Army Counter-UAS 2021–2028

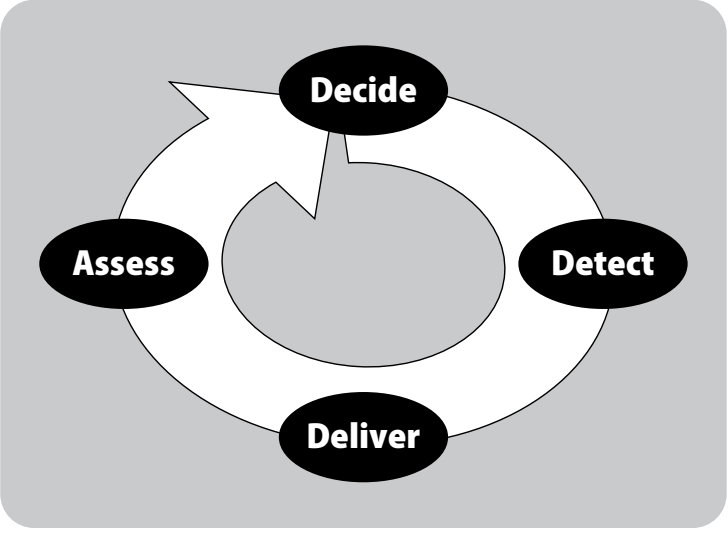
Maj. Benjamin Scott, U.S. Army

Targeting and destroying the enemy's UAS ground control stations is the division's number-one priority for the next twenty-four hours.

—Maj. Gen. Jamie Jarrard, 25th Infantry Division

"Kill what is killing us." This maxim oriented the 25th Infantry Division's (25 ID) priorities in deliberate and dynamic targeting. After six days of simulated battle, through the reconnaissance fight, offense, and transition

into deliberate defense, the enemy's rocket and tube artillery continued to kill the division. Enemy unmanned aircraft systems (UAS) and dismounted special-purpose forces (SPF) positioned throughout the division's area of operations (AO) provided accurate targeting for the enemy's integrated fires command to exploit. Though the division directed combat power successfully to locate and attack to destroy SPF observers, it continued to see a familiar pattern as the enemy commander employed a multitude of UAS to identify division high-value targets and engage its units with massed indirect fire. In the division's main command post, the air defense and airspace management (ADAM) cell would announce, "Attention in the TOC [tactical operations center]! Enemy UAS identified northeast of Objective Lions, observing 3rd Brigade, 4th Infantry Division." Minutes later, reports began to flow in of massed enemy artillery fire against a friendly armored brigade combat team (BCT). Casualty reports followed that highlighted significant losses and reduced combat power, and the division conducted counterfire and directed fixed-wing assets in response to the latest killer of U.S. forces. The enemy's ability to effectively degrade the division's combat power was limited primarily by its will to engage as evidenced by consistent and effective prosecution of its high-payoff target list. 25 ID's combat losses to indirect fire were concentrated in main battle tanks, fire support and target acquisition systems, and grounded rotary-wing aircraft; the enemy regularly got the greatest possible return for the risks of uncovering and exposing its indirect fire systems. The enemy was destroying combat power more quickly than the division could generate it. Despite recognizing the need to neutralize or reduce the enemy's ability to effectively engage friendly forces with indirect fire, the division remained ineffective. It had decided, but its efforts to effectively detect, deliver, and assess were failing. The division needed to figure out why it was failing, how to remedy those failures, and then execute. 25 ID was not immediately successful at defeating enemy UAS; the problems of enemy UAS required the division staff to accurately identify the center of gravity for the enemy's fires and target acquisition systems, form a specialized counter-UAS task force, achieve shared understanding across warfighting functions in the current operations integration cell (COIC), and integrate throughout the targeting process to successfully defeat enemy UAS threats.



(Figure from Army Techniques Publication 3-60, *Targeting*)

Figure 1. The Decide-Detect-Deliver-Assess Methodology Cycle

25th Infantry Division's Counter-UAS in Warfighter 20-03

Warfighter Exercise (WFX) 20-03 marked the first time in over twenty-five years that a U.S. Army corps received the mission to conduct a deliberate defense during a Warfighter. Like in many previous WFXs, I Corps, comprised of two U.S. Army divisions, conducted

Previous page: A soldier from the 2nd Brigade Combat Team, 25th Infantry Division, engages a low, slow, and small enemy unmanned aircraft (UA) with a directed-energy system October 2020 during Task Force Warrior's decisive action training environment rotation at the Joint Readiness Training Center, Fort Polk, Louisiana. These systems attempt to break the link between the control element and the UA or otherwise neutralize the targeted UA. (Photo courtesy of the U.S. Army)

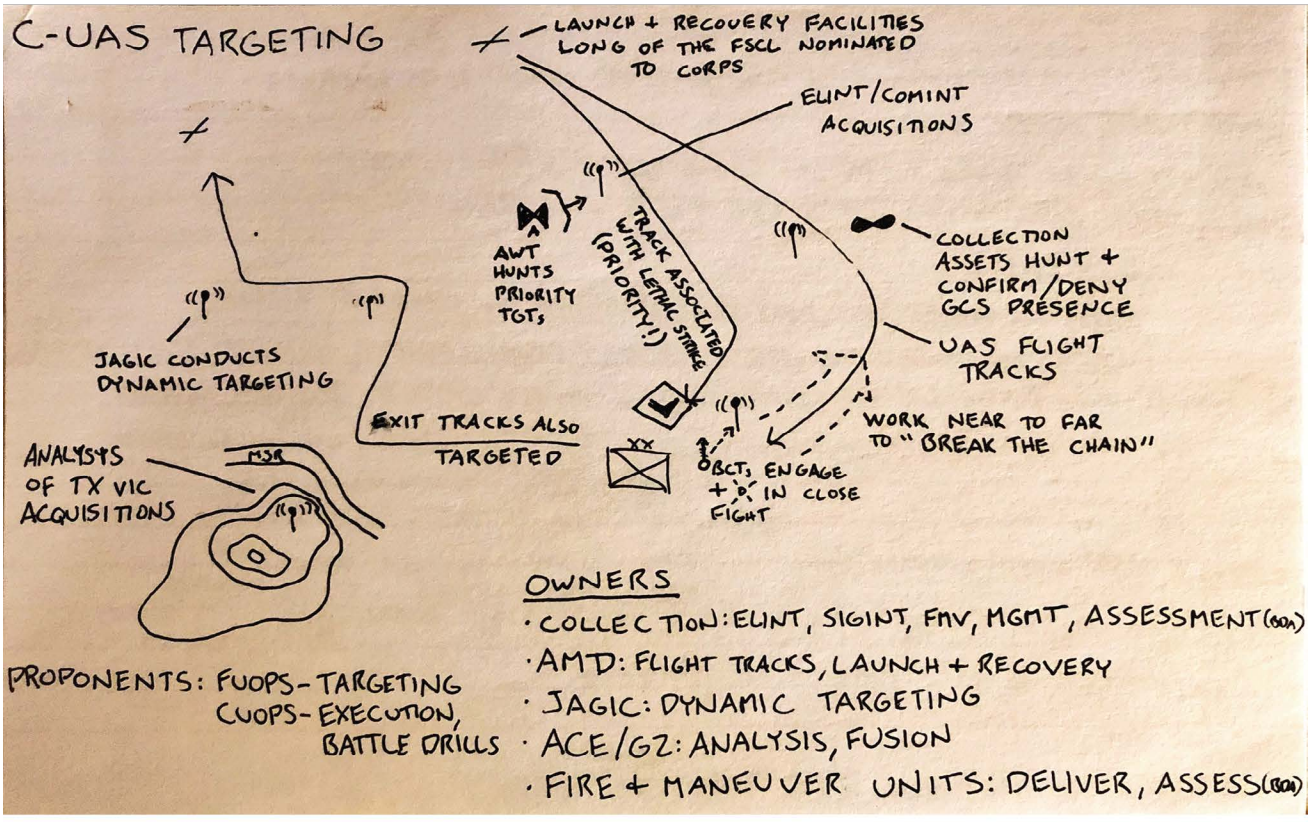
an offensive operation to defeat a peer threat on terrain resembling the Korean peninsula. 25 ID, along with the 40th Infantry Division of the California Army National Guard, commenced offensive operations on 4 February 2020. Following two successful division river-crossing operations and the seizure of initial march objectives, I Corps issued an order for both divisions to retain key terrain and establish deliberate defenses to defeat an enemy counterattack. The divisions had seventy-two hours to establish security, develop engagement areas, defeat spoiling attacks, and prepare to conduct the defense.

