SOF community to conduct space, terrestrial, and cyber preparation of the environment on adversarial SEI. As this IW campaign continues

to grow, the security force assistance brigades and National Guard's State Partnership Programs should be brought into the fold to augment OAIs surrounding building partner-nation capacity.

Areas for Future Research

Given the limitations on this research and the ever-changing nature of the operational environment, there are several areas that warrant additional scrutiny:

- What are the appropriate command and control relationships for employing SOF elements in support of targeting SEI? Is it the respective theater special operation commands at the geographic combatant commands, a SOF cell in the operations section at U.S. Space Command; or as a geographic combatant command, does U.S. Space Command warrant its own theater special operation commands, granting access to major force program eleven funding? Furthermore, who is augmenting U.S. Space Command's staff with planning irregular warfare OAIs?
- Through the lens of orbital warfare, what are the SOF-facilitated effects in the space segment itself? What does maneuver warfare look like on orbit? While the physics and energy requirements do not currently support a robust answer to this question, what might it look like ninety years from now? As SOF cannot be mass-produced, this capability would take time to generate, and it may be a mission most suited for a future SOF component within the U.S. Space Force.
- In the same vein that the Department of Defense has aerial and sea points of departure, how do the Department of Defense and its civil and commercial partners exploit on-orbit capabilities, and how might we operationalize the Lagrange points (points of gravitational parity between two celestial bodies) into celestial points of debarkation to enable space logistics that support IW?
- Given the amount of specialized training that SOF service members receive, how does the SOF community grow a cadre of SOF space experts amongst the officers, warrant officers, and senior noncommissioned officers? ■

Notes

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16. JP 3-13, *Information Operations* (Washington, DC: U.S. GPO, 2014).

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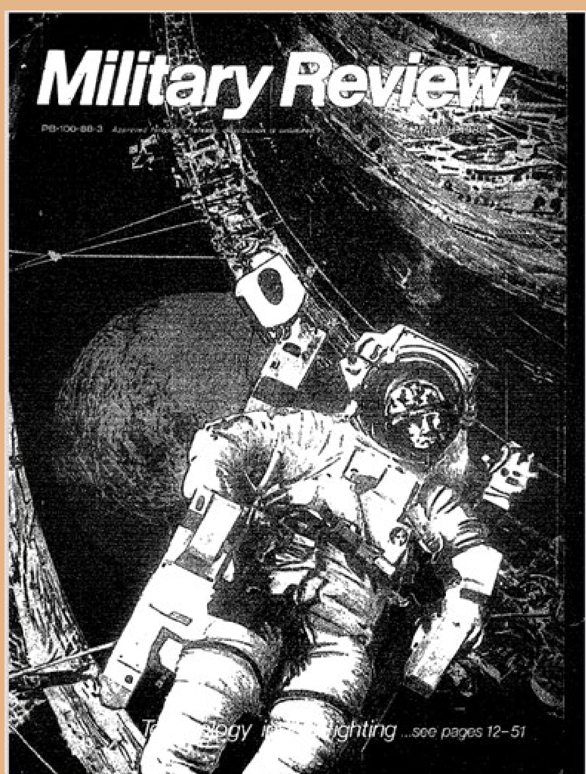
Your attention is invited to a legacy edition of *Military Review* with a special section on exploitation of space technology. See pages 12–51 of the March 1988 edition at https://cgsc.contentdm.oclc.org/digital/collection/p124201coll1/id/515/rec/9.



A soldier assigned to 2nd Battalion, 1st Air Defense Artillery Regiment, 35th Air Defense Artillery (ADA) Brigade, talks to his higher headquarters during the Freedom Shield training exercise in South Korea on 19 March 2023. The purpose of 35th ADA's training was to improve individual soldier capability and to maintain unit readiness. (Photo by Sgt. Josephus Tudtud, U.S. Army)

"Shield or Glue" Revisited

Multinational Missile Defense Policy Variables

Marxen W. Kyriss, PhD

In 2018, I published a dissertation titled "Shield or Glue? Key Policy Issues Constraining or Enhancing Multinational Collective Ballistic Missile Defense."[1] My original goal was to show which of eleven ballistic missile defense (BMD)-related policy variables would encourage or discourage a nation from joining a coalition or alliance that used BMD as a core capability. Since its inception and nature, BMD comes with a lot of political baggage, and countries view the implications of its use differently. This article aims to summarize that research and conclude with some assessments about changes in my findings due to changes in the world since 2018.

I based this research on my insights as a fourteen-year-core member of the U.S. Strategic Command's Nimble Titan campaign series of multinational missile defense (MD) policy experimentation (which has since moved to U.S. Space Command with the transfer of the missile defense mission in the 2023 Unified Command Plan). I learned over several two-year campaigns that eleven MD-related policy topics continued to be the main areas that challenged the players the hardest politically, and these became my policy variables. Nimble Titan is a community of twenty-four nations and three multinational organizations from Europe, the Gulf Region, the Indo-Pacific, and North America, and its participants are split between defense and foreign affairs professionals from all these states.[2] Approval by the Nimble Titan national leads to conduct my research gave me unprecedented insights into the variety of thinking on these policy variables as they differ between states and regions, and defense and foreign affairs personnel.

During my research, I learned not only which policy variables might encourage or discourage a nation from joining a coalition or alliance using BMD, but I also found that some were only relevant within an operating coalition or alliance. Some, if poorly handled, could lead to a decision by a state to leave a coalition or alliance. I also learned that some variables were drivers of others and hence had interaction effects, that some were weighted more strongly than others, and that this weighting varied by geographic region. This ultimately caused me to change my original analytical model (see figure 1) to something richer and much more complex.

Briefly summarized, my original research model can be read as follows: Given the listed antecedent conditions, using the intervening variables of state types (those states that own BMD, support other states with BMD directly or indirectly, or do not own BMD or support BMD-equipped states), which of these intervening variables (IVs, listed as hypotheses), viewed through the lenses of national, foreign affairs, and defense perspectives, would encourage or discourage a state from joining a coalition or alliance that uses BMD (the dependent variable)?

Using standardized questions related to the policy variables, data was gathered through extensive interviews with defense and foreign affairs personnel from most Nimble Titan states and multinational organizations.

The Policy Variables Explained

I defined BMD-related policy issues as those involving the use, or potential use, of BMD. This includes discussions between national political and military leadership, and between nations involved in collective political-military action. These issues may require national or multinational decisions or agreements. These issues became the eleven policy variables explored, which, in the original model, broke down into three categories of IVs; that is, those that are adversary-centric, those that are internal to a coalition or alliance, and those that are related to third (or external) parties. In the dissertation, I expanded on each variable's military and political implications, which we, unfortunately, do not have room for in this article.

