Counter-Small Unmanned Aircraft Systems

The 1st Cavalry Division trains with new counter-small unmanned aircraft systems equipment on Fort Cavazos, Texas. U.S. Army photo by SPC Cheyne Hanoski.

(Where Does Aviation Fit In?)

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In the not-so-distant future...

You are a drone hammer team—one UH-60M loaded with the latest software-defined radio jammer and suite of updated survivability equipment and an AH-64E—all tied together with digital radio links. You are both flying 100 feet above ground level approximately a mile behind the forward line of own troops (FLOT), low and slow. Your wingman scans the skies with his radar set to look for the swarm of angry plastic you know is out there somewhere. It's the eve of a big attack for your supported ground forces, with early dawn reluctantly rising in the east.

Your Purple Team radar picks up telltale small radar contacts and kicks right pedal at hover to begin unleashing a hail of flechette rockets and 30-millimeter cannon. In no time at all, they are on your flight—small glints filling your windscreen as you come to a high hover—and crank up the power on your radiofrequency jammer. Your two-ship flight digs its heels in, knowing it's up to you to stop this. Your aircraft survivability equipment (ASE) announces "DRONE 3 O'CLOCK," but your common infrared countermeasures program is already going to work melting plastic engines and optics one after another. Your copilot keys the mic, but there is no time to warn the infantry below as the drones are coming on faster and thicker. Behind you, the Apache cannon thumps away as clouds of drones are felled. You climb to 150 feet to give your door gunner better line-of-sight and your jammer a more favorable altitude.

Miles away, operators on the other side of the FLOT frantically attempt to switch frequencies on their consoles, but links are immediately lost as the localized jamming of their control frequencies is too powerful. Many drones and their payloads are caught harmlessly in treetops or crash in open fields.

A second wave comes on strong with different controller frequencies, now faster and from your flight's 12 o'clock! With -2 still engaged behind, there is no time to warn him and your crew as you brace for impact. Below, air defense artillery (ADA), fed with targeting data from your aircraft, fills the sky with hot lead as the wave disappears in smoke and secondary explosions. With your aircraft fed data into the system, the local Army ADA sites wreaked havoc on the second swarm. The whole engagement lasts a mere 2 minutes. What could've been a disaster for your ground forces became clear skies for the attack!

Miles away, operators stare blankly at screens and goggles wondering what happened to 2 weeks worth of unmanned aircraft systems (UAS) production with nothing to show for their efforts. A phone rings behind the drone unit commander; the GEN on the phone is expecting success…

The modern battlefield and UAS

The ubiquitous presence of UAS on the modern battlefield can be seen across media of all platforms. Videos of modern conflict on social media show the terrifying efficiency and effectiveness of these systems on equipment and individual soldiers. Forces fighting in Ukraine are reported to expend tens of thousands of drones a month. Everyone from the trained infantryman to specialized electronic warfare units support these small UAS (SUAS). Adapting to this distributed network of reconnaissance and direct attack threats must occur to ensure success in the next conflict.

The topic of the SUAS is broad; therefore, the scope of this article is limited to categories as defined in Army Techniques Publication (ATP) 3-01.81, "Counter-Unmanned Aircraft System (C-UAS)," as those systems included in categories 1-3.[1]

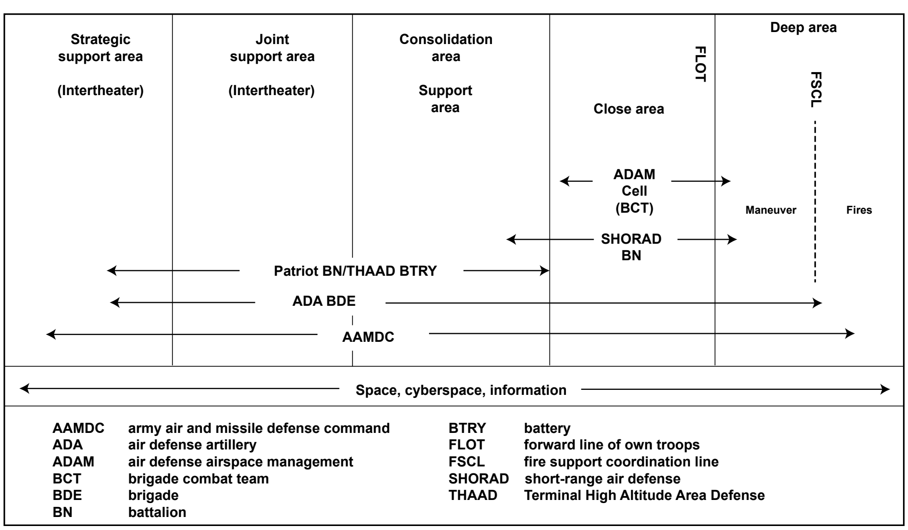

Figure 1. Army Air Defense echelons in support of a theater of operations. Example of a typical brigade-level C-UAS employment (DA, 2020, p. 1-9).