For this defense to be successful, 25 ID prioritized security operations and controlling interior lines. The lethal, frequent, and persistent indirect-fire attacks on units forced the division and the corps to focus critical assets on neutralizing enemy indirect fire units massing on friendly forces. As the corps targeted enemy firing units, 25 ID focused on destroying enemy observers to provide the space and time for its brigades to develop engagement areas and prepare for combat. The division directed its brigades to target and destroy SPF in zone while the division staff targeted the enemy's UAS ground control stations (GCS). Through center of gravity analysis, the division staff identified the enemy's UAS GCSs as the critical capability enabling the indirect fire system of systems. The enemy's UAS GCSs possessed the ability to direct multiple tactical and operational UAS systems to identify and target friendly forces with the enemy's integrated fires command. During a division target decision board on 11 February, 25 ID commander, Maj. Gen. Jamie Jarrard, stated, "Targeting and destroying the enemy's UAS ground control stations is the division's number-one priority for the next twenty-four hours." The division understood the commander's intent and immediately began the systematic destruction of all enemy observers and UAS GCSs in the division's AO.

The division staff conducted detailed analysis of the enemy's UAS GCSs during the division's operations and targeting processes. Applying the Army targeting methodology (see figure 1, page 66), the division identified enemy GCSs as the number one high-payoff target.[1] Detection was accomplished by mixing organic collection assets and support from echelons above division. Most commonly, exploitation of communications and electronic warfare (EW) support was deliberately planned and then dynamic in execution. By the third day of fighting, most of the enemy's launch and recovery sites sat beyond the fire support coordination line (FSCL) and beyond the range of the division's organic delivery assets; these were nominated to corps for prosecution by echelons above division. The UAS themselves were engaged whenever possible within capabilities (approximately eleven systems were engaged and destroyed with Stingers or Avengers), but this largely reactionary activity proved of limited effectiveness and often did not prevent the massed fires the UAS would so often herald. The enemy had enough aerial systems to absorb these losses and continue generating UAS sorties. GCSs were the critical vulnerability in the enemy's UAS system of systems, and in wider scope, a critical vulnerability in the enemy's fire support and target acquisition machine. In the dynamic targeting process, the joint air-ground integration cell (JAGIC) received combat information from EW, signals intelligence (SIGINT), other electronic intelligence (ELINT), and other signature acquisitions and dynamically delivered lethal fires or retasked available collection assets to develop targets. The division had used and continued to use every tool at its disposal to destroy or neutralize the enemy's eyes, but it had not honed its killing machine to maximum effectiveness; it was not achieving the tactical success the division demanded of itself at echelon. To improve its effectiveness and degrade the enemy's capabilities, the division deputy commanding general–operations, Brig. Gen. Josh Rudd, formed Task Force Ground Control Station to produce better results and destroy the division's number one high-payoff target. The task force developed a visual model to enhance shared understanding and better synchronize the staff (see figure 2, page 68).

Critical elements in 25 ID's GCS targeting process included shared understanding and timely, effective communication.

Maj. Benjamin Scott, U.S. Army, serves as operations officer for the 1st Battalion, 27th Infantry Regiment, after completing assignments as executive officer for 2nd Squadron, 14th Cavalry Regiment, and as a future operations planner for the 25th Infantry Division on Schofield Barracks, Hawaii. Scott is an infantry officer and received his commission from the University of Tennessee. He holds an MA in military operations from the U.S. Army Command and General Staff College. His operational assignments include multiple tours in Iraq and Afghanistan and a humanitarian assistance mission to Liberia.



ACE–Analysis and control element
AWT–Attack weapons team
BCT–Brigade combat team
BDE–Battle-damage assessment
COMINT–Communications intelligence
C-UAS–Counter-unmanned aircraft system
CUOPS–Current operations
ELINT–Electronic intelligence
FMV–Full-motion video
FSCL–Fire-support coordination line
FUOPS–Future operations
GCS–Ground control station
JAGIC–Joint air-ground integration cell
MSR–Main supply route
SIGINT–Signals intelligence
TGT–Target
TX–Terrain
UAS–Unmanned aircraft system
VIC–Vicinity

(Figure by author)

Figure 2. Visual Model of the Division's Counter-Unmanned Aircraft Systems Targeting Efforts during Warfighter Exercise 20-03

In short, integration throughout the decide-detect-deliver-assess cycle needed to improve to achieve destruction of enemy GCSs. The operators behind various systems—the ADAM cell, the intelligence current operations cell, and the JAGIC—were the missing links required to enable the division to punch as hard as it could. Rudd gathered the owners and proponents of counter-UAS processes and functions and oriented the team. The division was already executing each part of the system depicted in the visual model, but it lacked crucial linkages between owners and induced unnecessary delays in building shared understanding. The absence of critical linkages was caused by failures of COIC warfighting functions to understand and integrate. For example, the ADAM cell would identify an enemy UAS using Sentinel Radar and track that unmanned aircraft beginning at acquisition, along a flight track, and through either destruction of the UAS or (more often) until the aircraft moved beyond sensor range. Up to this point, the ADAM cell Air and Missile Defense Workstation (AMDWS) operators had

been announcing the activities of enemy UAS in the division's AO and the air and missile defense officer in charge contributed relevant information and discussion at division battle-rhythm events. What the division had not been doing was immediately communicating tracks from the AMDWS operators to the intelligence and fires current operations cells; this included failures to verbally communicate such information between members of the JAGIC and COIC sitting within twenty feet of each other. Part of this failure to achieve shared understanding was the inability for the AMDWS to seamlessly integrate with the myriad other systems in the division main command post; the larger part of this failure, one that the division owned and controlled, was the failure of its staff to understand the integration of warfighting functions and to push information to those who needed it and for those who needed information to pull from those who possessed it. Our integration between the intelligence, fires, protection, and movement and maneuver warfighting functions was inadequate because (1) leaders had not educated, rehearsed, or supervised battle drills at the user level; and (2) battle drills did not provide timely, required information to all owners of the counter-GCS effort. The battle drills, if executed effectively, would provide timely information to detect targets and deliver fires. Integration into the COIC and JAGIC paired with fires assets dedicated to the commanding general's number one priority would also enhance effectiveness.