Adversary-centric IVs. The first two are relational issues between the country that is considering joining a military coalition

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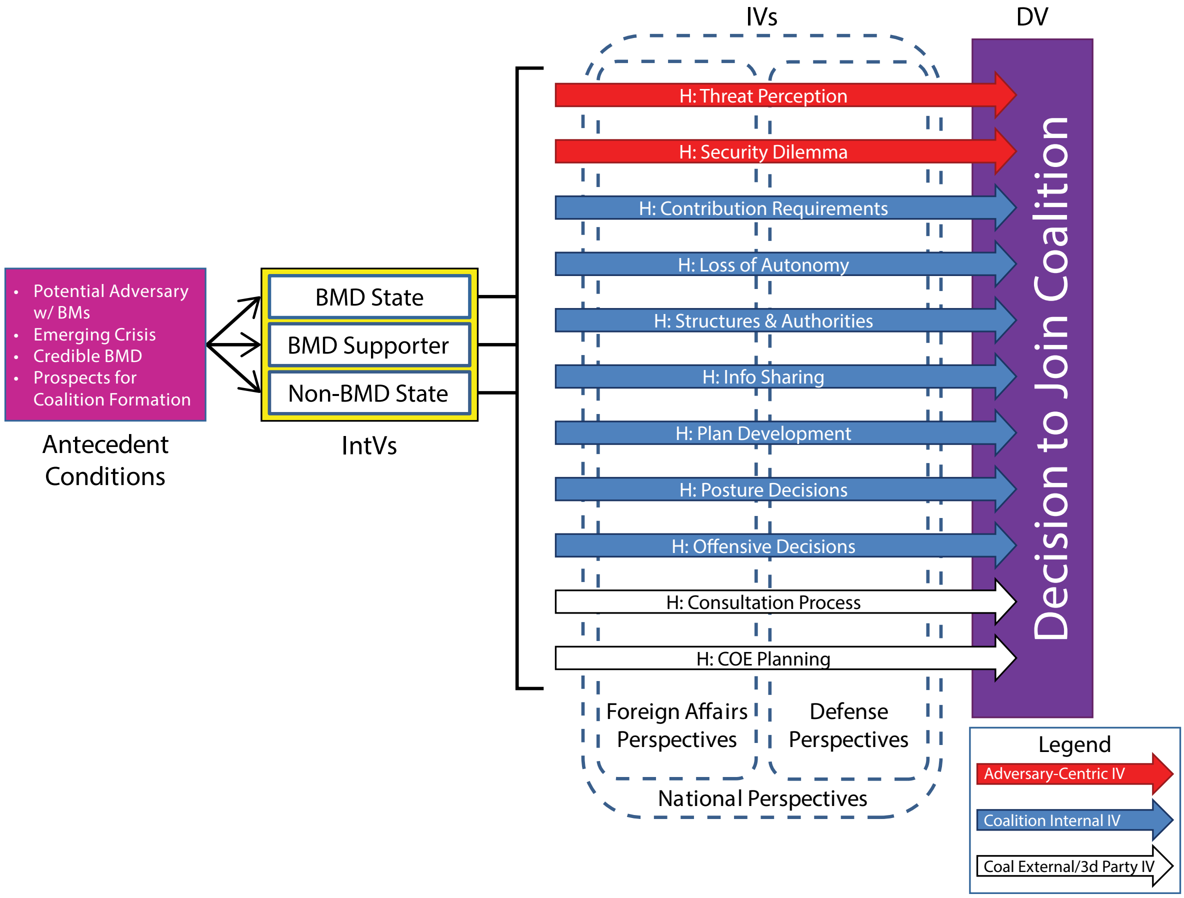


(Figure by author)

Figure 1. Original Theory

or alliance that uses BMD and a potential adversary that uses missiles. While relational, they are also perceptual variables, rather than concrete and quantifiable ones, in that they both include the *perceived* relationship between the joining state and their potential adversary.

Hypothesis 1 (threat perception). The greater the perception of threat from a potential BM-equipped adversary, the more the likelihood of a state joining a multinational military coalition or alliance that uses BMD increases. Two assumptions underpin this: (1) the political situation is such that the state considering joining an alliance or coalition feels potentially threatened by the adversary (i.e., the adversary has possible intent) and (2) the state is within range of the adversary's missiles (i.e., the adversary has existing capability).

Hypothesis 2 (security dilemma). As adversary concerns with friendly coalition/alliance military buildup increase, adversary tensions and pressure on the state not to join increase, and the likelihood of that state joining a multinational military coalition or alliance that uses BMD decreases. A derivative of the classic security dilemma, as John Herz and Robert Jervis laid out, exists for BMD.[3] In this view, the acquisition of BMD may make potential adversaries feel insecure in their ability to use their offensive forces to settle a dispute and hence feel the need to further their offensive capabilities to offset the BMD, thus creating an arms race. Assumptions include that (1) the joining state must have an independent means of settling the dispute with the potential adversary from the rest of the coalition or alliance, and (2) there cannot be prior political commitments to the coalition or alliance that can overcome adversary pressure not to join.

Internal coalition-centric IVs. These factors are internal to the coalition and exist between some or all coalition partners.

Hypothesis 3 (contribution requirements). As national military force contribution and commitment requirements for coalition membership are made less restrictive, the likelihood of a state joining a multinational military coalition or alliance that uses BMD increases. Assumptions include that (1) there will be some price of admission into the coalition wherein the other states will impose some requirement for national contribution of capabilities to collective military operations; (2) these national contributions and/or commitments will guarantee collective defense of the giving state; and (3) these national contributions may or may not have to be in the form of BMD weapon systems but could also be economic or political support, use of territory for basing or overflight, or contribution of other military capabilities that complement BMD, such as air defenses, offensive strike aircraft, intelligence-gathering capabilities, etc.

Hypothesis 4 (loss of autonomy). As the possible loss of national autonomy for military decision-making and command and control of its forces increases, the likelihood of a state joining a multinational military coalition or alliance that uses BMD decreases. Assumptions underlying this include (1) the states wish to maintain national command over their forces within a multinational coalition or alliance military structure, (2) the proposal is that the state must transfer its forces under the command of military leadership from another coalition or alliance state, and (3) there are no preexisting arrangements between the state and the coalition or alliance for transfer of national forces subordinate to the collective military structure.

Hypothesis 5 (structures and authorities). As collective BMD command-and-control (C2) structures and engagement authorities are made more inclusive, the likelihood of a state joining a multinational military coalition or alliance that uses BMD increases. I assume (1) the coalition will establish a single military C2 structure, (2) coalition military forces will be subordinated to this single C2 structure, and (3) each nation may impose specific limitations or restrictions (e.g., legal, constitutional, or political red lines) on the use of their military forces, which must be taken into consideration by the coalition military leadership.

Hypothesis 6 (information sharing). As multinational information sharing, information disclosure, and shared early warning increase, the likelihood of a state joining a multinational military coalition or alliance that uses BMD increases. Assumptions include that (1) all coalition states recognize the value and efficiency gained in sharing information with each other; (2) information disclosure processes within the coalition will be streamlined to ensure more rapid exchange of information before and during a potential conflict; and (3) a shared early warning that consists of the real-time provision of warning of adversary missile launches using satellite, ground, and maritime-based sensors will be provided between all members of the coalition. This is done to warn civil defense and military air and MD forces of an inbound attack.

Hypothesis 7 (plan development). As collective defense prioritization, level of protection guidance, and defensive plans development are made more inclusive, the likelihood of a state joining a multinational military coalition or alliance that uses BMD increases. This assumes that (1) coalition or alliance military planners will take political guidance and centrally develop a BMD defensive plan that prioritizes what gets defended and to what level of protection. Such planning will dictate where BMD forces are placed, what they will defend, for how long, and how many interceptors BMD forces must be prepared to fire per inbound threat ballistic missile; and (2) the coalition national political leaders will collectively approve such prioritization guidance and planning.

Hypothesis 8 (posture decisions). As collective decision-making regarding posturing of forces (including the military need for deployment versus the political need for deterrence and de-escalation) is made more inclusive, the likelihood of a state joining a multinational military coalition or alliance that uses BMD increases. Assumptions include (1) nations in the coalition or alliance may collectively or independently work on political measures to deescalate the crisis with the ballistic missile-equipped adversary or to deter his attack; (2) some nations in the coalition or alliance may need to deploy forces into the theater to prepare for conflict, while other states may comprise this theater and already have their forces in place; (3) decisions regarding posturing of forces may be made by the coalition or alliance military structure or could be made by member nations independently; and (4) movement of additional forces into the theater from outside will be visible and seen by the potential adversary, which could, in turn, escalate the situation.