These categories include systems weighing from zero to 1,320 pounds, capable of traveling anywhere from under 100 up to 250 knots with service ceilings from less than 1,200 feet to 18,000 feet above ground level (Ferguson & Lemler, 2024; Department of the Army [DA], 2023, p. 1-2). In a theater of operations, UAS groups 1-2 typically operate in deep and close areas, and for the larger category 3 UAS, into the consolidation and support areas. In UAS groups 1-2, the smaller the platform the shorter the range and the smaller the payload and required logistical footprint to operate. The ADA Branch, combined with other joint agencies, are tasked with mitigating the threats of these SUASs. Figure 1 illustrates an overview of ADA equipment and general location in a theater.

How can aviation formations adapt to this threat, and more importantly, how can we help reduce this threat to the combined arms force? How can aviation help task-saturated ADA assets and command and control (C2) nodes enable successful early warning and engagement, while reducing the risks of fratricide?

What if an aviation formation could provide effective integration into brigade and below C2 nodes to detect, identify, and defeat UAS across a wide area of coverage for a maneuver commander? Or, what if it could provide a localized C-UAS coverage "bubble" to allow a commander time and space, while mitigating effects on the battle by using equipment (early warning/detection, targeting, direct attack, etc.) already fielded by the Army and other services?

C-UAS: The Army process

For the purposes of this article, we will focus on active measures used to mitigate the effectiveness of these systems. According to Army doctrine, **modern C-UAS consists of Detect, Identify, Decide, and Defeat threats** (DA, 2023, p. 3-7). Layered approaches to this process are critical for success of formations at every level. These layers can be seen in Figure 2 and rely on networking devices and sensors to build a reliable picture of airspace.

Monitoring the operational environment for these threats can be an overwhelming task, particularly as the operational environment shifts, and units constantly move. Connectivity of these devices is essentially handled through joint networks such as Link-16 and internally within divisions as the internal inter-forward area air defense (FAAD) network, which is then typically operated in brigade air defense airspace management cells computers using FAAD software. This makes networking these monitoring and C2 devices particularly complex, with networking outages or latency quickly degrading the effectiveness of these defenses.

Army Aviation to the rescue?

The following are some examples of how aviation can fit into this problem set. This list is broken down into the detect, identify, decide and defeat categories:

1. Detect and Identify
Detecting UAS is primarily accomplished via line-of-sight sensors of various kinds. Since aviation platforms operate at various altitudes depending on thorough consideration of the operating environment, additional sensors at altitude can greatly aid in early detection and identification. Currently, aircraft-based detection means are limited to the AH-64 fire control radar (FCR) and visual observation by aircrew. However, with the advent of software-defined radios and other specific electronic warfare devices, electronic signatures can be gathered and triangulated automatically. The Navy and Marine Corps currently operate electronic warfare devices such as the ALQ-231 (V) Intrepid Tiger II, which is mounted across both rotary- and fixed-wing platforms (Naval Air Systems Command, n.d.). I believe the Army could adopt devices such as these already in approved use from other services, giving additional capability and battlefield situational awareness to commanders at all echelons and at a much lower cost than a new program.

Connecting these devices across the battlefield can consist of networks such as Link-16 and the friendly force tracking system, Force XXI Battle Command Brigade and Below. These legacy networks are often overloaded, slow, and require in-depth maintenance and specialized technical know-how to keep operating. The modern digitally networked radios currently being fielded across the force, such as the MPU5, act as WiFi routers in the sky and on the ground, transmitting voice and data with minimal required operator input or maintenance. This ad hoc distributed network can be used as a data pipeline to transmit needed sensor inputs from every platform the Army fields. The networking and integration of these data