Far from being the sole missing link, the example of failed integration of the AMDWS operators' acquisitions and flight tracks illustrated a larger trend. Sometimes, communications intelligence was not effectively relayed prior to target decay. At other times, flight tracks and identification of enemy UAS system attributes did not cue timely collection within targetable collection areas such as associated uplink and downlink frequencies. In still other instances, targets could not be prosecuted quickly enough because of other priority missions. Finally, the division sometimes lacked the range, delivery asset, or timely cross-boundary coordination to deliver against a detected emitter. With the visual model built and shared among the owners and proponents, the staff communicated the systems and processes throughout their sections and to the operator level. The division had already destroyed ten of twelve UAS GCSs within the 25 ID AO, and over the next twenty-four hours, destroyed those remaining in the division's AO. The division was still subject to UAS controlled from beyond the FSCL, and in some cases, in adjacent unit AOs. While the division was finally punching as hard as it could, the division and the U.S. Army must now be able to punch harder.

> “Current Army capabilities and doctrine, especially that found in Army Techniques Publication (ATP) 3-01.81, *Counter-Unmanned Aircraft System Techniques*, are insufficient to meet the demands of the present and future battlefields.”

Current Fights

Current competitor and threat capabilities are accessible to state and nonstate actors in varying but generally increasing degrees; further, enemy UAS will be faced on current and future battlefields along the continuum of competition and armed conflict.[2] Finally, trends toward more capable, cheaper, and ubiquitous threat-UAS capabilities and increased costs to counter these threats will continue and likely accelerate.[3] Current Army capabilities and doctrine, especially that found in Army Techniques Publication (ATP) 3-01.81, *Counter-Unmanned Aircraft System Techniques*, are insufficient to meet the demands of the present and future battlefields.[4] Army counter-UAS doctrine reflects current materiel and organizational limitations, especially at echelons brigade and below. ATP 3-01.81 primarily details passive air-defense measures augmented with limited active defense including Stinger and direct-fire employment against UAS seen or heard by soldiers.

The Army categorizes UAS into five groups; this enables discussion of various types of UAS by significant

characteristics (see figure 3, page 71).[5] Groups 1-3 contain what the U.S. Army categorizes as "low, slow, small systems," though there are significant differences between groups and large variations within group 3 in characteristics and capabilities. Groups 4 and 5, persistent and penetrating UAS, respectively, each weigh more than 1,320 pounds. For targeting purposes, use of groups to categorize enables description and assignment of responsibilities for certain types of UAS to specific headquarters and echelons. Such delineation of responsibilities is essential to an effective counter-UAS approach.

Each echelon must provide contributions synchronized in time, space, and purpose in the counter-UAS fight. The first step in achieving such synchronization and effectiveness is defining the "fights" owned by each echelon. The author's experiences with echelons above division are limited to nominations to corps and support from corps and above in the corps' deep area and beyond. This article provides support requirements and desired effects from echelons above the division level but does not provide a delineation of deep fights for corps, echelons above corps, or the joint force. Beyond the FSCL, corps and higher echelons own offensive and defensive counterair against group 3, 4, and 5 UAS. Corps and higher echelons must provide collection and delivery against launch and recovery sites, UAS on ground or in flight, GCSs, and associated support assets. Ideally, the combined forces air component command, combined/joint forces land component command, and corps will specify and synchronize efforts to best achieve layered collection, delivery, and assessment at echelon. The primary required effects from corps-and-higher echelons beyond the FSCL are destruction (at minimum, degradation and disruption) of enemy capabilities able to influence the division that reside beyond the division's capability to influence with organic or supporting systems. This minimum standard includes the provision of support or capabilities short of the FSCL to enable the division and subordinate echelons to win their "fights;" such support will often include commitment of air-defense assets such as Avenger support and extended-range munitions in the form of multiple launch rocket systems or employment of fixed-wing support.

Three different 3D-printed payloads are on display 30 January 2020 at the Drone Demonstration in the Rotational Unit Bivouac Area, Fort Irwin, California. Each payload fulfills a different function in the training environment: the leftmost resembles a large caliber strike, the middle can be used to simulate a chemical attack, and the rightmost replicates a mine. (Photo by Pfc. Gower Liu, U.S. Army)

The division owns offensive and defensive counterair against groups 3 and above throughout the division's AO. The division normally possesses collection and delivery assets best employed when cued by supporting collection assets from higher echelons. For collection, the division's primary assets include Gray Eagle UAS, AH-64 Apache helicopters, Shadow UAS, and air-defense radars. EW support payloads enhance the effectiveness of the division's UAS for collection against UAS GCSs and other emitters. Air-defense radars provide the division with detection of enemy group 3 and above UAS at distance and prior to the enemy's ability to detect and target friendly forces. The division's combat aviation brigade and organic 155 mm howitzers (to include rocket-assisted projectiles to extend range) are its primary organic delivery assets. Ultimately, the division's organic ability to collect is modest and its ability to deliver is limited to the

Group 1 Micro/Mini unmanned aircraft system (UAS)	Weighs 20 pounds or less and normally operates below 1,200 feet above ground level (AGL) at speeds less than 100 knots	These systems are generally hand-launched including hobby type UAS. These offer real time video and control, and have a small payload capabilities. Operated within line of sight of user.
Group 2 Small tactical	Weighs 21–55 pounds and normally operates below, 3,500 feet AGL at speeds less than 250 knots	Small airframes, low-radar cross sections, and provide medium range and endurance. Requires line of sight to the ground control station.
Group 3 Tactical	Weighs more than 55 pounds, but less than 1,320 pounds, and normally operates below 18,000 feet mean sea level (MSL) at speeds less than 250 knots	Range and endurance varies significantly among platforms. Requires a larger logistics footprint than groups 1 and 2.
Group 4 Persistent	Weighs more than 1,320 pounds and normally operates below 18,000 feet MSL at any speed	Relatively large systems operated at medium to high altitudes. This group has extended range and endurance capabilities (may require runway for launch and recovery).
Group 5 Penetrating	Weighs more than 1,320 pounds and normally operates higher than 18,000 feet MSL at any speed	Operated at a medium to high altitudes having the greatest range, endurance, and airspeed. Requires large logistical footprint similar to that of manned aircraft.