Hypothesis 9 (offensive decisions). As collective decision-making regarding the timing of, triggers for, authorities required for, and legitimacy of offensive operations is made more inclusive, the likelihood of a state joining a multinational military coalition or alliance that uses BMD increases. Assumptions include that (1) BMD forces are inadequate to defend everything, so offensive strikes on the adversary's ballistic missile forces are likely to be required to compensate for defensive shortfalls; (2) the decision to commence offensive strike operations against the adversary's missiles may be required prior to the formal commencement of hostilities; (3) coalition nations may have differing views on what provides legitimacy to authorize offensive strike operations (e.g., some states require a United Nations Security Council resolution authorizing the use of force, while others may feel the situation meets the "clear and present danger" criteria for anticipatory self-defense outlined under the Caroline Incident of 1837; and (4) coalition nations may collectively decide when to begin offensive operations or may feel the need to do so unilaterally. Such unilateral decision-making may stress coalition political cohesion.[4]

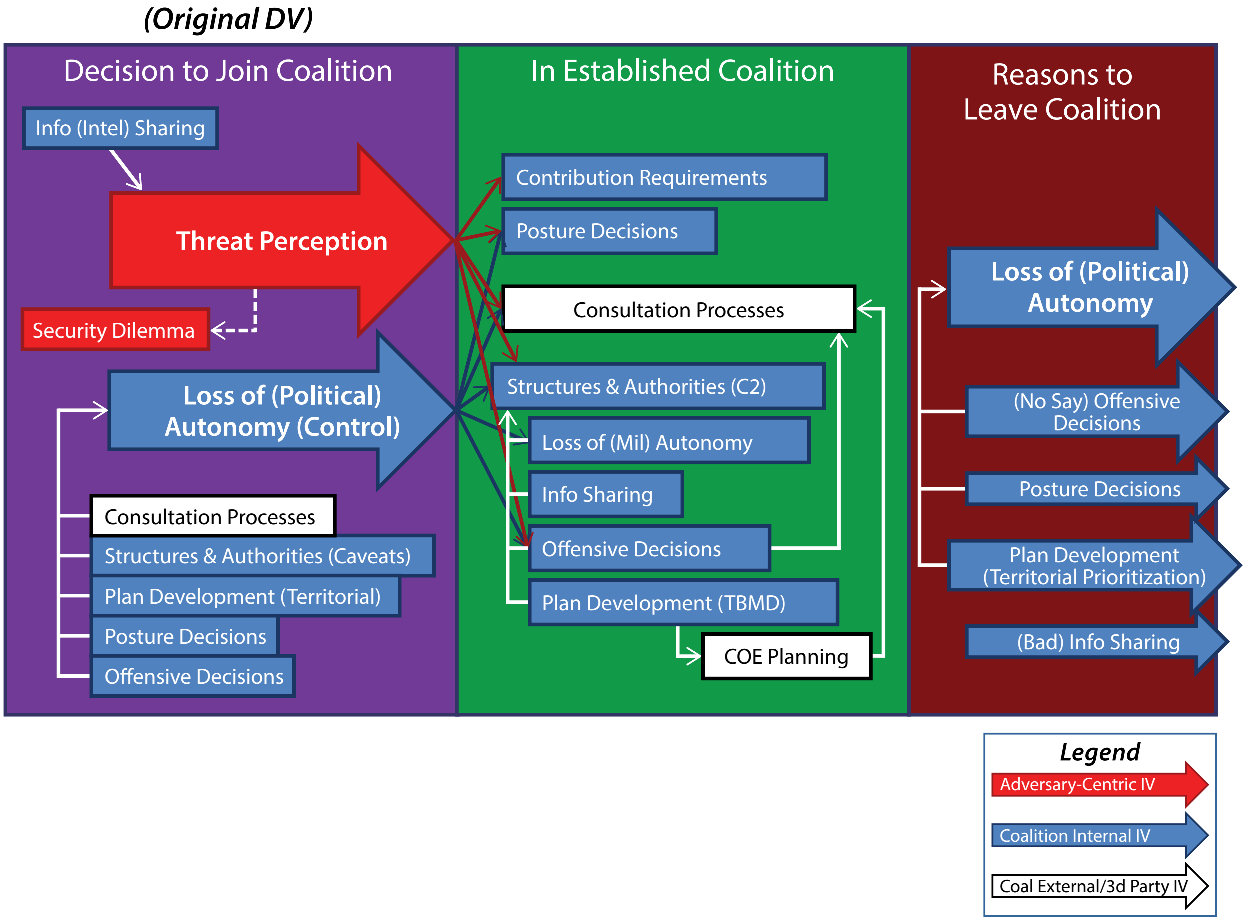
External third-party-centric IVs. These factors apply to how the coalition engages with third parties. We define third parties as nations or multinational organizations that are neither a part of the coalition or alliance nor aligned with the potential adversary.

Hypothesis 10 (consultation processes). As collective consultation processes and engagement with third parties (including strategic communication and declaratory policy) are made more inclusive, the likelihood of a state joining a multinational military coalition or alliance using BMD increases. This assumes that (1) a military coalition or alliance's nations may collectively coordinate external consultations, strategic communications, or declaratory policies prior to external engagement with third parties, or these nations may independently or bilaterally engage without internal coalition consultation; and (2) coalition or alliance states want to coordinate these endeavors to prevent fratricidal or conflicting messaging with third parties or the potential adversary. I define "consultation" as the exchange of views and the conduct of deliberations either among the authorities of the participants or between participants and third parties (including potential adversaries), aiming at harmonizing positions and formulating recommendations on issues of common concern. I define strategic communications as all actions and activities participants conduct to send persuasive messages to various desired audiences, through the most suitable communication channel, at the appropriate time, to contribute to an overarching strategy. Lastly, I define declaratory policy as information transmitted via diplomatic and/or public channels containing and/or describing the intentions or possible actions of the participants in order to influence the behavior of adversaries, neutrals, or potential supporters.

Hypothesis 11 (consequences-of-engagement planning). As collective planning for consequences of engagement (COE) (including civil warning, consequence management, and liability for damages from successful or unsuccessful MD intercepts) increases, the likelihood of a state joining a multinational military coalition or alliance that uses BMD increases. I assume that (1) states will wish to take all prudent precautions possible in advance of a conflict to minimize COE, and (2) that the degree and scope of what defines prudent precautions is open to debate. I define COE as the political-military consequences from all phases of BMD operations that could arise because of an interceptor's launch (or lack of launch). This includes consequences of intercept plus prelaunch activities (such as consultation, rules of engagement, intelligence about a potential launch, and planning) that could affect policy and possible military response, and the effects from the interceptor owing to an unsuccessful intercept. Consequences of intercept is defined as the physical hazards arising from the intercept of a threat ballistic missile and its effects on the civilian population, critical infrastructure, and military capabilities. Consequence management is defined as those measures taken to protect public health and safety, restore essential government services, and provide emergency relief to governments, businesses, and individuals affected by the consequences of intercept, engagement or that of a chemical, biological, nuclear, and/or high-yield explosive situation.

The Final Model Explained, with Recommendations for Policymakers

I discovered that there were not eleven BMD-related policy variables that might influence whether a nation would join a coalition or alliance that uses BMD.



(Figure by author)

Figure 2. Final Model

Ultimately, there were two major factors that seemed to do so but which had important linkages to seven other variables in the precoalition-formation stage. Four of the original IVs were seen as actually more significant once a coalition was formed, while five more were subsets of one of these four. Lastly, five of the original IVs, if mishandled, were cause for a state to leave an established coalition (two of which are only subsets of a larger one). These findings were reflected in my final model (see figure 2).