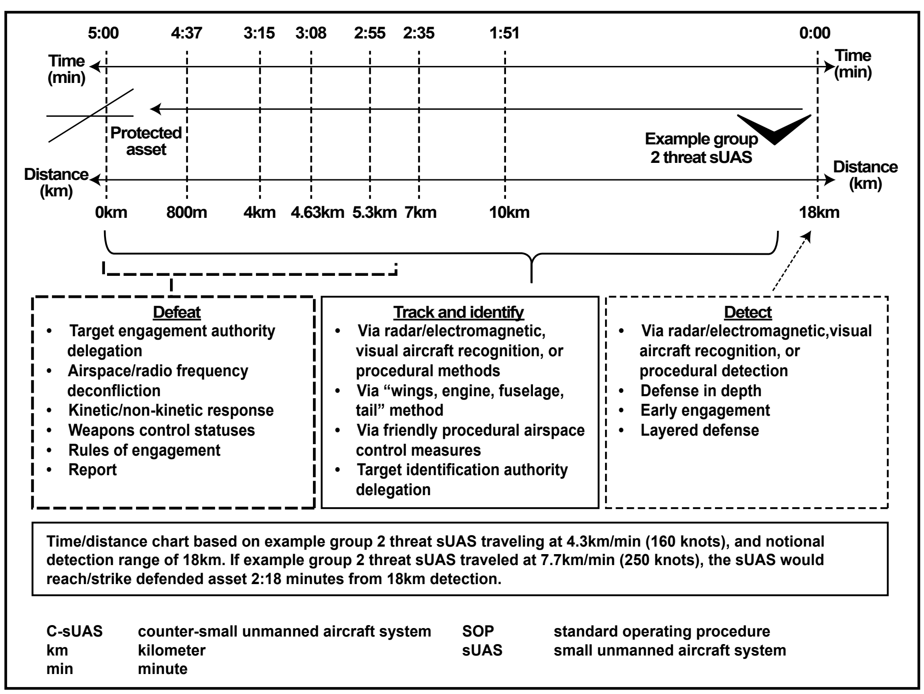

Figure 2. Counter-SUAS time/distance engagement sequence planning consideration (example engagement sequence) (DA, 2023, p. 3-16).

[1] "UASs are categorized in Groups 1 through Group 5, this designation is based on weight, operating altitude, and speed" (DA, 2023, p. 1-2).

can also facilitate identification between friend and foe UAS and avoid fratricide of friendly platforms. An ad hoc networked FCR system being flown just behind friendly lines can greatly extend both ADA and battlefield awareness by feeding data back into ADA and fires networks.

For additional detection and identifying capabilities, ASE can aid in the detection, gathering, and fidelity of these data.

A UH-1Y Venom is staged on the flightline with an AN/ALQ-231(V)3, which enhances the airborne electronic warfare capability for fixed- and rotary-wing aircraft. U.S. Marine Corps photo by Sgt Samuel Ruiz.

2. Decide and Defeat
With these airborne ad hoc networks, data gathered by aerial platforms are routed and fed into the appropriate systems on the ground. This allows the decision and allocation of hard or soft kill options on these UAS targets by appropriate C2 nodes. Some theoretical examples of hard kill are the assignment of ground-based ADA assets to direct fire on adversarial UAS or the assignment of a nearby AH-64 flight to use rockets or cannon. The Army has taken this capability seriously by investing in the XM1223 Multi-Mode Proximity Airburst munitions,[2] of which I believe a variant should be developed for the AH-64. Hard kill can also be a reprogramming of laser-based ASE to destroy critical components on UAS, such as optics or engines. Targeting data for these lasers can come from electro-optic missile sensors or from off-platform cueing, such as AH-64 FCR or ground-based ADA radar.

Notional soft kill options can consist of aircraft-mounted jammers and electronic warfare modules, such as the previously mentioned ALQ-231, already fielded by sister services. New software-defined radio receivers that can be mounted to aircraft at low cost can be used to isolate and triangulate drone operator radiofrequencies and generate targeting data for air- and ground-based fires onto drone repeating stations or operator stations, either severing controlling links or destroying or killing operators themselves.

A way forward

The proposals presented here are largely a fight to gather and share data across the battlefield faster than the enemy and to share these data across the breadth and depth of echelons that opposing forces cannot hope to match. This data sharing allows our aviation and ground-based forces to bring the maximum amount of reaction time and appropriate firepower to bear on the modern UAS threat. The solutions presented here are entirely within the realm of technical achievement, much of it at very little additional cost to the currently employed platforms. Further UAS countermeasures are currently being tried on ground platforms that would also work the same, or better, when mounted to aviation platforms with minimal additional modifications to equipment (DA, 2023, Appendix B). Additionally, the development of air-launched effects is also ongoing and are outside the scope of this paper, yet could yield great results in mitigating the UAS threat (PEO Aviation, 2020).

Ad hoc networks specifically presented in this article are the key to tying these devices all together in the air and on the ground, allowing Army Aviation continued relevance in the future fight and ensuring successful overmatch on the next battlefield.

For further reading on the foundation of this topic, please see Field Manual 3-01, "U.S. Army Air and Missile Defense Operations" (DA, 2020); ATP 3-01.81 (DA, 2023); and common access card-enabled handbook, *Surviving the Swarm: Recommended C-UAS Tactics, Techniques, and Procedures at the Brigade and Below* (Center for Army Lessons Learned, 2024). This document also owes much of its foundational conceptualization to *Needles in the Haystack: Hunting Mobile Electronic Targets* by Maj. Michael Pietrucha, U.S. Air Force (2003).

Biography:
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[2] "DEVCOM AC [The U.S. Army Combat Capabilities Development Command Army Research Laboratory] designed a programmable proximity cartridge along with a contact fuze setter, the XM1223 Multi-Mode Proximity Airburst (MMPA), a fiscal year 2024 new-start program that achieved Technology Readiness Level 6—a system model or prototype demonstrated in a relevant environment—in technology maturation" (Santamaria & LaGue, 2024).