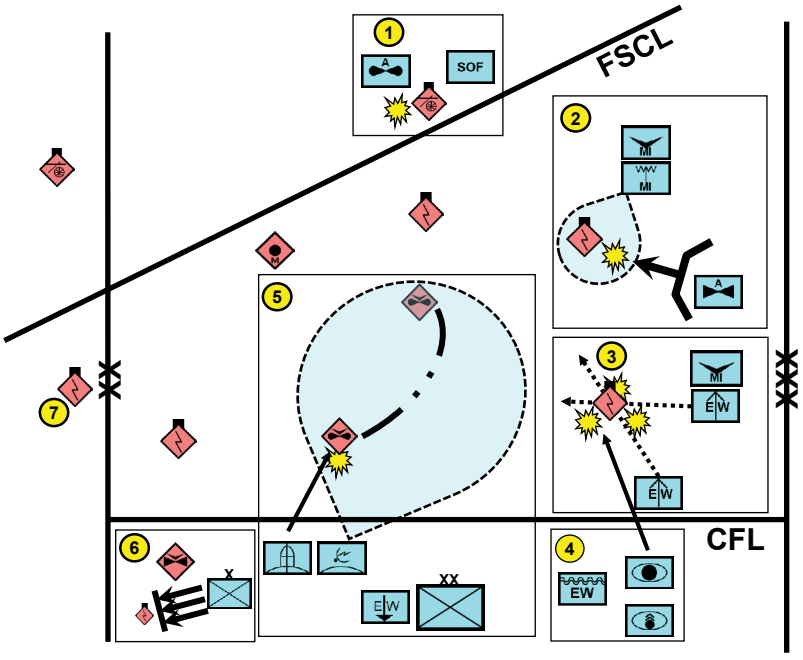
(Figure from Army Techniques Publication 3-01.81, *Counter-Unmanned Aircraft System Techniques*)

Figure 3. Low, Slow, Small Unmanned Aircraft Systems (UAS) Highlighted in UAS Techniques

maximum range of organic fires to about thirty kilometers (155 mm high-explosive rocket-assisted artillery); the critical contribution of the division to a multi-echeloned approach to counter-UAS resides within its staff. The division is the lowest echelon to conduct robust deliberate and dynamic targeting processes against group 3 and above UAS GCSs. The COIC owns current operations integration. Within the COIC, the intelligence collection, analysis, and exploitation pairs with the division's JAGIC in dynamic targeting and the division's targeting working groups and boards in deliberate targeting to

- nominate targets beyond the capabilities and responsibilities of the division in the corps' deep area,
- request and synchronize collection and delivery assets to target enemy systems beyond the division's capabilities but within its responsibilities in the division's deep area,
- dynamically target the light and mobile UAS within the division's capabilities (with or without augmentation), and
- support subordinate brigades by creating favorable conditions and enabling dominance at decisive points in the division's close area.

When enabled by corps and higher echelons with rocket artillery (including extended-range munitions), air-defense radar and short-range air defense, and EW



Application and Dynamic Targeting

1. Division nominates and submits support requests for collection and delivery beyond the fire-support coordination line (FSCL)
2. Leveraging signal intelligence and unmanned aircraft system (UAS), division develops and prosecutes targets using attack weapons team
3. Using airborne and ground-based direction finding, division identifies and develops targets
4. Protecting critical assets at decisive points with jamming, surface-to-surface fires destroy ground control stations
5. Sentinel RADAR detect UAS (group 3 and above) and track prior to destruction by Avengers. With electronic warfare (EW) support, this enables further analysis of assessed ground control stations and target development feeding targeting
6. Small UAS (groups 1 and 2) are identified and neutralized by brigade combat team and below actions
7. Cross-boundary coordination in deliberate and dynamic targeting is essential to neutralizing the threat within the division's area of operations

Division sets conditions for execution using the deliberate targeting process. The division commander has **decided** to target enemy UAS ground control stations; these are the critical vulnerabilities in the enemy's target acquisition system of systems. The division requests and synchronizes EW support to **detect** enemy UAS ground control stations. Assets are in position and ready to fire to **deliver** lethal effects. Division leverages organic and supporting assets to **assess** prosecuted targets. This sketch depicts dynamic execution that enables the division to "kill what is killing us."

(Figure by author)

Figure 4. Visual Model of the Division's Counter-Unmanned Aircraft Systems Targeting Efforts

support, the division becomes a formidable headquarters for the counter-UAS fight.

Figure 4 depicts the division's scheme when enabled by such external support. First, the division conducts the deliberate targeting cycle in concert with corps and subordinate inputs and requirements. Using the decide-detect-deliver-assess methodology, the division helps itself by informing corps and higher echelons of necessary and desired targeting of elements of the enemy's UAS systems. These systems include launch and recovery sites, GCSs, the unmanned aircraft themselves, and support infrastructure generally beyond the FSCL. Support is also requested from special operations forces for detection and to aid in or execute delivery and assessment. Fixed-wing aviation support is requested against known and likely systems and facilities. Short of the FSCL and long of the coordinated fire line, the division requests and is enabled by airborne platforms with communications intelligence, EW support including direction-finding capabilities, and various delivery systems to detect and destroy enemy GCSs using dynamic targeting; this dynamic targeting is accomplished primarily by near real-time coordination between collection current operations staff and the JAGIC. Emitters not immediately targetable are refined to enable future detection and destruction. As the division aggressively targets the enemy's UAS capabilities, it simultaneously defends key assets with jamming and air-defense systems. These air-defense systems enable the division not only to engage enemy UAS but also to further target and refine collection and targeting data on enemy GCSs and launch and recovery sites. This is achieved by the collection of flight data including flight tracks and

the dissemination of this data across collection, analysis, exploitation, and delivery functional cells including the collection manager, mission managers, the G2 fusion cell, the JAGIC, and the targeting working group.