The model is read chronologically from left to right, with the purple box representing the precoalition-formation stage in which my original dependent variable, the decision to join a coalition or alliance that uses BMD, is captured. The middle green box represents an established coalition or alliance that uses BMD, while the dark red box on the right represents the factors that may result in a decision by a state to *leave* a BMD-using coalition or alliance.

Starting with the decision to join coalition box, the information sharing IV itself is insufficient to cause a state to join, but one element of it, shared intelligence, is a critical piece in developing the threat perception, whether that of an individual state or the collective threat perception of multiple states. Threat perception itself was observed as one of the two major factors in the decision to join. Without a threat, there is no need to establish a short-term military coalition or long-term military alliance. One spinoff of threat perception was the IV security dilemma, which is, in effect, the reaction of the adversary or other third parties to the actions taken by the state or coalition based on their threat perception. Security dilemma was not seen as either causal of joining or even impactful, but most respondents agreed that the reactions of an adversary or major third party like Russia or China must be taken into consideration. Most felt this would generally be done by an established coalition or alliance via political consultation processes to ensure the intent of coalition action was clearly understood by outsiders.

The six IVs in the bottom half of the decision to join coalition box are also related. Most respondents saw the original loss of autonomy IV as really two elements: only loss of (political) autonomy was significant in the decision to join. Loss of (military) autonomy was not discussed but will be discussed shortly. Where the five IVs below it on the model were discussed as impacting the decision to join, it was generally within the context of how each was an element of loss of (political) autonomy. Consultation processes are viewed as the sovereign right of a nation's political leadership; should the coalition or alliance mandate nonunilateral consultation, many states would see this as a loss of political autonomy. Within structures and authorities, several states mentioned that maintaining political control over their forces would be done by retaining red cards or caveats on their use; if this loss of political control happened, they would not be comfortable joining a coalition. Within plan development, most states felt that if they lost political control over the planning and defense prioritization that would account for territorial or homeland BMD, they would, again, be uncomfortable joining the coalition; this contrasted with theater BMD planning to protect deployed forces, which was seen as a coalition military concern only. Some also mentioned the loss of political control over elements of posture decisions and offensive decisions, both seen as potentially politically and militarily escalatory, as a potential reason to not join, but again, within the context of "loss of (political) autonomy."

> Threat perception was the main, positive *driver* in coalition joining, while loss of (political) autonomy (or control) was the single significant *detractor* that would cause a state not to join.

In short, threat perception was the main, positive *driver* in coalition joining, while loss of (political) autonomy (or control) was the single significant *detractor* that would cause a state not to join. Both major IVs linked to several IVs in the next phase of the model.

In the central "in established coalition" box are nine related factors that are seen as mainly only relevant between members of an established and active coalition. Threat perception was shown to be the principal driver behind five IVs. Nations felt the threat would dictate contribution requirements; nations would provide forces necessary to address the types of threats perceived. "Posture decisions" would be made based on how the coalition or alliance perceived the intent of the adversary. Again, engaging with the adversary or third parties would be done via consultation processes based on a desire to deescalate or deter perceived hostile intent by the adversary. Military structures and authorities would be established by political leadership to prepare for a perceived threat. Lastly, as a crisis escalated, and adversary preparations for missile use in conflict became perceived, "offensive decisions" could need to be undertaken based on the imminence of the threat.

Loss of (political) autonomy was seen by many as impacting established coalition or alliance cohesion and effectiveness. Political decision-making and consensus was seen as important behind posture decisions, and consultation processes. The establishment of the C2 structures and relevant authorities behind structures and authorities was necessary to direct subordination of national forces under multinational control in loss of (military) autonomy, and a major prerequisite for offensive decisions, which were seen by several as the decision to go to war.

In an established coalition or alliance with a set structures and authorities military C2 structure, loss of (military) autonomy was observed as a necessary element of this C2 structure in which unity of command and unity of effort are cardinal military virtues; after all, someone must be in charge. Information sharing, offensive decisions, and plan development, particularly for the theater BMD mission to protect deployed forces in a military theater, were seen by many as responsibilities of, or functions necessary for, an effective C2 structure. COE planning was generally seen as a to-do list item under plan development, in that MD planning is not complete without factoring in COE considerations. While discussing consultation processes, many respondents cited the necessity to engage with partners and third parties about potential COE and the need for accurate COE data to inform these consultations; I reflect this in the model with COE planning also feeding into consultation processes as a related variable.

or incomplete information provided would result in loss of life or damage of vital interests by the receiving coalition member. Lastly, in plan development, several states noted that if their vital national interests were not considered when prioritizing territorial or homeland BMD, they would have no good reason to belong to a BMD-using coalition or alliance. This last is an important consideration, especially when there are inadequate defenses to protect the territories of all coalition members. In summary, these five IVs are the ones extant coalition political and military leaders must pay the most attention to *prevent* member defection.

“The first, most obvious requirement for a coalition is developing a shared common threat perception. This is *the* necessary and sufficient condition that collective military action requires.”

A major, albeit serendipitous, finding was not just what would cause a nation to *join*, but, perhaps more importantly, what would cause a nation to *leave*. This led to the rightmost “reasons to leave” the coalition area of the model. I do not show these as linked to IVs within the established coalition box because they are variables that only apply if handled badly.

Unsurprisingly, since loss of (political) autonomy was the largest detractor from joining a coalition, it should be the one cited most as a principal reason to leave. Should a nation feel it has lost its say in political matters, it would be highly motivated to pull out of a coalition. A related element would be if a state had no say in offensive decisions about when and why to initiate offensive operations. If this political decision to go to war were taken from a coalition member, yet that government would be expected to share the consequences, then that nation could find the domestic and international pressure too much to bear. Similarly, if posture decisions were taken away from a state by the collective, then the state would bear responsibility for any escalatory or provocative actions undertaken by the coalition, which could have a similar impact to offensive decisions. I reflect both IVs as subordinate elements of loss of (political) autonomy in the model for these reasons.

Although only mentioned a small number of times, the idea that bad information sharing would be a deal-breaker for some members has some merit, especially in circumstances in which intentionally bad

Recommendations for policymakers. Based on the final model, I divided my recommendations for policymakers into three groups. The first includes those areas that the coalition-builder must do to successfully achieve coalition building. The second are those that a coalition-builder must not do should they wish to build and sustain their collective. The last are those in which the collective political leadership of an established coalition or alliance should do to optimize the success of the multinational BMD mission.

Must-dos. The first, most obvious requirement for a coalition is developing a shared common threat perception. This is *the* necessary and sufficient condition that collective military action requires. In the case of a BMD-using coalition or alliance, such common threat perception must be based on a common belief in the capability and intent of a missile-armed potential adversary. Simple negotiations to gain consensus on the threat may be inadequate to spur coalition formation. It is necessary for nations wishing to encourage others to join them to overcome political, procedural, or legal hurdles to share credible military intelligence that highlights potential threats common to all. This must include the adversary’s capability and intent vis-à-vis the threatened states to truly garner support. It is not enough just to say the adversary could hurt a potential partner; they must believe they have incentive to try. Thus, per my model, the intelligence element of information sharing leading to common threat perception that motivates partner nations is imperative.

Second, a nation that wishes to create a coalition or alliance must assure prospective partners it will maintain political control over critical decision-making, even if military autonomy and control is subordinated under another nation within the coalition C2 structure. Specific BMD-related decisions must remain within the purview of individual nations acting within a collective decision-making apparatus. Nations must feel they retain the right to unilateral consultation processes despite the benefits of collective political engagement. Within structures and authorities, caveats or red cards must be retained that enable nations to either withhold their national forces from certain unpalatable or illegal (for them) actions or withdraw from the coalition should the situation become politically untenable. Having a say in territorial defense prioritization to ensure critical national assets, population, and infrastructure make the cut within plan development is another major political element; without this right, states may not feel the cost to join and participate is worth the effort. Lastly, having a political say in the nature of and timing or triggers for potentially escalatory posture decisions to deploy and posture offensive and defensive forces, and offensive decisions to initiate use of coalition or alliance offensive strikes, must be guaranteed to encourage membership. Taking these rights away will not only dissuade joining but could encourage defection from the coalition or alliance, due to excessive domestic and international political costs.