In the fight against enemy UAS, the brigade and below are primarily responsible for offensive counterair against groups 1 and 2 UAS and for limited defensive counterair or deliberate targeting of group 3 and above UAS.[6] The primary tasks of echelons below division are to diligently execute passive protection measures against group 3 and above UAS while employing active measures to defeat, neutralize, or degrade the enemy's ability to successfully employ groups 1 and 2 UAS. Passive measures include rigorous enforcement of dispersion and camouflage, hardening, electromagnetic spectrum awareness and management, employment of air guards, and immediate displacement upon suspected observation by enemy UAS. Brigades and below are also still responsible and capable of targeting enemy UAS capabilities by collecting on and destroying associated systems not related directly to the enemy's UAS. Active measures against groups 1 and 2 UAS include targeting (within capabilities) enemy GCSs for these UAS and active patrolling to deny or degrade their employment. With the current capabilities and proliferation of groups 1 and 2 UAS, active patrolling against likely and potential launch and recovery locations as well as GCSs is essential and represents the main counter-UAS actions for brigades and below. This includes the use of all intelligence, specifically human intelligence and technical intelligence, to derive the timely sourcing of technology and skills required in scope for building, operating, and maintaining these systems. In many cases, these sites will be temporary and provide minimal signatures; prioritization of such missions, including (and sometimes especially) in rear areas, and allocation of combat power and assets is essential to countering the threats posed by groups 1 and 2 UAS. At the brigade level and below, there are currently few assets to aid in the destruction or defeat of groups 1 and 2 UAS in flight. Experience in Iraq, Syria, and Afghanistan has demonstrated the limited abilities of U.S. forces to effectively counter limited quantities of improvised and commercially available UAS; one need only review Ukrainian experiences against UAS employed for target acquisition for real-world vignettes of what 25 ID experienced in WFX 20-03. While vehicle-mounted and dismounted systems capable of destroying or neutralizing groups 1 and 2 UAS using kinetic or nonkinetic means exist and are being fielded, these systems are expensive, exist in limited quantities, and often do not disable enemy UAS prior to the transmission of actionable target-acquisition data to enemy forces. Additionally, currently fielded systems will not provide the required protection against threats anticipated in the coming months and years.

Preparing for the Future

This section is framed using the counter-UAS operational approach detailed and recommended in the recent article, "The Imperative for the U.S. Military to Develop a Counter-UAS Strategy," by Maj. Edward A Guelfi, Dr. Buddhika Jayamaha, and Lt. Col. Travis Robison. The three lines of effort envisioned in their article are soldier, materiel, and software.[7] Further, the author recommends the Army change its force-capabilities time frames for counter-UAS to reflect the immediate (less than one year), imminent (three to five years), and emerging (six to eight years) threats advocated in *Counter-Unmanned Aircraft System Capability for Battalion and Below Operations,* published by The National Academies of Sciences, Engineering, and Medicine in 2018.[8]

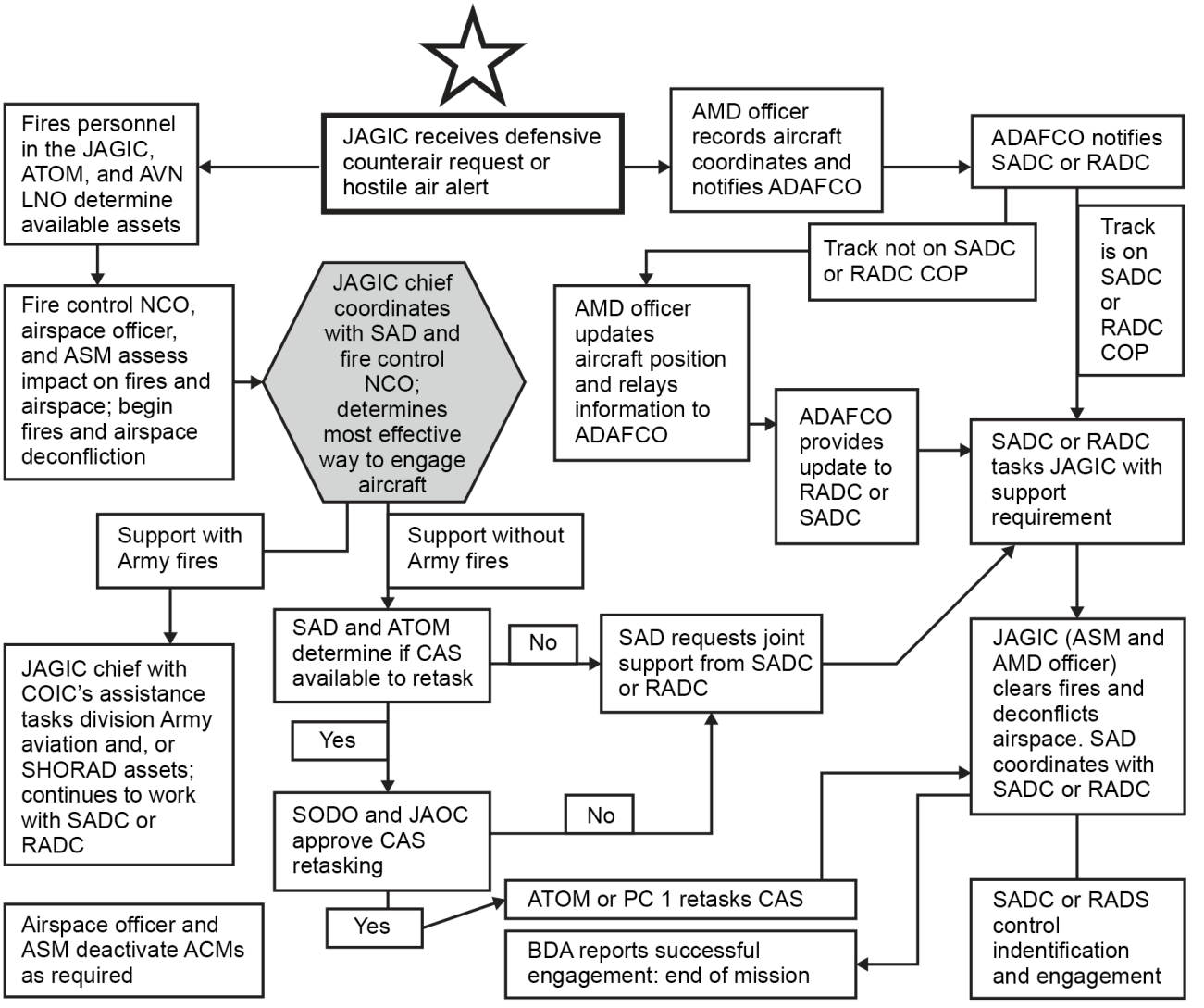
The soldier line of effort. The soldier line of effort includes changes and updates to doctrine, training, and leaders. ATP 3-01.81 must be revised to provide adequate specificity and useful techniques for the brigade and below and augmented to describe counter-UAS at the division and above. The planning, approach, passive defense, and air-guard techniques are beneficial, but the active defense portions of the document demonstrate significant gaps in detection and defeat capabilities of brigades and below. The current ATP begins with acknowledgment that divisions and above lack the capability to detect and defeat UAS from groups 1, 2, and 3. Currently, the publication accurately depicts the challenges for the brigade and below in countering group 4 and 5 UAS. Omitted are the significant challenges these echelons face in countering group 3 UAS and the not insignificant challenges associated with groups 1 and 2 with current personnel, organization, and equipment. The doctrine asserts that group 4 and 5 systems can be detected and effectively countered with integrated air and missile defense capabilities and targeted due to larger signatures and support requirements. In the simulation, 25 ID possessed only passive defensive measures against these threats and was impotent against them with air-defense systems based on

maximum engagement ranges. While effective detection and engagement of groups 4 and 5 might exist for the joint force and echelons above division in the present (far from a certainty), sound doctrine must anticipate and prepare for rapid developments in technology, continued UAS proliferation, and emergent enemy tactics, techniques, and procedures. Within the Army's doctrine hierarchy, needs for timely doctrine in an environment of rapid change demands publication and maintenance of an associated counter-UAS Army tactics, techniques, and procedures publication. Similarly, the current published ATP should be updated or a companion ATP produced to better address the counter-UAS techniques employed at the division-level and above.

JAGIC procedures outlined in ATP 3-91.1, *The Joint Air Ground Integration Center*, including "call for defensive counterair (with and without established tracks)," must be updated to reflect the proliferation and evolution of UAS.[9] In its current form, these procedures and the treatment of UAS throughout the doctrine are hamstrung by the dearth of current capabilities at the division level but especially at echelons below division. For example, the procedure to call for defensive counterair without an established flight track tells the tale of a subordinate echelon observing a low, slow, and small UAS. The doctrine notes that, "Small UAS are a concern to ground maneuver commanders due to their ability to interfere with operations and the challenges they present to systems in terms of detection, tracking, identification, and engagement."[10] While the "concern" is acknowledged, no arrow exists in the subordinate echelons' quivers, nor would the JAGIC receive an engagement report. Instead, the most probable outcome of this procedure is "shared understanding" and a report as the observed unit remains exposed to the hazards of enemy observation. This was the scene so commonly encountered by 25 ID during WFX 20-03. A cursory view of "Call for Defensive Counterair" (see figure 5, page 75), will provide the reader with a sense of the limited options for Army divisions and below to defeat low, slow, and small UAS with current capabilities.[11] The doctrine is fundamentally sound but reflects current gaps in capabilities present in the "materiel" and "software" lines of effort.

Within existing doctrine, it is imperative that the Army develops counter-UAS and multi-domain operation (MDO) battle-drills or "playbooks." At the division level and above, this likely mirrors the bespoke "plays" already developed that link numerous collection and delivery assets with long build-up times, short persistence, and long reset intervals to strategically significant and infrequent operations. At the division level and below, such playbooks should orient on deliberate and dynamic targeting. Two simultaneous and distinct drills must occur, one within the COIC and JAGIC as assets are dynamically requested and a second across the staff as the chief of operations in the COIC, the division G3, or one of the deputy commanding generals approve or deny shifting CAS or other assets owned by the division outside of preplanned triggers. For deliberate targeting, the division's plays integrate collection and effects that are planned and resourced on horizons from twenty-four hours to approximately 120 hours. These plays support significant, synchronized, division-level operations such as a contested wet-gap crossing or BCT(-) air assaults. Dynamic targeting, enabled by increased collection and effect visibility, should seek to leverage already resourced or short to very short build-up assets to exploit fleeting or short-duration windows of opportunity. Army doctrine should maintain responsibilities for deliberate and dynamic multi-domain collection and targeting at the division echelon and above while emphasizing those echelons' enabling roles for BCTs and below. Doctrinal additions and modifications must emphasize not only the dependency of the BCT and below but also explain how BCTs and below support the division's ability to achieve convergence, penetration, dis-integration, and exploitation.

> "It is imperative that the Army develops counter-UAS and multi-domain operation battle-drills or 'playbooks.'"



ACM—Airspace coordinating measure
ADAFCO—Air defense artillery fire control officer
AMD—Air and missile defense
ASM—Airspace manager
ATOM—Air tasking order manager
AVN—Aviation
BDA—Battle damage assessment
CAS—Close air support
COIC—Current operations integration cell
COP—Common operational picture
JAGIC—Joint air-ground integration center
JAOC—Joint air operations center
LNO—Liaison officer
NCO—Noncommissioned officer
PC—Procedural controller
RADC—Regional air defense commander
SAD—Senior air director
SADC—Sector air defense commander
SHORAD—Short-range air defense
SODO—Senior offensive duty officer

(Figure from Army Techniques Publication 3-91.1, *The Joint Air Ground Integration Center*)

Figure 5. "Call for Defensive Counterair" from the Joint Air Ground Integration Center

The COIC and JAGIC at division and above remain the principal agencies capable of supporting and executing deliberate and dynamic targeting while ensuring synchronization. Paired with cross-domain collection efforts, the JAGIC will remain the most capable and effective entity to synchronize and execute dynamic

A Warrior Brigade soldier prepares a Black Hornet soldier-borne sensor for employment August 2020 during new-equipment training at Schofield Barracks, Hawaii. (Photo by Spc. Robert Lee, U.S. Army)

targeting within capabilities against group 3 and above UAS. Division and above targeting working groups and targeting decision boards can be effective in conducting deliberate targeting to enable dynamic execution through anticipation and synchronization of assets across domains; these working groups and boards can only be as effective as the dynamic execution capabilities of the current operations team. Shortfalls in the division's WFX counter-UAS targeting were largely tied to failed integration and insufficient processes rather than organizational gaps. Key to success for both the JAGIC and division targeting efforts is integration of multi-domain collection and cross-domain fires. While BCTs and below can sometimes provide limited deliberate and dynamic multi-domain collection and cross-domain fires, these echelons require augmentation or support to understand, synchronize, and leverage joint and cross-domain collection and effects; this augmentation is in tension with the demands of an increasingly lethal and hyperactive battlefield where signatures must be minimized and agility is required to survive. Instead of augmenting BCTs, divisions and above should focus on

creating windows of opportunity and shaping to enable BCTs to dominate in the close area. Organizational modifications should focus on enhancing the capability of the division to conduct cross-domain collection and enabling the COIC and its JAGIC to synchronize and execute dynamic targeting.

Counter-UAS in an MDO must be trained at echelon and encompassed in multi-echelon training. For the division, command-post exercises, including Warfighters, must encompass multi-domain collection, cross-domain fires, and multi-domain maneuver. This is already occurring in such exercises as Warfighters, but simulated collection and effects are largely executed by "white card" as the simulation is unable to sufficiently replicate multi-domain collection and cross-domain effects. This can marginalize practitioners of multi-domain collection and nonkinetic fires while participants in the division targeting process miss opportunities for repetitions employing these capabilities, including in detection and defeat of enemy UAS. Divisions and BCTs must also conduct counter-UAS, multi-domain collection, cross-domain fires, and multi-domain operations at the combat training centers; these rotations should reflect the role the divisions play in enabling BCT operations and the requirements for BCTs to support division operations. Whenever possible, divisions and BCTs should incorporate live-fire execution of these concepts into training events. Ultimately, the Army should execute a live-virtual-constructive training event that incorporates a division Warfighter, BCT combat training center rotation, and multi-domain live-fire exercise.[12]

At the BCT and below, counter-UAS, multi-domain collection, cross-domain fires, and cross-domain maneuver must be viewed as part of the modern battlefield. To achieve this, current and emergent technologies; capabilities; and tactics, techniques, and procedures must be replicated in training events. While the goal is still to have team leaders, tank commanders, platoon sergeants, and platoon leaders as masters of their respective crafts, soldiers must be introduced to and familiar with threat and friendly capabilities and actions. Integration of one small UAS in a situational training exercise or enemy targeting based on electromagnetic spectrum (EMS) signature during a tactical decision-making exercise costs little and requires little modification of existing training events or programs of military instruction when compared to the concrete experience provided to soldiers and leaders.