Must-not-dos. The natural obverse of the above would be for the coalition-building nations to restrict critical military intelligence via information-sharing mechanisms to prospective partners that would inhibit the development of a common threat perception. Because foreign disclosure processes are complex and convoluted in many nations, the natural inclination, especially in time-critical situations, maybe to try to build common threat perception without adequate shared and agreed intelligence. The risk of this is that it may actually slow down coalition or alliance building while the builders struggle to convince partners to join without adequate rationale. It will also harm international support for the coalition operations, particularly in the form of United Nations Security Council resolutions, which may require the presentation of credible intelligence. Therefore, states should implement expeditious foreign information disclosure processes in peacetime based on presumption of a need to share rather than the preclusive need to know doctrines integral to most national intelligence apparatuses.

Coalitions and alliances are trust-based, so policymakers within an existing and operational collective must protect the sanctity of information sharing to sustain this organization of like-minded states. Beyond intelligence, if nations appear unwilling to share information about friendly forces or capabilities necessary for collective military planning and operations, this may stress coalition or alliance cohesion and possibly result in fragmentation or even defection. At the extreme, providing intentionally bad information, or intentionally restricting or withholding critical information, may lead to bad decision-making by partner nations and possibly even loss of life or destruction of critical property. This may break the trust of these nations should it become known that it was done intentionally and could lead to partner defection from the alliance or coalition. In the worst case, intentional internal deception may increase coalition risk, as a spurned partner defects, taking what it knows of coalition plans and processes, potentially to be shared with outsiders.

A more significant set of must-not-dos entails taking any actions that would be seen as imposing a loss of (political) autonomy on partners or allies, which could inhibit the desire of a state to join or force a coalition partner or ally to defect should they feel they are losing the ability to perform obligatory political oversight. Care must be taken to ensure states do not believe the collective political body is taking away their say in posture decisions or offensive decisions with which they do not agree but for which they are politically answerable either internationally or domestically. Lastly, the coalition or alliance must ensure states retain a say in collective territorial defense prioritization (plan development), and if the collective military leadership is unable to meet an individual nation's prioritization demands (due to a lack of BMD resources, assessed lack of need, or because there is no agreed threat to them), they must be clear in explaining their reasoning to these nations to ensure they do not feel their concerns are being ignored.

Should-dos. Many of the IVs discussed ended as policies or procedures used mainly within an extant coalition or alliance. Of these, the following may, if observed being done well from the outside, encourage new members, and internally enhance collective cohesion within a BMD-using coalition or alliance.

There is a strong need for coalition or alliance members to develop and present common strategic messaging to adversaries and third parties via well-defined collective external consultation processes; these must not preclude an individual nation's consultation processes and, in many instances, may be enhanced by them when a partner nation has an existing relationship or engagement mechanism with the adversary or third party. Strategic communication engagement appears to be important, especially when used to preclude a potentially escalatory security dilemma or posture decision situation with a potential adversary through clarifying coalition or alliance intent about the deployment and employment of defensive forces. These also facilitate engagement with third parties to assuage their concerns about COE damages or liability before, during, or after a conflict.

Similarly, a clearly defined set of internal collective political-military consultation processes to gain rapid political decisions through the entire cycle of military planning and operations is also very attractive. Such deliberate, structured processes as demonstrated by NATO demonstrate a serious, committed organization that may appeal to many external nations.

Because nations join coalition or alliances with expectations that they may need to provide forces or supporting capabilities, having clearly defined roles, responsibilities, missions, and authorities for their national contribution requirements is also important. Suppose processes are in place for partners to easily understand what part their forces play within the coalition or alliance mission and military structure. In that case, these processes may help a joining nation see, up front, what its contribution requirements likely could be. This can be doubly important for BMD-equipped nations wishing to join the coalition or alliance; in such cases knowing *what* or *who* they may be required to defend can be used to make cost-benefit assessments and garner political support at home for joining.

Lastly, policymakers within a coalition or alliance need to establish clearly defined roles, responsibilities, missions, and authorities for their military C2 structures and authorities. In addition to normal military headquarters structures for land, air, and sea military operations, BMD-using C2 has additional requirements. This C2 structure must include a well-defined and very inclusive multinational chain of command to mitigate concerns about loss of (military) autonomy by including national oversight by senior military personnel within the collective structure. The collective C2 structure must have streamlined information-sharing arrangements to expedite planning and operations, coupled with the national intelligence necessary to do so. Well-understood, doctrinally rigorous territorial BMD and theater BMD plan development processes that allow all partners seats at the prioritization table are imperative in any BMD-using coalition or alliance.

Multinational C2 structures must also include mechanisms, processes, and tools for COE planning to support national and collective defensive force positioning and COE consultations within and outside of the coalition or alliance. Modeling and simulation tools to perform COE analysis may assuage concerns about liability and damage from debris.

Lastly, the C2 structure must include offensive and defensive planners familiar with all adversary and friendly defensive and offensive systems necessary to provide options to coalition or alliance military leadership and to inform political offensive decisions and their subsequent military implementation.

Conclusion: Changes in the World since 2018 and Their Implications

Continuance of experimentation up through the Nimble Titan 2024 campaign continues to highlight the relevance and importance of these policy variables. However, some significant changes in geopolitics, as well as in the views of the global MD community, have occurred since I drafted my BMD-focused dissertation in 2018.

First, the current war between Russia and Ukraine has significantly influenced previous thinking. Prior to that, it was an almost forbidden topic to discuss MD against Russia; the United States has consistently avowed across its Missile Defense Reviews that its homeland BMD systems are neither sized nor structured to offset the large strategic arsenals of Russia or

China, while NATO has been seemingly hesitant to consider changes to its MD to address Russian missile threats.[5] This has changed with the war in Ukraine. The United States has placed cruise missile defense of its homeland against Russian long-range cruise missiles on the table, and the 2023 NATO Vilnius Summit Communiqué makes clear a change in NATO IAMD policy against Russian air and missile threats to NATO territories.[6] The accession of Finland and Sweden to NATO because of the war also provides excellent case studies for the application of the model in this dissertation—and for further exploration in venues such as Nimble Titan.

Second, the Ukraine conflict also highlights something that is of no surprise to MD practitioners—"BMD" is no longer an adequate stand-alone concept. Nations cannot think of BMD as an activity all by itself. It is generally accepted that BMD is part of a broader MD field, which, in turn is a subset of an even broader integrated air and missile defense (IAMD), which defends against an even wider set of threats. The good news is that, had I replaced all instances of "BMD" with "IAMD" throughout my research, I believe my findings would likely still have generally held.

The last area of emerging thought revealed through continued experimentation and driven by real-world lessons from Ukraine is related to adversary operational use of advanced weapons that are more difficult to defend against than ballistic missiles. These include maneuvering hypersonic glide vehicles, uncrewed aircraft systems, advanced cruise missiles, and so on. While Russian use of these systems in Ukraine has been less-than-impressive (in relative terms), the fact that many of these systems are dual-use (e.g., nuclear and conventional) means they cannot be simply overlooked, and other adversaries that possess similar capabilities may use them more effectively. The major implication here is that if you are unable to defend against these threats credibly, you may be driven to offensive action earlier than against more "traditional" threats. This "need" for anticipatory self-defense makes many nations uncomfortable and places stress on coalitions or alliances in which perceived legal offensive thresholds may vary between partner nations. Anticipatory self-defense against missile threats can be achieved through multidomain approaches (both kinetic and nonkinetic), each of which comes with its own set of policy implications.

Because no one nation can shoulder the complex air and missile fight alone today, the need to continue experimentation to understand multinational IAMD policy, planning, interoperability, and legal issues remains. This just highlights the need for wargames such as Nimble Titan to continue and expand our collective understanding with partners and allies. To quote Sir Winston Churchill, "There is only one thing worse than fighting with allies, and that is fighting without them."[7] ■

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Enduring Threats and Enduring Presence

Integrated Air and Missile Defense in the U.S. Central Command Area of Responsibility

Col. Glenn A. Henke, U.S. Army

Integrating air and missile defense forces in the U.S. Central Command (USCENTCOM) area of responsibility (AOR) spans all phases of conflict, from competition to large-scale combat operations (LSCO). Much like in the other geographic combatant commands, this integration occurs with multiple partners and allies against a backdrop of emerging threats and external competitors. These partners pursue integrated air and missile defense (IAMD) solutions tailored to address their unique requirements, which challenges broad discussions of regional integration in favor of more precise and discrete outcomes for common defense of mutual interests. Unique to USCENTCOM, U.S. forces face lethal air and missile threats from Iranian forces and their proxies who have conducted (and continue to conduct) attacks against American troops. This reality raises the urgency of all integration efforts and creates challenges not faced by forces serving in other geographic combatant commands.

The Threat

The 2022 *National Security Strategy* assessed that Iran remains a critical strategic concern due to the regime's continued hostility to U.S. interests and active interference in the affairs of its neighbors.[1] In addition to their robust missile and unmanned aircraft systems (UAS) capabilities, groups across the region supported by Iran have demonstrated both the means and intent to attack U.S. forces. These groups range from militant groups operating in Iraq and Syria to proto-state actors like the Houthis in Yemen, with some measure of territorial control within existing states.

These actors wield a broad range of threat capabilities, including tactical ballistic missiles (TBM), cruise missiles, and UAS. Hostile forces have employed many of these systems against U.S. and allied forces, sometimes with lethal effect. In 2020, Iran launched multiple TBMs against two U.S. bases in Iraq.[2] Iran has continued to launch ballistic missiles against Kurdish forces in Iraq, with the most recent attack occurring in 2024.[3] One of Saudi Arabia's largest oil refineries suffered a significant complex attack by Iranian cruise missiles and lethal UAS in 2019.[4] Houthi forces are by far the most prolific TBM users in the region, launching frequent attacks against both Saudi Arabia and the United Arab Emirates (UAE) for nearly a decade. Saudi Arabia credits the Houthis with more than 430 TBM and 851 UAS attacks against the kingdom since 2015.[5] Houthi forces have also launched several ballistic missile and UAS attacks against the UAE during the same period.[6] In

A Patriot surface-to-air missile is fired on 7 November 2017 at the NATO Missile Firing Installation in Chania, Greece. The U.S.-made Patriot weapon system is used by numerous U.S. allies around the world and is a crucial component of integrating air and missile defense in the U.S. Central Command area of responsibility. It has been employed successfully by Saudi Arabia and the United Arab Emirates in defense against Iranian-backed Houthi missile and drone attacks. (Photo by Officer Candidate Sebastian Apel, German Air Force)

January 2022, a terminal high altitude area defense (THAAD) battery operated by UAE missile defense forces successfully intercepted missiles launched against the southern portion of the country in two separate attacks, the first-ever combat engagement by the THAAD system.[7] While Iranian-made UAS employed in Ukraine have focused global attention on this threat, UAS attacks have been a regular feature in the Middle East for some time. Militant groups have launched one-way-attack UAS against U.S. bases for several years, intensifying since October 2023, with some attacks resulting in U.S. casualties.[8]

One point worth emphasizing is that these attacks all occurred in what current U.S. joint doctrine would describe as the "competition phase" and not during large-scale conflict. These limited attacks have demonstrated only a small sample of the extant capabilities that could be brought to bear by Iranian military or proxy forces in a crisis that would drive the ruling regime to employ more of its extensive arsenal. While much of the international community remains understandably focused on Iran's nuclear aspirations, the regime has invested significant resources into building lethal ballistic missiles, cruise missiles, and UAS. The Center for Strategic and International Studies (CSIS) credits Iran with the "largest and most diverse missile arsenal in the Middle East, with thousands of ballistic and cruise missiles."[9]

Partners and Allies

Ever since the U.S.-led coalition expelled Iraqi forces from Kuwait in 1991, nations across the region have endeavored to build their own missile defense capacity. Kuwait understandably led this trend and remains one of our longest-enduring ballistic missile defense (BMD) partnerships. Saudi Arabia and UAE have also built robust missile defense forces armed with U.S.-built Patriot and THAAD systems that they have employed successfully in recent years to defend their interests against Houthi attacks. The CSIS

Missile Defense Project estimates that Saudi forces intercepted 177 missiles launched by the Houthis between 2015 and September 2020 (when CSIS ceased collecting data).[10] Qatar and Bahrain are presently fielding U.S.-built BMD systems to deal with many of the same threats from across the region.

In 2020, President Donald Trump updated the Unified Command Plan to shift Israel from the U.S. European Command (USEUCOM) AOR to the USCENTCOM AOR.[11] Israel and the United States have long partnered on building BMD capacity to defend the country, with Israeli forces using Patriot and their own home-built systems developed with U.S. support and funding. These systems include Iron Dome, David's Sling, and Arrow. The 2020 Abraham Accords, during which UAE and Bahrain agreed to recognize Israel's sovereignty and right to exist, began the initial steps of normalizing Israeli relationships with some Gulf Arab states.[12] The effect of these two developments added one of the world's most BMD-capable nations as a potential partner for the countries in the region. While the ultimate results of these changes remain to be seen, particularly in the aftermath of the Gaza crisis beginning in October 2023, Israeli BMD capability and systems have the clear potential to accelerate capacity building across the USCENTCOM AOR in the years to come.

The Air and Missile Defense Fight

With an active and growing threat, U.S. forces cannot build a "break glass" capability for the simple reason that the glass is already broken. The USCENTCOM IAMD enterprise operates continuously and must maintain the ability to expand as required through all phases of conflict. As with all geographic combatant commands, joint doctrine provides the defensive counterair framework to organize air and missile defense, as described in Joint Publication 3-01, *Countering Air and Missile Threats*.[13] Under this construct, the combined forces air component commander (CFACC) is the supported commander for air and missile defense, responsible for integrating AMD forces and effects. In this capacity, the CFACC serves as the area air defense commander (AADC) for the joint force commander, developing the area air defense plan for the joint force commander and supervising daily execution of these operations. In the USCENTCOM AOR, the U.S. Air Forces Central commander fills these doctrinal roles.

The Army provides significant support to the AADC, primarily with the 32nd Army Air and Missile Defense Command (AAMDC). The 32nd AAMDC commanding general serves as the deputy area air defense commander to the CFACC, responsible for integrating all Army AMD capabilities and supporting the integration of joint and combined capabilities. The 32nd AAMDC also leads all combined and joint AMD planning to develop options for the AADC to present to the USCENTCOM commander for decision. Like all AAMDCs, the 32nd AAMDC commanding general also serves as the theater army air and missile defense coordinator and senior air defense artillery (ADA) commander for U.S. Army Central in its role as both the combined forces land component commander and Army Service component command to USCENTCOM. As the senior ADA commander, the 32nd AAMDC commander exercises control over most Army AMD forces in the region.

Unique amongst the three active component AAMDCs, the 32nd AAMDC also serves as the global force provider for active component AMD on behalf of U.S. Army Forces Command. Unlike the AAMDCs assigned to USEUCOM and U.S. Indo-Pacific Command, the 32nd AAMDC is both service retained and aligned with USCENTCOM. I will address the implications of this force provider role later in this article.