Like training, leader requirements demand that counter-UAS and MDO are "baked in" to extant leadership development programs. A cognitive shift is required at echelon; this shift may be a significant task but need not be a daunting or cost-intensive endeavor. Current competition and conflict provide vignettes of current and emergent threats and trends. Simultaneously, production and distribution of a novel or set of stories envisioning battle in 2021 and 2028 could assist in this shift. Such a work would be a blend of the near-future fiction found in August Cole and P. W. Singer's *Ghost Fleet* and *Burn In* (already present on many professional reading lists) and the professional foundation of General Sir John Hackett's *The Third World War.*[13] It would resemble in scope and nature a 2021 or 2028 version of Harold Coyle's Cold-War novel, *Team Yankee*.[14] The Center for Army Lessons Learned has made contributions in this effort with the *Musicians of Mars* series.[15] While a complete approach would be essential to achieving this cognitive shift, a blend of education, training, and experience is in line with Army leadership development and incurs low costs relative to returns. Part of this coherent approach to the Army's cognitive shift includes leader professional development. Classes on counter-UAS at echelon and signature awareness to educate leaders on passive protection, collection in EMS-contested environments, and communications plans are needed.[16] These types of grassroots approaches must be shared and incorporated into a larger conversation and body of knowledge to prepare leaders for the conflicts the U.S. Army may face.

The materiel line of effort. Data visualization and the common operational picture are both areas in need of significant improvement. The battlefield of 2028 is described in *The U.S. Army in Multi-Domain Operation 2028* as "increasingly lethal" and "hyperactive" as the Army acts rapidly to seize windows of opportunity.[17] Current mission command systems such as the Command Post of the Future (CPOF) and other mission command systems resident at BCT and below are inadequate to enable understanding and visualization. The Command Post Collaborative Environment (CPCE) can be a step in the right direction, but additional improvements and capabilities are still required. Specifically, real-time and near real-time collection, especially SIGINT, must be visually depicted. Such a depiction would include lines of bearing from collection assets, assessed and identified "bubbles" for sensors and ranges, and employment of both friendly

and enemy cyber electromagnetic and space effects. Within this visualization, the ability to depict friendly signatures, associated vulnerabilities, and probability of detection is essential. A common operating picture would ideally include a "dashboard" depicting availability of cross-domain collection and effects. Such a system must function both when connected to upper tactical internet and when connectivity is degraded or denied to include a "listening silence" capability. Depiction of collected data must reflect current tracks as well as target decay (with elements such as fade or uncertainty "inkblots") while probabilistic assessments of associated systems is desired. For instance, detection of a radiating enemy air-defense radar, aided by artificial intelligence and human assessments, could be overlaid against terrain and the enemy order of battle to create likely position areas for artillery used by enemy long-range indirect fires. This probabilistic analysis and display would then enable more effective cueing of collection assets and dynamic targeting.

At the BCT and below, materiel solutions are needed to enable collection, protection, and speed when processing information. BCTs are increasingly required to employ passive protective measures such as dispersion, hardening, decoy employment, and camouflage. To achieve this, they have simultaneously sought to become lighter and more agile while becoming self-aware and managing EMS signatures. This tendency toward lighter, more agile formations with smaller signatures is in tension with any efforts to provide the BCT with more staff, more assets, and more "owned" tasks and capabilities. BCTs require enhanced capabilities to conduct BCT operations with smaller signatures. This can be provided through more capable systems that emit smaller EMS signatures or through active camouflage or obfuscation effects for EMS signatures. Similarly, BCTs require tactical counter-UAS capabilities. Depending on BCT-type, the echelon and mounted or dismounted capability required will vary. At minimum, the BCT, battalion, and company/battery/troop must be capable of detecting and defeating threat and enemy small-UAS. At echelon, this capability must be appropriate to the threat and effects required to ensure Army units are not found and immediately engaged with indirect fire. BCTs and below should also be enabled with effective active defenses against some group 3 UAS such as Stinger man-portable air-defense systems or other similar systems.

BCTs and below must also be either equipped with ELINT and SIGINT capabilities or receive actionable ELINT/SIGINT from divisions and above. For echelons below the BCT, these aerial and ground systems should augment higher-echelon assets and enable cueing, mixing, and redundancy. BCTs and below can also be enabled by the production of low-cost, "one-way" collection assets. Ideally, these assets would provide a mix of EW support, antiradiation, volley fire, and loiter capabilities to stimulate, identify, destroy, and suppress enemy air defense, fire-finding radar, and UAS GCSs. Such capabilities enable the identification and destruction of emitting enemy systems equipped with active protection measures. The enemy is presented with the dilemma of either risking his systems while in use or safeguarding his systems by not employing some portion of them. Either decision provides effects against the enemy system. These munitions and systems must be low-cost relative to the threats they defeat and produced in the quantities required for protracted conflict to layer effects against enemy systems and create windows of opportunity. Effective data visualization and integration of artificial intelligence amplify the impact of enhanced collection assets and capabilities.

Speed of processing remains a significant limiting factor in the Army's ability to dynamically target, create, recognize, and exploit windows of opportunity. Artificial intelligence possesses the potential to speed information processing, analysis, and dissemination of intelligence. Paired with data visualization and effective human interfaces, artificial intelligence provides a significant opportunity if developed and employed or a risk if not exploited by the United States and capitalized by its competitors; this opportunity and risk centers around information analysis, intelligence dissemination, and effective employment of collection, protection, and delivery assets.

The software line of effort. The final line of effort links soldier and materiel solutions with systems software within the existing structure of U.S. Army division and BCT systems. The first step to develop these solutions requires development of software for existing systems to enable detection and tracking of UAS. Current air-tracking systems can already track larger operational UAS; focus must be placed on smaller tactical UAS. Tactical UAS have smaller radar cross-sections due to their small infrared and electromagnetic signatures. The Army must invest in software for current

A TALON tracked military robot picks up a downed unmanned aircraft system 19 May 2020 during Combined Joint Task Force-Operation Inherent Resolve at al-Asad Air Base, Iraq. (Photo by Spc. Derek Mustard, U.S. Army)

and future sensors that can better detect tactical UAS. An uncertain budget environment makes acquisition of new radar systems unlikely, and previous acquisition failures suggest that the Army should not invest limited funds in a specialized counter-UAS radar. Instead, the Army must develop better software for existing radars like the AN/MPQ-64 Sentinel and AN/TPQ-53 radar systems. The Army is testing the AN/TPQ-53 radar, originally designed to track rocket, artillery, and mortar rounds, to determine its ability to track UAS.[18] One advantage modern radars possess is an active electronically scanned array. Radars with an active electronically scanned array have proven more versatile than older systems, so developing software for these systems to track tactical drones provides a solution short of developing a new radar system. The Army must enable its radars to better "look up" while also improving their abilities to see tactical UAS when "looking out."