Current Operations

With this framework in place, the USCENTCOM commander maintains the capabilities to pursue assigned strategic objectives. Since the end of Operation Desert Storm in 1991,

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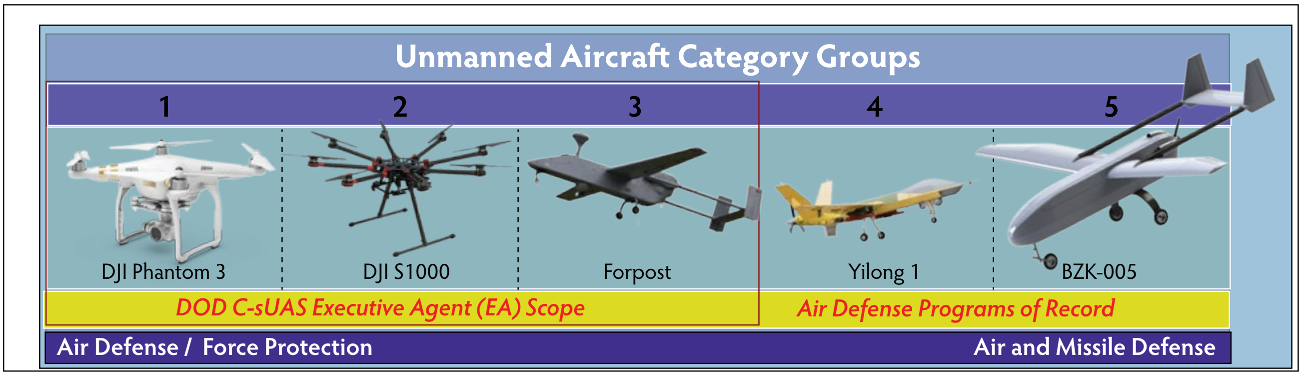

(Figure courtesy of the Joint Counter-Small UAS Office)

Figure. Unmanned Aircraft System Groups

the United States has maintained a near-continuous presence of U.S. Patriot units in the region, with only a short gap between the elimination of the Iraqi TBM threat in 2003 and the ascendency of the Iranian TBM threat, which drove the United States to reintroduce U.S. Patriot units in 2006, where they have remained ever since.[14]

Beyond Patriot units, the Army has deployed numerous short-range ADA capabilities to the region. This includes the Counter-Rocket, Artillery, Mortar (C-RAM) system based on the Navy's Phalanx system used to defend ships against air threats. C-RAM units first deployed to Iraq in 2010 and have remained in use ever since.[15] In 2021, C-RAM units defended U.S. retrograde operations at Kabul's Hamid Karzai International Airport following the collapse of the U.S.-backed government. As UAS threats have proliferated, the Army has upgraded the C-RAM system to address some UAS platforms.[16] The United States also employs Stinger-based Avenger weapons systems and continues to field additional counter-UAS capabilities across the region.[17]

The UAS threat is clearly the most visible growth portfolio in our adversaries' capabilities, which, in turn, has driven significant efforts to develop defeat options by the United States and partners. The Department of Defense designated the Army as the executive agent for defeating Groups 1-3 UAS, that, in turn, established the Joint Counter-Small UAS Office (see figure).[18] USCENTCOM has C-UAS capabilities across the region to defend U.S. forces. While kinetic, electronic warfare, and directed energy capabilities are critical, optimizing how these systems are integrated into a layered defense has proven to be the more significant planning task. Given the range of threats and tactics available to Iran and proxy groups, no single system can provide a comprehensive defense by itself. In short, there are no "silver bullets" in the counter-UAS fight. Instead, commanders must take all capabilities and employ them intelligently while looking for every opportunity to innovate.

As the United States employs a broad range of AMD capabilities, partners and allies continue to build and employ capabilities to address the range of threats. The United States supports these efforts in three broad categories. The first is through the initial capability fielding, particularly in cases of U.S. foreign military systems, where we provide fielding teams to assist. During fielding activities, partners receive both materiel and operator training. The second category begins once units begin to employ the new AMD capabilities. In this phase, the United States supports capacity-building through exercises and combined training events intended to enhance interoperability. Capacity building efforts typically occur over many years and signify U.S. commitment to its partners.

The third category covers broader regional integration efforts. In this case, conversations about integration require precision and must focus on specific goals. This prevents the term "integration" from becoming too vague to be useful. To paraphrase a panel discussion during the 2023 U.S. Army Fires Symposium, the key questions are to determine *what* is being integrated and for *what purpose*.[19] Meaningful integration efforts cannot describe broad end states. Instead, they must be more precise and discrete. One example is the Middle East Air Defense Initiative.[20] In spite of the expansive name that suggests a comprehensive effort, it is focused on establishing a shared regional air picture available to partners and allies through the Combined Air Operations Center at Al Udeid Air Base in Qatar.[21] This one example demonstrates the need to constrain and, therefore, focus integration efforts in order to achieve desired objectives. Broad and seamless integration remains elusive for a number of reasons, not the least of which is cost. In some cases, the limiting factor is our partners' relations with each other. The recently healed split with UAE and other Gulf Arab states offers one example of these types of challenges.

Large-Scale Combat Operations

Addressing the persistent air and missile threat in the USCENTCOM AOR requires significant organizational energy and leadership. In this environment, the gravitational pull of current operations certainly has the potential to become all-consuming for headquarters staffs rightfully focused on solving pressing problems. However, like all geographic combatant commands, USCENTCOM must be prepared to respond to a broad range of contingencies that could tip into LSCO. The addition of Israel to the USCENTCOM AOR also brings the responsibility to execute operations in that country if directed by national leadership.

Routine exercises with partners and components provide the best opportunities to prepare for potential LSCO. These exercises typically provide U.S. and partner forces training opportunities nested within theater security cooperation objectives, some of which primarily focus on IAMD. Whether a specific exercise or training event mimics what may be required during LSCO is largely beside the point. Training with partners is more about building relationships and identifying future combined training requirements than perfecting any given operational task.

When training headquarters staffs, AMD-focused exercises must provide a range of "bad days" for the training audiences. Like all units, headquarters staffs require stressful training environments to achieve desired readiness objectives. The more robust the exercise, with broad component participation and a fully committed higher headquarters stimulating the event through decision-making (and all the supporting mechanisms that support decision-making), the more effective the training. This is as true for AMD exercises as for any other type of operation. Since any fight in USCENTCOM AOR will undoubtedly include a robust air and missile threat, this is truly foundational training.

Theater-level AMD exercises generally train on two separate levels. In the first level, those units specifically tasked to execute the air and missile defense fight will practice the specifics of their craft. This includes the air component command (under U.S. Air Forces Central) in its role as the area air defense commander (and supported commander for air and missile defense), the maritime component command (under U.S. Naval Forces Central Command) executing Aegis ballistic missile defense, and the Army air defense units operating under the control the 32nd AAMDC. At this level, these exercises focus on both active defense to defeat inbound threats and attack operations to defeat threats before they can be launched.

At the second level, USCENTCOM and its component commands execute the totality of combat operations outside the direct AMD fight but considering the effects of possible enemy attacks on friendly forces. For instance, if a specific base is the primary target of Iranian ballistic missiles, the affected component (or components) must adjust their plans in the aftermath of these attacks. These exercises further inform the development of future plans and options in order to provide the USCENTCOM commander the maximum level of flexibility to achieve U.S. objectives in the region. This is in marked contrast to the U.S. Army's Mission Command Training Program Warfighter exercises used to train corps and division staffs. In these exercises, the scenario is designed to stimulate training objectives, not test the validity of any specific war plan. In theater-level exercises executed by geographic combatant commands, the validity of plans themselves are part of the assessment process.