Conclusion

The 25th Infantry Division overcame initial shortcomings in integration within the decide-detect-deliver-assess cycle to maximize the dynamic execution of the deliberate targeting process. Further development of U.S. Army counter-UAS capabilities and an effective counter-UAS approach are essential to meeting the challenges of the battlefields of today and the battlefields of future. From counterinsurgency to large-scale ground combat operations, UAS present threats to U.S. Army forces today and should be anticipated to continue to do so. Immediate actions and changes can maximize counter-UAS effectiveness within current capabilities as the Army and the joint force continue to build effective and robust multi-echeloned counter-UAS capabilities to meet the threat today and threats expected to emerge in the next eight years. ■

Notes

Epigraph. Jamie Jarrard, 25th Infantry Division commanding general, to the division staff during a Warfighter Exercise 20-03 target decision board, 11 February 2020.

1. U.S. Army Techniques Publication (ATP) 3-60, *Targeting* (Washington, DC: U.S. Government Publishing Office [GPO], 7 May 2015), 2-1.

2. Dan Gettinger, *The Drone Databook* (Annandale-On-Hudson, NY: Center for the Study of the Drone at Bard College, September 2019), viii–xix, accessed 22 October 2020, https://dronecenter.bard.edu/projects/drone-proliferation/databook/. Recent proliferation, operational, and development trends are well documented in *The Drone Databook*. Remarkable for timeliness and scope, his "key findings" are concise and immediately helpful and buttressed with thoroughly researched and detailed information on all ninety-five countries now known to possess unmanned aircraft systems (UAS). It is perhaps the best open-source document on the subject.

3. Arthur Holland Michel, *Counter-Drone Systems*, 2nd ed. (Annandale-On-Hudson, NY: Center for the Study of the Drone at Bard College, December 2019), accessed 22 October 2020, https://dronecenter.bard.edu/files/2019/12/CSD-CUAS-2nd-Edition-Web.pdf. Michel provides an excellent and timely publication on current counter-UAS systems. His paper, "Counter-Drone Systems (2nd Edition)," provides a timely counter-UAS system database but is especially useful for its background, C-UAS 101, counter-drone kill-chain, and challenges sections. Advances in UAS technology, proliferation, and costs of counter-UAS systems are of interest.

4. Edward A Guelfi, Buddhika Jayamaha, and Travis Robison, "The Imperative for the U.S. Military to Develop a Counter-UAS Strategy," *Joint Force Quarterly* 97 (2nd Quarter, 2020): 4–12, accessed 22 October 2020, https://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-97/jfq-97_4-12_Guelfi-Jayamaha-Robison.pdf?ver=2020-03-31-113800-930. The current gaps in U.S. Army and joint doctrine and capabilities are well described and documented in the article. One of its contributors, Ed "JAGIC-Magic" Guelfi, served as a joint air-ground integration cell (JAGIC) chief during the 25th Infantry Division's Warfighter Exercise 20-03.

5. ATP 3-01.81, *Counter-Unmanned Aircraft System Techniques* (Washington, DC: U.S. GPO, 13 April 2017), 1-2. NATO and the Center for a New American Security's Kelley Sayler provide and use alternative categorizations for UAS.

6. Joint Publication (JP) 3-01, *Countering Air and Missile Threats* (Washington, DC: U.S. GPO, 21 April 2017), II-8. Offensive counterair is defined as "offensive operations to destroy, disrupt, or neutralize enemy aircraft, missiles, launch platforms, and their supporting structures and systems both before and after launch, and as close to their source as possible." Defensive counterair is defined as "all defensive measures designed to detect, identify, intercept, and neutralize or destroy enemy forces attempting to penetrate or attack through friendly airspace"; Dillon R. Patterson, "Defeating the Threat of Small Unmanned Aerial Systems," *Air & Space Power Journal* 31, no. 1 (Spring 2017): 15–25, accessed 2 November 2020, https://www.airuniversity.af.edu/Portals/10/ASPJ_Spanish/Journals/Volume-29_Issue-2/2017_2_03_patterson_s_eng.pdf.

Application of the offensive and defensive counterair framework to defeat the threat created by small UAS is advocated by Patterson in his article and is further applied by the author of this article based upon Patterson's original use.

7. Guelfi, Jayamaha, and Robison, "The Imperative for the U.S. Military to Develop a Counter-UAS Strategy," 4–12.

8. National Academy of Sciences, Engineering, and Medicine, *Counter-Unmanned Aircraft System (CUAS) Capability for Battalion-and-Below Operations: Abbreviated Version of a Restricted Report* (Washington, DC: The National Academies Press, 2018), 1, https://doi.org/10.17226/24747. This abbreviated version of the restricted report captures current and anticipated challenges and shortfalls in the Army's counter-UAS capabilities.

9. ATP 3-91.1, *The Joint Air Ground Integration Center* (Washington, DC: U.S. GPO, 17 April 2019), A-13–A-15.

10. Ibid., A-14.

11. Ibid., A-15.

12. This idea was presented by Lt. Gen. Gary Brito at the Unified Challenge 19.2 roundtable discussion on 23 August 2019. His specific idea was to link a Warfighter and combat training center rotation. The author has added the element of multi-domain live-fire integration based on observations from Lightning Strike 2019.

13. P. W. Singer and August Cole, *Ghost Fleet* (Boston: Houghton Mifflin Harcourt, 2015); P. W. Singer and August Cole, *Burn In* (Boston: Houghton Mifflin Harcourt, 2020); John Hackett, *The Third World War: The Untold Story* (New York: Macmillan, 1979).

14. Harold Coyle, *Team Yankee* (New York: Presidio Press, 1987).

15. The series includes *The Musicians of Mars: A Story of Synchronization for the Company/Team Commander*, *Musicians of Mars II, Musicians of Mars III: The Cobra Strikes*, and *Musicians of Mars IV: The Mustangs' War (Deliberate Attack).* These publications can be found on the Center for Army Lessons Learned "Publications" website at https://usacac.army.mil/organizations/mccoe/call/publications.

16. Maj. Ben Hartig described this leader professional development session and larger series in the 23 August 2019 roundtable for Unified Challenge 19.2 with Brito.

17. U.S. Army Training and Doctrine Command (TRADOC) Pamphlet 525-3-1, *The U.S. Army in Multi-Domain Operations 2028* (Fort Eustis, VA: TRADOC, December 2018), vi.

18. Sydney Freedberg, "Drone Defense: Army Anti-Artillery Radar Tracks UACs," Breaking Defense, June 2016, accessed 22 October 2020, https://breakingdefense.com/2016/06/drone-defense-army-anti-artillery-radar-tracks-uavs/.