Tensions

A 2023 report discussed the challenges facing U.S. Army ADA units. This report highlighted the gap between supply and demand that has endured for decades, concluding that the "simple, pure math" suggests that the United States has far more air defense requirements than the Army has capacity.[22] Some groups like the Missile Defense Advocacy Alliance have suggested that the Army needs to immediately reprioritize force structure to deal with this reality, and that the Department of Defense (DOD) mission area itself requires a "fundamental review."[23] The war between Russia and Ukraine has reinforced both the criticality of air defense and the effectiveness of the Patriot system in particular.

Unlike U.S. Indo-Pacific Command and USEUCOM, USCENTCOM has no forward-stationed Army ADA units. Every Patriot, C-RAM, and Avenger formation serving in the region since the end of Operation Desert Storm in 1991 deployed from the United States (and sometimes from other geographic combatant commands). Under any force generation model, this continued commitment ties up large portions of the Army's AMD forces, making them unavailable for other requirements. As previously mentioned, the 32nd AAMDC also serves as the Army's global force provider for active component AMD forces. This puts the command in the unique situation of having to provide military advice to meet USCENTCOM objectives that may directly impact its mission to provide trained and ready forces for U.S. Army Forces Command when balanced with global requirements. As the AAMDC supporting USCENTCOM responsible for all Army AMD forces in the region, the 32nd AAMDC is primarily providing forces to itself in its warfighting role.

Regional integration with partners and allies offers a potential way to mitigate this gap between supply and demand. In theory, partners can replace U.S. units with their growing AMD capacity. This regional integration certainly offers opportunities, although this comes with two extremely important caveats. The first caveat is the capabilities of systems such as Patriot, which are ultimately point or small-area defense systems that can cover a discretely defined geographic area (such an airbase). These systems cannot provide wide-area defense, and those systems that can provide this type of defense (such as THAAD) face limitations on the threats they address. Critics of the Patriot system usually overlook this point; the system will only engage direct threats to the defined defended asset. In short, nonengagements of threats impacting outside the defended asset are a conscious decision and not a bug in the system.

This reality leads to the second caveat, which is the geopolitical requirements of the partners themselves. Without exception, every nation builds air and missile defense capacity primarily to defend its own interests. With point and small-area defense systems, every defended asset decision requires acceptance of what will *not* be defended. None of our partners across the globe purchased Patriot or THAAD to become a force provider for the United States. These trade-off decisions are particularly acute in the USCENTCOM AOR, where our partners face the same robust Iranian and proxy threat that we face. Given the enduring presence of U.S. Patriot units across the region, Army ADA forces themselves could also be viewed as clear demonstrations of American commitment to the region; while any force posture must be viewed in totality and not focused on any specific unit type, the presence of U.S. Army ADA units remains a concrete symbol of resolve.[24] This perception has the potential to increase the difficulty of conversations with partners on a range of topics not limited to air defense.

Conclusion

Over the past ten years, air and missile threats to U.S. forces and American interests in the USCENTCOM AOR have continued to multiply. This should hardly surprise any observer familiar with the Army's role in the Middle East since the end of the 1991 Gulf War. Operation Desert Storm made the Patriot widely known and ADA forces a near continuous feature of posture decisions from then until now. The current air and missile threats are also multiplying against our allies and partners, who are accelerating their own efforts to build robust air and missile defense capabilities. It is worth highlighting that Israel, UAE, and Saudi Arabia's AMD forces are combat-tested and proven against persistent lethal threats. Importantly, all of this is occurring against the backdrop of competition for influence with China and Russia. Based on Iran's TBM and UAS inventory alone, future LSCO in the region have the near certain potential to see missile and air attacks that make Russian attacks on Ukraine seem small in comparison.

American units operating in the USCENTCOM AOR remain the only U.S. forces across the globe who face routine air and missile attacks. This challenging threat also offers the Army unique opportunities to experiment in real time with the range of AMD capabilities available to joint and combined forces. While the DOD must balance global force posture decisions in pursuit of the *National Military Strategy*, the USCENTCOM AOR and Iran remain critical to defined strategic objectives. Although "CENTCOM fatigue" is certainly a real challenge, the region also borders China and Russia, which raises the stakes of competition.[25] Given this stark reality, the Army should expect to provide some level of AMD forces to USCENTCOM during competition phase and be prepared to surge during LSCO. How the DOD and the Army balance these requirements going forward remains a critical challenge. ■

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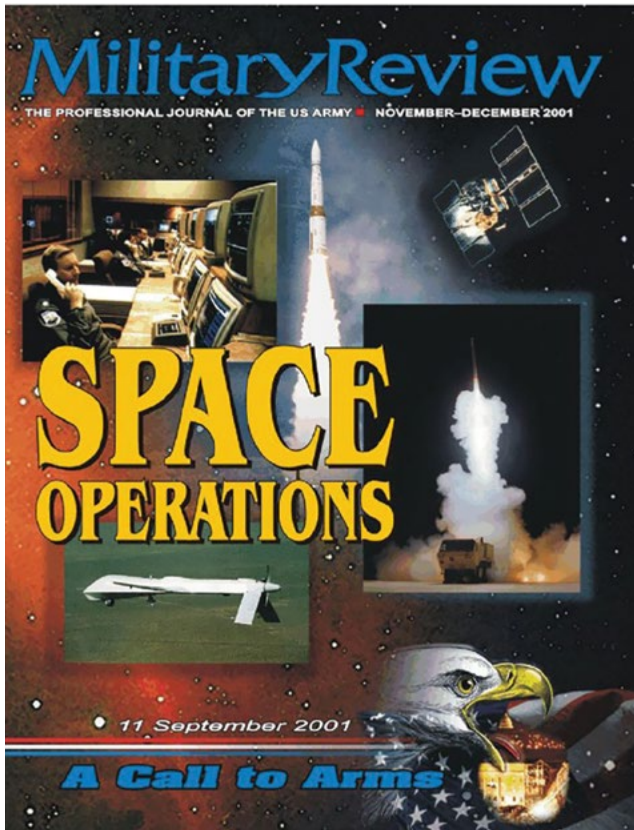
Space Operations Special Edition—2001

The November-December 2001 issue of *Military Review* provided articles outlining the increasing importance of the space domain to the U.S. Army of the time. It focused on advances in technology that had been made up to that date in the employment of space assets. The edition's foreword stated, "Perhaps the most important aspect of space operations is the role space plays in communications and information management. In fact, space operations entail getting the right information to the right user at the right time."

It has been more than twenty years since publication, but many of the articles are still relevant to the continuing evolution of Army space operations. As the edition's foreword also asserted, "The best thinking about the future comes from those who have an appreciation for the past, a solid grasp of the present, and an enthusiasm for the future."

Of particular interest, the editor in chief of *Military Review* invites your attention to two articles that reflect prescient observations concerning the importance of space to the future development of the Army as seen two decades ago: "U.S. Space Command: Warfighters Supporting Warfighters in the 21st Century" by Lt. Gen. Edward G. Anderson III (pages 11–17); and "Space: Enabling Army Transformation" by Lt. Col. Brad Baehr, Lt. Col. Thomas D. Houston, and Maj. J. G. Byrum (pages 35–41).



Military Review, November-December 2001

The purpose of this 2024 special edition of *Military Review* is to continue its legacy of promoting awareness of the Army advancements in space technology and application as well as to further stimulate the best thinking among military professionals on the future Army exploitation of space to attain national security objectives. The 2001 edition of *Military Review*, "Space Operations," can be found online at https://cgsc.contentdm.oclc.org/digital/collection/p124201coll1/id/229/rec/1. ■